



Pilkington Library

Author/Filing Title ABDULLAH I

Vol. No. Class Mark T

**Please note that fines are charged on ALL
overdue items.**

open	shelf	copy
------	-------	------

0402293444





**AN EXAMINATION OF THE WEAKNESSES IN CURRENT
ONLINE HELP SYSTEMS AND A PROPOSED SOLUTION
USING AN INTEGRATED INFORMATION BASE**

By

Usman Gambo Abdullahi

A Doctoral Thesis

Submitted in partial fulfilment of the requirements

For the award of

Doctor of Philosophy


Loughborough University

February, 2000

Department of Computer Science

Loughborough University

© Usman Gambo Abdullahi

 Loughborough University PHE 100
Date <i>Dec 00</i>
Class
Acc No. <i>040229344</i>

M00026614B

Dedication

I dedicate this work to my late father and my mother whose tireless effort made me who I am today, and to my wife for her patience and support, and to my children for their patience and understanding.

ACKNOWLEDGEMENTS

All praise and gratitude be to Allah, the Mighty and the Majestic for enabling me to reach this stage of my research study.

I wish to acknowledge and express my sincere thanks and gratitude to my Supervisor, Professor James L. Alty, for his invaluable supervision, encouragement, suggestions and help throughout this research study. Thanks must also be extended to my director of research, Dr Chris J. Hinde for his continuous support and encouragement.

My thanks also go to the entire staff and research students of LUTCHI and the entire staff and research students of Department of Computer Science for their support during my experiments. Thanks must also be extended to my numerous friends for their support and encouragement.

My appreciation also goes to the Commonwealth Scholarship Commission for funding my PhD study.

Finally, I wish to express my love and appreciation to my wife and my children for their constant love, devotion and patience, which has taken many of the hours that should have been dedicated exclusively to them. Also to my late father and mother who persevered and offered their warm encouragement and help over the past years.

ABSTRACT

This thesis reports results of a research study into the usefulness of On-line Help Systems for application software users. The main objective of the research was to examine existing On-line Help systems, identify their weaknesses, and propose a means of rectifying the problems identified.

A study of the available relevant literature revealed that both users and designers have divergent views as to the overall usability and efficacy of On-line Information, and this diversity has contributed to the problems inherent in On-line Help systems.

An initial user survey was conducted with a group of computer users who were professionals in their own areas, many of whom also have considerable experience in the applications examined. The results are in agreement with the hypothesis that in spite of the long history of software development and the existence of research in the area, users of On-line Help Systems still find them unsatisfactory. The results also revealed that even experienced users find some aspects of existing On-line Help Systems difficult to use, and that, in general current versions are not well received.

A set of exploratory experiments has been carried out with users interacting with Microsoft Excel, using the On-line Help system at one sitting and the User Manual at another. These investigations revealed the existence of design and accessibility problems. Three terms best describe the problems identified – Vocabulary, Compartmentalisation, and the lack of an Integrated Base. An optimal approach to the design of On-line Help systems that will overcome these problems is proposed and a prototype system implemented and evaluated.

The research has achieved its aim of providing a contribution to the design and implementation of On-line Help Systems that should enhance both the usability and efficacy of On-line support systems.

TABLE OF CONTENTS

DEDICATION	II
ACKNOWLEDGEMENTS	III
ABSTRACT	IV
TABLE OF CONTENTS	V
LIST OF FIGURES	XIV
LIST OF TABLES	XVII
<u>CHAPTER I</u>	<u>1</u>
1.0 INTRODUCTION	1
1.1 THE GROWING NEED FOR ONLINE HELP SYSTEMS	2
1.2 THE DESIGN OF INTERACTIVE HELP SYSTEMS	4
1.3 LIMITATIONS OF RESEARCH INTO ON-LINE HELP SYSTEMS	6
1.4 EXPERIMENTAL HYPOTHESES	6
1.5 CHOICE OF AN EXPERIMENTAL DOMAIN	7
1.7 STRUCTURE OF THE THESIS	7
<u>CHAPTER II: GENERAL TAXONOMY OF ON-LINE HELP SYSTEMS AND USERS</u>	<u>10</u>
2.0 INTRODUCTION: ON-LINE HELP DEFINED	10
2.1 WHY ARE ON-LINE HELP SYSTEMS NEEDED?	12
2.2 CLASSIFICATION OF USERS OF ON-LINE HELP SYSTEMS	14

2.2.1 Sex Differences	16
2.2.2 Experience	16
2.2.3 Age	17
2.2.4 Ethnic Culture	17
2.2.5 Cognitive Abilities	18
2.2.6 Personality Traits	20
2.3 CLASSIFICATION OF ON-LINE HELP SYSTEMS	21
2.3.1. Passive versus Active On-line Help Systems	21
2.3.2 Static versus Dynamic On-line Help Systems	24
2.3.3 General versus individual On-line Help Systems	24
2.3.4 Intelligent On-line Help System	24
2.4 ACCESS MECHANISMS OF ON-LINE INFORMATION	25
2.4.1 Access through On-line Manuals	26
2.4.2 Access through Keyword Help	27
2.4.3 Access through Menu-based Help	28
2.4.4 Access through Context-Sensitive Help	29
2.4.5 Access through Query-In-Depth	30
2.4.6 Access through Natural Language Help Systems	30
2.4.7 Access through Spoken Help Requests	31
2.4.8 Access through Other Mechanisms	32
2.5 ACCESS COMPLEXITY OF ON-LINE INFORMATION	33
2.6 PRESENTATION ISSUES OF ON-LINE INFORMATION	34
2.6.1 Presentation Techniques	34
2.6.2 Presentation Source	36
2.6.3 Text Quality	37
2.6.4 Integration	38
2.8 DISCUSSION AND CONCLUSION	40

CHAPTER III: A REVIEW OF ON-LINE HELP SYSTEMS	42
3.0 INTRODUCTION	42
3.1 GUIDELINES FOR DESIGNING ON-LINE HELP SYSTEMS	42
3.2 PREVIOUS STUDIES OF PARTICULAR ISSUES	45
3.2.1 On-line Vs Printed Documentation	45
3.2.2 Cognitive Ability	54
3.2.3 Improved On-line Documentation	58
3.2.4 Human Vs Computer-based Instruction	66
3.2.5 Evaluation Approaches	70
3.2.6 Other Approaches	72
3.3 THE DICHOTOMY BETWEEN DESIGNERS' AND USERS' VIEWS	73
3.4 THEORETICAL APPROACHES	74
3.5 SYSTEM EVALUATION TECHNIQUES	78
3.5.1 Common Approaches to evaluation	79
3.5.1.1 Analytic Evaluation (Formal modelling as an approach to evaluation)	79
3.5.1.2 Expert Evaluation (Walkthrough approaches)	80
3.5.1.3 Experimental Evaluation	81
3.5.1.4 Observational Evaluation	83
3.5.1.5 Survey Evaluation	84
3.5.2 Selecting an Evaluation Method	88
Analytic	89
3.5.3 Usability testing	89
3.5.3.1 Effectiveness	90
3.5.3.2 Learnability	90
3.5.3.3 Memorability	91
3.5.3.4 Attitude/satisfaction	91
3.6 DISCUSSION AND CONCLUSION	94
CHAPTER IV: A SURVEY OF ON-LINE HELP USE	96

4.0 INTRODUCTION	96
4.1 A SURVEY OF ON-LINE HELP SYSTEM USAGE	97
4.2 RESULTS OF THE SURVEY	98
4.2.1 User Expertise By Application	99
4.2.2 Use Of On-line Help By Application	100
4.2.3 Comparison with User Manuals	104
4.3 ACCESS MECHANISMS IN MICROSOFT EXCEL	106
4.3.1 The Contents Tab	107
4.3.2 The Index Tab	108
4.3.3 The Find Tab	111
4.3.4 The Answer Wizard	114
4.3.5 The 'Context-Sensitive' Help of Excel	115
4.4 DISCUSSION AND CONCLUSION	116
<u>CHAPTER V: EXPERIMENT WITH MICROSOFT EXCEL I: USING ON-LINE HELP</u>	<u>118</u>
5.0 INTRODUCTION	118
5.1 EXPERIMENTAL SETTING:	118
5.1.1 Software	118
5.1.2 Equipment	119
5.1.3 Subjects	119
5.1.4 Procedure	120
5.1.5 Tasks	120
5.1.6 Task Completion Questionnaire	122
5.2. RESULTS OF THE ON-LINE HELP STUDY	123
5.2.1 Seeking Help	123
5.2.2 Examples of User Activity When Accessing on-line Help	124

5.2.2.1 Task: Import a Dbase File (Using Microsoft Query)	124
5.2.2.1.1 An Example: A Novice User	124
5.2.2.1.2 An Example: An Intermediate User	128
5.2.2.1.3 An Example: An Expert User	132
5.3 GENERAL OBSERVATION: CHARACTERISATION OF USER BEHAVIOUR	134
5.4 ANALYTICAL RESULTS	139
5.4.1 Total Number of Access to On-line Help	145
5.6 TEST FOR STATISTICAL SIGNIFICANCE	148
5.6.1 Analysis of Variance (ANOVA)	148
5.6.1.1. Test for homogeneity of Variances	148
5.6.1.2. Test for Normality	149
5.6.1.2.1 Bonferroni Test	150
5.6.1.3 ANOVA Test Run	150
5.6.2 Kruskal-Wallis H Test for K-Independent Samples	152
5.6.3 Mann-Whitney Test	154
5.6.3.1 Expert Vs Intermediate Users	155
5.6.3.2 Expert Vs Novice Users	156
5.6.3.3 Intermediate Vs Novice Users	157
5.6 ANALYSIS OF TASK COMPLETION QUESTIONNAIRE	158
5.7. DISCUSSION OF RESULTS	160
<u>CHAPTER VI: EXPERIMENT WITH MICROSOFT EXCEL II: USING MANUAL</u>	162
6.0 INTRODUCTION	162
6.1 EXPERIMENTAL SETTING:	162
6.1.1 Subjects	162
6.1.2 Procedure, Task and Task Completion Questionnaire	163
6.2. RESULTS OF THE 'USER MANUAL' STUDY	163
6.2.1 Seeking 'Help'	163

6.2.2 Examples of User Activity When Accessing the 'User Manual'	164
6.2.2.1 Task: Import a Dbase File (Using Microsoft Query)	165
6.2.2.1.1 An Example: A Novice User	166
6.2.2.1.2 An Example: An Intermediate User:	167
6.2.2.1.3 An Example: An Expert User	168
6.3 GENERAL OBSERVATIONS: CHARACTERISATION OF USER BEHAVIOUR	170
6.4 ANALYTICAL RESULTS	173
6.5 TEST FOR STATISTICAL SIGNIFICANCE	180
6.5.1 Analysis of Variance (ANOVA)	180
6.5.2 KRUSKALL WALLIS TEST FOR K-INDEPENDENT SAMPLES	181
6.5.3 Mann-Whitney Test	183
6.5.3.1 Expert Vs Intermediate Users	183
6.5.3.2 Expert Vs Novice Users	184
6.5.3.1 Intermediate Vs Novice Users	185
6.6 DISCUSSION OF RESULTS	187
<u>CHAPTER VII: DESIGN OF AN INTEGRATED BASE ON-LINE HELP SYSTEM</u>	189
7.0 INTRODUCTION	189
7.1 PROBLEMS IDENTIFIED WITH THE MICROSOFT EXCEL ON-LINE HELP SYSTEM	189
7.1.1 The Vocabulary Problem	191
7.1.2 The Compartmentalisation Problem	191
7.2 PROPOSAL: AN INTEGRATED BASED APPROACH TO THE DESIGN OF ON-LINE HELP	192
7.3 DESIGN & IMPLEMENTATION CONSIDERATIONS	194
7.4 FEATURES OF THE INTEGRATED BASE HELP SYSTEM	196
7.4.1 The Contents Tab	196
7.4.2 The Index Tab	197

7.4.3 The Find Tab	199
7.4.4 The "Browse" Facility	199
7.4.5 Other Features	200
7.5 DISCUSSION AND CONCLUSION	203

CHAPTER VIII: EXPERIMENT WITH MICROSOFT EXCEL III: USING THE INTEGRATED BASE ON-LINE HELP SYSTEM **205**

8.0 INTRODUCTION **205**

8.1 EXPERIMENTAL SETTING: **205**

8.1.1 Subjects **205**

8.1.2 Procedure, Task and Task Completion Questionnaire **206**

8.2. RESULTS OF THE INTEGRATED BASE HELP SYSTEM STUDY **206**

8.2.1 Seeking Help **206**

8.2.2 Examples of User Activity When Accessing the Integrated Base Help System **207**

8.2.2.1 Task: Import a Dbase File (Using Microsoft Query) **207**

8.2.2.1.1 An Example: A Novice User **208**

8.2.2.1.2 An Example: An Intermediate User **211**

8.2.2.1.3 An Example: An Expert User **213**

8.2.2.2 An Unsuccessful Attempt **215**

8.2.2.2 An Example: Reformatting Columns **216**

8.3 GENERAL OBSERVATION: CHARACTERISATION OF USER BEHAVIOUR **218**

8.4 ANALYTICAL RESULTS **223**

8.5 TEST FOR STATISTICAL SIGNIFICANCE **228**

8.5.1 Analysis of Variance (ANOVA) **228**

8.5.2 KRUSKALL-WALLIS TEST FOR K-INDEPENDENT SAMPLES **229**

8.5.3 MANN-WHITNEY TEST **231**

8.5.3.1 Expert Vs Intermediate Users **231**

8.5.3.2 Expert Vs Novice Users **233**

8.5.3.3 Intermediate Vs Novice Users **234**

8.6. DISCUSSION OF RESULTS	235
<u>CHAPTER IX: COMPARATIVE ANALYSIS OF RESULTS</u>	<u>236</u>
9.0 INTRODUCTION	236
9.1 ANALYTICAL RESULTS	236
9.2 TEST FOR STATISTICAL SIGNIFICANCE	239
9.2.1 Analysis of Variance (ANOVA): Expert Users Across Applications	239
9.4 DISCUSSION OF RESULTS	241
<u>CHAPTER X</u>	<u>243</u>
SUMMARY, CONCLUSION & CONTRIBUTIONS TO KNOWLEDGE	243
10.0 SUMMARY & CONCLUSION	243
10.1 LIMITATIONS OF THE STUDY	251
10.2 CONTRIBUTIONS TO KNOWLEDGE	252
10.2.1 Clearly Defined Taxonomy	252
10.2.2. Detailed Literature Survey	253
10.2.3 Detailed and Structured Experimental Study	253
10.2.4 The Identification of the Vocabulary Problem	253
10.2.5 The Integrated Base Approach to Building Help Systems	254
10.3 ISSUES FOR FURTHER INVESTIGATION	254
10.3.1 Enhancement of the Integrated Base On-line Help System	254
10.3.2 Enhancement of the System's Graphical User Interface Capability	254
10.3.3 Making the System Adaptive	255

REFERENCES	257
APPENDIX A: INITIAL SURVEY QUESTIONNAIRE	A.1
APPENDIX B: ONLINE HELP EXPERIMENT TASKS	B.1
APPENDIX C: ONLINE HELP EXPERIMENT QUESTIONNAIRE	C.1
APPENDIX D: USER MANUAL QUESTIONNAIRE	D.1
APPENDIX E: INTEGRATED BASED HELP SYSTEM QUESTIONNAIRE	E.1
APPENDIX F:	F.1
PUBLISHED PAPER:	1
APPENDIX G: TEST FOR STATISTICAL SIGNIFICANCE	G.1

LIST OF FIGURES

CHAPTER I

Figure 1.1: Thesis Outline

CHAPTER IV

Figure 4.1: Distribution of Subjects by Level of Expertise

Figure 4.2: Usefulness of Online Help across Applications

Figure 4.3: Organisation of Microsoft Excel's Online Help System

Figure 4.4: Lower Detail of Content's Topic

Figure 4.5: Lowest Level of Content's Hierarchy

Figure 4.6: Seeking Help Through Index

Figure 4.7: Second Level of Access Through Index

Figure 4.8: Lowest Level of Access Through Index

Figure 4.9: Access Through Find

Figure 4.10: Available Options of the Find Access Mechanism

Figure 4.11: Accessing Help Through the Answer Wizard

CHAPTER V

Figure 5.1: Novice User Searching Contents I

Figure 5.2: Novice User Searching Contents II

Figure 5.3: Novice User Using Find

Figure 5.4: Novice User Using Index

Figure 5.5: Novice User Using Answer Wizard

Figure 5.6: Intermediate User Using Find I

Figure 5.7: Intermediate User Using Find II

Figure 5.8: Intermediate User Using Find III

Figure 5.9: Intermediate User Using Find IV

Figure 5.10: Expert User Using Contents I

Figure 5.11: Expert User Using Contents II

Figure 5.12: A Typical Search Path I: Vocabulary Problem

Figure 5.13: A Typical Search Path II: Vocabulary Problem

Figure 5.14: User Performance Based on Time

Figure 5.15: Actual Distribution of Success/Failure with Online Help

Figure 5.16: Actual Completed Tasks and Performance

Figure 5.17: Intermediate User Accessing Help for 'AutoFill'

Figure 5.18: Histogram showing Normality of On-line Help Data

Figure 5.19: Normal Q-Q Plot showing Normality of On-line Help Data

CHAPTER VI

Figure 6.1: User Performance Based on Time

Figure 6.2: Actual Distribution of Success/Failure with 'User Manual'

Figure 6.3: Actual Completed Tasks and Performance

Figure 6.4: Histogram showing Normality of User Manual Data

Figure 6.5: Normal Q-Q Plot showing Normality of User Manual Data

CHAPTER VII

Figure 7.1: Conceptual Diagram of the Integrated Base Approach

Figure 7.2: The Contents Tab of the Hybrid Online Help System

Figure 7.3: The Index Tab of the Hybrid Online Help System

Figure 7.4: The Find Tab of the Hybrid Online Help System

Figure 7.5: Basic Level Help Screen of with Browse Buttons

Figure 7.6: How to Use the Integrated Base Help System I

Figure 7.7: How to Use the Integrated Base Help System II

CHAPTER VIII

Figure 8.1: Novice User Searching Index

Figure 8.2: Novice User Using Hypertext Link

Figure 8.3: Novice User Using Find

Figure 8.4: Novice User Using 'Browse' Button

Figure 8.5: Intermediate User Using Contents I

Figure 8.6: Intermediate User Using Contents II
Figure 8.7: Intermediate User Using Contents III
Figure 8.8: Expert User Using Find I
Figure 8.9: Expert User Using Find II
Figure 8.10: Expert User Using Find III
Figure 8.11: User Accessing Contents Tab
Figure 8.11: User Accessing Contents Tab
Figure 8.12: User Accessing Index for 'Reformat'
Figure 8.13: User Using Find for 'Reformat'
Figure 8.14: User Accessing Contents Tab I
Figure 8.15: User Accessing Contents Tab II
Figure 8.16: User Accessing Find Tab I
Figure 8.17: User Accessing Find Tab II
Figure 8.18: Vocabulary Problem Online Help (from Figure 5.12)
Figure 8.19: User Performance Based on Time
Figure 8.20: Actual Distribution of Success/Failure with On-line Help
Figure 8.21: Actual distribution of task completion by aid mechanism
Figure 8.22: Histogram showing Normality of Integrated Base Data
Figure 8.23: Normal Q-Q Plot showing Normality of Integrated Base Data

CHAPTER IX

Figure 9.1: Histogram showing Normality of Combined Data (Experts)
Figure 9.2: Normal Q-Q Plot showing Normality of Combined Data (Experts)

LIST OF TABLES

CHAPTER III

Table 3.1: Differences Among the five Evaluation Methods (adapted from Preece, 1993)

Table 3.2: Advantages and Disadvantages of the five Evaluation Methods (Jeffries et al., 1992, Preece, 1993).

CHAPTER IV

Table 4.1: Use of Online Help in the three Applications

Table 4.2: Use of Online Help by Expertise Level

Table 4.3: Degree of Supportiveness of Online Help and Experience

Table 4.4: Amount of Use of Online Help in relation to Experience

Table 4.5: Degree of Effectiveness of User Manual Compared to Online Help

CHAPTER V

Table 5.1: Distribution of Subjects on Online Help Experiment

Table 5.2: Scores Allocated to Sub-Tasks

Table 5.3: Use of Online Help by Task Difficulty and Experience

Table 5.4: Average User Performance based on Time

Table 5.5: Average Success/Failure of Online Help Access

Table 5.6: Average Distribution of Task Completion by Aid Mechanism

Table 5.7: Average Time Assistance given and Performance

Table 5.8: Analysis of Variance Test (ANOVA) for 3 Independent Samples

Table 5.9a: Kruskal-Wallis H Test for 3 Independent Samples

Table 5.9b: Kruskal-Wallis H Test Statistic for 3 Independent Samples

Table 5.10a: Mann-Whitney U Test for 2 Independent Samples

Table 5.10b: Mann-Whitney U Test Statistic for 2 Independent Samples

Table 5.11a: Mann-Whitney U Test for 2 Independent Samples

Table 5.11b: Mann-Whitney U Test Statistic for 2 Independent Samples

Table 5.12a: Mann-Whitney U Test for 2 Independent Samples

Table 5.12b: Mann-Whitney U Test Statistic for 2 Independent Samples

Table 5.13 Subjects Agreement with statements about On-line Help

CHAPTER VI

Table 6.1: Distribution of Subjects in the User Manual Experiment

Table 6.2: Scores Allocated to Sub-Tasks

Table 6.3: Use of 'User Manual' by Task Difficulty and Experience

Table 6.4: Average User Performance Based on Time

Table 6.5: Average Success/Failure of User Manual Access

Table 6.6: Average Distribution of Task Completion by Aid Mechanism

Table 6.7: Average Time Assistance given and Performance

Table 6.8: Analysis of Variance Test Results for User Manual Study

Table 6.9a: Kruskal-Wallis H Test for 3 Independent Samples

Table 6.9b: Kruskal-Wallis H Test Statistic for 3 Independent Samples

Table 6.10a: Mann-Whitney U Test for 2 Independent Variables

Table 6.10b: Mann-Whitney U Test Statistic for 2 Independent Variables

Table 6.11a: Mann-Whitney U Test for 2 Independent Variables

Table 6.11b: Mann-Whitney U Test Statistic for 2 Independent Variables

Table 6.12a: Mann-Whitney U Test for 2 Independent Variables

Table 6.12b: Mann-Whitney U Test Statistic for 2 Independent Variables

CHAPTER VIII

Table 8.1: Distribution of Subjects on Integrated Base Experiment

Table 8.2: Scores Allocated to Sub-Tasks

Table 8.3: Use of Integrated Base by Task Difficulty and Experience

Table 8.4: Average Number of Times of Accessing the Browse Button by Task Complexity

Table 8.5: Average User Performance Based on Time

Table 8.6: Average Success/Failure of Integrated Base Help Access

Table 8.7: Average Distribution of Task Completion by Aid Mechanism

Table 8.10: Analysis of Variance Test Results for the Integrated Base study

Table 8.11a: Kruskal-Wallis H Test for 3 Independent Samples

Table 8.11b: Kruskal-Wallis H Test Statistic for 3 Independent Samples

Table 8.12a: Mann-Whitney U Test for 2 Independent Variables

Table 8.12b: Mann-Whitney U Test Statistic for 2 Independent Variables

Table 8.13a: Mann-Whitney U Test for 2 Independent Variables

Table 8.13b: Mann-Whitney U Test Statistic for 2 Independent Variables

Table 8.14a: Mann-Whitney U Test for 2 Independent Variables

Table 8.14b: Mann-Whitney U Test Statistic for 2 Independent Variables

Chapter IX

Table 9.1: Comparison of On-line Help, Manual and Integrated Base Help Experiment by Time

Table 9.2: Average Success/Failure Based on Assistance Mechanism.

Table 9.3: Comparison of the Three Experiments' Task Completion by Aid Mechanisms

Table 9.8 Analysis of Variance Test Results for the Three Experiments

CHAPTER I

1.0 INTRODUCTION

Is it a common observation that technology has a significant effect on the way humans carry out their every day life and the way they think about things around them. Due to advancements in technology, several complex and pervasive tools have emerged and are at man's disposal. These tools enable us to accomplish tasks that once seemed impossible. One such tool is the Computer.

Today, Computers have become an integral part of virtually all aspects of man's day-to-day activity. Services are being automated with computers. There are automatic tellers, computerised libraries, automated offices, computerised stock management, computerised entertainment and tourist information services in hotels, and so on. Most importantly, all these technical services share one thing in common - in each case, an individual operates a computer to obtain a particular service that otherwise would have been performed by other human beings.

Statistics have shown that there are over two hundred million computers in use at the present time, and this number is predicted to continuously grow beyond the turn of the century.

Not only is the number of computers in use growing but also the number of software packages is rising exponentially. At least twelve thousand firms are actively competing in the microcomputer software industry. From a recent survey published in the *PC Magazine* (October 1999), more than two thousand large firms have entered the microcomputer software industry since 1991. This growth is not only in the number of applications but the number of alternatives available for any particular application area as well. In the word processing category of microcomputer software alone, the major products that gained recognition are WordStar, MultiMate, DisplayWrite, AmiPro, WordPerfect and Microsoft Word.

As a result of this growth in software applications, there is a need for tools that serve as aids to the users of this software.

Unlike early computer users, most of today's users are not trained in programming and have little or no interest in computers or how they operate. Instead, they want to accomplish their goals, and the computer is simply a tool to enable them to do that. Ideally, they want to focus on whatever task they have at hand rather than learning the intricacies of the tool they are using. In essence, computer users want to carry out their work with computers without having to have an in-depth knowledge of the underlying software and hardware.

1.1 THE GROWING NEED FOR ONLINE HELP SYSTEMS

A computer user is faced with a hard decision as to what software application to acquire, due to the large number of alternatives for a particular application as well as the number of applications. Even after acquisition, a user faces the problem of learning how to put such software into effective use.

It could be argued that learning how to use software might not be difficult because most software applications come with the necessary manuals to enable a user to exploit the application. These days however, applications are often not shipped with their manuals, while sometimes only the 'Getting Started' manual is provided, together with the application's On-line Help System. Whatever their form, the materials are often problematic for both users and designers. Among these problems are:

- **The Volume of the Manuals** - Most applications come with a set of three manuals - the 'Getting Started', the 'User's Guide' and 'Language or command Reference'. These are often bulky and make the search for any particular aspect difficult, even with an index and table of contents, thus slowing the learning process and hence affecting the overall performance on such an application.

- **The Space they Occupy** - The computer needs software, and any software on the computer means space has to be provided for its manuals. The more software a user has, the more manuals and the more the space has to be provided.
- **The Cost of Production and Distribution** - There is a high cost associated with the production and distribution of manuals to users. These costs are due to the time spent in writing, editing, typesetting and printing of these manuals. Added to this, any upgrade to the software means a modification to the manuals is required, sometimes requiring the production of a completely new set, making the old ones obsolete. For small updates, additional inserts have to be sent out, resulting in problems of version control.

These problems, among others, have made it increasingly necessary to provide a form of an "Interactive Aid", so that a user can access information while performing his tasks on the application. A typical Interactive Aid is an On-line Help System.

Until recently, On-line Help Systems have been given little attention by system developers. The basic reason for this neglect has been a belief that these software applications are 'easy to use' and 'self explanatory'. However, users vary, and even these 'easy to use' and 'self explanatory' systems will be difficult and complex for some users. Also, in reality, it is difficult to build systems that are so well designed and tested that no user assistance is ever needed. Although such claims are made, systems designed with such intentions are proving not to live up to their sales claims (Coventry, 1991). It is not always possible to anticipate what potential users will do or in what ways they will use the software.

Other reasons for the neglect have been the cost involved in putting information online, inadequate technology, and lack of the knowledge of how to create such

systems. But with the availability of hypertext systems and the current technology, such reasons are less tenable.

System developers need to pay more attention to the provision of On-line Help Systems, developing them as integral parts of the application. Done properly, this might result in a significant reduction in the need for the user manuals as well as a reduction in the training period required for such applications. This is because they would contribute step-by-step to missing user knowledge in context. Also, in principle, the computer has an intrinsically better capability for helping users using linked online help information than manuals with their indexes and table of contents. Searching done manually in printed manuals is less effective.

Finally, On-line Help Systems can take information about the state of the interaction into account (history tracking), thus enabling the user to 'backtrack', which is not possible with the printed manuals.

1.2 THE DESIGN OF INTERACTIVE HELP SYSTEMS

Most computer applications today have On-line Help Systems as an integral component. However, studies have shown that most of these systems have not been well received by users. The major reason for this lack of satisfaction on the part of users is the manner in which these systems have evolved. Designers tend to use their experience and expertise; and assume what assistance is likely to be needed, and then design the systems as such, rather than surveying real user needs. In addition, they always assume that they are starting on fresh grounds, working on a problem that has never been properly handled before, thereby failing to address the pertinent questions that should be of utmost concern.

Designing more usable interactive help systems for inexperienced as well as experienced users of an application is an enormous challenge. To meet this challenge, designers must address the following issues:

- *How can the system facilitate the accomplishment of a particular task by a user who has no previous knowledge of how to accomplish such a task?*
- *How simple is the system to use?*
- *How can users with different ability and background knowledge be catered for?*

It is clear that these questions are very practical criteria for judging an interactive help system. The first question addresses the need of inexperienced users as it relates to task-specific queries. However, this is not necessarily the case that an interactive help system that is most effective in this sense will also be the one which users are comfortable with. Similarly, if users' long-time usage of the application is considered, the help system that is most effective at initial learning might not offer the greatest aid to continued skill acquisition. Although simplicity is addressed in interface design in general, it is uniquely important to interactive help systems due to the level of knowledge requirement for its use. There is no doubt that simplicity is a virtue for any user interface for it to be 'user friendly' and 'transparent', but it is even more vital for interactive help systems.

Typically, an interactive help system is not used as an independent system but as a tool to aid in the use of an application. It is therefore used by "*people in a hurry' often total novices, often already frustrated, who have absolutely no desire to learn any more than the bare minimum about the help system*" (Boreinstein, 1985). Hence any design feature that hinders the user's speedy understanding and slows the completion of the task at hand will make the system unhelpful and unappealing.

In summary, interactive help systems should be designed to be helpful, easy to use, attractive and enjoyable, by utilising the many features offered by the computer.

1.3 LIMITATIONS OF RESEARCH INTO ON-LINE HELP SYSTEMS

Previous research on On-line Help Systems (detailed in Chapter III) shows that current On-line Help Systems are limited in the following ways:

- Most designers consider On-line Help Systems not to be an integral part of the entire system, and hence they are considered only at the end of the software development cycle
- Most designers exploit new technologies in building On-line Help Systems, rather than utilising the ones already available and improving on them.
- Most interactive help systems are centred on the application for which they were designed for rather than on the users. They make the assumption that users, no matter their level of expertise, understand the context of searching for help as well as receiving the help.

It is the aim of this research to provide an optimal approach that will hopefully overcome these limitations.

1.4 EXPERIMENTAL HYPOTHESES

The hypotheses this thesis intends to address through a set of experiments are:

Hypothesis I:

The time taken to complete any given task will vary according to user experience, irrespective of aid mechanism.

Hypothesis II:

When compared, the performance of users on any two or more aid mechanisms will differ.

Hypothesis III:

An improvement in On-line information that uses printed documentation features will greatly improve user performance and satisfaction.

1.5 CHOICE OF AN EXPERIMENTAL DOMAIN

The research is limited to the applications on Personal Computers. Even in this category, only three categories of applications are considered - Word Processing, Spreadsheets and Database Management Applications.

This choice was made after considering the recent trend in the acquisition of computers by professionals of all sorts, where there is spectrum of user expertise, from novices to experts.

1.7 STRUCTURE OF THE THESIS

Figure 1.1 gives an outline of the thesis. This chapter is a general introduction to the research and highlights the motivations of the work, the limitations of previous research and what the research aims to achieve.

In order to fully understand the concept of Online Help systems and carry out a meaningful study, the underlying concepts need to be identified and defined. These concepts and the general taxonomy of interactive help systems are discussed in chapter II.

Chapter III reviews the literature of previous research on help systems, both theoretical and practical. Also a critique of each approach and the lessons learnt from these reviews are discussed.

Chapter IV reports the results of an empirical survey conducted on a group of software users. Also reported are the analytical results of the survey.

The results of the empirical survey provided an opportunity to identify and define some tasks that are likely to force users seek assistance from the assistance tool provided, or make enquiries from the experiment. The experimental setting, task specifications and the procedure followed in carrying out an experiment with Online Help system users is discussed in chapter V. Since the research hypotheses aims to assess the performance of users on task-specific queries, there is a need to compare the results of the online help study with a standard documentation. Chapter VI presents the result of the standard documentation (user manual) study as well as a comparison the performance of users of the two studies.

Analyses of the results obtained from the two separate experiments enabled the identification of the problems inherent in Online Help Systems. This necessitated the proposal of an optimal approach that aims at solving of the problems identified. In chapter VII, the conceptual model of the proposed approach is presented and discussed. Also the components of the model are outlined.

In chapter VIII, the performance evaluation and analysis of the designed system and hence the methodology is discussed, while in chapter IX a comparative examination of the overall results is presented. In chapter X, a summary of the work, conclusions arrived at and recommendations for further work are presented.

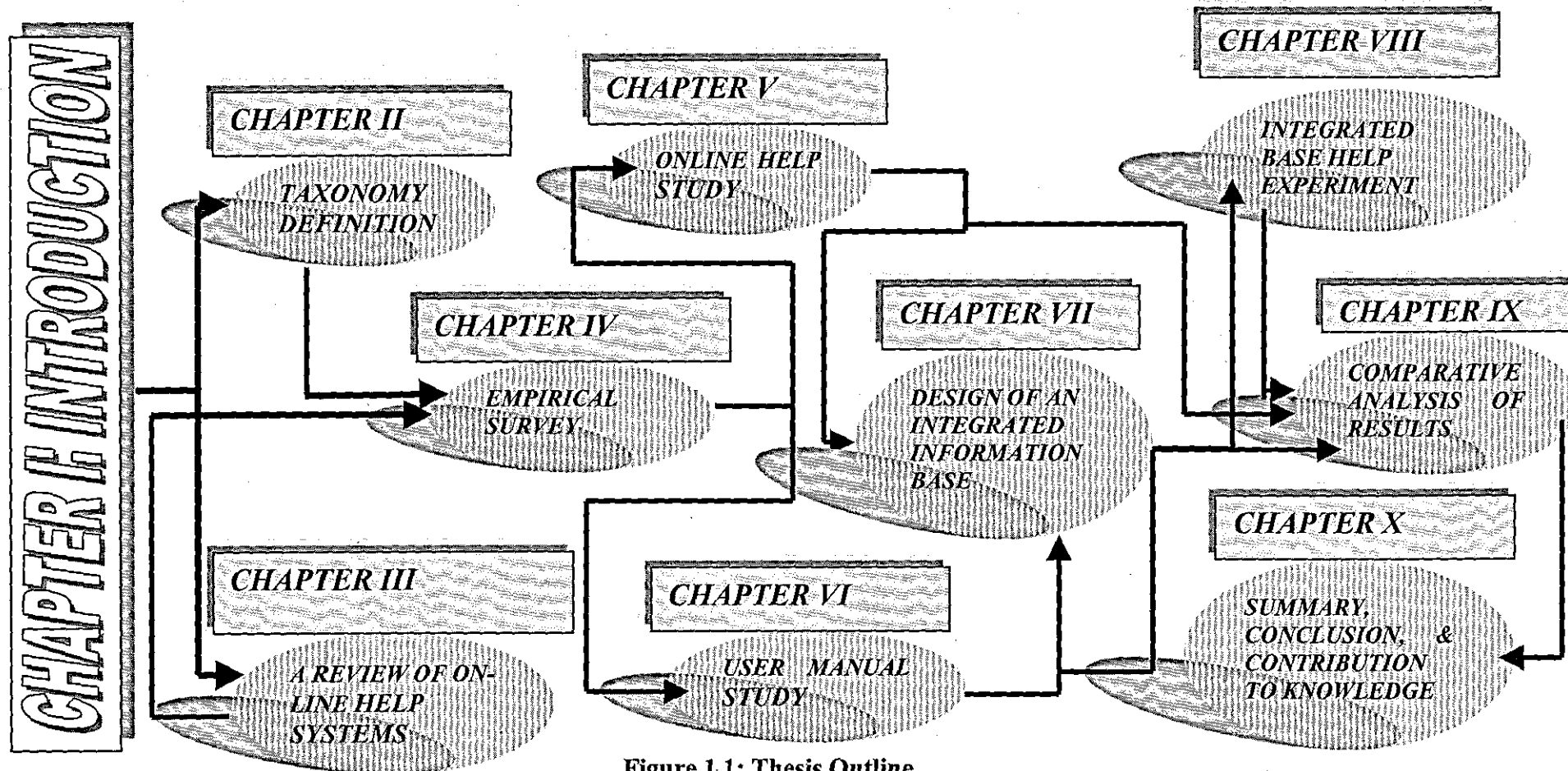


Figure 1.1: Thesis Outline

CHAPTER II:

General Taxonomy of On-line Help Systems and Users

2.0 INTRODUCTION: ON-LINE HELP DEFINED

An On-line Help System can be defined as “*one or more computer programs designed to provide users with assistance whilst they are carrying out computer-based tasks*”. The system can either be completely integrated with the application program (as most of the current On-line Help Systems are) or a separate system, running concurrently with the application.

There are two fundamental aspects of On-line Help Systems that directly affect users: *the interface and the content*. The *interface* includes how the help information is displayed as well as how the information is accessed by the user. The *content* is the actual help information provided for the user. Both aspects are of equal importance. An On-line Help System will fail to be of assistance if either a poor interface design makes it difficult to use, or if the information it provides is unhelpful, unclear or inaccurate.

On-line Help Systems are intended to lower the effort of using application software because, if there is a good On-line Help System, there may be no need for reading bulky manuals. They also help in reducing the training time required, because any missing knowledge is contributed step-by-step through the On-line Help System.

Software developers have been building interactive help systems almost as long as they have been building software systems of any kind. In general, however, On-line Help Systems, like most interface designs, have been added later, often quickly and hastily constructed and only marginally integrated into the larger system. As Borenstein puts it, *Although most Programmers enjoy programming, they are not so fond of documenting their code, and even less fond of writing documentation for the final users of the systems* (Borenstein, 1985). Borenstein

would almost certainly have placed "Design and Implementation of On-line Help", still lower in the hierarchy of the designers' preferred activities.

Notwithstanding this generalisation, over the years, a number of interesting approaches to the provision of On-line Help have been tried, but they have generally been in isolated settings and implemented in an ad-hoc manner. There have also been attempts to survey the field (Sondheimer, 1982; Houghton, 1984; Borenstein, 1985), but these have been less than successful. Borenstein (Borenstein, 1985), for example, purported to survey the area of On-line Help Systems, but failed to include topics such as error messages and prompting, arguing that these topics were very diverse. However, in the case of On-line Help Systems that aim to assist users with their current tasks, such topics are very relevant.

A more meaningful Taxonomy of On-line Help Systems was developed by Roesler and Mclellan (Roesler & Mclellan, 1995). Their survey describes how the content of help information should be organised, as well as the means by which such information should be accessed. However, even they did not consider other issues such as error messages and integration

In the sections that follow, the current design principles used in On-line Help Systems together with other related issues are examined. These include:

- why On-line Help is needed and what are the benefits
- a classification of users who access On-line Help
- a classification of On-line Help Systems.

The dimensions along which an On-line Help System may vary *as the user sees it are also examined*. These are: '*Help Access Technique*', *Help Presentation Style*, and (probably most important) the issue of *Integration* - the degree to which the various help features are uniformly available in all potentially relevant contexts.

Other dimensions considered are error messages, prompting messages, as well as issues of implementation.

2.1 WHY ARE ON-LINE HELP SYSTEMS NEEDED?

On-line Help Systems are provided because people often find it difficult to use the computer facilities that are intended to help them complete their tasks quickly and efficiently (Shneider & Thomas, 1983). Some users are often reluctant to make use of all facilities available to them (Nickerson, 1981; Goodall, 1991) and those that are used are often used inefficiently (Jerrams-Smith, 1987; Jerrams-Smith, 1989). These observations suggest there is a mismatch between appropriate knowledge in the system, and the system concepts, of the user.

Theoretically, it might be possible to build application programs that are so well designed and tested that no user assistance is needed in using the system. However, in the practical sense, this is extremely unlikely. It is always difficult to anticipate what users of a particular piece of software will do or how the piece of software will be used. This is due to the diversity of the users of such software. Hence On-line Help Systems provide a means by which some of this diversity can be supported, and allow for usage which might not have been anticipated initially.

Shneiderman (Shneiderman, 1998) has commented that most interface users experience anxiety, frustration, and disappointment due to poorly designed menus, displays, or prompts that lead to error conditions, or simply from the inability of the users to know what to do next. One essential difference between On-line and Off-line help systems is screen information versus printed information. Though much progress has been made to the interface design process, it is likely that there will always be the need for supporting materials, both On-line and in printed form.

The technology of printing text on paper has evolved for more than 500 years. The paper surface, colour, the typeface, character width, letter sharpness, text contrast with the paper, width of the text column, size of margins, and spacing between

lines, have all been exploited in efforts to produce the most appealing and readable format.

Technological developments in computing have offered the visual display unit (VDU) as an alternative medium for the displaying text and graphics, so researchers have looked at ways of optimising the use of this new medium to meet user needs (Creed, 1988; Hansen, 1988; Osborne, 1988; Horton, 1990). However, it must be noted that a video screen and a sheet of paper are alternative ways of presenting text or other visual media. Each has its own strengths and weaknesses for particular types of presentation task.

Many early studies found slower task times for comprehension or proof reading of text on computer screens as compared to paper (O'Hara & Sellen, 1997). Similarly, other workers have shown that written manuals result in faster learning times (Hertzum, 1996). These issues are examined in more detail in section 3.2.

The following items have been identified as potential disadvantages of reading from the computer screen:

- poor fonts, especially on low resolution displays
- low contrast between the characters and the background
- fuzzy character boundaries
- emitted light from displays may be more difficult to read than reflected light from paper
- reading distance can be greater on displays than for paper, displays are fixed in place, and may be placed in a higher uncomfortable position for the eye. Grant (Grant, 1990) provided five ways by which the eye can adjust to seeing close items *accommodation* (lens-shape change), *convergence* (looking toward the centre) *meiosis* (pupillary contraction), *exyclotorsion* (rotation), and *depression of gaze* (looking down). However, long term use of these techniques can also lead to fatigue, leaving the problems unsolved.

Other problems include layout and formatting problems, reduced hand and body motion, limited display size and unfamiliarity of displays.

Despite these negative side effects, the On-line environment opens the door to a variety of new approaches (Roesler, 1995) that might not be practical in printed form. Such approaches include (Relles, 1981):

- successively more detailed explanations of a displayed error message
- a displayed question or prompt
- explanation or definition of a specified term
- a description of the format of a specified command
- a list of allowable commands
- a display of a specified section of documentation
- a description of the current value of various system parameters
- instruction on the use of the system
- news of interest to users of the system
- a list of available user aids.

Another important facility is the concept of hypertext linkage. This is an example of the sort of facility that an On-line Help System should aim to exploit.

In the next section, the dimensions on which application users may differ are discussed.

2.2 CLASSIFICATION OF USERS OF ON-LINE HELP SYSTEMS

A comment has already been made in the preceding section that one reason why the design of a perfect On-line support system is so difficult to achieve is the diversity of users that most systems have to support. Users differ in many respects - computer background, task experience, application software experience, as well as other personality characteristics such as reading speed, attention span, learning style, or patience (Kearsley, 1988). As a result of such factors, each user may

react differently to an application program and it may be difficult to predict what any particular individual's reactions might be. Understanding the physical, intellectual and personality differences among users is vital, as this will reflect in the user's motivation to learn and become knowledgeable about the system (Maclean, 1990). There are also cultural and language difficulties which may affect understanding.

User compatibility, otherwise known as 'knowing the user', was the first principle given in Mayhew's list of general principles of user interface design (Mayhew, 1992). Although it sounds intuitively obvious, it is in fact a difficult principle to achieve and is often undervalued. The most common error among software developers is to make two assumptions -that all users are alike, and that all users are like the developer. The first erroneous assumption leads designers to conclude that, if an interface is acceptable to one or two users, it will be acceptable all. The second assumption leads designers to reason that if they themselves can use it so can any user. The safest attitude for a designer to assume is that users are different both from the designer and from one another, and designers should therefore set out to understand the different users and define the variations among them.

This diversity is a challenge to system designers. When considered together with the possible range of situations, tasks, technologies and frequencies of use, the resultant possibilities are enormous.

There are several dimensions along which application software users have been classified (for example, see Zmud, 1979; Payne, 1980; DeHaemer, 1991). These include

- Sex Differences
- Experience
- Age
- Ethnic Culture
- Cognitive Abilities
- Personality Traits

2.2.1 Sex Differences

Researchers have systematically examined the effects of sex differences to the user-computer interaction process. Fowler & Murray (Fowler & Murray, 1987), for instance, reviewed the implications of sex differences for the interface. They predicted that sex differences may result in preferences for different styles of interaction, with females preferring a structured, inflexible and natural language interaction with their male counterparts preferring a more flexible and graphical mode of interaction.

2.2.2 Experience

Several papers have reported studies on the differences in experience of software users (Barnard, 1982, Borenstein, 1985, Cohill, 1985, Emdad, 1989, Briggs, 1990, Baxter, 1991, 'Ydewalle, 1995, Shneiderman, 1998). However, each study has its own particular ratings of experience, each of which is generally subjective, and underestimate the variability in human computer interactions that occurs in natural settings where users with different backgrounds work side by side.

The common sense view most people hold of expertise is that more time spent by a user with a system will equate with more practice, more knowledge and hence more experience on the system. However, this may not necessarily be the case. Potosnak (Potosnak, 1984), in his study, found that computer use and experience are two separate dimensions, though this view is not shared by other researchers, who treat them to be same. Draper (Draper, 1984), for example, has proposed that expertise does not mean that users will know more commands but that they are better able to find the necessary information when required. Similarly, experience has been found to overshadow other dimensions (Lamberti & DeHaemer, 1990; DeHaemer, 1991). The researcher shares a similar view to that of Draper. Experience or expertise is regarded as being solely dependent on the extent of the user's exploitation of the features of the application package. Thus the ability to

assist others is introduced as a key factor for assessing experience (Abdullahi & Alty, 1998)

There are numerous categorisations of users based on experience. These include naïve, novice, intermediate, advanced, expert, skilled frequent, professional, and casual users. However, the meaning of most of these terms depends on the context of their use.

2.2.3 Age

Most studies in human-computer interaction have not appropriately studied the impact of age on task performance. The range of age used in most studies is usually restricted (often students are used as subjects) and may correlate with experience. The common sense belief is that there are age-related reductions in performance, especially with complex tasks, but the reason for this is not known. A representative study in this dimension is that of Gomez, Egan & Bowers (Gomez, Egan & Bowers, 1986). They studied first-time users of a text editor and looked at the effects of age, spatial ability, and memory ability on learning rate. Their results showed that older people have more trouble learning to use the text editor. However, the results did not indicate whether they were able to use the package at the end of the learning period.

2.2.4 Ethnic Culture

Another perspective on which users of computer systems may differ is that of culture, racial or linguistic backgrounds. Users who are brought up reading Arabic, Chinese or Japanese writings may scan screens in a manner different from those brought up with Western background. However, studies in these areas are scarce, if not absent.

2.2.5 Cognitive Abilities

The volume of literature on user cognitive abilities or styles is large and a variety of dimensions have been proposed and investigated. Users of information systems employ a variety of cognitive processes when they retrieve information, including learning, problem solving, memory, and comprehension (Allen, 1992), and cognitive abilities contribute to these processes.

Representative research in this area includes that of Egan & Gomez (Egan & Gomez, 1985) in which the users' ability to learn to use a text editor was examined. They found differences related to visual memory (the ability to remember the configuration, location and orientation of a figural material) and associational fluency (the ability to produce words which share a given area of meaning or some other common semantic property). In another study, Vincente et al (Vincente, Hayes & Williges, 1987), found that verbal comprehension and spatial visualisation, (the ability to manipulate or transform patterns into other arrangements), accounted for 45% of the variance in the time taken to find items when searching a hierarchical file system.

Yoder (Yoder, 1986) studied the relationship between an individual's cognitive style as measured by the Myers-Briggs Type Indicator (MBTI) (Briggs, 1983), and their performance on two tasks using the IBM VM/SP and VM/CMS operating systems. Briggs and Mayers Type Indicator provided four scores of individuals' preferences in dealing with people and situations: feel-think and sense-intuit. Feeling and thinking reflect two modes of judgement, while sensing and intuition reflects two modes of perception. This test provides a representation of the relationships between professionals and personality types. It has been applied to testing user communities and providing guidance to system designers.

Yoder developed five different formats of help messages that varied along the following dimensions:

- verbal versus graphical

- explanations versus examples
- directive versus tutorial

Participants in the study were asked to complete the task using the help system as their only source of guidance. Total completion time, number of help requests, and errors made, were measured as well as the participant's preferences for the different help formats.

Although her conclusions were not firm because of the small number of participants (36 - 2 per category) and the large number of possible cognitive style categories (16), there were some suggestive results regarding preferences for certain formats depending upon cognitive styles. For example, almost all of the Extroverts preferred graphic formats and most categories of Introverts preferred explanatory formats. Most importantly, most participants were found to perform better with formats based upon examples, and performed badly using help messages involving abstract explanations.

Similarly, Greene, Devlin, Cannata, & Gomez (Greene, Devlin, Cannata, & Gomez, 1990) tested typical users of a business database system, and found that individual differences in logical reasoning, integrative processes, visual memory and induction (the ability to form and test hypotheses that fit a set of data) affected the users' ability to use logical operators. When they performed another experiment using a system that did not require the use of logical operators, users' performance greatly improved.

Other cognitive style dimensions include field dependence (in which users react to a situation as a whole without analysing it, responding on the basis of what it does rather than what they do with it), and field independence, (in which users prefer to keep the different parts of a situation separate from each other, ignoring the parts that are irrelevant to their needs). These dimensions formed the basis of the study carried out by Coventry (Coventry, 1991). She studied eight third year computing students using UNIX. His aim was to determine the amount of knowledge

acquired by the users, the nature of help requests and whether these were affected by users' level of field dependency. He found out that the more field independent users are, the more commands they know. On the other hand, the more field dependent users are, the more help they require. This however is just a suggestive result rather than a conclusive one because of the number of users in the study (N=8).

2.2.6 Personality Traits

Another dimension of individual differences among system users is that of personality trait. An essential part of an effective and desirable interface is the ability to communicate with the user in a constructive dialogue. Research conducted by Nass et al, (Nass et al, 1995) indicated that users preferred interfaces with personalities similar to their own. Similarly, a study by Chin (Chin, 1996) found that both Expert and Novice users of a voice mail system ascribed similar personality traits to the user interface: practical, intelligent, courteous, efficient, straight-forward, sophisticated, methodical, progressive, imaginative, alert, and scientifically-minded.

The above is a brief discussion about the dimension upon which users may differ. As it can be seen from this discussion, it is difficult from the perspectives of On-line Help Systems, to take all these into consideration when designing help systems. Most personality differences are too complex to measure in any simple fashion, and in most cases, lengthy tests are usually required. The best practical strategy is to study carefully the user population and note any systematic and re-occurring differences among users. The system is then built with the capability to allow users to change parameters or functions that are important to them. Another way of dealing with these differences is to provide multiple options and user customisation in the system.

Finally, it is important to state here the hypothesis that *that a good On-line Help System may compensate for individual differences by allowing users to explore a*

system in whatever fashion is most suitable to them (Kearsley, 1988). However, the successful exploration of a system by users is only possible when their appropriate experience or expertise exists and can be exploited. This further reiterates the researcher's view on individual differences.

In the next section, a broader classification of On-line Help Systems is discussed.

2.3 CLASSIFICATION OF ON-LINE HELP SYSTEMS

There are many ways of giving assistance to an application user, and On-line Help Systems can be classified according to the manner in which they provide assistance.

2.3.1. Passive versus Active On-line Help Systems

In **Passive On-line Help Systems**, help is initiated explicitly by the user, either by pressing the help key (such as F1) or by accessing the help menu. Most of the existing On-line Help Systems are passive help systems.

In **Active On-line Help Systems**, help is initiated by the system, when the system detects that a user needs assistance. This type of help includes services such as automatic spelling correction, as in Microsoft Word (versions 7.0 & 8.0), prompting for missing parameters, and hints on actions with serious consequences. The most advanced type of Active On-line Help System is one in which user activity is continuously monitored and provided with advice based on current user activity to improve task efficiency.

Early studies carried out on active help include that carried out by Cohill & Williges (Cohill & Williges, 1985) They studied three help situations - user/system initiated help, user/system selection of topics and On-line/offline presentation of information. Their results indicated that user-initiated and user-

selected groups performed better than the system groups, but the offline presentation outperformed the two.

However, there are several problems associated with active help. Carroll & Aaronson (Carroll & Aaronson, 1988) studied active help and reported several usability problems. For example, users are always pre-empting and discarding any advice given to them which may lead to further errors in the process of recovery due to their unique personal histories, timing of presentation of information and *too much expectation from the system by the users.*

Most currently implemented systems are passive help. No help is presented until the user activates some explicit mechanism to request help - for example, by pressing the 'F1' key in most applications or selecting 'HELP' on the menu. In such systems, the help component may be viewed simply as a utility program that is activated by specific commands.

Fischer, Lemke & Schwab (Fischer, Lemke & Schwab, 1985) designed and implemented two related knowledge-based help systems - *Activist* and *Passivist*. These are respectively active intervening and passive request-driven systems designed to provide assistance for EMACS-like editor. The *Passivist* system takes natural language questions or requests for help and interprets them in light of the current context of the user, that is, with respect to what the user has been trying to do. From this information, *Passivist* tries to deduce what information the user is seeking.

The *Activist* system is an active help system that monitors user behaviour and intervenes when it detects the user performing below some optimal level, *predefined to the system. There are two kinds of performance level used. Firstly,* the user can invoke several commands to do something that could have been done with fewer commands. Secondly, the user may use more than the minimum number of keystrokes for a command. As an example, a user might type a command name when a function key would do the job. Here, the system must

infer the user's overall plan and provide information appropriate to that goal. This system is rather limited, as the metric used to identify sub-optimal behaviour is a count of keystrokes.

One major problem of the active approach is that of balance. A help system which successively issues help messages to the user can cease to be helpful and can become an annoyance. Yet, if help is not given when needed, the user is left at a loss of what to do next. Also, users may have their reasons for using the longer version of a command, which may be unknown to the system, and comment, thought to be helpful by the system, might actually be counterproductive and annoying to the user. In such situations, if the user refuses to change from their preferred method of working then it is necessary for the system to adapt its policies towards the user.

In other systems, however, initiative may reside wholly or partially with the help system. In several tutoring systems, the program will intervene and suggest new approaches or provide new information when the user seems to need it. In more conventional systems, software carefully engineered for novice users may provide automatic help in the form of two-level menus that indicate some consequences of possible menu choices.

Other possibilities of mixed-initiative systems include systems that automatically offer help if the user is idle for a certain period of time, systems that attempt to interpret invalid commands as requests for help of some sort, and systems that maintain a constantly updated display of help that seems appropriate for the current context.

In classifying help systems according to access initiative, systems are simply placed on a continuum between systems in which human users have the sole initiative and systems in which the computer has the sole initiative. In practice, it is very rare to find a system in which the computer is more active than the human user, but systems with somewhat mixed initiative are common.

2.3.2 Static versus Dynamic On-line Help Systems

In **Static On-line Help Systems**, the same information is given all the time, irrespective of user's context and interface conditions. Most of the existing On-line Help Systems are static as well as passive On-line Help Systems.

In **Dynamic On-line Help Systems** the user's context and the interface condition at the time of requesting information is considered. The information given varies according to variations of context and interface conditions.

2.3.3 General versus individual On-line Help Systems

General On-line Help Systems give same kind of information to all kinds of users or group of users. They do not take the user's experience or personality trait, cognitive ability or any of the individual differences dimension discussed above into consideration.

An Individual On-line Help System distinguishes between users based on a data base of user characteristics.

2.3.4 Intelligent On-line Help System

One reason why most of the existing On-line Help Systems are of limited value is because, as Kearsley puts it, 'they are stupid' (Kearsley, 1988). That is, they do not understand what the user is trying to do, what the user wants to know, or the meaning of the assistance given. Making On-line Help Systems 'smart' involves the use of artificial intelligence techniques and an AI methodology.

Several researchers have analysed naturally occurring help interactions between humans and these have been used as models for intelligent On-line Help Systems (Alty & Coombs, 1980a; Alty & Coombs, 1980b; Alty & Coombs, 1981; Pollack, 1985; McKendree, 1986; Aaronson, 1987a; Aaronson, 1987b). These works

identified a variety of ways in which people ask other people for advice, and how advice is given. From these, three aspects of providing intelligent On-line Help can be identified:

- providing a natural language interface to the On-line Help System
- adapting the information to the individual by maintaining a model of the user and tracking user goals and current context (adaptivity)
- determining when the user requires assistance and intervening when necessary without an explicit request from the user.

Another important requirement of an intelligent On-line Help System is a comprehensive knowledge base of the application for which it is designed. If the On-line help system cannot make inferences about how the application works, or cannot associate one concept with another, it will not be able to understand user help requests.

Some 'intelligent On-line Help Systems' have been built and they include the works of Fischer et al (Fischer et al , 1985), Aaronson & Carroll (Aaronson & Carroll, 1987a, 1987b), Carroll & Aaronson (Carroll & Aaronson, 1988), Thies (Thies, 1994), and Baeg (Baeg, 1995). However, these systems are concerned with breaking new grounds in the implementation issues rather than the usefulness of such approaches.

The above discussion provides a general classification of On-line Help Systems. However, there is another dimension on which On-line Help Systems can be further classified: by the manner in which they are accessed. This is discussed in the next section.

2.4 ACCESS MECHANISMS OF ON-LINE INFORMATION

There are numerous mechanisms of accessing On-line information implemented in the literature. These mechanisms include: On-line manuals, minimal help texts, diagrammatic help, query-in-depth, keyword help, concrete and simulated

examples, menu-based help, command prompting, context-sensitive help, graphically invoked help, window-based help, natural language help, intelligent On-line Help, spoken help requests and wizards to assist with particular problems.

These mechanisms are discussed in terms of human-initiated help. However, the same mechanisms can be available for communicating with a system in which the computer takes the initiative; and in such a case, they are simply mechanisms for requesting further help or clarification, rather than initial help requests. The exception to this generalisation are context-sensitive or context-dependent help, intelligent On-line Help, concrete and simulated examples, and active On-line Help. These are generally useful for an initial help request, rather than in requests for clarification. However, context is an essential component of any help that is initiated by the computer.

2.4.1 Access through On-line Manuals

Most of the early systems, especially those on Mainframe systems, have their printed manuals loaded On-line. One of the primitive implementations is the UNIX *man* facility, which is still in use. This has a textual description of each command and its options. In this facility, users must know the names of the commands to find help about them.

There are numerous problems with the UNIX *man* facility. For example, the system is keyword-based, human-initiated, has a higher access complexity, lack of context-sensitivity, and is poorly integrated with the system – a user cannot access help anywhere on the system except at the top command level. Several researchers have attempted to address these problems, each differing in the method used to handle user request for assistance. One example is a study carried out by Borenstein (Borenstein, 1985), where several access mechanisms were provided and Coventry (Coventry, 1991), where user diversity was considered in accessing help information. These studies were discussed in the previous chapter.

With the wide availability of the CD-ROM players, many user manuals can now be obtained on CD-ROMS. These manuals are exact images of the printed manuals. Examples include the Sun Microsystems On-line Manuals, and the Apple Macintosh's *Inside Macintosh* series, which are both available on single CDs with scanned images and hypertext links.

One of the vital features that On-line manuals should incorporate is a properly designed table of contents that can remain visible to the side of the page of text. Selection of a chapter or other entry in the table of contents should immediately produce the appropriate page on the display. Other features that can enhance On-line manuals are availability of string search, electronic bookmarks, annotation, hypertext traversal and history tracking.

2.4.2 Access through Keyword Help

This is probably the most common help mechanism. Here, the user simply specifies a keyword which the system uses as an index to its help database. However, the sophistication of the keyword mechanism can vary greatly.

Most often, the only keywords acceptable to a system are the actual names of commands. This method suffers from the obvious disadvantage that users cannot get any help until they know the name of the command they need to learn about. Furnas et al (Furnas et al, 1987), described how new and intermittent users often use the wrong word for accessing a command name. Knowing the correct command name is not an easy task. This effect is partially compensated for, in some systems, by allowing the system to print a list of the keywords it knows about. By browsing this list, users can try to guess which keyword is the one they want. This, however, is not feasible on large systems where the list of keywords may number in the hundreds or thousands.

A more sophisticated keyword mechanism might search through a sectioned database for any keyword that might be specified, printing out or displaying for

the user those sections of the database that contain the keyword. Although this approach might be quite easy to implement, in a large database it can be very time-consuming. Some systems modify this approach by searching through a header area of each section of the database, rather than through every line of the database. This improves the system's performance at the cost of a substantial reduction in the number of keywords recognised and the proportion of relevant entries found.

One problem with any method that involves searching through a textual database for an arbitrary word or phrase is that such unintelligent searching inevitably finds text that is totally inappropriate. Applying the computer's raw power on the task of searching can thus have the undesirable result of overwhelming the user with irrelevant information.

Unfortunately, what is probably the 'right' technique for constructing keyword help mechanisms is also the most difficult and expensive. Each section of the help database should be explicitly indexed by the relevant keywords. This places a heavy burden on the documentation designer, in that it is crucial that all such keywords are provided. However, it is the surest method for guaranteeing that all relevant keywords will find the text, while also ensuring that keyword requests for common or short words will not overwhelm the user with useless information. This form of keyword request is rare in On-line Help Systems, though it is more common in large information retrieval systems.

2.4.3 Access through Menu-based Help

The second most common type of help access mechanism is the *menu*. In a menu system, the user is given a list of help topics from which to select the topic of interest. Details of menu implementation can vary greatly, generally along a simple line of ease of use. Menu selection can be as simple as pointing with a mouse, or can depend on a complex syntax for requesting the next menu item. Menu systems also differ in the mechanisms by which the first menu is created.

Menus can be created in response to erroneous commands, in response to explicit requests for help, or a follow-up to the previous menu selection. One advantage of menu-based On-line Help Systems is that of Closure. Closure indicates that the search problem is bound, especially to Novice users. Expert users prefer to have control to the manner in which they seek for assistance, and menus do not favour that. They provide the users with restricted choices that they have to choose from. These systems are therefore more useful to Novice users than Expert or Intermediate users.

2.4.4 Access through Context-Sensitive Help

Context-sensitive help is a technique whereby the user is provided with different messages from the On-line Help System, depending on where they are in the application. For example, help requested from inside a dialog box produces a window with information about the dialog box.

Another approach is to have the user position the cursor and then press F1 or a help key to produce information about the item on which the cursor is resting. A subtle variation is to use the mouse to click a help button or a question mark (?) to turn the cursor into a question mark. Then, the cursor is dropped on a field, icon, or menu item, and a pop-up window describes that item. This strategy is followed by most current existing windows-based applications.

Several help systems have had some success with providing information based on the user's current context. In such a system, information ranging from a partial command line to a user's entire history of use of the system can be used to determine the help most appropriate at that moment.

Obviously, an ambitious context-dependent help system would be a major programming undertaking. Yet the basic mechanisms that have proved useful in some systems are relatively simple - a parser that analyses the current partial command line and uses it as a help request. Another simple mechanism is to keep

usage statistics to show which commands and options a user had often executed in the past, and use this to choose among possible interpretations of help requests.

A common failure of context-sensitive help systems is a failure to integrate the context-dependent help with other components of the help system. That is, the system makes it impossible for the user to pursue more information from the help system without abandoning the current Command State.

2.4.5 Access through Query-In-Depth

As the name implies, query-in-depth provides variable levels of help to the user. The user is allowed to access additional On-line assistance beyond that provided in the first help inquiry. Relles & Price (Relles & Price, 1981) implemented this sort of help facility, and carried out experiments using it. Their experiments showed that this method of On-line assistance was an excellent approach (Houghton, 1984). However, many existing On-line Help Systems do not provide multiple level of help. In most cases, only first and second levels are provided. Microsoft approached this method of multiple level help through the more information buttons and hypertext linkages within the different levels of help information. However, the multiple nature of these buttons and linkages tend to overwhelm the user and often leads to irrelevant information being presented.

2.4.6 Access through Natural Language Help Systems

An obvious possible access mechanism for On-line Help is natural language. After all, if the nature of the task domain presupposes that the user is having some kind of difficulty using the computer, it seems logical to suppose that communication in the user's native tongue would be an invaluable assistance. Indeed, this kind of communication seems so natural that its desirability is accepted, without question, in the sparse literature on On-line Help Systems. The Development Manager of Microsoft, for example, stated that 'The Office family On-line Help Systems

would allow users to enter requests for assistance in a natural fashion' (MS Bulletin, 1997).

Such uncritical assessments are made possible only by the difficulty of implementing such systems. Panaceas generally last until they are tried, and the difficulty of constructing natural language interfaces has so far prevented any realistic testing of them in the context of On-line Help.

Unfortunately, there are several reasons for supposing that Natural Language help systems may not be that helpful. Natural Language is extremely wordy; thus it seems possible that the time necessary to actually type in a natural language help requests will at least partially compensate for the ease with which such requests can be formulated in the mind. Moreover, expert users seem to rebel against any systems that force them into what might be considered 'needless wordiness'. Interestingly, some researchers have suggested that Expert Users may in fact be the most important users of certain kinds of help systems (Coventry, 1991); if this is true, it weakens the case for natural language help.

2.4.7 Access through Spoken Help Requests

One mechanism that has hardly been explored in On-line Help Systems is speech recognition. Speech recognition has obvious potential usefulness in On-line Help Systems; for example, a natural language system that understood spoken input would not be vulnerable to most of the criticisms of natural language help systems that were listed above.

Speech is the most natural and diverse form of human communication. Speech recognition has had considerable successes in some domains such as music, hearing and verbal communication. Several applications have evolved over recent years. These applications can successfully recognise vocabularies of thousands of spoken words. People can now speak to their computers when they want to write

letters and reports, rather than type them. These, in essence, aim at improving efficiency.

In the March issue of PC Magazine (Barrett, 1998), five leading speech recognition packages were reviewed, representing both discrete and continuous speech systems. They claimed in the review that these systems cover the vast majority of the installed base of speech recognition.

A similar review a year after (Bannett, 1999), six leading speech recognition packages were reviewed. A major improvement of these systems was the incorporation of continuous speech recognition engines, allowing more natural dictation than the previous generation of discrete speech products. Earlier systems could only take dictation, not commands, and only into their own word processing package. However, current systems allow for dictation into any application, as well as controlling Windows and performing other tasks that are usually done with the mouse. They also claimed that one could even use natural language commands for some of their tasks.

However, the reviewers indicated that although the theory behind speech recognition is more than 20 years old, it is only now that the power of the Personal Computer has reached the level necessary to implement such systems. This technology is still in its infancy and is limited in what applications and actions it can support, but it holds great promise. These are indications that speech recognition in On-line Help Systems is a likely possibility, although no such work has yet been done.

2.4.8 Access through Other Mechanisms

There are a number of technical approaches, also called access mechanisms, which explore the available technology to provide sophisticated help interfaces to users. They explore the feasibility of new help interfaces. However, few, if any, focus on the user's needs for On-line assistance. Examples include:

- Access Through Concrete and Simulated Help
- Access Through Graphically-based Help Systems
- Access Through Minimal Help texts
- Access Through Diagrammatic Help
- Access Through Command Prompting

2.5 ACCESS COMPLEXITY OF ON-LINE INFORMATION

On-line Help Systems may differ in the complexity of the mechanisms by which the user issues a help request. From the user's point of view, practically all the access mechanisms described in the previous section may be implemented well or poorly. The difference can be significant in terms of its effect on the system's effectiveness.

For example, systems where the On-line Help System requires many keystrokes to reach a goal would compare unfavourably with systems that require a single keystroke. The syntax of commands has to be as simple as possible, for the system to be helpful to the user who is, when seeking help, often in a state of confusion or ignorance. Hence any aspect which adds confusion is likely to impede success.

In addition to syntax, there are several other factors affecting the complexity of help access mechanisms. In menu systems, the branching factor is crucial: a system with too many choices at each level can overwhelm the user, while a system with too few choices can force the user to choose too often, making the process of actually finding the right information a strenuous one. Similarly, in context-dependent help systems, the systems should react in a number of ways when help requests are ambiguous in context. Dynamically-generated menus that allow the user to choose between the ambiguous interpretations are clearly less complex and frustrating to the user than a message which simply tells the user that the request is ambiguous.

In summary, the important message here is that users' access to On-line information should be as simple and effective as possible.

2.6 PRESENTATION ISSUES OF ON-LINE INFORMATION

On-line Help Systems vary greatly, not only in the manner in which they are accessed, but how the information content in them is presented as well. In this section, the three principal dimensions along which the presentation of On-line Help information may vary are discussed.

2.6.1 Presentation Techniques

The simplest and most common method of presenting help information is to simply place it onto the user's screen, with no regard to what was there before. This is the *teletype model of interaction*, which views the user's screen as a one-way device that can do nothing more than accept sequential lines of text. Although this model is out of date, it is simple to implement and often forms a key part of the mode of presenting information in many of the existing On-line Help Systems. Its great drawback is that it almost always causes the user's previous context to scroll off the screen, so that it can no longer be seen. As a result of such interaction the user has to request further assistance.

Another method, that is as easy to implement as the first, is to simply rely heavily on the printed manual. The On-line component of the help system can simply tell the user which part of the manual to look at, thus serving no more purpose than 'an electronic index'. The advantage of this method is that it drastically reduces the volume of output from the On-line Help System, thus partially preserving the user's context on the screen. The disadvantage of this method is its reliance on paper. A user without the printed manual is left stranded, not knowing what to do

next. Similarly, a user with an outdated version of the printed manual can be in even a worse situation: rather than having no information at all, the information may be erroneous.

Screen technology has allowed more modern On-line Help Systems to use multiple windows. In such systems, the user can preserve the context at the bottom of the screen, for example, while scrolling through help information on the top of the screen. The penalty here is that the available screen size for each of these activities is only half, or a portion, of the screen size to which the user is accustomed. Large displays such as those found in the new generation workstations as well as the multitasking capabilities of Windows 95 will hopefully alleviate this problem to a large extent. If On-line Help Systems that make use of multiple windows become commonly available in consonant with larger screens, users are less likely to resent the screen area taken over by the On-line Help information.

It should be stressed, however, that despite the penalty that multiple windows can impose on screen real estate, the overall effect of windowing technology is very beneficial, and has facilitated a host of new techniques. Multiple windows and multiple processes, which facilitate On-line Help processes running independently of the application program, have fundamentally changed the landscape of On-line Help Systems.

Finally, the future holds the promise of new technologies that might be useful for the presentation of help information. Synthesised speech might provide help without sacrificing any of the screen real estate, though no experiments have been conducted on such a systems. New displays also make it plausible to include pictures, animation or even videoclips as part of a help message. Thorough investigation of these possibilities will require substantial effort in both hardware and software development, and this is beyond the scope of the current study.

2.6.2 Presentation Source

Besides the question of how the help information is to be presented, there is the question of where it is to come from. This may seem to be primarily an implementation question: text may be taken from a monolithic On-line manual, it may be retrieved from a network of help texts, or accessed by keyword from a relational database. However, there is a more fundamental issue here as well. The text can either be retrieved verbatim from some data structure that contains it, or it may be generated by some natural language composition mechanisms acting on an underlying knowledge representation.

Dynamically generating text from an underlying knowledge representation is an interesting project for computer science and indeed many current researchers are examining this approach to On-line Help. However, it seems reasonable to question the motivations of such an effort. Certainly getting computers to generate reasonable natural language from a knowledge representation base is a fascinating and useful research topic. But in the domain of On-line Help, presumably, the primary goal is not to build an On-line Help System that is theoretically interesting but rather to build an On-line Help System that helps the user. In the light of this, there is no evidence to suggest that dynamic generation of text is likely to produce higher quality texts than human documentors would produce if they prepared all the system's texts in advance. However, it may be useful to use language generation facilities to dynamically generate examples or to customise explanations to a specific context in which the user is having difficulties.

Given the current state of language generation, this does not yet sound like a feasible proposition. Still, a state of the art help system might want to provide standard texts for standard situations, dynamically generated examples, and dynamically generated or dynamically modified texts for unusual situations, most notably situations involving ambiguous help requests where none of the "canned" texts unambiguously apply.

2.6.3 Text Quality

The final dimension along which help presentation varies is that of *text quality*. Help texts are English prose, and as such, vary in quality as widely as the readings and compositions vary in an English class. The literature on text readability is enormous, and nearly all of it applies to help texts.

What this suggests primarily is that a specialist should design such texts. Nonetheless, it is possible for non-specialists to evaluate their own texts in the light of certain very general criteria. It should be noted, however, that most of these have not been experimentally studied for their importance in the particular domain of On-line Help Systems.

- *Readability*: Several standard measures exist by which text readability can be measured. Documentation writers can use automated tools to determine the reading levels of their texts.
- *Organisation*: Familiarity with the task domain and user population of a help system can assist documentation designers in organising their texts intelligently. In addition to standard considerations of reasonable structure, and knowledge about the tasks and users, the most commonly-needed texts can be placed up front. Little details such as these can save enormous amounts of user time and frustration cumulatively over the life of a system.
- *Formatting & Headers*: Designers of paper documents have long been aware of the importance of headings, font size, and similar considerations of layout. With the advent of bitmap display technology, these same issues are becoming relevant to On-line Help designers (Brockmann, 1990; Horton, 1990).
- *Chunk Size*: Complementing meaningful highlighted headings should be

texts divided into small pieces. If the headings are meaningful and easy to read and notice, then they allow the user to only read the relevant sections of text. In order to make this work, the text should be divided into sections that are as small as is reasonably possible, thus, minimising what the user actually has to read. One may ask: 'How small is small enough?' It seems likely that this depends on several factors, including task complexity and display characteristics. Certainly it is best if the texts fit in a window without any need to scroll, but even this is not always possible.

- *Voice and orientation:* It is likely that the use of the passive voice, anthropomorphic orientation, and similar considerations of style may heavily affect the usefulness of text. While passive voice is universally condemned, other issues such as anthropomorphism are more disputed. Houghton (Houghton, 1984) declares it to be absolutely wrong, but at least some professional documentation writers think that texts in the "You User. Me Computer" style put users at ease and make the texts generally clearer (Shneiderman, 1998).

2.6.4 Integration

Finally, perhaps the most important aspect of an On-line Help System as a whole is its level of integration. Many computer systems provide several On-line Help mechanisms, each with its own database, operating completely independently. Similarly, some systems make On-line Help an independent utility, accessible only when the user is not doing anything else, while others try to make the help available within the context of most other, larger tasks.

The advantages of integration are obvious: by providing uniform access to help, confusion for the user can be minimised and makes it easier for the user to stay in context. By making various mechanisms access a single help database, it is easier for the user to try all of the mechanisms provided. Of course, integrated help is more challenging than non-integrated help from an implementation perspective,

but considered within the context of the user, it will demonstrate that the problem is neither impossible nor, indeed, particularly difficult.

An excellent example of the need for an integrated On-line Help System has been found in the observational study carried out with Microsoft Excel users, reported in Chapter V. A user was attempting to import an external dBASE file, and, after going endlessly through the help information provided by the On-line Help, realised that he needed to use the 'Microsoft Query' utility. Upon loading the utility, he could not understand the function of some of the dialog boxes, and when he tried to use the 'context-sensitive' help key (?), the system did not allow it because it was not integrated into the window. Similarly, when he tried to invoke the main On-line Help topics, the system would not allow him do that either. After several unsuccessful tries, the user had to get out of the MS Query utility to the main Excel window to review the help information again. Had the context-sensitive help mechanism been integrated with the main help system, the user would have been able to use the (?) key to retrieve the relevant information while within the MS Query window.

This, and similar difficulties are what most of the Excel and other application users have to go through in most cases where there is a modal dialog box implementation. These implementations restrict users' freedom of accessing other parts of the application, they must complete the action required by the modal dialog box before continuing with any other work. This explicitly exemplifies the need for integrated On-line Help Systems

Furthermore, an integrated On-line Help System would be helpful to the On-line Help System designers as well as to the users. In non-integrated systems, several different databases of help information must be created and maintained which is inevitably more work than maintaining a single database.

It should be noted that an "integrated" help system, in which all help systems access the same database and are available together in all contexts, is not at all the

same as an “integral” help system. An “integral” help system is one in which the help is provided by the same program that executes the command. The help is viewed as an essential part of the program’s functionality, hence the term “integral”. The argument in favour of integral help is that the help system can provide better help because it has access to the program's underlying data structures. While this may be true in the case of an extremely sophisticated help system, it is unlikely in most cases to compensate for the loss of a uniform help system available for use in all programs. Essentially, this is the same trade-off involved in the choice between designing sophisticated user interfaces for each program, or designing a single user interface management system which will communicate with all of the underlying programs. One may sometimes have to sacrifice a little functionality if they really want a well-designed, uniform interface.

It is also worth noting that the availability of multiprocessing capabilities makes it reasonable to consider an elaborate non-integral help system. In an environment without multiple processes, it would be much harder to design an integrated help system that preserved any arbitrary command context.

2.8 Discussion and Conclusion

This Chapter has examined a number of concepts relating to Online Help Systems.

A number of issues have been considered:

- Basic issues of terminology and factors necessitating the design and implementation of On-line Help Systems – helping users at task-specific queries are presented.
- Classification of users of software applications with some highlight of individual research into these classes of users. A research issue here would be to look at the effect of each of these classes on user performance. Each of these

classes need further research, however, the researchers favoured the classification based on experience as experience could possibly compensate for other classes.

- Classification of On-line Help Systems with the relevant research in each class as well as the advantages and disadvantages of each of these classes. Most current On-line Help Systems cannot be categorised into one specific class due to their features. In this regard, a research into the effect of the different classes on user performance might be efficient, as this will imply researching on a specific feature of the On-line Help System rather than the whole system.
- Access mechanism of Online Help systems - the gateway between the information stored within the system and the user of the system. Most current On-line Help Systems contain most of these mechanisms and research into a specific On-line Help System would imply looking at most of these mechanism
- Access complexity and presentation issues – issues relating to the ease or otherwise of access to the information stored within On-line Help Systems as well as the quality of the information.

Each of the above a open research issues that can still be investigated, and in Chapter III, these issues are discussed further as they relate to existing literature.

CHAPTER III

A REVIEW OF ON-LINE HELP SYSTEMS

3.0 INTRODUCTION

In this chapter, a summary of key design principles is presented and, relevant surveys and experiments that provide results appropriate to On-line Help Systems' design are reviewed. Relevant research from the areas of Cognitive Psychology and Artificial Intelligence is examined. Also discussed are the techniques employed in system evaluation. This Chapter builds on the taxonomy definition and the relevant sections discussed in Chapter II.

Generally, an On-line Help System can be thought of as a 'safety net' (Kearsley, 1988) that assists users when they do not find the application software 'self-explanatory' or 'natural' as they were led to believe it would be (Coventry, 1991). Hence, there are two different goals that On-line Help Systems aim to fulfil: a *short term goal* of facilitating the users in completing their current task, and a *long term goal* of enabling the users to increase their knowledge and improve future interactions. Whether or not the system achieved either of the two goals stated above is examined.

3.1 GUIDELINES FOR DESIGNING ON-LINE HELP SYSTEMS

Kearsley (Kearsley, 1988), suggested the following guidelines for On-line Help System designers:

- make the help system easy to access and easy to return from
- make help as specific as possible
- collect data to determine what helps are needed
- give users as much control over the help system as possible
- supply different helps for different users
- make help messages accurate and complete.

These are elaborate guidelines that, when taken into consideration during the design phase of On-line Help Systems, should result in effective systems that users will find easy to use and user friendly. However, underlying these apparently straightforward guidelines are complex relationships that are not well understood. For example - “make help as specific as possible” – is self evident, but the problem is identifying what the problem actually is. “Supplying help for different users” is also a sensible suggestion, but how does a designer decide which type a user is, and what sort of help is most appropriate? Many existing On-line Help Systems are usually easy to access and easy to return from. This may perhaps be the only guideline that has been followed by designers of such systems.

These guidelines, although a decade old, are still not fully implemented by the designers of most of the existing offerings (as can be seen in the discussions made in the sections that follow). Designers tend to use their own experience and expertise; and assume what assistance is likely to be needed, and then design the systems as such, rather than surveying real user needs.

The guidelines given by Goodall (Goodall, 1991), state that the designer should

- know the audience to which he’s designing for
- know very well the application he’s designing for
- anticipate the questions both experienced and novice users would ask.

In the real context of design, “*knowing users*” means carrying out all the necessary steps in determining the needs of the target audience, Goodall meant something more than this. Mere knowledge of the application, target audience for which the system is designed for as well as anticipating questions is not likely to result in the implementation of a ‘highly reliable system’ (Brad et al, 1988). Goodall expects the designer to anticipate user needs as well. This is discussed further in Section 3.5.

Although the ultimate objective of an On-line Help System is to improve both immediate and long-term performance of the user, none of the current offerings to-date fully realise either goal. As a result, many of the systems end up increasing the time a user requires to solve a problem (Dunsmore, 1980), (Elkerton, 1984), and (Czaja, 1986).

In considering the manner of presenting On-line Help, Harrison (Harrison, 1995) has found that the use of text-based On-line Help was generally ineffective. In this regard, Shneiderman (Shneiderman, 1983) had previously hypothesised that *the use of graphical demonstration is probably the most direct way for novices to learn the basic functionality and steps necessary to perform procedures within the graphical user interface environment*. Research conducted separately by Palmiter & Elkerton (Palmiter & Elkerton, 1991) and Palmiter, Elkerton & Baggett, (Palmiter Elkerton & Baggett, 1991), showed that this method was partially effective.

Other guidelines in the literature include:

- Visuals should be accompanied by some form of written or spoken instructions in order to cue the user to the important aspects of the visuals (Spangenberg, 1973)
- Visuals should be used to help eliminate orientation errors (Stone, 1981)
- Spoken instructions should begin simultaneously with or slightly after the visuals are presented (Baggett, 1984)
- Visuals should accurately depict the procedural step since users often prefer to follow the visual examples rather than the instructions (LeFevre, 1986)
- Explanations providing goal structure or organisational information should be presented at the beginning of the procedural task (Dixon, 1987)
- The opportunity to perform the procedure should be delayed until all steps of the procedure have been illustrated (Baggett, 1988)

- Information within each step should be explicitly stated, and the most important information is presented first (Dixon, 1988)
- Animation should be segmented to focus the user's attention on specific parts of the animated displays (Rieber, 1989,1991)
- Procedural instructions should be divided into small steps with each step labelled and presented in the order they are to be executed (Bovair, 1991)
- Instructions should be segmented to reinforce the concept of chunk or steps for completing the procedure (Bovair, 1991)
- Spoken instructions should begin simultaneously with or slightly after the visuals are presented (Mayer, 1991)

The above guidelines have emphasised most of the key aspects in the design of acceptable On-line Help Systems. One of the aims of this thesis is to determine whether current offerings of On-line Help Systems take into account these guidelines in their design, and if not, propose an optimum approach to the design and implementation of On-line Help Systems.

3.2 PREVIOUS STUDIES OF PARTICULAR ISSUES

There are a number of studies of particular aspects of On-line Help Systems. This research will review the more recent ones, and highlight their relevance to the present work. Due to the considerable body of research, it is convenient to categorise previous studies into On-line Versus Printed Documentation, Cognitive Ability, Improved On-line Documentation, Human Versus Computer-based Instruction, Evaluation Approaches and Other Approaches. Some of the studies are quite old, but these are included to show how long the provision of On-line Help has been an issue.

3.2.1 On-line Vs Printed Documentation

Relles (Relles, 1979), conducted one of the first formal studies of On-line Help Systems. His experiment was centred on the performance of subjects using an

ELECTRONIC TELLER, a simplified bank account management system. The users were given some tasks to carry out. The subjects were divided into four groups:

1. Group One was given printed manual but no On-line aids (control group)
2. Group Two had a printed manual and the traditional 'unsophisticated' single-level help facility
3. Group Three was given a printed manual and a 'sophisticated' (context-sensitive, multilevel) On-line Help facility
4. Group Four was given only the 'sophisticated' On-line Help facility.

In the first experiment, six computer-naïve students participated, and the On-line Help group had poor performance compared to those with the manual only. The On-line help facility confused the subjects and caused loss of confidence, making users reluctant to use it and more inclined to rely on written documentation.

In the second experiment, he used experienced programmers and the results obtained were more positive. Users provided with the 'sophisticated' On-line Help performed significantly better in comparison to those without such On-line Help facility. They were also more confident that they could use the system without the written documentation.

The results from these experiments were as expected; novice users are not familiar with the syntax and the semantics of programming and therefore could not effectively frame queries that the On-line Help System could understand so as to get a meaningful response. Rather, they prefer to use the written documentation that gave them the ability to browse until they find information that appeared relevant. This sort of approach is not possible in current On-line Help Systems. Expert users are already familiar with the syntax and semantics of programming, and this made it easier for them to frame meaningful queries, so the system was able to provide them with the relevant information. Neither group of users were ideal candidates for the experiment. Target users (for example, bankers or accountants) should have been used instead.

In another experiment, Dunsmore (Dunsmore, 1980), studied the performance of novice computer users using a sports-oriented, question-and-answer information retrieval system that was designed for use by non-programmers. Subjects were divided into three groups: the first received a brief written summary of the capabilities, commands, and available data; the second group received the brief summary and two additional pages of more detailed On-line documentation; and the third the brief summary and the two additional pages in printed form.

The results indicated that the third group with the additional two-page printed information had the best performance, while the second group with the same two-page information (but On-line) had the worst performance. Dunsmore concluded that On-line documentation took valuable time away from problem solving, and that important information may have rolled off the screen during the process of requesting it.

The results of this experiment are similar to the conclusion of Relles, from his first experiment. One may argue that the poor performance of the novice users in this experiment may likely be due to the size of the screen and the fonts and text styles used. Also windowing software that enables users scroll up and down thereby bringing hidden information to view was not available. These observations are clarified in the study carried out by Wright & Lickorish (Wright & Lickorish, 1983).

Wright & Lickorish studied proof-reading of 134-line texts that contained 39 errors, comprising typographic and spelling errors, missing words and repeated words. They used 32 subjects and divided them into two groups: the first read from an Apple II computer using an 80-column display on a 12-inch black & white screen, and the second read from a printed copy generated by a dot matrix printer.

The results indicated a significant increase in detected errors with the printed text. There was also a 30- to 40-percent advantage in speed using the printed text. These results are clear indications that users experience difficulties reading from screens, although in this case they used a small display (12-inch), which is rather small when compared to what is currently available today. A study whose results showed a close match between the screen and the printed documentation was that reported by Gould & Grischkowsky (Gould & Grischkowsky , 1984).

Gould & Grischkowsky studied the proof-reading for typographic errors on displays and on output from a computer-controlled photocomposer. Both the On-line and the printed versions had 23 lines of text per page, with an average of nine words per line. 24 subjects spent 8 hours reading in each format.

The results indicated that reading rate was significantly faster on the printed version (200 words per minute) than on the screens (155 words per minute). Similarly, accuracy was higher on the printed version than on the screen. However, when they later carried a series of similar experiments on improved displays, the differences were much smaller than the earlier ones (Gould, 1987a,1987b).

These results are indicative of the fact that display technology has to match that of paper before users can fully be comfortable with On-line information.

Cohill & Williges (Cohill & Williges, 1985), in their study, compared three situations - user/system initiated help, user/system selection of help topics and On-line/offline presentation of information. They used nine naïve users in eight groups to cover all possible combinations of the three situations. Their results suggested that user-initiated and user-selected groups performed better than the system-initiated/selected groups. Also, they found that the offline mode of presentation was the best of the three.

It is interesting to see that this study also does not favour active On-line Help Systems. This is because the general perception among researchers is that users tend to favour a system in which assistance is given when the system realises that the user needs it. The results of this experiment suggest otherwise. This could possibly be because of the limited number of subjects (N=9). This means that there was only one person per category (there were eight categories in all). Hence the results are just suggestive rather than conclusive.

The results on printed documentation can be accepted since they are in agreement with the previous research carried prior to their study. It would have been interesting to find out whether this user behaviour changed due to advancement of technology. There is no recent literature on the subject.

Emdad (Emdad, 1989), studied the instructional effectiveness of printed documentation in comparison with the On-line Help System of a database management application. His study was based on Shneiderman's classification of the interaction modes available to a database management system user (Shneiderman, 1978):

- Host Language Embedding
- Self-contained language
- Computer-directed
- Natural Language
- Human Intermediary.

The study centred on the Natural Language mode of Interaction, in which the novice users typed their queries in a natural language fashion. He conducted the experiment with 44 junior-year undergraduates. They had no computer background, and were divided into two groups of 22 each. The first group was introduced to the Natural Language interface through the use of the On-line tutorial facility of the system, and they used it for their learning. The second group was given printed manuals and used it to learn the system's concepts. They were then tested for their ability to formulate queries using simple, as well as

advanced, features of the system not covered during the training session, and also printed simple reports. They were asked to formulate 20 queries, to retrieve relevant information from a database containing employee data. Four instructors monitored the experiment, answering and recording the questions asked by the subjects.

Time was determined to be one of the success criteria (instructional effectiveness), a measure of the time taken by a subject to correctly formulate a query. At the end of the experiment, the subjects were asked to complete a questionnaire, and among the questions asked was a rating of the degree of confidence in their formulation of queries. The rating ranged from 1-very sure correct to 5-very sure not correct.

The results indicated that those who used the printed manuals performed better than those who used the On-line tutorials. The users were more confident in their query formulation than those using On-line documentation and also took less time. The users of the On-line group expressed their dissatisfaction with the On-line documentation due to lack of detailed information as well as its constant referrals to the printed documentation - which was considered frustrating.

In this study, the designer employed a questionable bad design principle: Referring users to the Printed Documentation which may not be available at the time the user is attempting to find ways of solving his task related queries On-line. This defeated the aim of providing the On-line tutorial.

In a similar experiment, Baxter & Oatley (Baxter & Oatley, 1991) studied the learnability of spreadsheets by inexperienced spreadsheet users and those with previous experience.

Their experiment was carried out using Microsoft Excel version 1.03 and Wingz version 1.0 (Informix Software). These two systems were chosen because they were marketed simultaneously and had similar functionality and were explicitly

compared in product reviews (Sudwants, 1989). They both used Apple Macintosh IICx for the experiment.

Thirty-two (32) subjects took part, 16 of which were naïve users and 16 experienced spreadsheet users. They were divided into four groups: naïve users learning Excel, experienced users learning Excel, naïve user learning Wingz and experienced users learning Wingz.

The subjects were asked to complete an initial questionnaire, which centred on finding out their previous experience with spreadsheets in particular, and computers in general. This was done in order to attribute the differences they found to previous spreadsheet use and type of spreadsheet being learned. Analysis of the results indicated no significant difference as a function of previous spreadsheet use, type of spreadsheet being learned or the interaction of the two. The authors concluded that previous general computer experience would be unlikely to contribute much to any of the differences found.

They also asked subjects to familiarise themselves with the spreadsheets, 60 minutes for the experienced subjects and 90 minutes for the naïve subjects. They were then given a simple task to complete in 15 minutes, after which they were asked to complete a questionnaire, which centred on the subjects' experience with the spreadsheet interface including the documentation.

The subjects were also asked to rate the usability of the documentation of the applications they learned, in terms of clarity and simplicity of the instructions, explanations of things done, recovery from errors, and how they compared with other documentation. The results indicated that users preferred the Excel documentation as opposed to that of Wingz. Experienced and Naïve users showed no significant differences in their opinions on this matter.

On the question relating to the preferred strategy of learning, the results indicated that majority of the respondents employed some mix of reading the documentation

and actually using the package (hands-on), as opposed to using On-line documentation and other means.

Also, respondents were asked to state the actions they usually took when they could not proceed. Results indicated that 87% of experienced users and 75% of naive users consult the documentation at some stage, while 25% of experienced users and 56% of the naive users consult a more expert user at some stage; and only 12% of experienced users and 18% of naive users consult the On-line Help at some stage.

Their overall findings were that previous spreadsheet experience had a large effect on task scores, and that this far overshadowed the effects of brand of spreadsheet being learned. In terms of performance, there was no difference between the two packages studied. These results are in agreement to the assertions made in chapter I: that the performance of subjects on given tasks will depend on their level of experience, and these are further discussed in chapters V and VI of this thesis.

O'Hara & Sellen (O'Hara & Sellen, 1997), in their experiment, compared reading from paper to reading On-line.

They held the view that On-line information may one day replace the printed paper, citing the existence of the Web, new hypertext applications, digital libraries, and digital document reading devices as their reasons for holding such views. Stating it in their own words "*these advances will make books obsolete and radically alter the author-reader relationship as well as the concept of libraries as repositories of physical volumes of books*". This may be true for On-line databases but it is certainly not obvious in the case of On-line documentation.

Their work is distinguished (in their view) from earlier in the following respects:

- took a broadly descriptive approach rather than focusing on the measurement of one or two narrowly defined aspects of reading behaviour used an

experimental task which, in their belief, was both naturalistic and representative in real work environment

- the recording of subjects' comments on videotapes, stating their own behaviour to enrich the experimenters' understanding of reading through the subjects' perspective.

According to their findings, previous research was limited by:

- (i) focusing on 'outcomes' such as speed, proof-reading accuracy, and comprehension
- (ii) devoting lesser effort in looking at 'process' differences between reading on paper and reading on the screen, such as how readers look at text in terms of eye movements, how they manipulate it and how they navigate through it.

They preferred text summarisation for their study, to other methods because, according to their argument, "*it encompasses most of the purposes of text reading (skimming it rapidly, scanning for a specific information and reading for comprehension or reading it reflectively)*". They used a word processor running on a workstation for their experiment.

The sample population was made up of 10 subjects from the research and administrative staff of their laboratory who use computers daily and were experienced users of the application used. They were given the task of producing a summary of about 200-300 words, of a 4-paged article from a science magazine. five subjects were asked to read on paper and summarise on paper while the remaining five were asked to read and summarise on the computer. They recorded each session on video and on completion, the subjects were individually interviewed about their activities, especially on items of interest to the research.

The results indicated that while reading on paper, annotation was very important, and that movement within documents was very important in both cases because it assists planning, referencing and checking understanding of the text read. Also, in

the case of the paper experiment, movement was very easy and speedy as well as being automatic while in the On-line situation, scrolling and navigation were irritating and distracting.

Similarly, the spatial layout of the documents were important in both cases because they enabled the subjects to gain a sense of the overall structure, cross-reference within text and interleave reading and writing. Also, in the paper situation, the ability to unclip the papers and lay them out individually and move them around freely was an important aspect exploited in the experiment, as well as the ability to quickly refer to other documents while writing. However, they noted, that in the On-line situation, the restricted nature of the computer display in terms of width/length gave a lot of concern to the subjects.

In summary, with the exception of the study of O'Hara & Sellen (O'Hara & Sellen, 1997), the results of the experiments presented in this section have favoured printed documentation over On-line Help Systems. These studies were done when display technology and the required programming facilities for designing and implementing 'sophisticated' interactive systems were not available as they are today. One might have expected that today's advancements would have enabled application designers implement such systems, and displays are large enough for the comfort of the eye. However, the story still remains the same: despite the advancements in technology, the preferred means of assistance by users of software is still the printed page (See Corrigan and Kennard, 1997).

3.2.2 Cognitive Ability

Barnard et al (Barnard et al, 1982), studied the ability of subjects to remember both command names and the function of the commands. The subjects were given a word processor to perform a word processing task - editing a distorted proverb. The subject pool comprised forty-eight (48) naïve computer users. The authors' aim was to assess the effects of different strategies for command names - which could either be named specifically, such as FRONT, INSERT or generally such as

MOVE, ADD. In both cases, they defined the measure of remembrance as *the number of times a user accessed a second level of help*: the first level being the definition of the commands; the second being the definition of the command's function. The subjects were divided into two separate groups: one group used the specific command names while the other used the general command names.

The results indicated that subjects using the general command names used the descriptive help information more often compared to those with the specific command names. Similarly, retention for command names was poorer for subjects who used the general commands despite greater exposure to help information.

They further analysed their data by looking at the cognitive failure score of subjects. The score was obtained from a questionnaire that asked subjects how often they forgot things such as names or appointments. The analysis indicated that subjects with high cognitive failure scores are less likely to consult the descriptive help level.

The likely reason for this observation from the study is: When users ask for help they are actually adopting a passive cognitive strategy for learning and this leads to a less efficient retention of information than if they had spent time actively considering the options.

Similarly, a possible explanation of the observation that subjects with high cognitive failure scores are less likely to consult descriptive help, may be because the subjects were more impulsive and less likely to take full advantage of the help available to them. Alternatively, it may be attributed to those subjects adopting a more active learning strategy, leading to a constructive mapping between command names and their meanings.

It can be deduced from Barnard's experiment that users' cognitive abilities play an important role when learning an application, and should be given consideration when designing learning systems, such as tutorials or On-line Help Systems.

In another experiment, Briggs (Briggs, 1990) studied the theoretical and practical issues associated with self-directed learning. She argued that such studies were interesting for both theoretical and practical reasons: in practical terms, they give direction to the design of an interface, manual or training package.

Briggs commented that previous studies had indicated that computer users were not very good at self-directed learning, and she gave three major reasons as contributing factors –

- that self-taught users were said to be beset by a 'motivational paradox' (Carroll & Rosson, 1987) in which the goal to complete work conflicts with the goal of learning more about the system.
- the presence of a 'cognitive' or 'assimilation' paradox (Carroll & Rosson, 1987) whereby people have to draw upon whatever experience is available to them, in order to assimilate new information into an already existing knowledge base.
- that this group of users may lack the meta-knowledge which tells them just what it is they do not know.

Briggs further pointed out that previous studies had shown that software designers assumed that users could teach themselves how to use the new systems. However, the opposite is almost always the case, because:

- (a) users may have little relevant experience to direct their learning;
- (b) even with experience, they may not be able to form the right queries;
- (c) the converse - that written explanations may not directly improve their performance on computer-based tasks.

Briggs also pointed out that embedded user models, which make assumptions about the user's knowledge of the system and based upon the user's performance

in certain tasks, could be doomed to failure if performance on these tasks did not mirror verbalised knowledge. Formal methods of user modelling may be of limited use if their underlying task decomposition fails to map onto the self-taught user's perception of the task.

The issues under investigation were:

- (a) the role of experience in a user's ability to generate queries about the task;
- (b) the extent to which this correlates with performance; and
- (c) the extent to which the mental task descriptions available to the experienced user map onto those anticipated by formal analyses.

Eighteen subjects, all studying some aspects of office work at a college of education, took part in the study. They were divided into three groups of six subjects each:

- Secretarial students, who completed a six months secretarial course and had experience in the use of a dedicated word processor
- Business studies students, who had a limited word processing experience using PC-based word-processors as well as other business software.
- Secretarial trainers, who were experienced secretaries, having knowledge of both dedicated and a variety of word processing software, and who were studying to become trainers.

Each of the subjects was assigned to an Apricot Xi system with word processing software (SuperWriter) running and a printer attached. Their task was to reproduce a typed letter. They were also told to ask questions before the start of the experiments, the questions were audio taped, and their actions during the experiments were recorded in shorthand. At the end of the experiment, they were given an additional on-screen testing which consisted of a set of edit functions.

The results were reported in three different categories: users' questions about the system; keystroke data on the task and subsequent test; and an analysis of user

behaviour during both task and test. The results indicated that subjects did not ask many questions; Group One asked an average of five questions, Group Two an average of eight, and Group Three an average of twelve. Further, the analysis of the questions revealed that the groups differed in the extent to which they were able to use their experience to generate useful questions. Here also, Group One were found to be unable to ask useful questions, Group Two were able to use their experience to verbalise additional queries, and Group Three were the most successful and able to use their experience to ask questions about both the task and the machine interface. She concluded that diversity of experience played an important role in the extent to which users learn advanced features of a system.

On the performance of the subjects on the task and the tests, the results indicated that there were no obvious differences between the groups, and she concluded that this provided additional evidence for the dissociation of verbalisable knowledge of a task, and performance ability. Performance observations, which were carried out to determine the kind of learning curves that might best represent self-directed learning in a performance domain, revealed a remarkably poor learning curve. During the task, performance improved but during the test, performance decreased.

Briggs concluded that although the study did not form a particularly coherent picture of subject strategies, it demonstrated the difficulties that would be contingent upon any attempt to 'parse' user actions, and to use these parsed actions as the basis of an embedded user model.

3.2.3 Improved On-line Documentation

A number of studies have utilised improved, and more varied methods for supporting On-line assistance.

Magers (Magers, 1983) described how he tested an improved version of the VAX/VMS operating system, using thirty (30) computer novices in a file manipulation task. The improvements included providing a help key, providing

context-sensitive help, more flexible syntax of help commands, additional tutorial information, elimination of computer jargon, use of examples, directory of synonyms, paging of information and rewriting help messages to be task-oriented. The results showed that the improvements, in the words of Magers, '*had a dramatic effect on user performance in the tasks*'. The users of the improved system completed the tasks faster, used more commands, made fewer errors, used help more often and asked less questions.

Mager's study showed that system redesign can be profitable, however it failed to identify a specific change or a combination of changes that particularly improved performance. There were so many variable changes that no specific conclusions could be drawn

Mason & Thomas (Mason & Thomas, 1984), implemented a prototype adaptive On-line Help System for UNIX. Users requesting information from the On-line manual (using the MAN command) were given different amounts of information. The information contained more extensive and sophisticated material for 'expert' or more system-proficient users. The quality of the information of their adaptive system was an improved version of the Standard MAN content. Eighty-five subjects were asked to carry out some tasks using the improved system as well as the standard MAN Documentation, and user activity was recorded. The results of the study indicated no meaningful improvement in performance between the two groups of users.

An analysis of the study revealed that the prototype system was poorly designed. If appropriate design principles had been followed, an adaptive system with improved performance might have resulted. Additionally, if the system had been made more context-sensitive, taking into account the level of user experience as well as the context of the help request, it might have been more useful than what was observed. This approach was tried by Borenstein (Borenstein, 1985).

Borenstein implemented a help system for UNIX called ACRONYM, combining several access methods, such as window-based, keyword, computer-initiated, menu-based and context-sensitive access methods. He used two groups of subjects - experienced and novice users, and asked them to complete a set of 22 tasks, and recorded the mean task completion time. He compared ACRONYM to three other systems - the Standard UNIX On-line manual, a simulated natural language system, and a human tutor. He divided the users into different groups. Those that were asked to use the baseline help system (MAN/KEY) were also given a copy of the UNIX manual as well, while those using the ACRONYM system were given instructions for its use. Those with the human tutor were allowed to ask any question, but were not allowed to rely on the tutor's prior knowledge of the problem. Those with the simulated natural language were asked to type their requests to the system, and an 'expert', unknown to the subjects, searched ACRONYM and sent them the responses. In essence, those using the simulated natural language were using the ACRONYM system, with an experimenter acting as a translator (a sort of Wizard of OZ technique).

The results of this study indicated that the ACRONYM system improved the performance of both experts and novices as compared to the simulated natural language help and the standard On-line manual of UNIX. The only help method shown to be superior to the ACRONYM system was the human tutor.

This study, however, had some shortcomings. Although the performance of the two groups of users was significantly enhanced by the improvements to the systems, the study failed to isolate the main factors that caused these improvements. The study should have identified whether the improved performance was the result of access methods or the help texts. Secondly, the main performance measure, the mean task completion time, can be affected by the number of help requests issued by a subject, the time taken to find the appropriate help and the number of uncompleted tasks, hence affecting the overall results. The effect of these factors are discussed in detail in chapters V and VI, where a similar experimental study is presented.

Ross (Ross, 1987), in his study, measured the usage and adequacy of the On-line documentation for the support of the interface of an EDP system. The documentation consisted of menu-driven screen documentation which provided an introduction, field definitions and review of input values for those fields, and error message documentation which allowed users to obtain further details for an error message. He automatically tracked and maintained the usage of the documentation, based on the frequency of access on a daily and weekly basis. The results of this study showed that users of the system were accessing both forms of documentation at various frequencies.

He then expanded the objective of the study to encompass an analysis of use as a function of time before, at, and after a major system change, analysis of use as new users are introduced to the system, and an analysis of frequently accessed error messages.

To achieve the first objective, he studied two subsystems of the main system, and the results indicated that documentation usage started to increase after users were trained and began using the modified system, and gradually decreased to expected levels. Similar results were obtained for the second and third objectives.

These experiments are interesting because they provided a means by which vague messages, production problems, missing explanations and poor design and documentation were identified, at different stages of the system development cycle.

Carroll & Aaronson (Carroll & Aaronson, 1988), in their study, used a technique called the 'Wizard-of-OZ' technique, where subjects interact with a computer through a standard interactive dialogue at a terminal in the belief that they are conversing with the computer. However, subjects' command lines are sent to another monitor where a human expert, known as the 'wizard' sends back reply to the subjects. They used this technique to monitor users' terminal activity and

provided error recovery when necessary. Help could only be initiated actively by the system, and if inadequate, the user option was to ignore it. Only a further error triggered assistance again. The 'wizard' provided two types of information: how-it-works and how-to-do-it. Subjects were divided into two groups, each receiving one of the two types of information.

Several usability problems were identified, among which were

- users often pre-empted and discarded advice given to them, and this often led to more errors during the process of recovery.
- timing of presentation of information,
- too much expectation from the system by the users.

There are a number of interaction problems in the design of their system. First, when a user returns to the task - after help is issued, the help window disappears, and in the case of a large number of procedural steps, the user may not be able to recall all the necessary steps required to successfully carry out the task. The help screen should be available while the task is being carried out, although this may also cause another problem - obscuring of the screen area. Secondly, users had no control over the manner in which help was presented: presentation of On-line Help depended only on user errors and could not be explicitly called. Thirdly, they did not examine users' reaction to the system or compare the performance of the two groups. Finally, there were only four subjects in each group with varied experience level, and there was no control group that used only the application's static On-line Help System.

Goodall (Goodall, 1991) has described an approach used in implementing an On-line Help System for PowerSoft PowerBuilder. She argued that most of the existing On-line Help Systems were not helpful to user, because they

- fail to provide users with useful answers
- were poorly organised
- were difficult to use
- had too many hypertext links.

Goodall's paper did not give details of the system; neither did it give the extent to which the aims of the system's implementation are achieved. Similarly, there were no details of any evaluation carried to test the system's acceptance and efficacy, with the intended user population.

In another experiment, Harrison (Harrison, 1995), compared still, animated and non-illustrated On-line Help with written or spoken instructions. She argued that most current On-line Help Systems used only text and that only a few studies had used computer based procedures and graphics or simulation.

She designed a prototype On-line Help System and used it to investigate the use of On-line Help

- with or without visual illustrations;
- with still graphics and with animated visuals
- with written instructions and with spoken instructions.

She used a HyperCard emulator, and 176 undergraduate students divided into eight groups, composed of 20 to 30 subjects, and into six randomly assigned treatment groups. They were asked to carry out a set of eight HyperCard authoring tasks.

The results of the study indicated that only 37.9% of the non-illustrated group completed the entire set of tasks assigned, while 66.1% of the illustrated group completed the entire set of tasks assigned. Similarly, individual subject's performance was measured and the average performance revealed that the non-illustrated groups had a combined average of 83.5% while the illustrated groups had a combined average of 92.5%

On evaluation of the error rates of the non-illustrated versus the illustrated groups, she found a significant difference, with combined cell means of 1.83 for the non-illustrated as opposed to 0.95 for the illustrated groups. Similarly, when the

average time taken to complete or attempting to complete tasks were compared, she found a significant difference, with the non-illustrated groups having a mean elapsed time of 13.80 seconds as opposed to 9.58 seconds for the illustrated groups.

Two reasons were given as to why the groups with the illustrated On-line Help outperformed the non-illustrated groups. Firstly, the visuals contained pictures of the objects in the graphical user interface that were to be used in performing the procedure. Secondly, they provided an example of the system response to the user input so the user was not surprised by the screen image displayed. The unexpected result of the study was the lack of significant difference between subjects' performance using still graphics and animated conditions. She suggested that the reason for this lay in the selected tasks. The experiment did not require animation, and segmentation of the tasks into individual steps. It is likely that the presence of Visuals contributed to minimising the vocabulary problem. So the users overcame the vocabulary problem due to the presence of the visuals. The vocabulary problem is discussed in detail in the succeeding chapters.

Roesler & McLellan (Roesler & McLellan, 1995), in their study, defined a taxonomy of On-line Help Systems, and used the taxonomy to design a modified On-line Help System for an application program. They found that the application's existing On-line Help System was grossly inadequate, being able to handle only 32% of users' help requests. They carried out three separate tests, the first was aimed at finding out what sort of help the users of the application actually wanted, the second, to validate the identified taxonomy, and the third was a repeat of test one but with the prototype On-line Help System.

In test 1, they used the Wizard-Of-Oz technique to capture how users formulated their requests for help as they encountered obstacles or questions as they carried the assigned tasks. Five subjects with varying experiences in using the application were asked to perform a set of 15 tasks, and think aloud as they perform the tasks.

They were also told to request for help from the wizard at any time, and the results were videotaped.

In test 2, they selected a set of six test subjects, consisting of application developers and technical writers, who were given the task of categorising about 209 questions gathered from test 1, alongside 131 errors committed during the test, based on the taxonomy. They were asked to indicate the location in help where they would first go in order to find the answers. The subjects were able to categorise all the questions, and achieved 80% accuracy. When they were given further information for the remaining 20%, the percentage accuracy of the categorisation rose to 97%.

Test 3 was performed in the same manner as Test 1, with the 'Wizard' replaced by the Prototype On-line Help System. Only three subjects performed this experiment, as opposed to five in the first. Here, also, they videotaped the interactions. Preliminary analysis of the results of Test 3 revealed that all subjects easily learned how to use the help system and referenced it as needed, and none of the subjects committed any of the errors committed by those in Test 1. There were 44% fewer overall errors than in the first test. Furthermore, no subject failed to find the help they were looking for.

Although these findings are interesting, they are statistically insignificant, and it is difficult to make any generalisations based on them because of the small number of subjects used in the experiment. In total, only 8 subjects performed the actual experiments; five for the first and three for the second. This is a very small sample of the total population to be used for any generalisation. Hence these results could be taken as suggestive only, unless a more elaborate experiment was carried, with a bigger sample population.

3.2.4 Human Vs Computer-based Instruction

Hicks et al (Hicks et al, 1991), studied the preferred instruction mode of learning spreadsheets, and compared computer-based and human modes of instruction.

Their hypotheses were based on the primary, short-term objectives of software instruction:

- the content of the instruction should be understood and remembered at least for a short span of time, especially at the syntactic level
- the software should be comprehended well enough so that students are able to make functional use of it
- the instruction should create a conducive environment so that students have a positive attitude towards it.

In order to evaluate the effectiveness of the modes of instruction, students' attitudes toward the mode of instruction were taken into account. These attitudes were expected to be affected by several factors, among which are the level of expertise of the user and their personality traits (Van Der Veer, 1985). They expected novice users to have a negative attitude toward computer-based instruction due to its inflexibility, and their attitude toward human instruction was expected to be more favourable.

They performed an experiment with different groups of fresh Business Studies undergraduates, who were taught how to use Lotus 1-2-3, either by a computer-based tutorial or by human instructors. The human instructors were divided into two: one group with over ten years experience in teaching at college level and with five years of spreadsheet teaching, and the other consisted of graduate students with little or no teaching experience, but were experts in Lotus 1-2-3. A total of 192 subjects participated in the experiment.

Subjects were randomly assigned to one of the three groups, and they were motivated to learn the spreadsheet by informing them that a performance of 60%

and above would count 3% of their final course grade. In each case, the same topics and examples were covered in all groups, and the instruction for both groups took 70 minutes, after which a recall test was administered to see if subjects could recall syntactic information. They were also asked to complete a post task questionnaire which contained biographical data as well as four different attitudinal variables using Osgood's semantic differential scheme (Osgood, 1957, Heise, 1970).

After the completion of the questionnaire, the subjects were given a simple spreadsheet problem to test their retention and comprehension of the materials taught during the instruction phase. A maximum of 15 minutes was given to complete the problem.

The results indicated that the amount of syntactic information retained in short-term memory was the same irrespective of the instruction mode, and this led them to conclude that computer-based tutorials could be used as effectively as human instructors to convey syntactic information.

They also found that comprehension and retention of taught concepts was better in the case of human instructors than the computer-based instruction, and the results remains the same irrespective of subject's previous experience with the computer as well as the instructor's level of expertise.

In terms of the subjects' attitudes towards modes of instruction, subjects did not show a significant preference for one mode of instruction over the other. The only exception was their attitude towards time pressure. The time given for each mode of instruction was the same, and this made those using the computer-based instruction to have poor comprehension due to an increased time pressure.

Subjects with computer experience found the material easy to learn and had a better comprehension of the material in both modes of instruction, and this led

them to assert that subjects with a high computer experience would benefit more from computer-based instruction than those low experience.

They concluded that their research indicated that computer-based tutorials can be assets to learning spreadsheet syntax, and hence could serve as introduction to the software. Users could then enhance their comprehension learning through human instruction, thereby saving expensive instruction time spent in the classroom. They also suggested that tutorials should be designed by expert human instructors, as this would improve comprehension learning, and that expert system modules could be embedded in them so that they can detect errors and provide a different instruction path, tailored to the students' needs.

A similar experiment was carried out by Ryan (Ryan, 1992). She studied the performance of 248 tertiary students, with no previous computer knowledge on three software applications - a word processor, a spreadsheet and a database management application.

The aim of her experiment was to redress the situation of the findings of most of the previous research, that novice computer users find information more quickly using printed documentation or with the assistance of a tutor than with the On-line Help.

Out of the 248 students, 49% were females and 51% were males, 21% never used a computer while 24% were regular users. Each student was given programmed lessons and printed documentation, and was encouraged to seek assistance from the instructors in deadlock situations. At the end of the training, they were asked to complete questionnaires.

The results indicated that 82% of the word processor users knew the availability of On-line Help, 86% for the spreadsheet and the same for the database. However 27% of the word processor users did not use it. Neither did 24% for the spreadsheet and 20% for the database.

In responding to how easy it was learning to use the help facility, 63% of word processor users found it easy, the same for the spreadsheet users and 58% of the database users. 19% of word processor users found it was hard to learn to use, the same for spreadsheet users and 24% of the database users, and 16% of word processor found it difficult, 17% of the spreadsheet users and 23% of the database users.

In responding to the question about the style of the help 17% referred to the On-line Help as being disruptive while 57% to 62% valued the fact that it could be accessed from anywhere within the package.

In response to the question on the language of the help statements, many indicated that it presented them with communication difficulties. 53-55% of the respondents found it was hard to find specific commands, 35-38% that it was useful only to those familiar with the system, 22-23% never found the commands they were looking for. The further shows the existence of the Vocabulary problem.

In response to the question about the contents of the help statements, the following responses were presented:

1. General information was available - 64-67%
2. Specific information was available - 38-40%
3. The information was not specific - 68-74%
4. The information was not concise - 39-44%
5. The On-line Help assumes too much knowledge - 51-57%
6. The On-line Help was useless - 45-52%
7. User had to wade through 'pages of text' to find the required information - 40-67%
8. The On-line Help gave sufficient information on how to use each command - 13%

9. The On-line Help enabled users to quickly find the information they were looking for - 12-14%.

In responding to the question on the preference of the type of help system, 81% preferred context sensitive help, 40% preferred menu help systems with windows, 38% menu help systems with indexed choices while 33% preferred indexed help systems.

In response to the question on the preference of the format of the help systems, 71% preferred text explanations, 66% graphic explanations where necessary, 62% a mixture of text and graphics, while an overwhelming 88% preferred stepped instructions on how to use specific commands.

She concluded that the overall result indicated that although On-line Help Systems may be the least preferred medium from which novice users seek assistance, the group found it necessary to use it even when they had generous access to their preferred media. Also, attention needed to be given to the format and content of the help systems to sufficiently cater for the requirements of users.

These studies are highly relevant to the current study. This is so for two reasons; Firstly, the applications considered in both studies are similar to what is considered. Secondly, a similar group of users is examined. However, the current study differ in methodological approach.

3.2.5 Evaluation Approaches

Brad & associates (Brad et al, 1988), designed a system Help Design Software (HDS) to be used in the design and evaluation of On-line Help Systems. The system had three components:

- Help Design Software to assist developers in the design

- Prototype Testing System to enable developers to collect user performance data on alternative menu designs and navigation systems
- On-line Help Evaluation Survey to provide developers with a hardcopy document for use in evaluating existing help systems

The system provided two levels of design guidance:

- a fully functional model help system, supporting different kinds of applications - spreadsheets, decision aids, word processors, and different system constraints - such as screen size or availability of a mouse. The user can enter and navigate the model, and finally adapt it to his needs
- a design aiding system, where a designer can request the principles and guidelines underlying the model help system, which are then displayed on the screen, and can request for further details. In addition, the developer can access various design support materials - any time within the system.

Another component of the system was the 'Prototype Testing System' - a set of tools to aid developers in experimentally testing alternative design strategies. It was aimed at enabling developers to create and test their design theories. A further component was the 'Help Evaluation Survey' - a 'pencil and paper' rating system for evaluating the design of existing help systems.

Twenty-five help systems, ranging from word processing, spreadsheets, database management, integrated processors, decision aids, and operating systems, were reviewed and the results analysed. A survey was carried and a rating system to rate various design features was developed. Four experts on On-line Help Systems were asked to evaluate HyperCard using the evaluation system. The experts rated the tool as "*a very highly reliable evaluation tool*".

It would have been interesting to see how systems such as this evolved with time and with the advancement in graphical user interface design. However, not much is obtained in the literature.

3.2.6 Other Approaches

Kiesler (Kiesler, 1997) reported the results of an experiment carried out in a community using the Internet.

They recruited subjects from high schools of four demographically diverse neighbourhoods. They carefully selected students who worked on their school's newspaper together with their families, and a journalism teacher and his family. The main reason for their selection of such subjects was to enable the subjects to have On-line discussions due to their common bond of journalism.

Their sample population was 133, made up of 57% females, 42% teenagers, 24% were members of minority groups; and 25% with household incomes less than the median US household income. They alleviated the economic and technological barriers of the families by providing each household with a Macintosh computer with 14.4 KBPS modem connected to a dedicated phone line, with each family member above 8 having a full Internet account.

The results showed that over 70% of the households called the help desk, reporting problems like installing a phone service, configuring the telecommunication software, busy signals, buggy software, inexperience with mice, keyboards, scroll bars, terminology, radio buttons and menus. However, few of them were engineers and knew what to do with the software and hardware.

After the experiment, they found out that the calls to the help desk as well as e-mail messages did not reflect the full range of usability problems - their initial model,

Usability problems -> Calls for help + Lower Usage,
was found to be entirely an opposite phenomenon from what was operating,

Usability problems -> Calls for Help + Higher Usage.

They also noted that having problems with computers was not common only to novice users but professional users as well, and hence the need for re-examining such problems, rather than just looking into help desks.

3.3 THE DICHOTOMY BETWEEN DESIGNERS' AND USERS' VIEWS

From the preceding sections, it can be seen that there exist divergent views among users and designers as regards the usability of On-line documentation in general, and On-line Help Systems in particular. While designers usually state that their systems are effective, easy to use and satisfy the user's needs, users have shown their dissatisfaction with the systems.

Designers of On-line Documentation in general take the On-line medium as the central axis in determining what the user interface and the On-line Help facilities should look like. As a result, they equip applications with the most sophisticated On-line Help Systems. In doing so, they rely on their experience and the familiarity with electronically presented data, being guided by their conviction that the On-line mode is to be preferred to other communication modes. On-line Help Systems that fit in with this design perspective can be said to be the result of an idealised task analytic model of how readers should use the On-line Help, knowing the advantages and capabilities of the On-line medium.

On the other hand, users rarely use On-line Help Systems and still largely prefer traditional techniques for providing assistance (especially paper).

Finally, until designers do away with their conceptual assumptions of the way in which things should work to the reality of the way in which things work, and replace them with the reality of the way things work by involving users at every stage, On-line facilities will remain as they are – under-utilised by those for whom they are designed.

3.4 THEORETICAL APPROACHES

Elkerton, (Elkerton, 1988) addressed the problems, both in theory and methods, poised by current On-line aiding systems, such as lack of knowledge in the design of these systems, and providing designers with only qualitative principles of design - such as “make the On-line Help task-oriented”. This, he said, was what made today’s On-line aiding systems fall far short of the ultimate goal of helping users with their problems, while also supporting continued skill acquisition at the interface.

He presented a task-analytic approach based on the GOMS (Goals, Operators, Methods and Selection rules) model of human-computer interaction, saying that the approach provides an opportunity for usability problems to be identified analytically so that dialogues can be implemented effectively based on quantitative predictions of performance time, learning time and user memory load.

A summary of prototypical On-line aiding dialogues was given, and divided into two categories:

1. On-line Assistance Systems - which have the goals of reducing the user’s efforts in accomplishing the current computer-based task, thereby reducing the amount of learning time and cognitive processing required, resulting in decrease in time and errors, and the need for user training and assistance.
2. On-line Instructional Systems which has its main goals as training and educating the user, and facilitating long-term performance

He noted that previous research on On-line Help Systems in particular, and behavioural investigations in general, have been limited considering that On-line Help is a major component of many user interfaces. Some studies have shown that On-line help can be improved and a few investigations have illustrated the potential for the disruptive effects of On-line Help. He pointed out that most research so far had generated only qualitative principles for On-line Help, but had not identified clear procedures for developing and predicting the possible improvements to On-line Help interfaces.

He further expressed concern at the primary focus of most research, saying that the focus was only on the computing technology for developing new help interfaces, and paying little attention to the method-based content required by the user of the On-line Help interface.

On the second category of On-line Aiding Dialogues; On-line Instructional Systems, have their main goals as training and educating the user as well as facilitating long-term performance. He gave a summary of the On-line instructional systems available as:

- On-line Tutorials
- Guided Exploration and problem solving
- Training wheels interfaces
- Scenario Machines
- Command-selection aids

He gave a summary of the research on Computer-Supported Interface Training, stating that behavioural investigations are available to demonstrate that it can decrease the training time and also promote skill transfer. These behavioural investigations have generated a set of principles based on theories of human learning but the principles, however, do not provide the designer with the

appropriate methods to determine what should be trained and do not provide a mechanism for predicting the usability of an instructional dialogue.

He then gave the characteristics of a theory-based approach of designing On-line aiding systems, that the theory should be capable of providing the substantive content for the aiding systems, predicting when and where On-line aiding is necessary through analysis of user interface tasks, predicting any improvements in usability which will result from the aiding dialogues.

He suggested the Design Principles for providing advice based on the GOMS Model, suggesting that goals in On-line aiding systems should be used to

- describe what can be done in task-oriented terms (interface actions and objects) for improved initial skill learning
- provide an adjustable level of detail on interface procedures for accommodating the information needs of a wide range of users
- provide procedurally incomplete advice so that users can actively learn for improved long-term performance and understanding the interface
- provide feedback to users which may help in reminding them of appropriate procedures to use particularly when recovering from errors
- develop modular assistance and instructional dialogue that can be used to describe similar and dissimilar procedural elements of the interface.

Similarly, that operators in On-line aiding systems should be used to

- describe simple actions, such as pressing specific keys or finding specific objects on the display, that are common to many interface procedures to assist the user in current task performance.
- provide detailed knowledge of interface procedures that inexperienced users can actively learn and that more skilled users can combine with other procedural knowledge to improve long-term performance and understanding of the interface.
- monitor user actions to provide context sensitive help or to actively diagnose user problems.

Also that methods in On-line aiding systems should be used to

- Present step-by-step interface procedures to assist the user with specific problems
- Improve user understanding and acceptance of On-line advice
- Decrease the cognitive load of users who are learning a new interface task by providing an explicit procedures for users to follow
- Provide procedural demonstrations of interface procedures so that users can quickly learn simple operations
- Map sequences of user's actions to a reduced set of interface goals to help provide context-sensitive advice to users

Finally, he stressed that Selection rules in On-line aiding systems should be used to help users select between multiple interface methods as well as provide users with an understanding of representative tasks to increase their knowledge of when to apply specific interface skills.

The GOMS model approach to the design of On-line Aiding dialogues is very elaborate. However, it has some limitations, which can be listed as follows:

1. The models were developed based on an error-free performance, and this made them to be ineffective when applied to systems that aid users who are generally unskilled and frequently commit errors
2. The approach does not explicitly address the individual differences of users, which may play a role in the success of an aiding interface.

It is noted, however, that this study has given a sound theoretical basis to the study of On-line Help Systems. An example of such studies that base their findings on the GOMS model include that of Coventry (Coventry, 1991) in which she studied the influence of Users' cognitive abilities on the use of UNIX On-line Help Systems, Wilkinson (Wilkinson, 1998) who studied the effect of individual abilities (cognitive style and spatial ability) and presentation methods (books and

hypertext in the acquisition of multi-disciplinary knowledge. The current study also adapted some of the concepts of the GOMS model in the system's design and implementation.

3.5 SYSTEM EVALUATION TECHNIQUES

In this section, a review of evaluation techniques is presented together with the advantages and disadvantages of each of the techniques.

As can be seen from the previous sections, evaluation is an important activity in software design cycle. In recent years, a number of practical methods have been developed, which can be applied to interface evaluation.

The term "tools", as in "software evaluation tools", or "usability assessment tools", has often been used to describe such methods. Each of the different approaches to evaluation has its own strengths and weaknesses. They also differ in their cost and in technical competence required to carry them out.

Evaluation can be either qualitative (how successful did you think the interface was?) or quantitative (what was the percentage speed-up in time to complete the task). Quantitative data deal with either user performance or attitudes that can be recorded in a numerical form. Qualitative data focus on reports and opinions that may be categorised in some way but are not reduced to numerical values. Often, the result of the evaluation of an interface is a set of design improvements.

There are two fundamental issues in evaluation:

- Deciding what dimensions to evaluate
- Putting values upon the dimensions to evaluate.

3.5.1 Common Approaches to evaluation

There are five common approaches to evaluation (Preece, 1993; Lansdale and Ormerod, 1994):

Analytic evaluation uses formal or semi-formal interface descriptions to predict user performance.

Expert evaluation involves experts in assessing an interface.

Experimental evaluation uses scientific experimental practice to test hypotheses about the use of an interface.

Observational evaluation involves observing or monitoring users' behaviour while they are using an interface.

Survey evaluation seeks to elicit users' subject opinions of an interface.

3.5.1.1 Analytic Evaluation (Formal modelling as an approach to evaluation)

Formal models attempt to define the interactive properties of the interface and cognitive skills required to use them. They fall into three overlapping categories:

1. They are exploratory tools in research. The attempt to develop formal models of interface performance reveals interesting insights and develops methodology further. To some extent, all the models described below fall into this category.
2. They represent theories of cognition and interfaces. At present, it seems optimistic to think that the models developed will qualify as scientific theories.
3. They are useful disciplines for the evaluation of interfaces.

A number of approaches to formal modelling have arisen in recent years. These are:

GOMS (Goals, Operators, Methods and Selection rules; Card et al., 1983, Elkerton, 1988)

CCT (Cognitive Complexity Theory; Kieras and Polson, 1985; Polson, 1987)

TAG (Task-Action Grammars; Payne and Green, 1986)

PUM (Programmable User Models; Young et al., 1989)

Such models have been associated with the following advantages (Olson and Olson, 1990):

- They can limit designs to psychologically plausible alternatives. For example, they can avoid overloading working memory.
- They can be used in deciding between two alternative designs for an interface.
- They can estimate performance times for given tasks.
- They can contribute to the development of training regimes and inform designers as to the most efficient methods.
- They can indicate hot spots of interface use where errors or delays can be expected, hence directing attention towards significant performance issues.

3.5.1.2 Expert Evaluation (Walkthrough approaches)

While informal demonstrations to colleagues or customers can provide useful feedback, more formal expert reviews have proved to be effective (Nielsen and Mack, 1994). Walkthrough approaches are structured methods, whose purpose is to allow evaluators to evaluate interfaces by stepping through their use without the need for formal modelling or usability testing. The expert works through the design for a particular task, step by step, identifying potential problems. For each task that the design is intended to support, the expert considers the following issues:

- What impact will the interaction have upon the user?
- What cognitive processes are required?
- What learning problems may occur?

Expert Evaluation that is guided by general 'rules of thumb' is known as heuristic evaluation (Nielsen and Molich, 1990). Heuristic evaluation consists of the application, by evaluators of varying degrees of expertise, of a set of heuristics to judge the adequacy of a design prototype. Its purpose is to be a stripped down rule base, which is simple to apply. The expert reviewers critique an interface to determine conformance with a short list of design heuristics such as the eight rules of interface design (Shneiderman, 1998).

The dangers with expert reviews are that the experts may not have an adequate understanding of the task domain or user communities.

3.5.1.3 Experimental Evaluation

One of the most powerful methods of evaluating a design or an aspect of a design is to use a controlled experiment. This provides empirical evidence to support a particular claim or hypothesis. An important feature of the experimental approach is that the evaluator can manipulate a number of factors associated with interface design and study their effects on various aspects of user performance.

The planning of the experiment requires the specification of three main elements:

1. The purpose of the evaluation has to be expressed in terms of what is being varied, what is being kept constant, and what is being measured.
2. The hypotheses have to be stated in a way that can be tested.
3. Statistical tests have to be selected to check the reliability of the results.

Two additional factors, which must be considered carefully in experimental design, are the subject chosen, and the variables tested and manipulated.

Subjects: In evaluation experiments subjects should be chosen to match the expected user population as closely as possible. Ideally, actual intended users of the system will be used as subjects for the experiment but this is not always possible. If subjects are not the actual users they should be chosen to be of a similar age and level of education as the intended user group. Their experience with computers in general, and with systems related to that being tested, should be similar as should their experience or knowledge of the task domain.

Another issue relating to the subject is the sample size chosen. This is often determined by external factors such as the availability of subjects or resources. However the sample size must be large enough to be considered to be representative of the population taking into account the design of the experiment and statistical method chosen for the analysis. Dix and colleagues (*Dix et al.*, 1993) suggested a sample size of at least ten subjects for controlled experiments as a rough guide.

Variables: There are two types of variables, those that are measured and those that are manipulated. The former is known as dependent variables, the latter known as the independent variables.

The dependent variables are those that are measured in the experiment. The dependent variable must be measurable in some way, it must be affected by the independent variable, and as far as possible, unaffected by other factors.

The independent variables are those characteristics of the experiment, which are manipulated to produce different conditions for comparison.

3.5.1.4 Observational Evaluation

A popular way to gather information about the actual use of a system is to observe users interacting with it. Usually a specific task is set by the evaluator and completed by the user, although, if the observation is carried out in the users' place of work, they may be observed going about their normal duties. Often, the conditions of the experiment make it impossible to have enough subjects for successful statistical testing. In such cases a longitudinal study may be undertaken in which subject behaviour is recorded and classified in the realistic environment and general observations made.

The evaluator watches and records the users' actions using a variety of techniques. Simple observation is not sufficient to determine how well the system meets the users' requirements since it does not always give an insight into the users' decision processes or attitude. Therefore, users are asked to 'think aloud' (describe what they believe is happening, why they take an action and what they are trying to do) to elaborate their actions.

The 'think aloud' process has a number of advantages:

1. The process is less constrained and therefore easier to learn to use by the evaluator
2. The user is encouraged to criticise the system
3. The evaluator can clarify points of confusion at the time they occur and so maximise the effectiveness of the approach for identifying problem areas.

The usefulness of the think aloud and general observation is largely dependent on the effectiveness of the recording method and subsequent analysis. There are a number of methods for recording user actions. These include:

Paper and pencil - This is a primitive method but allows the evaluator to note interpretations and extraneous events as they occur. However, it is hard to get

detailed information, as it is limited to the evaluator's writing speed. Coding schemes can be developed during preliminary studies to improve the rate of recording

Audio Recording - This is useful if the user is actively 'thinking aloud'. However it may be difficult to correlate information from the audio recording to some other form of protocol such as a hand written script.

Video Recording - This has the advantage that what the subject is doing can be seen.

One problem with the "Think Aloud" approach is that it can interfere with subjects approach to the task. Where possible, automatic logging is preferable.

Computer Logging - There are two computer logging techniques that can be used. These are Keystroke Logging and Screen Recording. Keystroke Logging makes it relatively easy to get a system to automatically record user actions at a keystroke level. Software such as *Lotus ScreenCam* enables Windows screens to be recorded and played back. This is similar to Video Recording. Direct logging has the advantage of being non-intrusive. Technical problems with it are the sheer volume of the data can become unmanageable and difficult to analyse.

3.5.1.5 Survey Evaluation

The purpose of survey methods is to address users' subjective opinions through the use of either interviews or questionnaires. The advantage of such methods is that they get the users' viewpoint directly and may reveal issues which have not been considered by the designer. In addition they are relatively simple and easy to administer. However, the information gained is necessarily subjective, and may be a rationalised account of events rather than a wholly accurate one. Also it may be difficult to get accurate feedback about alternative designs if the user has not experienced them, which limits the scope of the information that can be obtained.

However, the methods provide useful supplementary material to other methods.

Interviews: Interviewing users about their experience with an interactive system provides a direct and structured way of gathering information. Interviews need careful planning so that the line of questioning followed is relevant to the interface being evaluated. Usually, some form of plan is made before the interview: either the sequence of general topics to be covered is determined or some form of checklist of topics or questions are prepared. General questions will usually be asked first about a task and progress to more leading questions (often in the form 'why...?' or 'what if...?') to elaborate aspects of the user's response.

Questionnaires: An alternative method to querying the user is to administer a questionnaire. This is clearly less flexible than the interview technique, since the questions are fixed in advance, and it is likely that the questions will be less probing. However, it can be used to reach a wider subject group, it takes less time to administer, and can be analysed more rigorously. It can also be administered at various points in the design process, including during requirements capture, task analysis and evaluation, in order to get information on the user's needs, preferences and experience.

Given that the evaluator is not likely to be directly involved in the completion of the questionnaire, it is vital that it is well designed. The first thing the evaluator must establish is the purpose of the questionnaire: what information is required? It is also useful to decide at this stage how the questionnaire responses are to be analysed. For example, is measurable feedback on particular interface features required, or user's impression of using the interface?

There are a number of styles of questions, which can be included in the questionnaire. These include:

General - These are questions which help to establish the background of the user. They include questions about age, sex, occupation, and the like. They may also include questions on previous experience with computers.

Open-Ended - These ask the user to provide unprompted opinion on a question, for example, 'In your opinion, what additional features can improve the On-line Help System of Excel?' They are useful for gathering general subjective information but are difficult to analyse in any rigorous way, or to compare. However, they may identify errors or make suggestions that have been missed by the designer.

Scalar - These ask the user to judge a specific statement on a numeric scale, usually corresponding to a measure of agreement or disagreement with the statement. For example,

The On-line Help System helps in learning how to use the application

Strongly agree 1 2 3 4 5 Strongly disagree

The evaluator chooses the granularity of the scale. Coarse scale (say 1 to 3) gives a clear indication of the meaning of the numbers (disagree, neutral and agree). However, it gives no room for varying levels of agreement, and users may therefore be tempted to give neutral responses to statements that they do not feel strongly about but with which they mildly agree or disagree. However, a very fine scale (say 1 to 10) suffers from the opposite problem: too many choices are offered to the user and these choices can be difficult to interpret. One user will undoubtedly interpret the scale differently from another. Scales of 1 to 5 or 1 to 7 have been used effectively (Baxter & Oatley, 1991; Dix *et. al*, 1993). They are fine enough to allow users to differentiate adequately but still retain clarity in meaning.

Multi-Choice – In this category, the respondent is offered a choice of responses, and is asked to select only one of these, or as many as apply.

How long have you been using Microsoft Excel?

- *Less than a year*
- *Between 1 and 3 years*
- *More than 3 years*

Which versions of Excel have you used to date? (Tick all that apply)

- *Version 2.0*
- *Version 3.0*
- *Version 4.0*
- *Version 5.0*
- *Version 7.0*
- *Version 8.0*

These are useful in gathering information on the user's previous background.

Ranked - These place an ordering on items in a list and are useful to indicate a user's preferences. For example,

Please rank the actions you take when stuck while using Microsoft Excel:

(1 first, 2 next, 3...)

[] Use the On-line Help System

[] Consult the manual

[] Repeat the steps just taken

[] Consult an expert

A questionnaire may consist of any number of these question types. Different question types are useful for different purposes as discussed above. However, in order to reduce the burden of the effort on the respondent, it is best to use closed questions such as scalar, ranked or multi-choice, as much as possible.

3.5.2 Selecting an Evaluation Method

Preece (Preece, 1993) identified three categories by which the differences among the five evaluation methods can be summarised: the stage of interface development for which they are suitable, the extent and type of user involvement, and the production of either qualitative or quantitative data.

METHOD	INTERFACE DEVELOPMENT	USER INVOLVEMENT	DATA AND INFORMATION
Analytic	Specification	No Users, task specified	Quantitative
Expert	Specification or Prototype	Role playing, no tasks restrictions	Qualitative
Experimental	Normally full prototype	Real users	Qualitative/quantitative
Observational	Simulation or Prototype	Real users, no task restrictions	Qualitative/quantitative
Survey	Simulation or Prototype	Real users, no task restrictions	Qualitative/quantitative

Table 3.1: Differences among the five evaluation methods

(adapted from Preece, 1993)

Similarly, the table below (Table 3.2) summarised the advantages and disadvantages offered by Preece (Preece, 1993) and Jeffries and colleagues (Jeffries *et al*, 1992).

METHOD	ADVANTAGES	DISADVANTAGES
Analytic	Usable in the design and few resources required	Extremely complex and requires expertise. Broad assumptions of user's cognitive operations. Limited guidance on how to use methods therefore can be difficult for evaluator
Expert	Less complex than analytic method. Strongly diagnostic, Overview of whole interface.	Cannot capture real user behaviour. Problems locating experts. Subjective and can miss important problems.
Experimental	Powerful Method. Quantitative data for statistical analysis. Can compare different group of users. Reliability and validity high. Replicable.	High resource demands. Requires knowledge of experimental method. Task can be artificial and restricted. Cannot always generalise to full system in typical working situation.
Observational	Quickly highlighting difficulties. Verbal protocols are valuable sources of information. Can be used for rapid iterative development. Rich qualitative data	Observation can affect user activity and performance levels. Analysis of data can be time consuming.
Survey	Address users' opinions and understanding of interface. Can be made to be diagnostic. Can be applied to users and designers. Questions can be tailored to the individual. Rating scales lead to quantitative results. Can be used on a large group of users	User experience important. Low response rate (especially to mailed questionnaires). Possible interviewer or recipient bias. Analysis can be complicated and lengthy. Interviews very time consuming.

Table 3.2. Advantages and disadvantages of the evaluation methods

((Preece, 1993); (Jeffries et al., 1992))

3.5.3 Usability testing

Usability testing is based upon the principle of experimental prototypes, capturing data about the system in use and the user performance, which can then be

analysed. The evaluator must decide what needs to be evaluated and its relevance to the usability aspect being analysed. For the outcome of these trials to have validity, it is important that the users tested are representative of the intended user population and that the tasks they are required to carry out are realistic. This can be difficult if the intended user population is small and specialised, or if the tasks concerned, are hard to simulate, as in hazardous situations.

Usability can also be decomposed into the following components (Shackel, 1986):

3.5.3.1 Effectiveness

This is a measure of how well the interface, and hence, the system, performs in achieving what the user wants to do. This can be measured in terms of:

- Error rates lower than a target level.
- Task completion time within a set time.
- Usage of system facilities above a minimum target frequency.

For example, a typical usability goal for effectiveness may be:

95% of the users complete the set tasks within 10 minutes with an error rate of less than 2 % of the transactions processed.

3.5.3.2 Learnability

This measures how easy it is to learn a system, and can be quantified with measures of:

- Decreased error rates over time from the start of system usage.
- Decrease in task completion time from the start of the system usage.
- Increase in user knowledge about system facilities over time.

A sample usability goal may be:

95% of the users can learn to use the system commands to complete the set tasks of the effectiveness goal with 20 minutes of tutored training before the test.

Another possibility is to set learning goals over successive sessions:

Errors should decrease to less than 2% and task completion times of x minutes should be attained by 95% of users after 5 sessions.

3.5.3.3 Memorability

It is important that an interface is memorable so that, when returning to use the system after some time, the user does not have to relearn it. Memorability is closely linked to learnability, and is measured either by comprehension/memory recall tests or by usage tests after an elapsed time period. Example measures are:

- Correct recall of system facilities, operational procedures or command names
- Percentage of system facilities or commands recalled after time period t
- Percentage of system commands explained adequately after time period t .

A usability goal for this component could be:

95% of users should be able to recall and accurately describe 90% of the system commands 7 days after training.

3.5.3.4 Attitude/satisfaction

Attitude is the subjective part of usability, which attempts to quantify user satisfaction with the system. It is measured by rating on a scale typically 1-7, where 1 = bad and 7 = excellent. Typical measures are:

- User satisfaction exceeds a target rating.
- User-perceived problems are kept below a set level.
- User motivation to use the system exceeds a set baseline level.

A usability goal for user satisfaction could be:

95% of the users rate the overall system quality as being 5 or better on a 7 point scale.

There are a number of data that can be collected by evaluators of Usability tests, some of which are (Lansdale and Ormerod, 1994):

Throughput: Throughput is a measure of productivity. It might include the number of pages proof-read, menus navigated, problems solved or forms dispatched. When two interfaces supporting the same task are being compared, throughput measures provide a reasonable way of differentiating between them.

Execution time: The converse of measuring the number of specified tasks carried out in a given time (throughput) is to measure the time taken to carry out a given operation. The usual assumption is that longer performance times reflect poorer design. They are usually associated with greater difficulty, reduced throughput and user frustration.

Sometimes the differences in the times taken to carry out a task with different interface designs are small, and hard to establish statistically without many observations from a large number of subjects. However, small differences can still mean poor usability especially if users carry out the task for extended periods.

Accuracy: Accuracy usually refers to performance in which the precision, rather than the correctness, of inputs are at stake.

Errors: When user actions are clearly distinguishable as either correct or incorrect, performance can be evaluated in terms of the number of errors made. Errors can be used to infer difficulties deriving from a mismatch between the interface design and the user's understanding of it. Errors can arise from a range of causes sometimes in combination with other sources of data.

Subjective measures: Many usability tests incorporate an assessment of the user's subjective responses, often derived from questionnaires or rating scales. They might record attitudes to a system, preferences between alternatives, and estimations of how easy things are to do.

There are two problems in the use of subjective measures in evaluation. Firstly, what people say in response to subjective rating methods is highly sensitive to the way in which they are asked. In practice, it is very difficult to design questionnaire and rating methods that are not open to biased interpretation. The second problem with subjective measures is that they can be misleading. What the users say they prefer and what is ultimately the best design solution is not always the same thing.

Video tapes and systems logs: Many systems allow for the capture of data, which records the user's inputs to the system and timing. A number of laboratories also use video recording of users' behaviour in usability trials (see Good, 1985). In the case of UNIX the availability of an event logging system has also resulted in number of studies aimed at understanding UNIX expertise by analysis of these logs (see Bradford et al., 1990; Coventry, 1992).

Although it is easy to capture this data, it is more difficult to analyse than discrete measures of performance. A major problem is to categorise sequences of behaviour by the keystrokes or movements on a video. In addition, analysis is very time consuming.

3.6 Discussion and Conclusion

In this Chapter, a number of issues relating to existing literature have been discussed. Some of these issues include:

- The existence of specific design guidelines for On-line Help System designers and how these guidelines have been interpreted. The research revealed the existence of a number of elaborate guidelines and the non-application of these guidelines as exemplified by the failure of most systems.
- An outline of a number of studies in which Online information is compared to printed information in a number of ways – using various categories of users. The results obtained have one common conclusion – that the performance of users with printed documentation was found to be better than those with On-line Help Systems, despite the improvements in such systems. A research question that needs to be addressed is whether the situation is still the same or another design situation might change the situation. This is further explored in succeeding chapters.
- Research into other areas such as Cognitive Psychology and Human versus Computer-Supported instruction are discussed. Most research show substantial improvement in performance as experience progresses.
- The various techniques that can be used that can be used in evaluating any given system are outlined. There are a number of lessons learnt from these and this research seeks to apply some of these.

It worth noting however, that in spite of the improvements in both the printed and On-line documentation, a recent study by Rieman (Rieman, 1996) showed that many users still wish to avoid the printed paper or On-line Help Systems, and prefer to learn system features by exploration. This issue is further explored in succeeding chapters.

The basic conclusion from most of the research reviewed here is that paper documentation still seems to be more effective in solving users' task-related queries as well as useful for long-term skill acquisition. Although this is partly due to the technology, there may be a more fundamental reason for this. This issue is further addressed also in succeeding chapters.

Some interesting pointers arise for the research covered in this chapter. For example, Briggs (Briggs 1990) noted that "even with the right experience, users may not be able to form the right queries". Harrison's experiment (Harrison, 1995), showed that the use of visuals seemed to contribute in minimising the mismatch between the user's way of expressing problems and that of the system. Roesler and McLellan (Roesler and McLellan, 1995) showed that when a careful study of what users actually wanted, was carried out, subject performance increased. The problem is therefore not just an inappropriate use of technology. There is a more fundamental VOCABULARY problem. Users find difficulty in expressing their problem in the *terms of the system*. Whilst approaches which increase the richness of On-line Help access, like Magers (Magers, 1983), later adopted by Microsoft, do improve matters, the fundamental problem remains. The solution is also connected with the way users utilise paper-based documentation. There is some feature or features in paper based documentation which solve this Vocabulary problem. This research hopes to identify this feature in a series of exploratory experiments.

A fundamental issue that should be addressed before going into a detailed exploratory study is the need to investigate application software users' subjective views of existing Online Help Systems of these applications. This is necessary in order to confirm or otherwise the results of previous research reported in chapter III. Hence the first task carried out was a survey and a small-scale pilot study, the results of which are discussed in the Chapter IV.

CHAPTER IV

A SURVEY OF ON-LINE HELP USE

4.0 Introduction

In this chapter, a summary of the results of a survey conducted with a group of computer users who are professionals in their own areas, many of whom also have considerable experience in the applications examined, is presented. The main of this survey is to assess users' subjective views on both printed and On-line information – whether advancement in technology has caused a deviation from the research results reviewed in Chapter III.

From the results discussed in Chapter III, it was observed that most On-line aiding systems make ambitious claims about their usefulness in aiding users (Coventry, 1991). How true these claims are, often remains a question to be answered. Some research has been done to find out how effective these aids are in helping users. Most of the previous research discussed in chapter III suggested that computer users, especially novice users, find information about the application they use more quickly using printed documentation, or from human experts, than from On-line Help Systems. However, advancement in technology has brought about large displays with high resolution, making screen text close match printed text.

These advancements, together with the fact that many application developers are now not even giving users the option of selecting between printed manuals or On-line Help (that is, they assume that the On-line Help System problems have been solved), prompted us to re-examine the situation. We also wished to widen the field of study to users with considerable experience (as well as novices) since many previous studies have tended to concentrate upon novices alone. More experienced users and less novice/naïve users were used because the main aim

was to assess the efficacy of the systems in responding to task-related queries rather than their usefulness as tools for learning.

4.1 A Survey of On-line Help System Usage

A survey was conducted among a group of computer users who are professionals in their own fields, ranging from departmental secretaries to professors, many of whom have had considerable experience in using the applications. The aim was to determine if these users considered that current On-line Help Systems could now serve as effective substitutes for user manuals. Such a survey might support, or otherwise, the recent trend of shipping applications without the necessary printed user manuals, solely because the system designers regard the On-line Help Systems to be sufficient enough for users needs (Briggs, 1990).

Some of the users had recently undergone organised training on the use of some of the commonly used computer software - Word Processing, Spreadsheet and Database Management software. They were asked to fill a questionnaire, which was designed to determine:

- their familiarity with the software applications
- their familiarity and use of the applications' interactive On-line Help Systems
- usefulness of the interactive On-line Help Systems to their needs
- the effectiveness of the interactive On-line Help Systems in answering queries in comparison to the user manuals

A copy of the questionnaire used in the survey can be found in Appendix A. A summary of the results obtained is presented in the next section.

4.2 Results of the Survey

In classifying users of an application package, time used is not always a good measure. (Shneiderman, 1976; Fisher, 1991). Therefore, the users were asked to classify themselves as either Expert, Intermediate or Novice users according to the following criteria:

Novice Users: Can use very basic elements of the package. Often have to seek help with anything slightly away from their experience. May have used the package intermittently for some time, or for more continuous usage for a few weeks (or may have recently come off a first course).

Intermediate Users: Are confident with straightforward usage. Occasionally extend their experience without help. Do not use advanced features. Probably have used the package routinely for some time. Might help a Novice.

Expert Users: Use the package to their own advantage. Either know most advanced features or can usually pick them up when required without help. An important feature of Expert users is that they advise both Novices and Intermediates.

A total of 80 respondents completed the questionnaire (about 250 questionnaires were sent to staff at various levels in the University who had undergone organised training on the use of these applications, the rest being to staff of the Computer Studies Department who were familiar with them anyway). Out of the 80 replies, all were familiar with, and are currently using, Word Processing software, 73 (91%) were familiar with, and are currently using, Spreadsheet software, while 63 (79%) were familiar with, and are currently using, Database Management software.

4.2.1 User Expertise By Application

Based on the user categorisation given above, 43% of the Word Processing application users were experienced users, 51% were Intermediate users, and 6% were Novice users. For Spreadsheets, 15% were Experienced, 55% were Intermediate, and 30% were Novice users. For Database Management software users, 11% were Experienced users, 43% were Intermediate, and 46% were Novices.

Figure 4.1 shows the user population distribution across application packages.

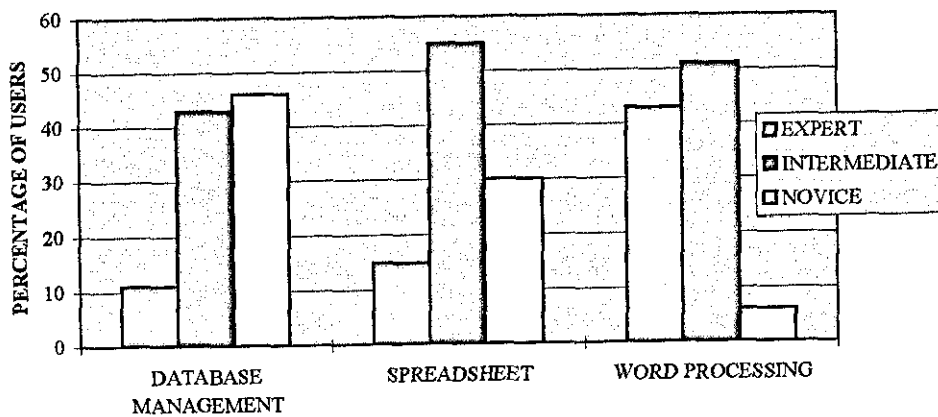


Figure 4.1 Distribution of Subjects by Level of Expertise

One can immediately see some understandable characteristics. For example, if an application package is well established (that is, has been around for a long time) the number of users of such an application in any survey will be high and their level of experience will also be relatively high. Word Processors have been around for a long time and hence people have become familiar with them due to constant use of the application. A similar assertion, perhaps less strong, can be made in the case of the Spreadsheet application. Note also Word Processing has the highest number in the category of Experienced users, where the number of experienced users is almost twice that of the Spreadsheet and Database applications combined.

This is also a measure of the popularity of Word processing. On the other hand, if an application package is relatively new or not well established, there will be fewer users of such an application and their level of experience will be relatively low. Database Management applications have not been around for so long and hence are not as common as Word Processors or Spreadsheets. This may be the reason why it has the least percentage of Experienced users in the survey.

The three applications, therefore, provide a nicely balanced base for these experiments. Word processing has a high Expert usage, Database Management, primarily Novice usage and the Spreadsheet having a distribution midway between the two.

4.2.2 Use Of On-line Help By Application

Users were first asked about their familiarity with the On-line Help System of the three software applications. A summary of the results is given in Table 4.1.

APPLICATION	Often %	Sometimes %	Rarely %	Never %
<i>WORD PROCESSOR</i>	10	41	41	8
<i>SPREADSHEET</i>	8	43	38	11
<i>DATABASE</i>	8	33	37	22
Overall	9	39	39	14

Table 4.1 Use of On-line Help in three Applications

Overall, over half the respondents in the survey either had never used, or rarely used the On-line Help System though all of them knew of its existence. Only 9% used them often. As one might expect, in the more established applications, all users had accessed On-line-help at some time, but this did not seem to encourage

regular use. It is interesting to note that less use was made of On-line Help in the less well established application package, that is Database Management. This is odd because one would have expected a high use when users were less familiar with the application.

An alternative explanation is that the distribution simply reflects the usability of the package - in other words, if a package is easy to use, then users will not often need to use the On-line Help System. However, with such a different distribution of experience with the three packages, one would not expect such a uniform response.

A more detailed breakdown of usage across Experience is shown in Table 4.2.

USER CLASS	Often %	Sometimes %	Rarely %	Never %
<i>WORD PROCESSOR</i>				
Expert	8.8	35.3	47.1	8.8
Intermediate	12.2	43.9	36.6	7.3
Novice	0	60.0	40.0	0
<i>SPREADSHEET</i>				
Expert	0	63.6	36.4	0
Intermediate	9.8	41.5	43.9	4.9
Novice	0	36.4	36.4	27.3
<i>DATABASE</i>				
Expert	0	42.9	57.1	0
Intermediate	11.1	44.4	44.4	0
Novice	10.3	20.7	34.5	34.5

Table 4.2 Use of On-line-help by Expertise level.

To probe whether users might not use On-line Help because it was not needed rather than because it did not provide the assistance they required, the researcher checked the users' opinion of On-line Help Systems in the three packages. They

were asked if they found the service Very Useful, Useful, Marginal (Occasionally Useful) or Not Useful. The overall result is shown in Figure 4.2.

Whilst there is some evidence that On-line Help is found to be useful in some cases (over all three applications 7% found it Very Useful, and 28% Useful), this still leave a massive 65% not sure of its value. If On-line Help is the only source of help (as current plans strongly indicate), users are not going to be satisfied with this lack of performance.

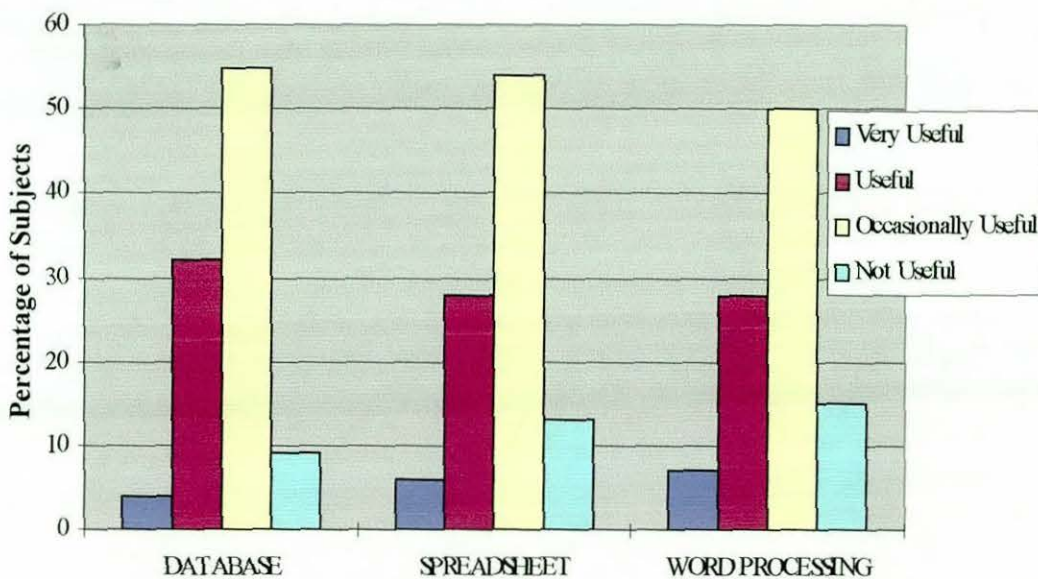


Figure 4.2 Usefulness of On-line Help across Applications

Since the On-line Help System is implemented in the same way across each application, the similarities in the distributions across all packages indicate that the response has more to do with a common problem in using On-line Help Systems rather than that for a particular package or user level. In other words there is a general problem in Microsoft On-line Help System. One might have expected differences in these distributions particularly since the user expertise distribution and package familiarity vary considerably across packages.

However, the responses above are from a mix of users. It is possible that the On-line Help System might be better suited to Experienced Users than to Novices.

The sample was therefore divided into two groups - Expert/Intermediate and Novice users, and those who found the systems supportive (i.e. Very Useful or Useful) were counted compared with the rest (Occasionally Useful or Not Useful). The results are given in Table 4.3. Actual usage (derived from Table 4.2) is given in Table 4.4.

	Supportive	Unhelpful
Experts + Intermediates	36%	64%
Novices	29%	71%

Table 4.3 Degree of Supportiveness of On-line Help and Experience

	Often	Sometimes	Rarely/Never
Experts + Intermediates	7%	45%	48%
Novices	3%	39%	58%

Table 4.4 Amount of use of On-line-help in relation to Experience

Comments from users in the survey indicated that whilst Experts blamed the system for failing to provide proper assistance, the Intermediates and the Novices often blamed themselves for the lack of usefulness of the On-line Help System. The results in Tables 4.3 and 4.4 are not encouraging for On-line Help System designers. It is not surprising that the more Experienced users get more out of On-line-help. They are more familiar with the syntax and the semantics of the applications, thereby making it easier for them to formulate meaningful queries which can be recognised by the system (Elkerton, 1988). However, Even the Experts rejected On-line Help by a ratio of 2:1.

The similarity between the responses for the two groups in Table 4.4 (7/3 45/39 and 48/58) suggests that On-line Help may be useful for certain types of queries and unhelpful for other types. So what we may be seeing is a response based on the type of problem for which assistance is being sought. For example, it may be that simple factual queries are well supported but that more complex queries are

not. This observation is similar to that of Roesler and Mclellan (Roesler, 1995), where they found that only 32% of the help requests from users could be answered or found in the On-line Help of the application studied. Similar observation was made by Mayhew (Mayhew, 1992), where she said most of the papers surveyed addressed the basic question of what the content or subject matter of a user assistance system should be. He proceeded by saying ‘Few researchers seem to have posed and answered the question “What kind of questions do novice and expert users actually ask when using a system?”’

Another reason for the similarity in responses from the three applications is that all applications used Microsoft On-line Help Systems that have been built using the same principles. Thus problems with On-line Help in the different applications may well have a common cause - design problems in Microsoft On-line Help model.

4.2.3 Comparison with User Manuals

The users were asked to indicate their preference between the User Manual and the On-line Help, based on their familiarity, use and effectiveness. 84% of the total population were familiar with and have used manuals in answering queries, while 16% were familiar with but have not used manuals to answer queries before. Of those that have used user manuals, 75% said the user manual was more effective than On-line Help in answering queries, while 18% said the On-line Help System was more effective. 7% of them said both are effective in different respects. Each of these responses was backed by a series of reasons as to why that choice had been made.

Manuals	On-line Help	Both
75%	18	7%

Table 4.5 Degree of Effectiveness of Manual compared to On-line Help

The clear preference for User Manuals is interesting since many users in the past have also criticised User Manuals as being unhelpful (Alty & Coombs, 1980a, 1980b, 1981). The result is also in agreement with that of O'Hara & Sellen (O'Hara & Sellen, 1997), as well as that of Corrigan & Kennard (Corrigan & Kennard, 1997).

The other important difference noted between On-line Help and User Manuals was an Vocabulary problem. Often users posed queries to the On-line Help System to which it gave a blank or unintelligible reply and it can take many attempts before a successful hit is made. Although this can happen with User Manuals as well (such as no entry in the index), the user is able to browse through the manual pages and often finds a suitable match to the query. On-line Help information is not usually organised in this way. It cannot easily be browsed. Ways into On-line Help often end at blocks of information and these blocks do not come together to form a whole, which can be separately browsed. On-line Help (at least in these three applications) suffers from the classical problems of Hypertext. There are many ways in, but the information is fragmented and cannot be viewed in a sequential way.

From the above results, one obvious question is why did such a large number of users still prefer user manuals, even though current On-line Help Systems are supposedly greatly improved, more interactive and said to be context sensitive? Several reasons were given by the subjects, among which was the fact that the User Manuals were more descriptive, more technical, and offered detailed examples. Also that the manuals give clear and detailed explanations of concepts, they were easier to scan through, had no restricted pattern of response, and were more procedural. Another reason given was that User Manuals did not compete with the application for screen area in contrast to On-line Help Systems. Many users also noted that it was easier to read paper manuals than On-line Help on the screen.

4.3 ACCESS MECHANISMS IN MICROSOFT EXCEL

Having conducted and discussed the survey results, this section discusses the access mechanisms of Microsoft Excel. Excel provides some of the access mechanisms mentioned in Chapter II. It is Menu-based, has Context-Sensitive buttons, has Keyword search capabilities, and an Index, together with a Table of Contents. Its designers also claimed it has a Natural Language access mechanism.

The On-line Help System of Excel is activated by clicking the 'Help' menu which then displays the menu commands such as Microsoft Excel Help Topics, Answer Wizard, The Microsoft Network, Lotus 1-2-3 Help, and About Microsoft Excel. The second method of accessing the On-line Help is by pressing the 'F1' key.

When the Microsoft Help Topics command is selected from the Help menu, the Help Window appears, showing the general organisation of the On-line Help System. Figure 4.3 below shows this.

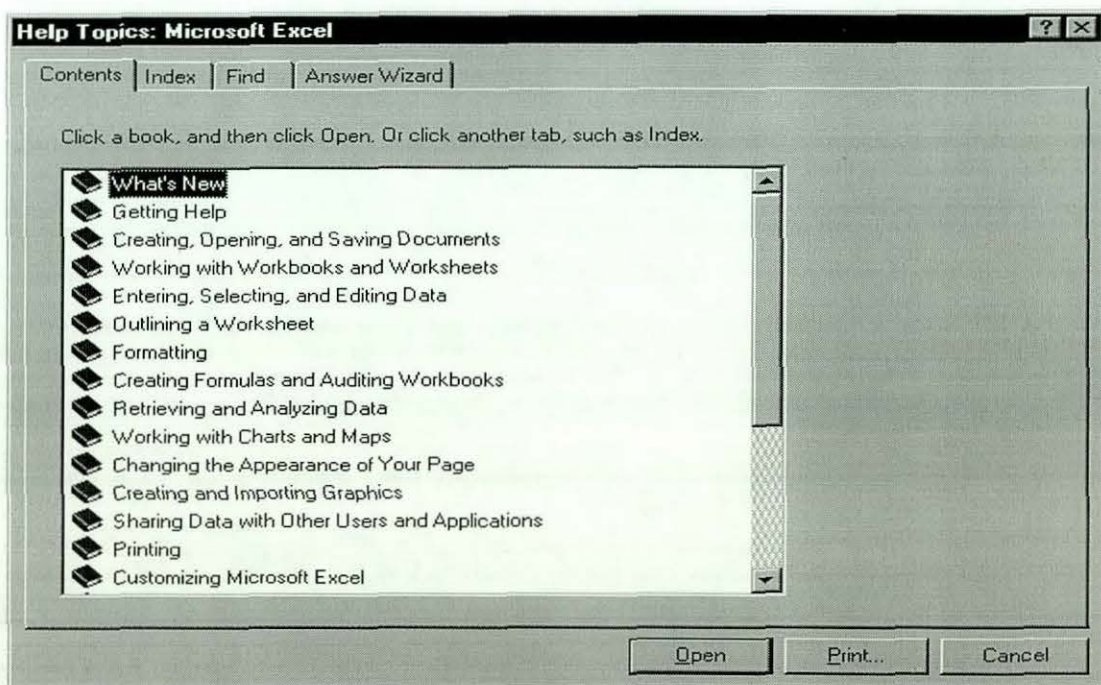


Figure 4.3: Organisation of Microsoft Excel's On-line Help System

The On-line Help dialog box has four tabs that can be used in different ways to access the required information from the Help database: Contents, Index, Find, and Answer Wizard.

4.3.1 The Contents Tab

The Contents tab is similar to the table of contents in a book. When the Contents tab is activated, each 'chapter' is represented by a closed-book icon together with the corresponding title, as shown in Figure 4.3.

When any of the titles is double-clicked, a hierarchical sequence of the titles within that title is displayed, as shown in Figure 4.4.

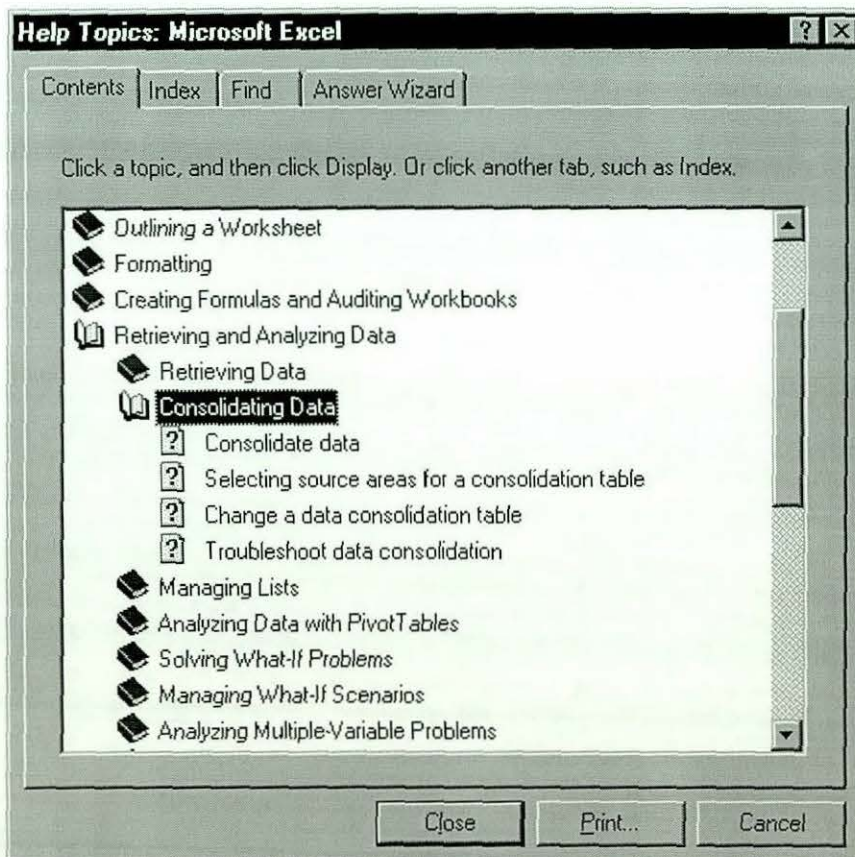


Figure 4.4: Lower Level Detail of Contents' Topic

The type of information provided at the lowest level in the hierarchy depends on the topic considered. At an instance, the displayed information will be a topic containing numbered step-by-step procedures, at another, it will be a graphic display with visual examples. Occasionally, the information displayed is an automated procedure where instructions appear in floating yellow notes telling the user each step along the way. At other times, a simple topic like the one in Figure 4.5 is displayed.

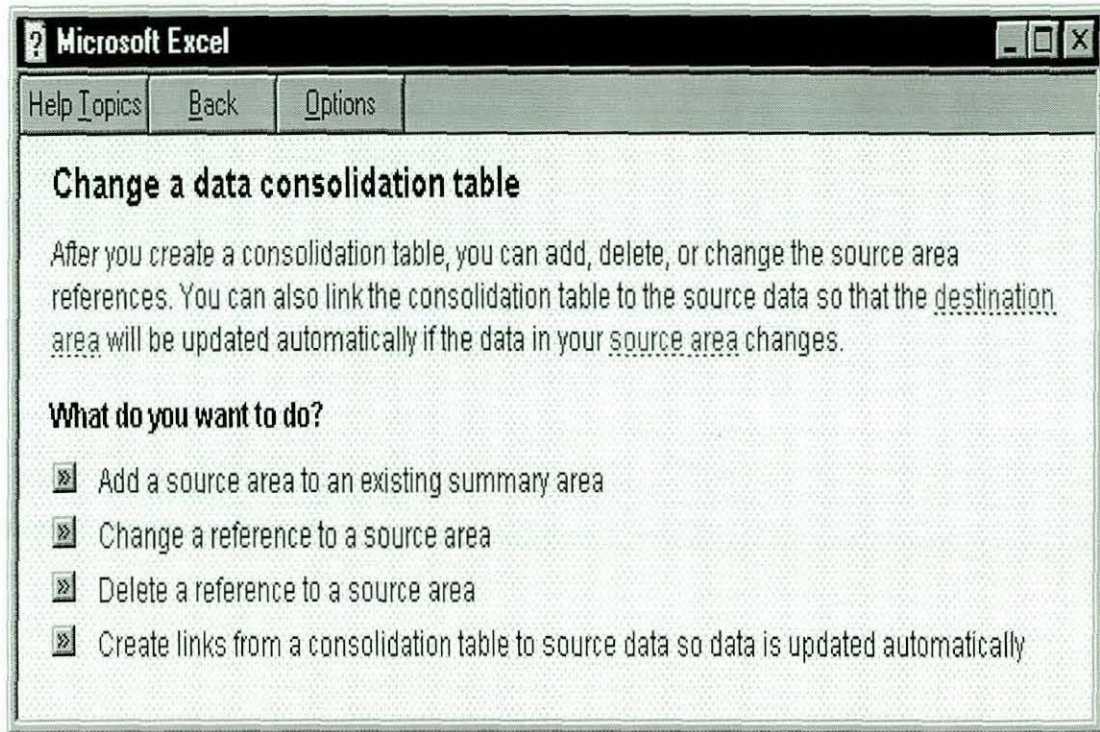


Figure 4.5: Lowest Level of Contents' Hierarchy

The Contents gives a general overview of the topics in the database, and is in most cases not suitable for On-The-Task queries, since most of these queries are not straightforward.

4.3.2 The Index Tab

The next option available to the user is the Index. It is also similar to that of the book. When the Index Tab is selected, the Help Window displays all the available keywords recognisable by the system, and a small window that enables the user to type his keyword, as is shown in Figure 4.6.

Here, the level at which the user accesses the required information, as well as the manner in which the information is displayed, depends on the topic. Some topics result into several transitions before the user accesses the required information, while in others, the transition is minimal.

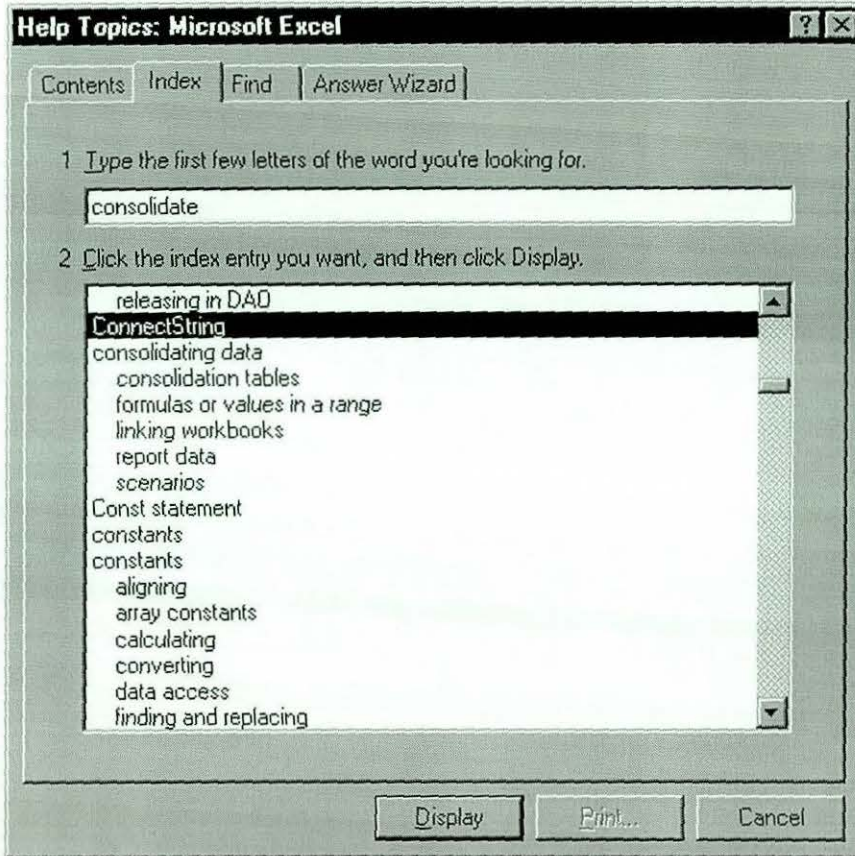


Figure 4.6: Seeking Help Through Index

As an instance, clicking at 'Consolidating data' from the window in Figure 4.6 gives the window in Figure 4.7.

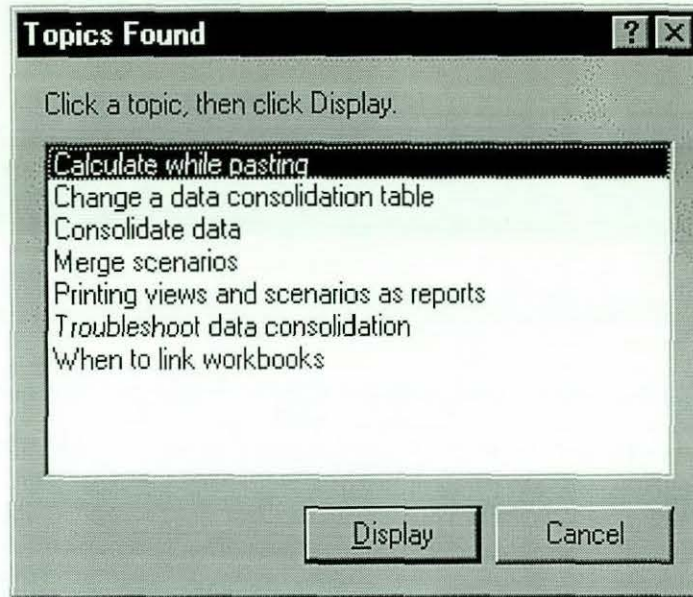


Figure 4.7: Second Level of Access Through Index

Clicking at the second topic from the window above gives same window as the window in Figure 4.5, while clicking at the fourth topic displays the graphical window shown in Figure 4.8.

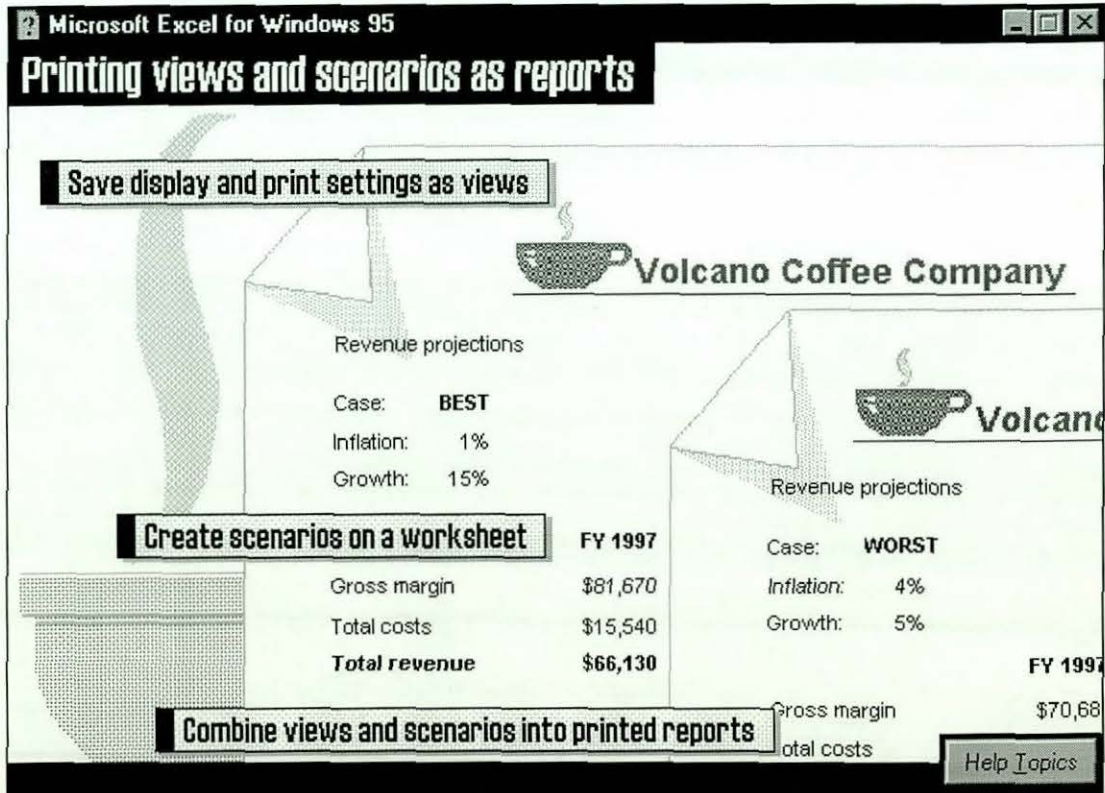


Figure 4.8: Lowest Level of Access Through Index

4.3.3 The Find Tab

A similar Access mechanism provided by the Excel Help system is the 'Find' mechanism, which is accessed by selecting its tab on the Topics bar. Here also, keywords are used, but the span of the topics displayed is more than that of the Index. As an instance of its use, typing same keyword as that used in the Index (Consolidate) displays the topics shown in the window of Figure 4.9.

An improvement provided by the current version of Excel's On-line Help System is the facility that enables the user to add additional criteria in the selection process. This helps in narrowing the search for a match. Another feature enables the user to specify the Help files to be searched in looking for the required keyword. This also assists in narrowing the search further. These features are accessed by clicking at the Options tab within the Find window, and are shown in Figure 4.10. A user finding information on Visual Basic Macro Programming for instance will select the Visual Basic Application reference Help File only. This greatly narrows the search.

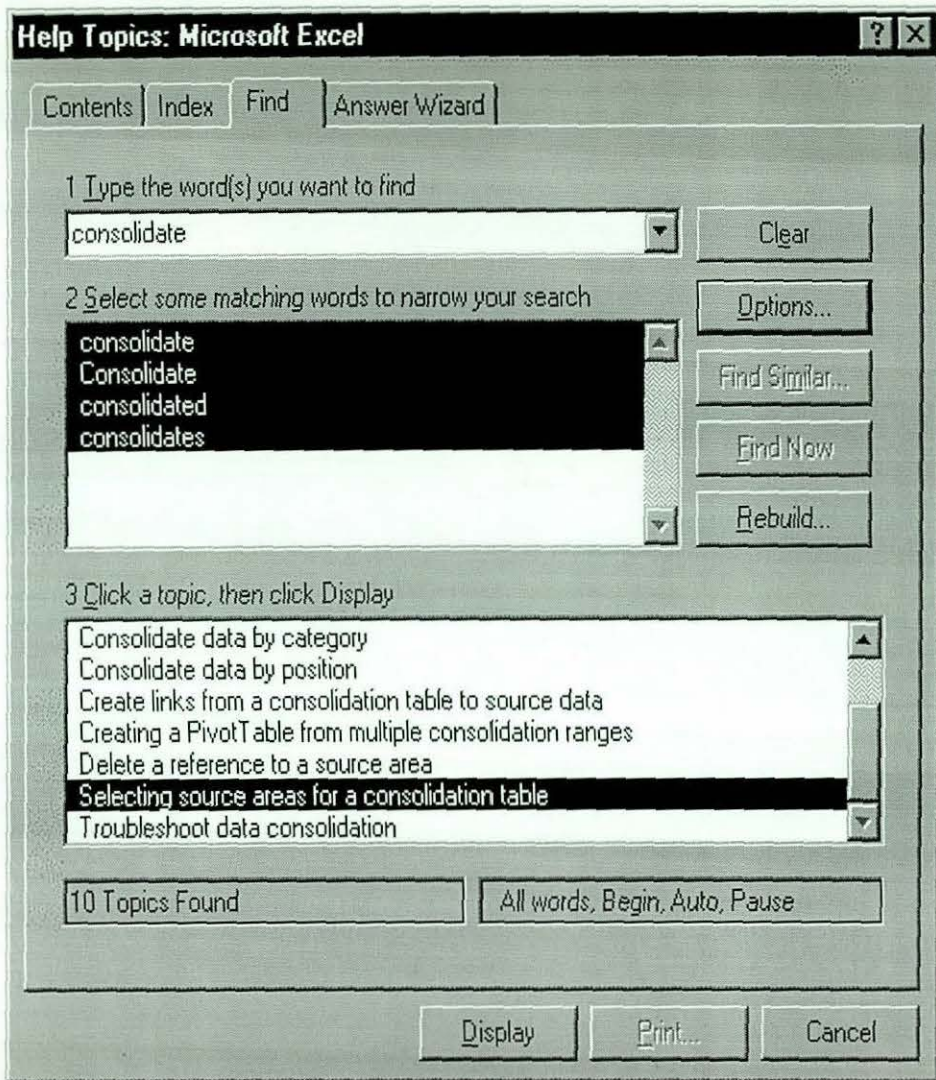
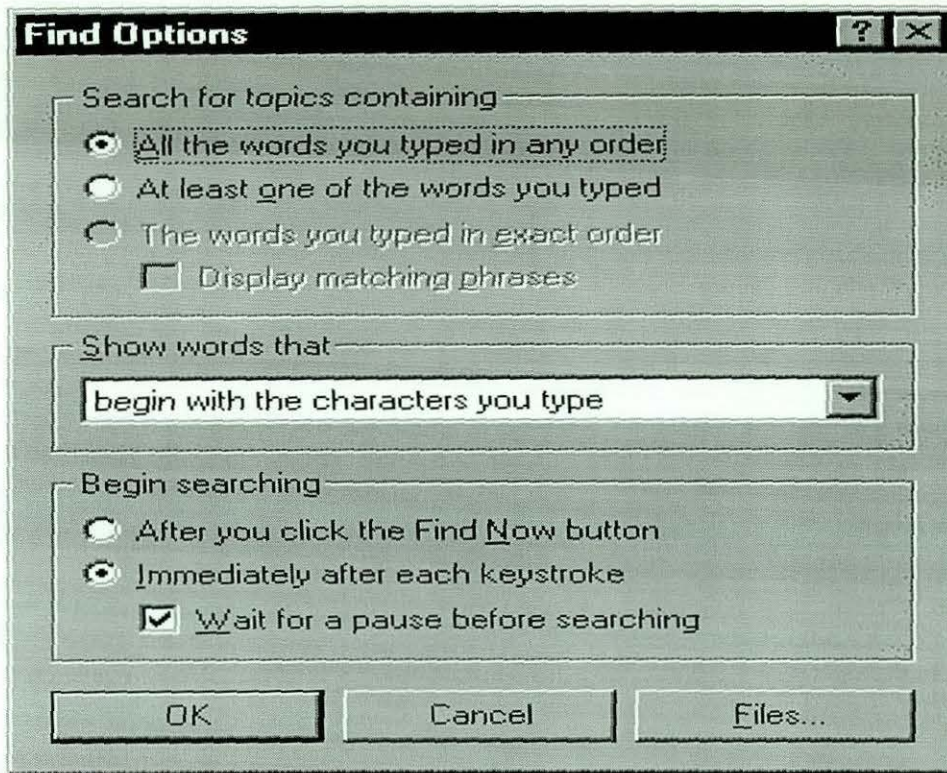
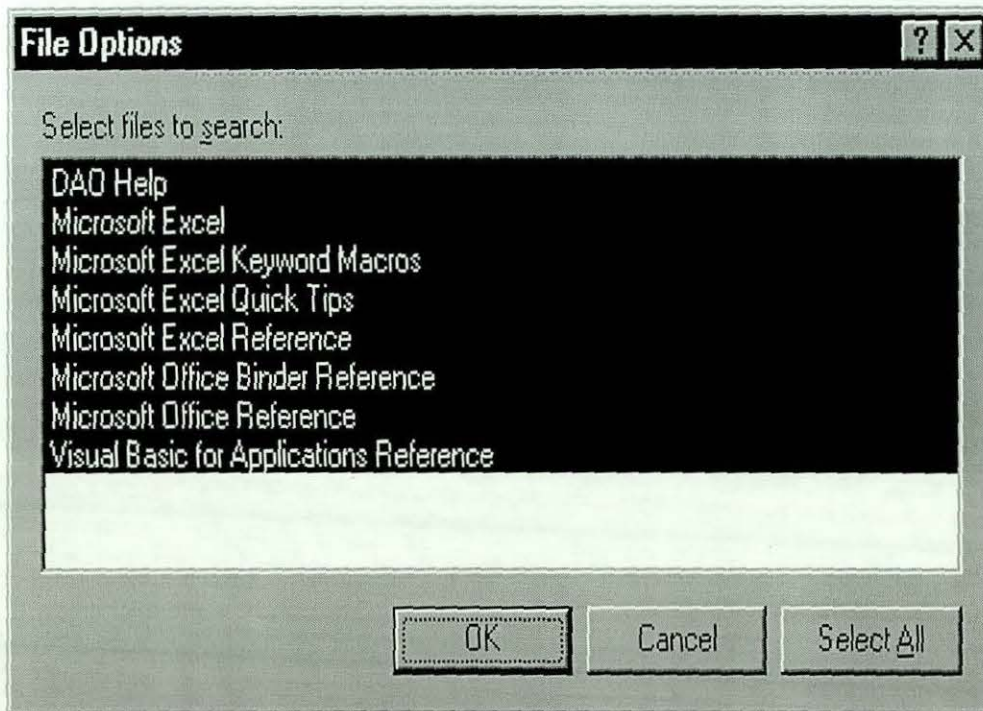


Figure 4.9: Accessing Help Through Find



(a)



(b)

Figure 4.10: Available Options of Find Access Mechanism

4.3.4 The Answer Wizard

The last tab in the Help Topics dialog box is one of the latest innovations in Microsoft On-line Help. The Answer Wizard (also called Office Assistant in Microsoft Office 97), allows the user to enter questions in full or partial sentences, using 'using natural language, just as if you were talking to the Excel guru down the hall' (Dodge, 1995).

The Answer Wizard takes the question entered by the user and, based on keywords, resemblance of words, and verbs used, returns a list of topics generated by a 'sophisticated' system of possibilities built into the wizard, called 'IntelliSense'.

When the user queries the On-line Help System using the Answer Wizard, it finds up to seven topics in each of three categories: 'How Do I', which lists procedural topics; 'Tell Me About', which contains reference and conceptual topics; and 'Programming and Language Reference', which lists topics dealing specifically with the macro programming aspects of the question. The figure below (Figure 4.11) shows a response of the Wizard using 'How do I consolidate my data?'

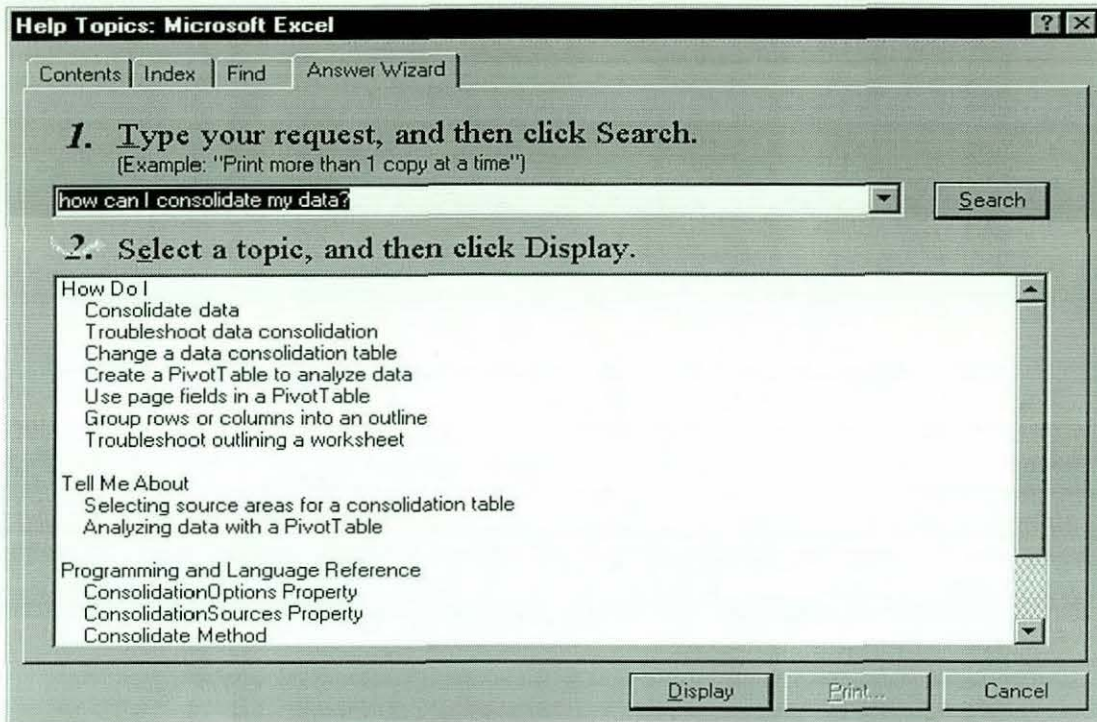


Figure 4.11: Accessing On-line Help Using the Answer Wizard

In the 'How Do I' section, the information are listed in a step-by-step format that can be followed by the user. If, for instance, the third topic under 'How Do I' section of Figure 4.11 is selected, the window in Figure 4.7 will be displayed.

In the 'Tell Me About' section, the information listed are generally the visualised form, which demonstrate the kinds of worksheets that can be created (similar to what is shown in Figure 4.8). It is generally a background information about how Microsoft Excel works.

And in the Programming and Language Reference section, the information is generally related to macro programming using the Visual Basic for Applications Language.

4.3.5 The 'Context-Sensitive' Help of Excel

Microsoft Excel has a 'Context-Sensitive' Help button, marked by an arrow and a question mark. If a user wishes to find out what a specific command within an

item in the menu or an icon within a toolbar, the user will click at the help button and point to the command or icon, and help responds by displaying the information on that command or icon.

Another 'Context-Sensitive' help button is the question mark only icon, which is present within most dialog boxes. It works like the first, but within dialog boxes.

Microsoft Excel also provides other sources of assisting the user while working. The ToolTip gives a descriptive label to a toolbar button when the mouse pointer is moved over the toolbar. The TipWizard gives tips and tricks on how a user can save time. It also monitors the way a user works, and if it has tips on the user's current task, it displays such task by 'lighting up', and the user has the option of either accepting the tip or rejecting it.

These are the ways of accessing the information within the On-line Help System of Microsoft Excel. The manner in which users find these access methods of Excel's On-line Help and the information in general are discussed in succeeding chapters.

4.4 Discussion and Conclusion

The results presented above show that the On-line Help Systems of the applications in the study are still lacking in many respects. For instance, many subjects indicated their dissatisfaction with the manner in which help information is given, that it is non-procedural, not concise and not specific, and that in most cases, irrelevant information is displayed. Others expressed their dissatisfaction with the inflexibility of the On-line Help Systems. Some felt that the On-line Help Systems assumed too much user knowledge about the system. Many users acknowledged that they had frequently abandoned use of the facility because they had failed to get appropriate assistance. However, it is also fair to point out that almost all respondents acknowledged the good aspects of the On-line Help

Systems of these applications, such as their rich indexes, search facilities, cue cards and the fact that they are accessed within the application. Users also noted that the most recent versions of On-line Help were improvements on previous versions, indicating that the designers at Microsoft are improving their understanding of On-line Help issues. Still, as Corrigan and Kennard puts it, 'for most people, despite modern technologies, the preferred presentation method is still the printed page' (Corrigan, 1997).

The results of this study are in agreement with previous research in the area discussed in chapter III. These results, it could be argued, are based on users' account of their satisfaction or otherwise of the existing On-line Help Systems – subjective views of users - and hence may be biased. This necessitated further exploratory study that will involve users of varying experience. Experience is chosen because of its ease of measurement as opposed to other evaluation metrics.

Three experimental settings are proposed:

1. using the existing On-line Help System of a chosen application software
2. using the User Manual of the chosen application software
3. using an improved version of the On-line Help System of the chosen application software.

A number of system evaluation techniques discussed in Chapter III should be employed to ensure careful and exhaustive capture of the experimental data as well as ease of analysis of results.

Microsoft Excel was chosen as the application software to be used for these experiments due to its position in the survey results reported here (midway between Word and Access) as well as that of a small pilot study. The experimental setting for the first experiment and the results are discussed in Chapter V.

CHAPTER V

EXPERIMENT WITH MICROSOFT EXCEL I: USING ON-LINE HELP

5.0 Introduction

To continue the research outlined in Chapter IV - on the usability of On-line Help Systems, a more detailed experiment was performed, capturing, on video as well as using Lotus Screen Cam 97, user activity whilst using the On-line Help System of Microsoft Excel. The subjects that participated were mainly postgraduate research students from various departments of Loughborough University. Most of them had considerable experience in using Microsoft Excel. The purpose of this study was to examine, in more detail, how users accessed Microsoft Excel's On-line Help System.

5.1 Experimental Setting:

5.1.1 Software

The software chosen for the experiment was Microsoft Excel for Office 95 (version 7.0). This choice was made for the following reasons:

- Excel is the most common spreadsheet application around, at least within the University, where the largest number of proposed subjects reside
- Excel in particular, and the Microsoft Office family of products in general, are commonly used applications world-wide
- Excel version 7.0 was the current release of the Microsoft Office family of application at the time of the experiment

- Excel, from our previous survey (reported in chapter four), had a popularity midway between the Word Processing application (Microsoft Word), and the Database Management application (Microsoft Access).

5.1.2 Equipment

- A Pentium 166 system with 16MB RAM and 3.2GB Hard Disk, and a 17 inch Monitor was used
- A DeltaScan Pro, Computer-to-Video Conversion Equipment, with a resolution of 1600x1200 was used to capture user activity on the screen and transmits video signals to a Panasonic Multi-System video cassette recorder for video recording
- 24 inch Cameron video monitor was used to monitor user activity remotely
- A Shure Mixer was used for capturing the verbal discussions between the experimenter and the subject performing the experiment.
- Lotus Screen Cam 97, a show-and-tell communication software, was used at later stages of the experiment, to capture user activity as well as their verbal comments and discussions with the experimenter.

5.1.3 Subjects

A Total of 22 subjects participated in the experiment. Users were asked to classify themselves as Experts, Intermediates and Novices using the criteria set out in the preceding chapter. The resultant distribution is shown in Table 5.1.

Subject Expertise	Number
Expert	5
Intermediate	12
Novice	5

Table 5.1 Subjects on On-line Help Experiment

5.1.4 Procedure

The experiment took place in a laboratory where the subject had enough space to work with no disturbances and so could concentrate on the given task. Each subject was briefed on what the purpose of the experiment was, and was told what they should do if, at any time during the experiment, they did not know how to proceed. They were asked to use the On-line Help system to sort out queries or misunderstandings, but that if after doing this they remained baffled as to what to do, they were to seek help from the experimenter. They were also instructed to seek the help of the experimenter at any time if they did not understand the goals of any particular task or sub-task.

5.1.5 Tasks

A set of tasks was constructed to test users' understanding of both basic and advanced concepts in spreadsheets. These tasks involved using Excel as a Database Management Application. This choice was arrived at after the analysis of the results of a pilot study conducted with a group of users of Microsoft Excel. The results indicated that only few of the users were aware of the fact that they could use it as a Database Management Application. This lead us to propose that the users were more likely to seek help in such a task.

The tasks required answers to four main questions, and each question was divided into a set of sub-tasks. Early sub-tasks had samples of the output expected, to enable subjects to fully understand what was required. A copy of the tasks used can be found in Appendix B. The experimenter discussed any concept that seemed unclear to the subjects thus ensuring that subjects fully understood what was required of them.

A scoring scheme was designed to enable the experimenter to assign scores to the tasks carried out. Each sub-task in a question had a maximum mark (between 1 and 4) allocated to it. The tasks and the scores assigned are shown in Table 5.2.

	TASK	SCORE		TASK	SCORE
1 (a)	Sorting data in ascending order of regions.	2	(i)	Filtering the required data	1
(b)	Adding subtotals of population to the data.	2	(j)	Copying filtered data to new workbook	1
(c)	Copying resulting data to new workbook	2	(k)	Putting a border round the table	1
(d)	Put a double-line border round the table.	1	(l)	Formatting the table	2
(e)	Colour the headings and the background	2	(m)	Adding titles to the table	1
(f)	Adding titles to the table,	2			
(g)	changing paper orientation	1	3 (a)	Invoking the Pivot Table Wizard	2
			(b)	Defining the Data	3
(h)	Removing the subtotals from the data	1	(c)	Using appropriate data values	2
(i)	Filtering out the required data	2	(d)	Formatting the report	1
(j)	Copying filtered data to new workbook	2	(e)	Adding a title to the report	1
(k)	Formatting the resulting data	2			
(l)	Adding titles to the data	2	4 (a)	Defining the appropriate columns	1
(m)	modifying page set-up	1	(b)	Filling the date column	2
			(c)	Filling both Product and SALES PERSON columns	2
(n)	Filtering the required data	2	(d)	Generate Gross Cost and Net Cost	4
(o)	Copying resulting data to new workbook	1	(e)	Calculating the Profit column	3
(p)	Formatting the resulting data	2	(f)	Copying and pasting the data onto itself	3
(q)	Adding titles to the data	1	(g)	Filtering out negative profit	2
			(h)	Copying the filtered data to another sheet.	1
2 (a)	Importing the Dbase file	4	(i)	Sorting the data by Sales Person	1
(b)	Reformatting the three columns	3	(j)	Adding subtotals	1
(c)	Adding the TOTAL SALES column	1	(k)	Collapse details of Helen, Mark & Scott	3
(d)	Computing the values of the added column	2	(l)	Copying the result to a new workbook	1
(e)	Adding TAXRATE & TAXPAID columns	2	(m)	Formatting the table	2
(f)	Computing tax paid by each company	4	(n)	Removing the subtotals	1
(g)	Copying and pasting the values of sheet	3	(o)	Creating report using the pivot table	4
(h)	Sorting the data appropriately	1			

Table 5.2 Scores Allocated to Sub-Tasks

The mark represented the task complexity, based on the number of different operations in the task and therefore was expected to be related to the time required to carry out the task. Thus, carrying out a SORT operation requires two operations, whilst putting a double line border round cells, or changing the paper orientation, is one operation. Importing a Dbase file, on the other hand, is more difficult requiring 4 operations. Later, repeated tasks are assigned lower values.

From table 5.2, it can be seen that some tasks were repeated several times. Tasks repeated were sorting, filtering, formatting in general, and using the pivot table.

User interaction with the On-line Help System was recorded, and they provided clear picture if a user sought help, or not, on a particular task, as well as whether they were successful, partially successful or not successful in getting the required information from the On-line Help system. A *Successful hit* in getting at the required information meant that the user was able to identify the required help information to accomplish the task, even if they were not able to carry out the task successfully. *Partially successful hit* meant that the user was on the correct way to identifying the required information but, because of the time, they could not proceed but abandoned the search and resorted to either exploration or sought for assistance from the experimenter. An *Unsuccessful hit* on the help window meant a failure to identify the required information from the On-line Help system.

5.1.6 Task Completion Questionnaire

Each subject was asked to complete a questionnaire at the end of the experiment.

The questionnaire was designed to determine the subject's view on:

- the ease/difficulty of the experiment
- their use of the On-line help system of Excel during the experiment
- the level of use of On-line Help during the experiment
- their satisfaction/dissatisfaction with the answers they got from the On-line Help

- general questions regarding the On-line Help system of Excel and the Excel User Manual.

The actual questionnaire used can be found in Appendix C.

5.2. Results of the On-line Help Study

5.2.1 Seeking Help

All subjects used the On-line Help system at one stage or another during the experiment. Some were able to get the needed help on-line easily for certain sub-tasks, whilst others had to scan through several screens of information before they accessed what they required. Yet again, others had considerable difficulty and had to be assisted by the experimenter. Table 5.3 shows the percentage of those who sought On-line Help on a particular task, by level of expertise.

Sub Task Level	Novice	Intermediate	Expert
1	48%	7%	0%
2	69%	35%	17%
3	80%	56%	50%
4	100%	85%	75%

Table 5.3 Use of On-line Help by Task Difficulty and Experience

This table increases our confidence in the task ratings and the user classifications. As expected, help is sought more by novices than experts, and increasingly by all classes as the tasks gets harder.

On-line Help provides four ways in which to access information - Contents, Find, an Index and A Help Wizard. No clear guidance is given as to which approach to use in what situation. Contents (or Help Topics) provides a top-down approach (often ending with the Help Wizard). In Find, the user supplies a word and a set of detailed topics is presented. The Index allows the user to scan the set of words in

the help system, and the Answer Wizard, in most cases, takes the user through a worked example.

5.2.2 Examples of User Activity When Accessing on-line Help

Because of the nature of the user activity during the experiment, out of many examples from the study, three will be given in this chapter. The subjects whose activities were presented in these examples were randomly selected, and not based on any criteria. The task chosen, however, was a common task where all users accessed the on-line help to find out how to carry it out.

5.2.2.1 Task: Import a Dbase File (Using Microsoft Query)

This was a task where all the subjects experienced difficulties, and where access to the On-line Help system was highest. Using On-line Help, most of the experienced subjects were able to eventually solve the problem. However, the inexperienced users had to request assistance.

5.2.2.1.1 An Example: A Novice User

The Novice User read the task and immediately tried to access On-line Help "Help Topics" was initially selected from the Help Menu. Several options were displayed. The topic the user thought was closest to his need was "Creating, Opening, and Saving Documents". This was selected and the window in Figure 5.1 was displayed:

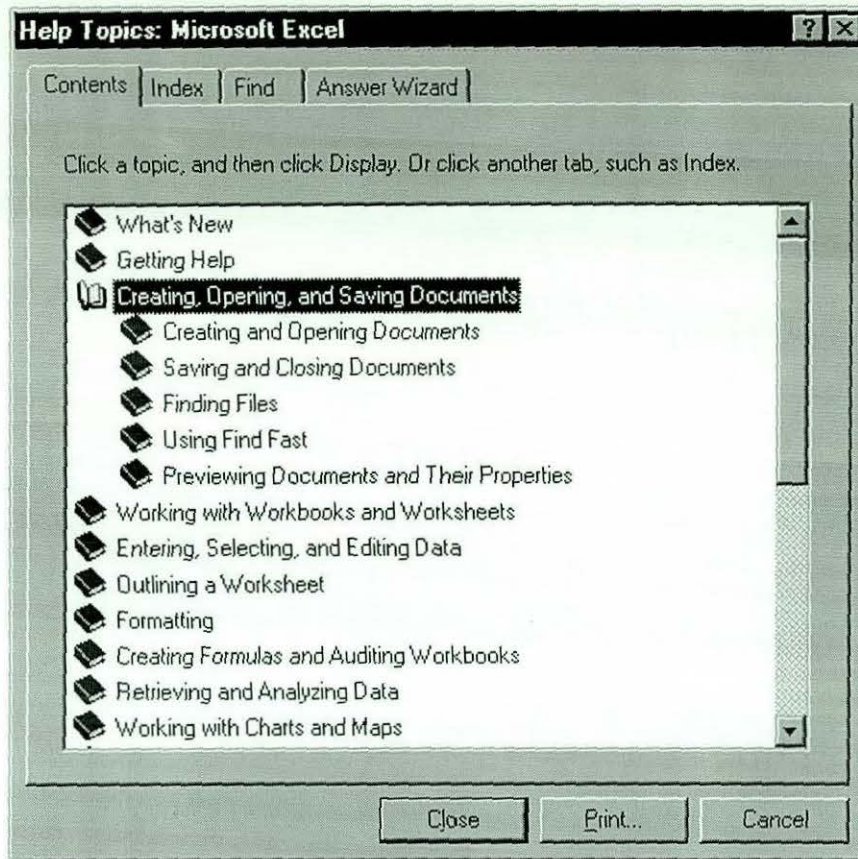


Figure 5.1: Novice User Searching 'Contents' I

The only one on this list which the user thought had relevance is the first (Creating and Opening Documents), so then user selected this and received the window in Figure 5.2. None of the displayed options looked promising so the user decided to try "Find". He typed 'import a file'. Help responded by displaying the window in Figure 5.3. Again, none of the options displayed seems to satisfy the user's need so he decided to use the "Index". He types "Dbase file" and help responded by displaying the window in Figure 5.4.

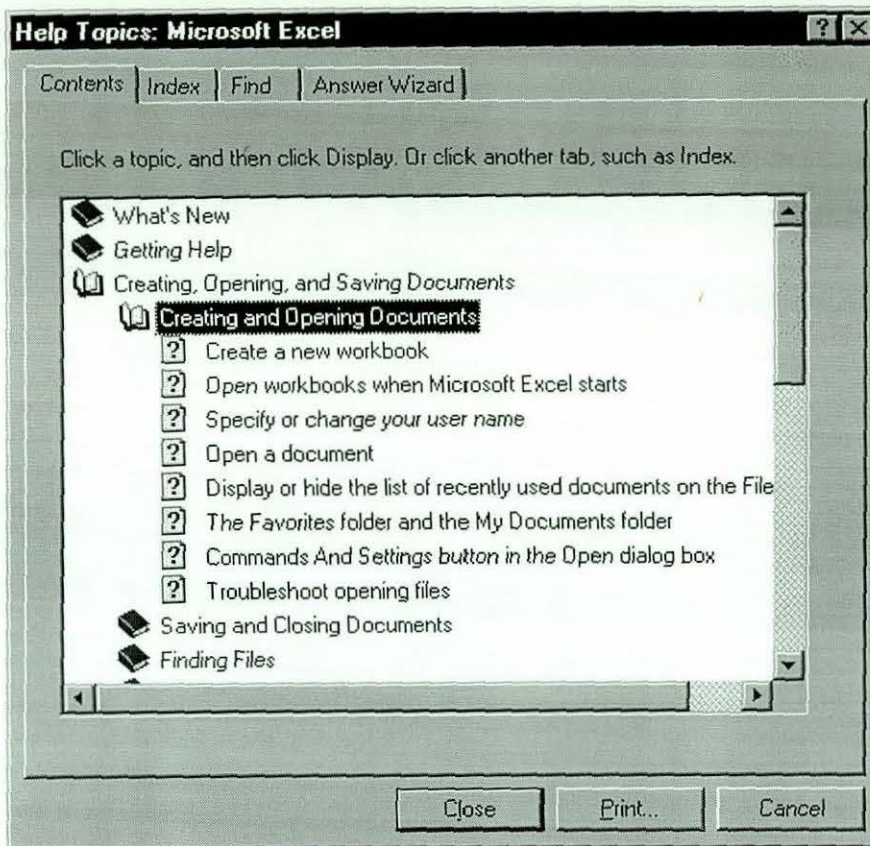


Figure 5.2: Novice User Searching 'Contents' II

The entry “dBASE file format” yielded a highly technical screen so the user selected the second item which provided a detailed list of File Format Converters. The user did not select the two others because “they did not have the word *file* in them”. The user appealed to the experimenter for help. In the user’s own words ‘*If I have to find this information myself, I may have to spend the rest of the time going forward and backward without success. Please tell me how do it or how I can get a meaningful response from the Help.*’

Rather than telling him how to carry out the task, the experimenter suggested he might try the Answer Wizard, and to use the phrase “Import a dBASE file”, which the user did. On-line help responded by displaying the window in Figure 5.5. The user selected the first topic, which provided a screen with 7 action points. One had an active link to “data source”. He followed this to a pop-up fact sheet. However, by this time fatigue was setting in and the user demanded further assistance from the experimenter. Ironically the user was close to the solution with the Wizard.

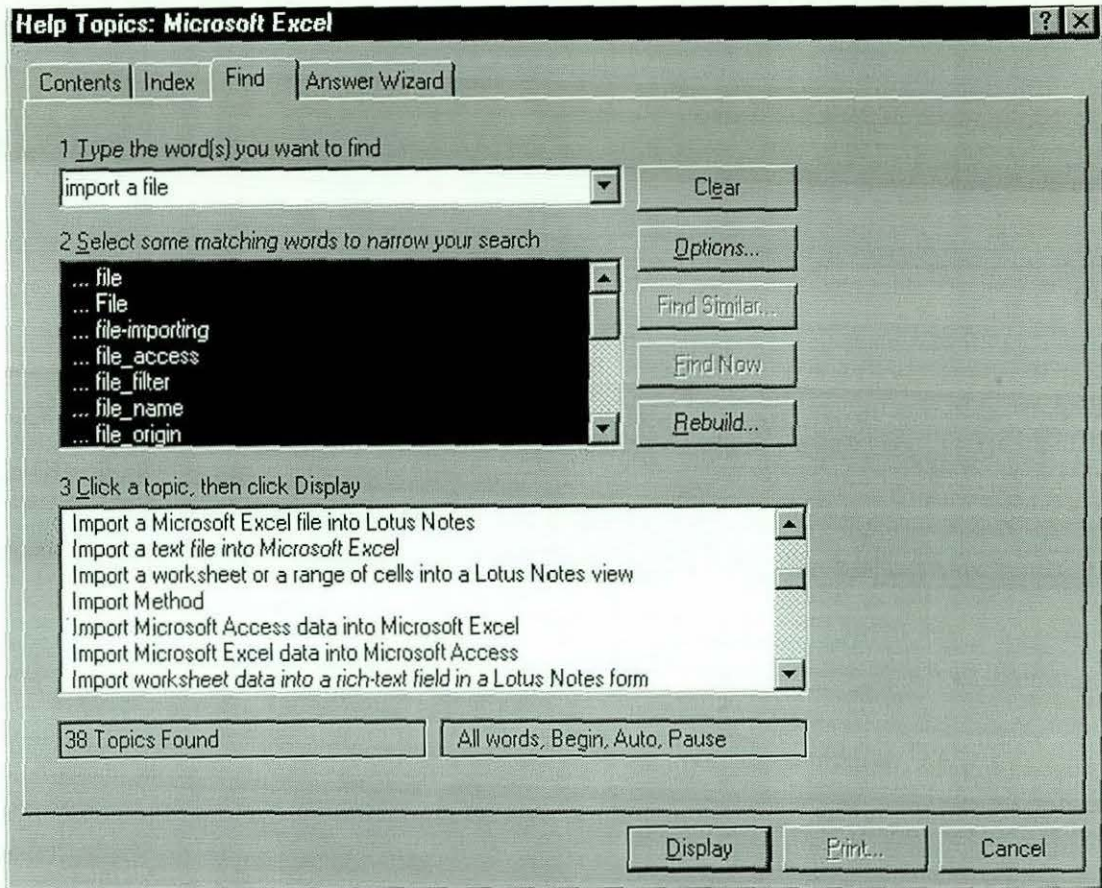


Figure 5.3: Novice User Using 'Find'

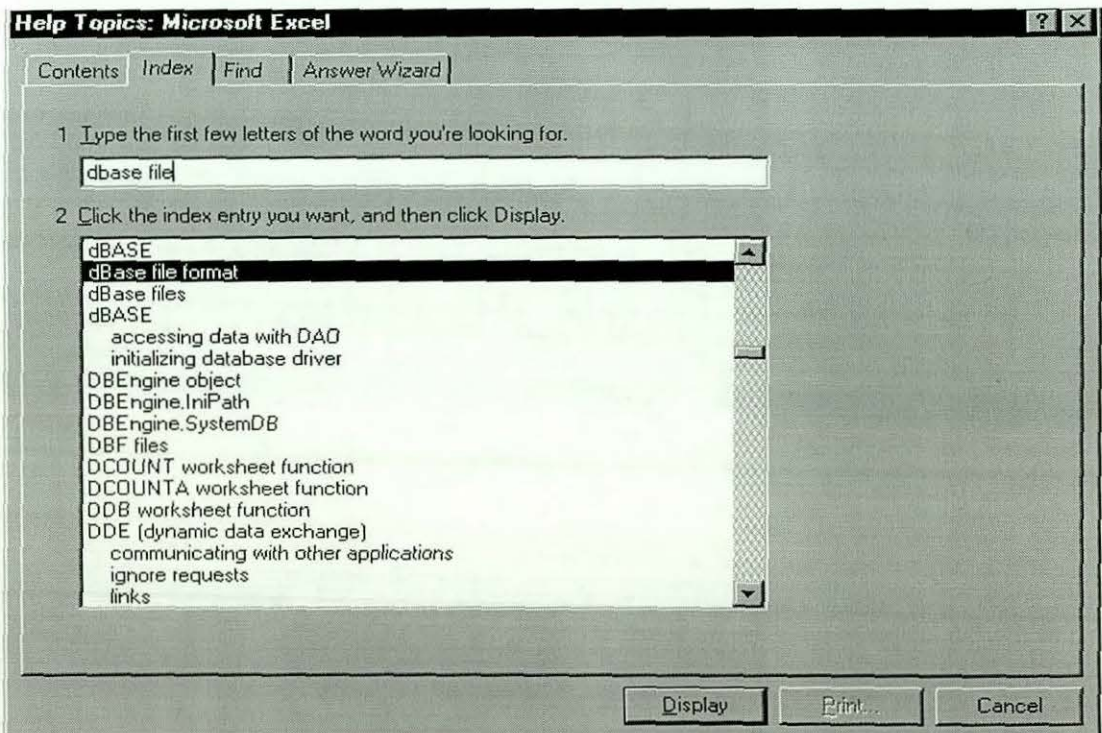


Figure 5.4: Novice User Using 'Index'

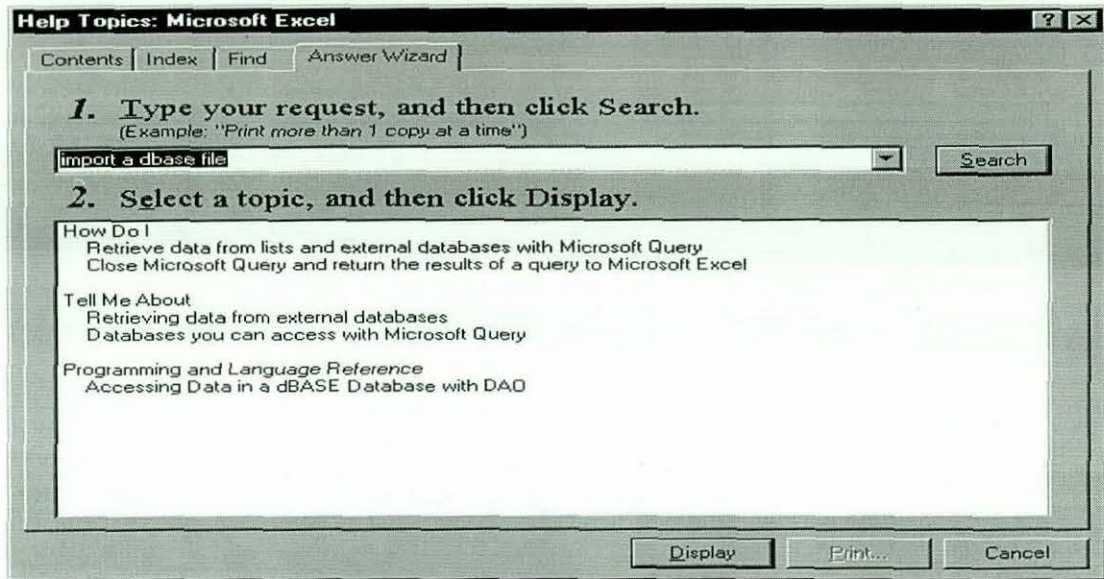


Figure 5.5: Novice User Using 'Wizard'

Surprisingly, all the Novice users (five) experienced a similar trend with the On-line Help system, and only one of them was able to perform this task successfully with some assistance from the experimenter.

5.2.2.1.2 An Example: An Intermediate User

The Intermediate user typed 'Import' using the 'Index' of the On-line Help, and the window in Figure 5.6 was displayed.

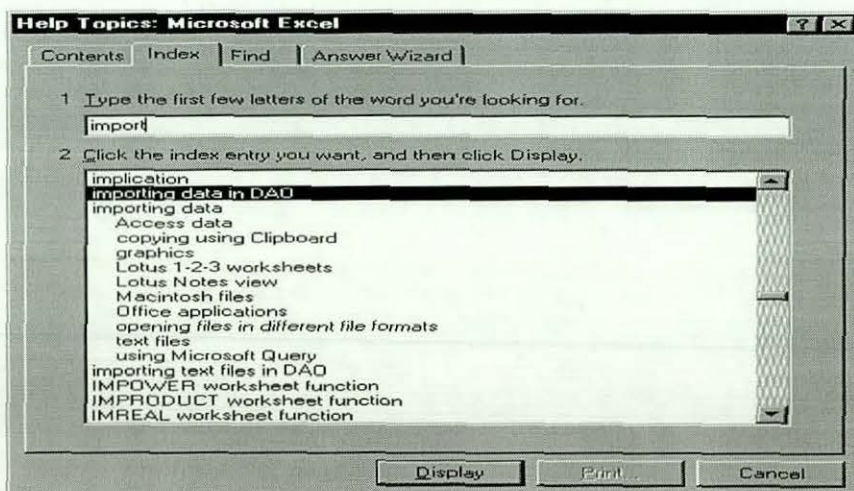


Figure 5.6: Intermediate User Using 'Find' I

He then selected 'Importing Data', and the window on Figure 5.7 was displayed. He then clicked at 'Databases you can access with MS Query' and the window in figure 5.8 was displayed.

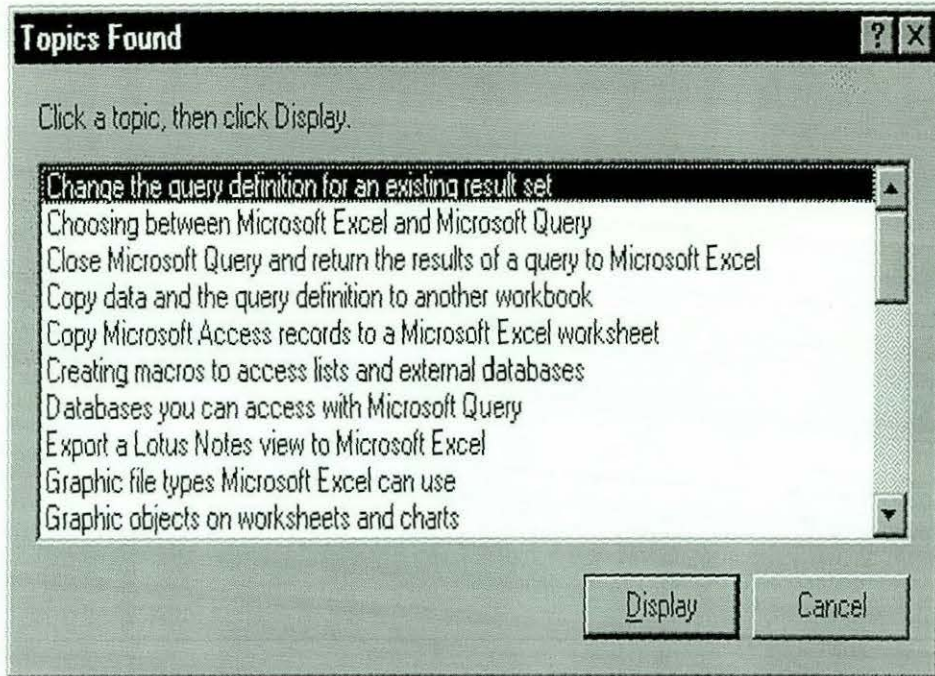


Figure 5.7: Intermediate User Using 'Find' II

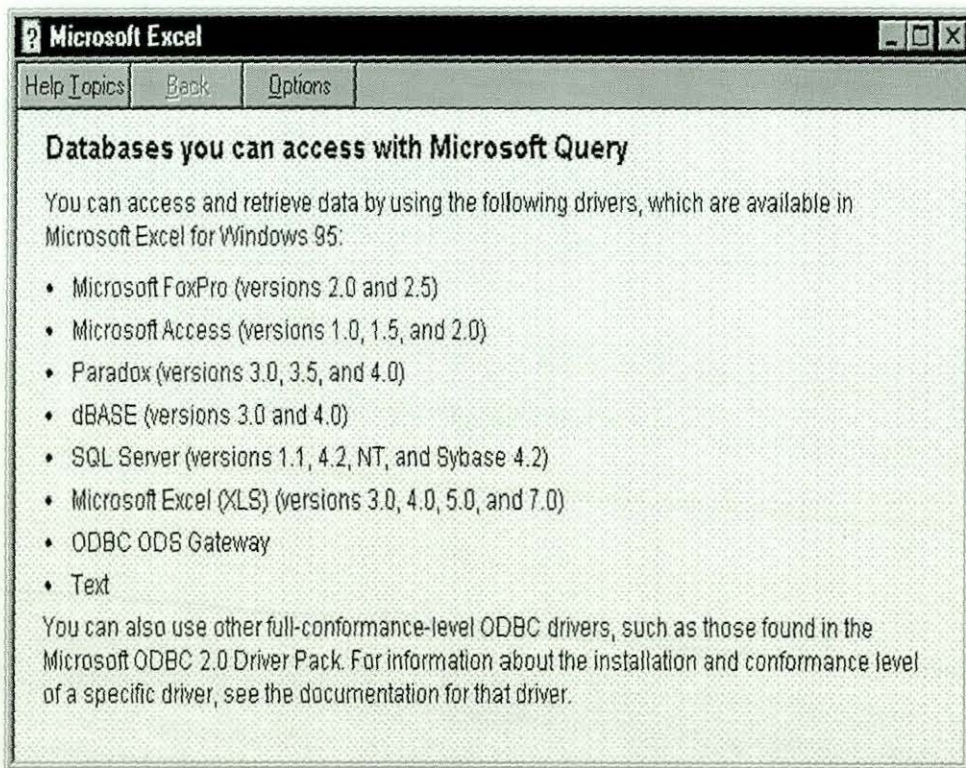


Figure 5.8: Intermediate User Using 'Find' III

He could not work out what to do from these windows, so he decided to close the window and tried exploration by going through most of the menu items, trying to locate the word 'import'. When this failed, he then went back to the help system and tried 'Find'. Out of the 77 topics found, upon scrolling, the only options found with the keyword were:

- Import a graphic
- Import a Microsoft Excel file into Lotus Notes
- Import a text file into Microsoft Excel
- Import a Worksheet or a range of cells into a Lotus Notes view
- Import Microsoft Access data into Microsoft Excel
- Import Microsoft Excel data into Microsoft Access
- Import worksheet data into a rich-text field in a Lotus Notes form
- Importing graphics
- Importing or converting files from another office application

He abandoned that and tried the 'Index' again, using the same keyword as in the previous attempt - 'Import'. He received same window as the one in figure 5.7. He selected the 'Importing data in DAO' option, and a window with technical descriptions was displayed. He exclaimed '*You don't expect me to use this one, do you?*'. The experimenter replied to the affirmative. He closed that window by clicking the 'Help Topics'. He scrolled down and found 'Retrieving data from external databases', and received the Graphic illustration in figure 5.9.

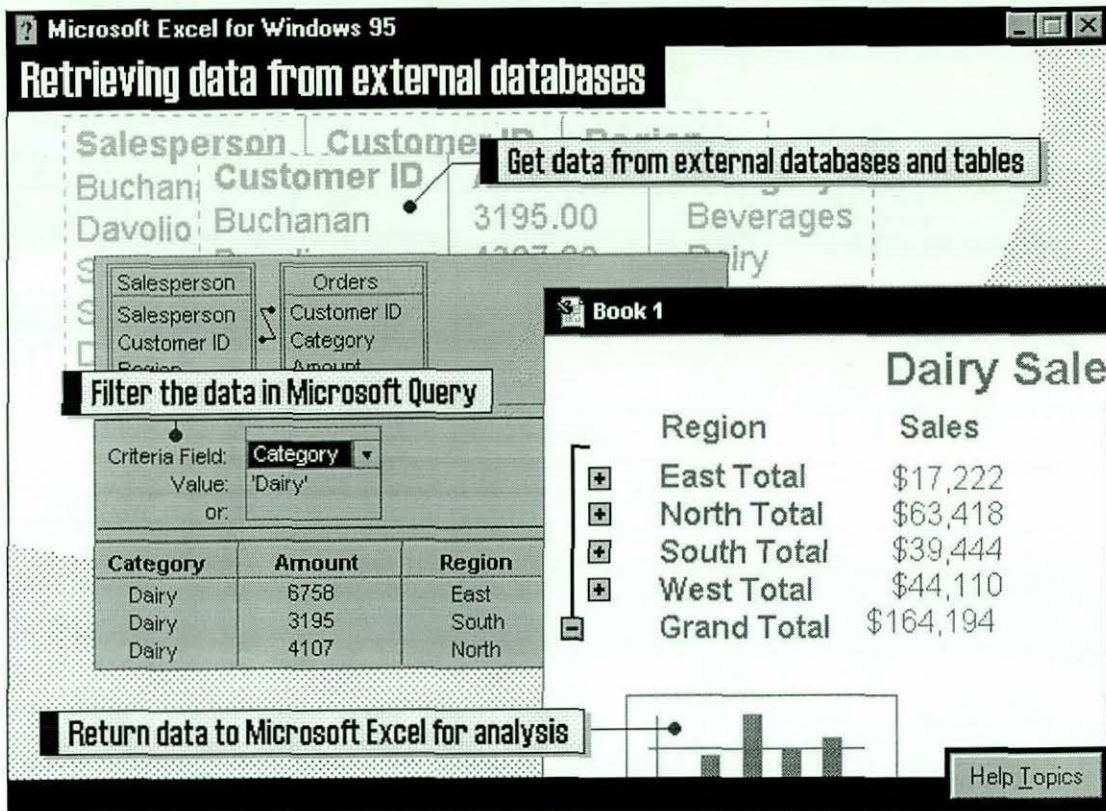


Figure 5.9: Intermediate User Using 'Find' IV

He closed that window, without clicking at the highlighted text to retrieve further explanation, possibly because he was not aware of that.

He again tried to explore, but realised that he could not, and he turned to the experimenter, saying 'You have to tell me what to do else I will spend the rest of the time doing nothing but going helplessly thorough the Help System.' The experimenter told him that he was close to the solution when he selected the graphical illustration. What he was required to do was to click at each of the highlighted text to get further help and explanation of how to do the task. He then loaded the graphical window again, and clicked at the 'Get Data from External Databases and Tables'. The following pop-up window was displayed.

When you need to work with data that is stored away from your computer—for example, in a Microsoft Access or dBASE database, or on a networked mainframe—using Microsoft Query saves you the work of retyping or opening large databases as spreadsheet files.

To start Microsoft Query, click Get External Data on the Data menu.

Seeing this, he closed the help window and selected the 'Get External Data' option on the Data menu. This loaded the Microsoft Query ad-in. However since he did not know how to define the query, he tried accessing help but could not. He had to close the query dialog box, load the help system, and then go through it again. Still he could not do it. The experimenter had to assist him through out the query definition phase.

5.2.2.1.3 An Example: An Expert User

The Expert first selected "Retrieving and analysing data" from "Contents" and the window in figure 5.10 was displayed. He then selected the first option and the window in figure 5.11 was displayed. Here, also, he selected the first option and the same graphical illustration as that in figure 5.9 was displayed. He was able to perform the operation required with the three highlighted texts, and further explanations were displayed. He was able to follow these and carried out the task.

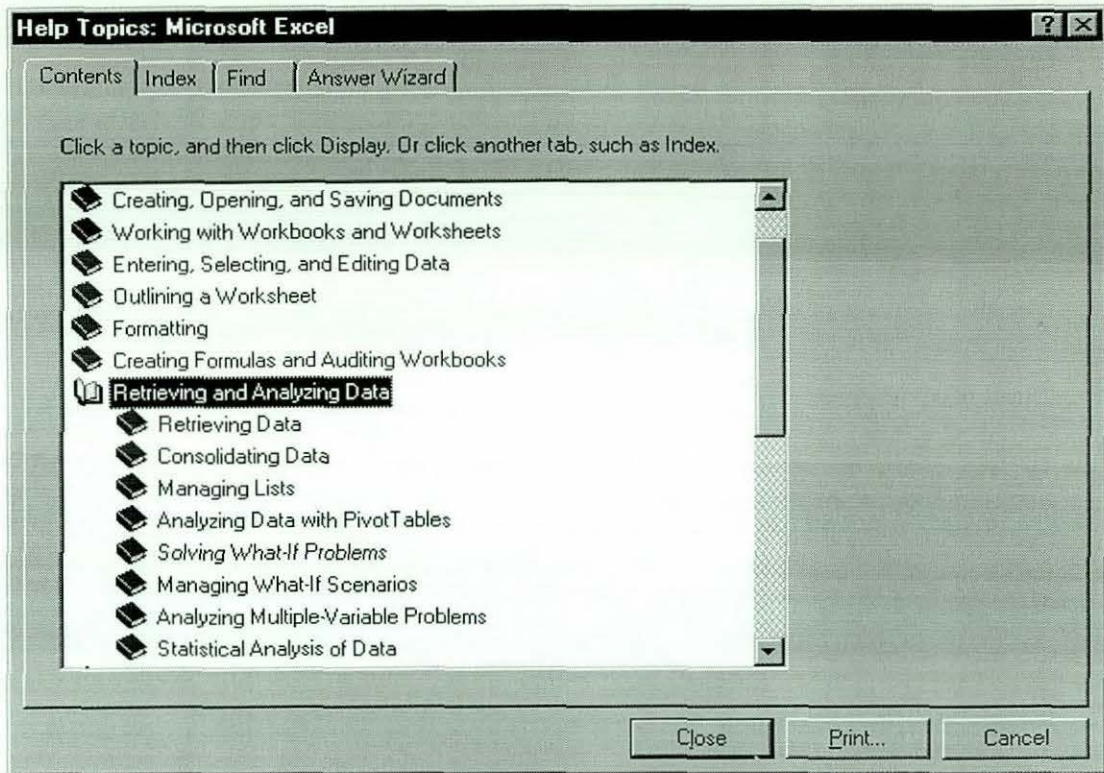


Figure 5.10: Expert User Using 'Contents' I

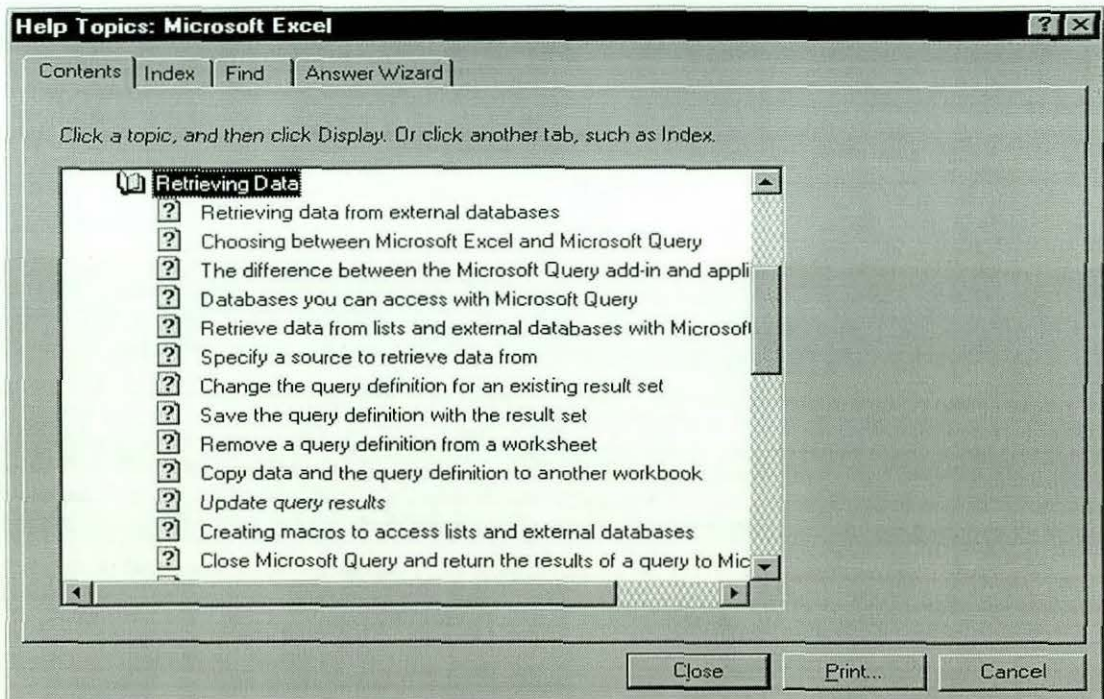


Figure 5.11: Expert User Using 'Contents' II

5.3 General Observation: Characterisation of User Behaviour

The example given above is just one of the many captured during the experiment. There were some simple tasks in which most of the subjects carried out without seeking for help. An example of such tasks that caused no difficulty was SORTing. Those who had to access On-line Help for assistance had no difficulty in solving their problem. In addition, all other sorting exercises were done without further help, so users learned rapidly. The On-line Help for SORT is easy for two reasons. Firstly, there is no Vocabulary problem. The word SORT is understood by subjects, it is in the question itself, and is in the help menu. Secondly, the help information is unidirectional and fans out to a number of clear answers.

On the other hand, there were some tasks that even the Expert Subjects found them difficult to carry out and also could not get meaningful results from the On-line Help System. A simple task that turned out to be difficult was inserting a double-line border round a table (task (d)). Although the word 'BORDER' appeared on both the task and the On-line Help, the information on changing line style from single to double was not clear, and users found it difficult to figure out how to carry this task as well as subsequent tasks. Various approaches to carrying out the task were 'devised' by, especially the experienced users. Here an Vocabulary problem surfaced.

One user after a prolonged exploration session, worked out where the double line style was located (in one of the menu items). He was able to put the double line border round the table, but on coming to put single line cell border, it changed the double line border round the table. He had to resort to putting the double line, one edge at a time. He commented '*..There should be a simple way of doing it but this is what I know. The thing is either I spend the time looking through the On-line Help or doing the job I need to do. If I have to do it again, then it might be worth spending the time finding it out, If at all I can find it...*' When he came to repeat the same in the second set of tasks (task (k)), he tried finding out how to do it, using the On-line Help. He tried the word 'BORDER' and went through several

help screens without success. He then tried the word 'STYLES' and also went through a series of help screens. He ended up giving up, without finding out what he wanted! Figure 5.12 represents a typical search path.

As can be seen from figure 5.12, the users in this case had exhausted all the mechanisms available for them – the Contents, the Index, Find and the Wizard. They also explored the application by going through the menu items one after the other, but were unable to find an 'appropriate' means of carrying out this simple task. This was the trend with most of the users that accessed the On-line Help system for information on how to carry out this task.

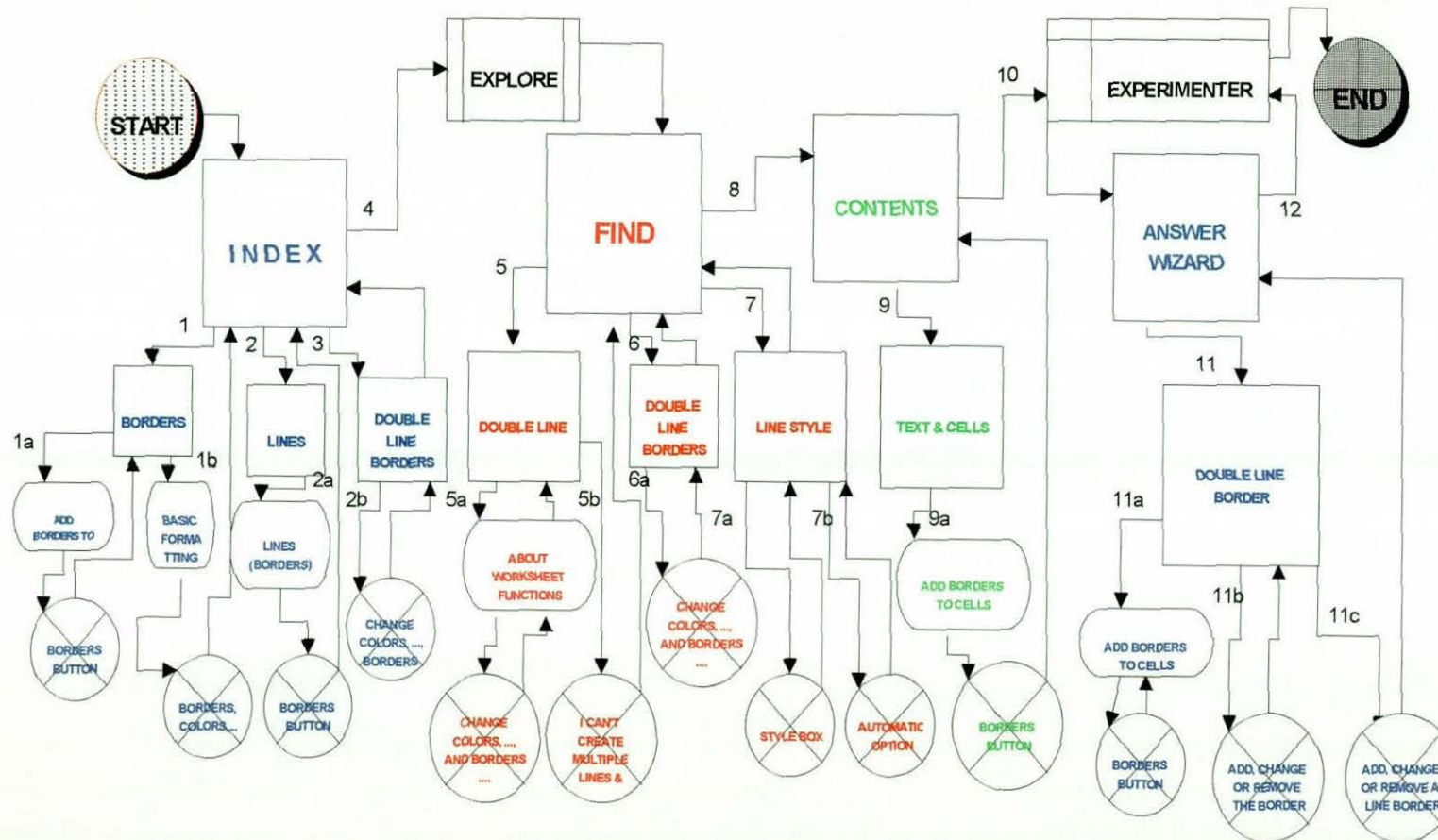


Figure 5.12: A Typical Search Path: Vocabulary Problem

Brief Description

As explained in the previous page, this figure shows a typical sequence of interaction with the Online Help System in trying to find out how to insert a double-line boarder. The user:

1. Started with the Index, first using Borders, then Lines, and then Double-Line Boarders – all leading to a deadlock – crossed circle.
2. Explored, and decided to use Find with the keywords Double Line, Double Line Boarders and Line Style – all leading to a deadlock.
3. He then used the Contents and selected Text & Cells, which also lead to a deadlock.
4. Turned to the Experimenter, and was asked to use the Wizard and the keyword Double Line Boarder – this also lead to a deadlock.
5. In the end, due to fatigue decided to give up!

A similar case to the one presented earlier can be seen from the figure above. The users in this case had exhausted all the mechanisms available for them – the Contents, the Index, Find and the Wizard. They also explored the application by going through the menu items one after the other, but were unable to find an ‘appropriate’ means of carrying out this task. This was the trend with most of the users that accessed the On-line Help system for information on how to carry out this task.

To illustrate this problem further, an additional example in which many subjects experienced varied responses from the On-line Help system for their queries is considered. This dealt with querying the On-line Help system for information on using the PIVOTTABLE (tasks 3(a, b, c), and 4(o)). One Intermediate user, after going endlessly through the On-line Help information, trying to locate the required information that will enable him carried out a task using the PivotTable, he could not get anything ‘meaningful’ in his own terms, and decided to explore. Upon loading the PivotTable Wizard, and wanted to define relevant data fields, he could not work out how to do it. He then turned to the context-sensitive help bar, and dragged it to the ‘ROW’ area of the PivotTable. The following pop-up menu appeared

To design the layout of your PivotTable, drag field names into the Row, Column, Data, or Page area.
For more information, click >>.

Even with the above, he was not satisfied, so he clicked at the ‘more information’ button, and he was taken back to the main Help screen, with some explanations, hypertext links as well as some options to select from. He went through some of them and decided to try it again. He ended up seeking the assistance of the experimenter.

This is the problem that most users of on-line documentation face – the problem of **Vocabulary** (Abdullahi & Alty, 1998). Users have difficulty in formulating queries that match the help model's Vocabulary in order to provide any meaningful response. Terms they felt perfectly defined their help need, and which they expected the system to understand, (especially the "Answer Wizard"), resulted in unhelpful information. Irrespective of the length of time users would spend wading through the information provided by the on-line help system, the user may never find the required information due to this problem.

This raises several questions, among which were:

- Why do other methods of assistance, especially written documentation, often overcome this problem?
- How can this problem be dealt with in On-line Help Systems?

The first question is discussed in Chapter VI, where the results of the User Manual experiment is presented and the second question is addressed in Chapter VII.

In the next section, a summary of the analytical results obtained when the data collected during the experiment was analysed, is presented.

5.4 Analytical Results

The observations from the experiment were analysed according to the following measurement criteria:

- Total time taken during the experiment
- Total time taken accessing on-line help
- Total time taken during exploration
- Time taken to perform actual tasks
- Number of completed tasks
- Method(s) employed during help access

- The number of successful hits
- The number of partially successful hits
- The number of unsuccessful hits
- Number of times assistance was given by the experimenter

The observations revealed that, generally, users took longer time in carrying out the tasks than initially anticipated. Some inexperienced users took more than six hours to complete the experiment, and there was no user who completed the whole experiment in less than an hour.

On average, Expert users took the least time (about two hours) in completing the experiment while Novice users took the highest time (more than six hours). The Intermediate users stood in between (about four hours). If the time spent accessing On-line Help is considered, the same trend can be seen, with Expert users taking the least time (about half an hour), the Intermediate users with about an hour, and the Novice users with about two hours. This means that Intermediate users spent twice as much as Expert users while Novice users also spent twice as much as Intermediate users. Thus Novices spent more of their time in On-line Help than either Experts or Intermediates.

These observations are interesting in the sense that each user group took twice the time of its immediate 'predecessor'. Although our initial hypothesis suggests that experienced users are likely to complete the tasks faster than the inexperienced users, the observed difference was lower than expected.

If the time spent trying to find out how to perform the task without using the On-line Help (Exploration) is considered, it will be seen that Expert users spent the least time (less than half an hour), the Intermediate users spent twice as much as the Expert users (about an hour and a quarter) and the Novice users spent about an hour and a half. Overall, the experts and the Intermediate users were more successful in exploration than the Novice users. Also, if the time taken to carry out the actual task after finding out how to perform the task, either by using the On-

line Help or Exploration, we see that Expert users took about an hour, Intermediate users took an hour and a half and the Novice users took about two hours. Table 5.4 gives the average distribution while figure 5.14 shows the actual distribution.

USER LEVEL	Total Time (mins)	Help Time (mins)	Exploration Time (mins)	Task Time (mins)
Expert	123.60	33.60	23.00	67.00
Intermediate	232.42	66.42	75.50	93.83
Novice	362.60	130.80	99.40	132.40

Table 5.4: Average User Performance based on Time

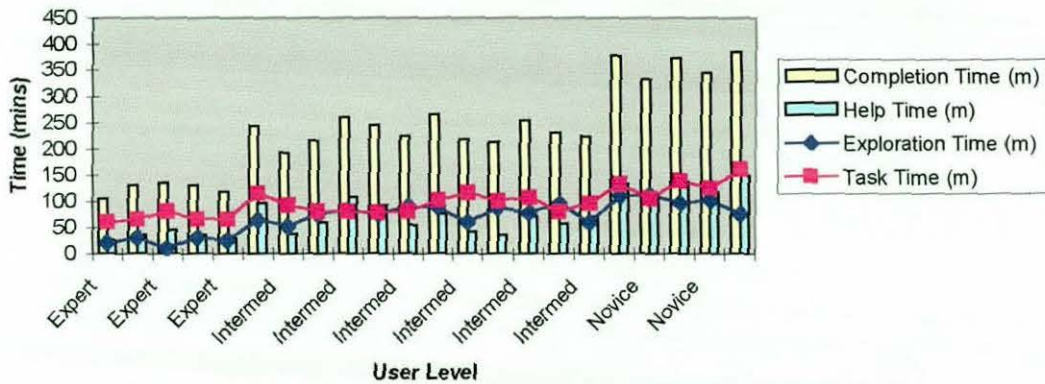


Figure 5.14: User Performance based on Time

Time has given us a reasonable measure of performance of the three groups of users. This is so because we separated the different times taken to perform separate activities and distractions from the main tasks during the experiment were kept to the minimum. Hence it can be said that time has given a good and clear picture about the performance of different user levels, and hence increased the researchers' confidence in earlier user characterisations (Abdullahi & Alty, 1998).

In terms of the interaction with the On-line Help, and whether the user achieved a successful hit - that is, the user was able to find what he was looking for and was able to use it in carrying out the task, or was partially successful or completely unsuccessful, the results did not present a clear picture of the distinction between users. On the average, Expert users accessed the On-line Help System eight times

and achieved 37.5% success and 25% failure. Similarly, the Intermediate users accessed the On-line Help seventeen times; more than twice that of the Expert users, 41.18% success and 29.41% failure. On the other hand, the Novice users had the highest number of access; with average access of 33 times and 24.24% success and 42.42% failure. Table 5.5 shows the average distribution while figure 5.15 shows actual distribution

USER LEVEL	Total Access (Average)	Successful Hits (%)	Partially Successful Hits (%)	Unsuccessful Hits (%)
Expert	8	37.50	37.50	25.00
Intermediate	17	41.18	29.41	29.41
Novice	33	24.24	33.33	42.42

Table 5.5: Average Success/Failure of On-line Help Access

Similarly, if the average number of times the users asked the experimenter for assistance is considered, it will be seen that Expert users were, on the average assisted 3 times, the Intermediate users were, on the average, assisted 10 times; more than three times that of the Expert users. The Novice users were, on the average, assisted 22 times, which is more than twice that of the Intermediate users.

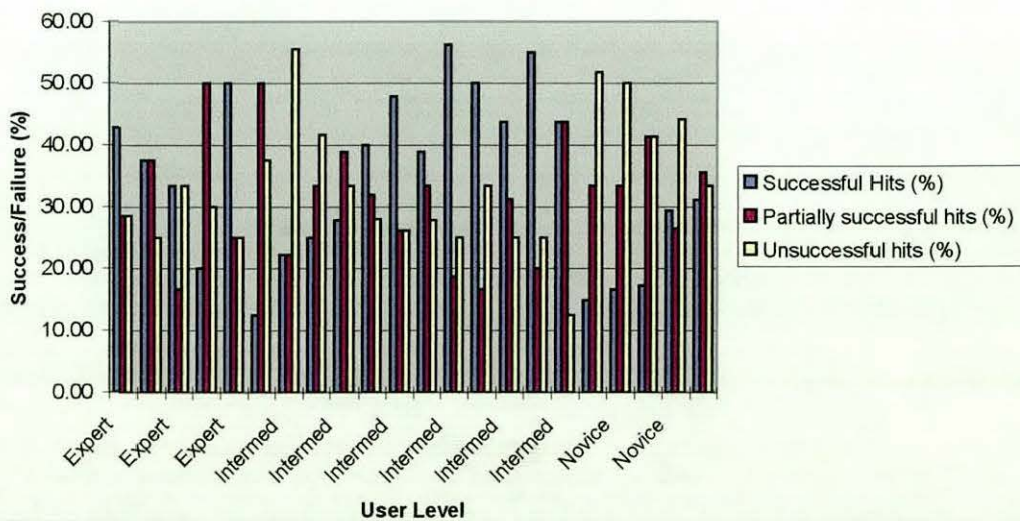


Figure 5.15: Actual Distribution of Success/Failure with On-line Help

If the total number of tasks completed by the users is considered, it will be seen that on the average, Expert users completed 36 tasks, about 78% of the total tasks. Similarly, Intermediate users, on the average, completed 28 tasks which is about 60% of the total tasks and the Novice users completed about 26 tasks which is about 56% of the total tasks. As the results above indicated, all users completed more than 50% of the tasks provided during the experiment. This goes to show that they were generally of moderate complexity

Similarly, if the average number of tasks completed using the various aids available to the subjects - the On-line Help System, By Exploration or Assistance from the experimenter is considered, the results analysed is summarised in the table below.

User Level	Completed Tasks (/50)	With On-Help	With Assistance	By Exploration	Ordinary
Expert	36	3	3	9	21
Intermediate	28	6	8	4	10
Novice	18	7	9	1	1

Table 5.6: Average distribution of task completion by aid mechanism

As can be seen from the above table, users, especially expert users, carried most of the tasks by exploration than by using the On-line Help System or employing the expertise of the experimenter. Similar observation can be made by considering the number of tasks done 'ordinarily', that is tasks carried out either without assistance entirely or after finding out how to carry out such tasks through on-line help, exploration or the assistance of the experimenter. This shows that expert users easily picked up new features and hence use the application to their advantage.

If the overall performance of the subjects is considered, it will be seen that the Expert users achieved the highest performance, with an average performance of about 78%, the Intermediates with an average performance of about 59% and the Novice users with an average performance of about 38%. It is interesting to observe that the percentage of the average completed tasks by Expert and

Intermediate users are almost similar to the percentage of their overall performance, while in the case of the Novice users it did not. This is so because the two values are separate statistical results. The first value was computed using the average completed tasks of the total possible tasks (50). On the other hand, the second value was arrived at by computing the average performance of individual users, using the scores assigned to each sub-task, as shown in table 5.2.

Table 5.6 gives the averages of number of times assisted as the overall performance while figure 5.16 shows the actual distribution.

USER LEVEL	Assisted (x times)	Completed Tasks (out of 50)	Overall performance (%)
Expert	3	36	77.68%
Intermediate	10	28	59.44%
Novice	22	18	37.53%

Table 5.7: Average time assistance given and performance

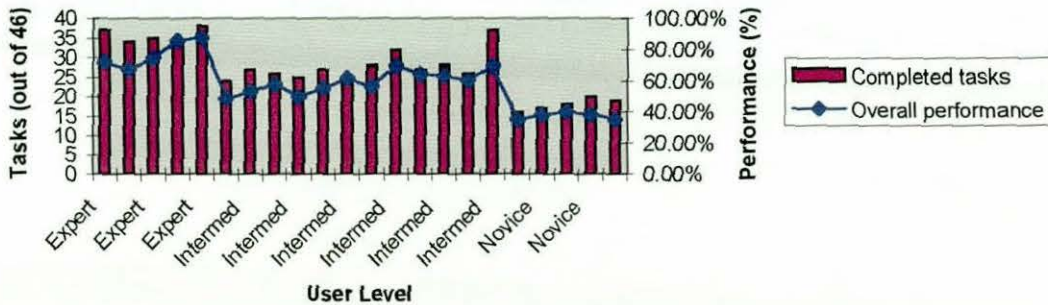


Figure 5.16: Actual Completed Tasks and Performance

In terms of the methods adopted in accessing the on-line information, all the access mechanisms provided by the On-line Help, that is Contents, Find, Index, Wizard, and the Context-Sensitive help button (?) were used by the subjects. Expert users mostly used the Content, Wizard and the Index, while Intermediate users mostly used the Content, Index and the Screen Tip (?). On the other hand Novice Users used the Content and the Index. Less use was made of the Wizard and the Find options. This is an interesting result because, despite the availability of the Wizard, Find and the context-sensitive help button (called the ScreenTip),

they were used much less than anticipated. The Wizard which, according to Microsoft, can understand questions in user's own words and lists On-line Help topics that relate to their request, was the least method that was used. A question that arises is why is this the least use?

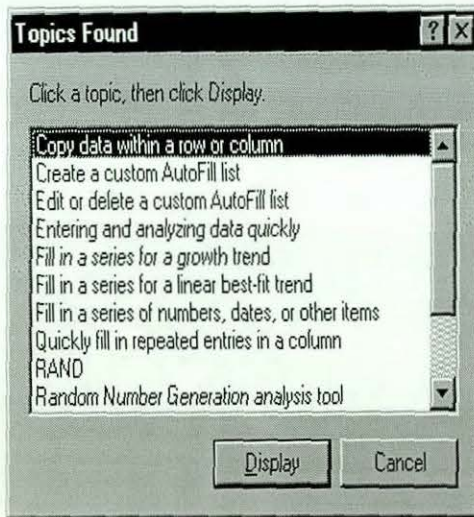
This observation could be due to the fact that users found them to be much different from what they claimed to be. All users knew of the existence of the Answer Wizard, for instance, but were less eager to use it because of their past experience with it. Some users, especially the Novice users were asked to use the Wizard by the experimenter, but had to be given the phrase to use. Secondly, it could be that users preferred using conventional strategies for looking for information on paper, to which they were more accustomed. This was found to be the case because only the Content (similar to a book's table of contents) and the Index (also similar to a book's index) were used across all experience levels. Users, especially the inexperienced, try to adapt their pages search strategies to on-line documents (see Anderson & Armbruster, 1985, Rubens, 1988, Kloster & Winne 1989, and Maes, Goutier & Linden, 1992). Unfortunately, the On-line Help database is not structured in a way that will be suitable for this type of search strategy (Abdullahi & Alty, 1998). This is further discussed in Chapter VI.

5.4.1 Total Number of Access to On-line Help

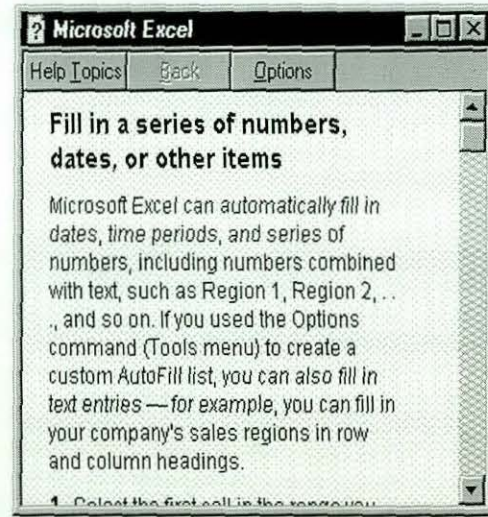
From earlier data presented, 5 experts accessed help an average of 8 times, 12 Intermediates accessed it 17 times and 5 novices accessed it 33 times. This provides a total of 409 Task access to On-line Help. However, users frequently had more than one attempt at using On-line Help. The total number of On-line Help access was actually 1012. So far, only three have been examined in detail. The type of On-line Help mechanism used by both experienced and inexperienced users does not follow any particular pattern. However, experienced users had fewer traversals than inexperienced users.

To get a clearer picture of the access strategies we are looking at in this section, we present an additional example, where an Intermediate user is trying to find out how to fill lists automatically (tasks 4b&c). The first task required the subject to fill in date column with days of the year, starting with 01-Jan-96 and ending with 31-Dec-96.

The user accessed Help using the 'Index' and typed Auto Date (access 1). On-line Help could not respond with any meaningful result. He then refined his keyword, this time typed 'AutoDate' (access 2). Here, also, nothing reasonable was displayed. He decided to use a different phrase 'Fill Date' (access 3). Help responded by displaying several options, among which was 'filling cells' (access 4). He selected this and the window on figure 5.15 (a) was displayed. He then selected the 'Fill in a series of numbers, dates, and other items' option (access 5), and the window on figure 5.15(b) was displayed.



(a)



(b)

Figure 5.17: Intermediate User Accessing Help for 'AutoFill'

The user was able to follow the step-by-step instructions in (b), and carried out the tasks, although with some level of difficulty. Carrying out the task, even with this

step-by-step instructions, was difficult for this user. He had to do, undo, and redo several steps before finally completing the task.

The next task required a similar operation, but this time using 'The Custom List within the system (created earlier)'. Here, the user, still using the Index, typed 'Custom' (access 1), and selected 'Custom AutoFill lists' (access 2). From the next displayed window, he selected 'AddCustomList Method' (access 3). This, however, was not helpful because of being *'too technical'*, so he backtracked and selected 'Create Custom AutoFill List' (access 4). He went through the explanation, but was not satisfied since he was not required to create it, rather, use an existing one. This was not what he wanted, so he backtracked again. He then selected 'Fill in a series of numbers, dates, and other items' option (access 5), same window as that in Figure 5.15(b). This was not helpful either, and he again backtrack, and selected 'GetCustomListContents Method' (access 6). However, this was too technical and hence not meaningful to him.

He abandoned the search, and wanted to try on his own, only to come back and continue with the On-line Help again. He decided to try 'system' (access 7), the last word in the problem statement. This, he said did not yield anything meaningful, so he had to revert to the previous word 'Custom' (access 8), and 'Custom AutoFill lists' (access 9), and finally 'Fill in a series of numbers, dates, and other items' option (access 10). He realised he was going round a circle, and this made him to request the experimenter for assistance.

These two examples of clearly showed the type of strategies users used in accessing Help information and the number of searches they do before making a successful hit or giving up. In the experiments, there was no clear distinction between the experienced and the inexperienced users in terms of the type of search used in On-line Help. However, in the general analysis, experienced users had fewer number of accesses than the inexperienced ones. This observation conforms with what was earlier expected: experienced users are familiar with the syntax and

CHAPTER VI
EXPERIMENT WITH MICROSOFT EXCEL II: USING
MANUAL

Page 162

6.0 Introduction

The experiment reported in this chapter builds upon that reported in Chapter V. Since it was observed that users, particularly Novice and Intermediate users, had considerable difficulty using Microsoft Excel's On-line Help System, and that strong preferences had been expressed for use of a User Manual, we decided to carry out the second experiment outlined in Chapter IV.

The basic aim of this experiment was to investigate how users would perform using a User Manual as the only source of help. In this regard, a similar experiment as that discussed in Chapter V was carried out, using same equipment, tasks and environment. However, the subjects used for this experiment are different from those of earlier experiment because using same subjects will invalidate the experimental results.

6.1 Experimental Setting:

The software and the equipment used in the experiment were same as those in section 5.1 of the previous chapter. The experimental procedure was identical, except all users could only access the written manual for assistance. On-line help was disabled.

6.1.1 Subjects

In all, 18 subjects participated in the experiment. Users were asked to classify themselves as Experts, Intermediates and Novices using the criteria set out in chapter IV. The resultant distribution is shown in Table 6.1.

the semantics of the application, and hence find it easier to formulate queries that are understood by the on-line help system than the inexperienced users.

5.6 Test for Statistical Significance

From the discussions of the analytical results, it can be seen that there appear to be noticeable differences between the various groups of users (Experts, Intermediates and Novices). It will be more useful to show the statistical significance of these results.

5.6.1 Analysis of Variance (ANOVA)

Analysis of variance is a method of testing the null hypothesis that several group means are equal in the population, by comparing the sample variance estimated from the group means to that estimated within the groups.

To perform Analysis of Variance, two assumptions regarding the data must hold. These are:

- Each group is an independent random sample from a normal population (*test for normality*).
- In the population, the variances of the groups are equal (*test for homogeneity of variance*)

5.6.1.1. Test for homogeneity of Variances

Numerous tests are available for evaluating the assumption that all groups come from populations with equal variances. Many of these tests, however, are heavily dependent on the data being from normal populations. Analysis of Variance

procedures, on the other hand, are reasonably robust against departures from normality (Norusis, 1993).

The *Levene* test is a homogeneity of variance test that is less dependent on the assumption of normality than most tests and thus is particularly useful with analysis of variance. It is obtained by computing, in each case, the absolute difference from its cell mean and performing a one way analysis of variance on these differences.

A Levene test is used to test the null hypothesis that the groups come from populations with unequal variance. If Levene's test is significant, that is it has probability of (<0.05), then the variances are unequal, and hence we can accept the null hypothesis that the groups have unequal variances.

This test was carried out and the result indicates that there is no enough evidence to suspect that the variances are unequal. For a detailed breakdown of the analysis results, see appendix G, Section G.1.

5.6.1.2. Test for Normality

Since the normal distribution is very important for correct statistical inference, it is necessary to examine the assumption that the data come from a normal distribution. One way to do this is with a normal probability plot. In a normal probability plot, each observed value is paired with its expected value from the normal distribution. The expected value from the normal distribution is based on the number of cases in the sample and rank-order of the case in the sample. If the sample is from a normal distribution, the points can be expected to lie more or less on a straight line.

Although normal probability plots provide a visual basis for checking normality, it is often desirable to compute the statistical test of the hypothesis that the data are from normal distribution. Some of the commonly used tests are the Shapiro-Wilks

test, the Lilliefors test, The Least Significant Difference (LSD) and the Bonferroni Tests.

If the observed significance level is small, the null hypothesis that the data comes from a normal distribution can be rejected.

However, if the sample size is large, almost any goodness of fit test (like the Bonferroni's test) will result in rejection of the null hypothesis. It is almost impossible to find data that are exactly normally distributed. For most statistical tests, it is sufficient that the data are approximately normally distributed (Norusis, 1993).

5.6.1.2.1 Bonferroni Test

Uses t tests to perform pair-wise comparisons between group means, but controls overall error rate by setting the error rate for each test to the experiment-wise error rate divided by the total number of tests. Hence, the observed significance level is adjusted for the fact that multiple comparisons are being made.

The Bonferroni test in conjunction with the Least Significant and the Dunnett tests were carried out and the results indicate the data did not come from normal distribution. However, both the histogram and the probability plot show a normal distribution. Based on this, we can assume that the data is from a reasonably normal distribution. For a detailed break down of these results see Section G.1 of Appendix G.

5.6.1.3 ANOVA Test Run

Based on the above results, we can see that the two assumptions regarding the data hold. These are, that each group is an independent random sample from a normal

population and in the population, the variances of the groups are equal. Hence this makes it possible to perform the Analysis of Variance test.

The results of the test run are shown in Table 5.8. From the table we can see that there exist significant difference between all the groups (Experts, Intermediates and Novices), with $p < 0.001$. Hence we can conclude that the overall results are significantly different from each other, and this could not have happened by chance.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Total Completion Time	Between Groups	143425.0	2	71712.52	171.619	.000
	Within Groups	7939.317	19	417.859		
	Total	151364.4	21			
Help Search Time	Between Groups	24978.40	2	12489.20	33.798	.000
	Within Groups	7020.917	19	369.522		
	Total	31999.32	21			
Exploration Time	Between Groups	15707.80	2	7853.900	45.576	.000
	Within Groups	3274.200	19	172.326		
	Total	18982.00	21			
Total Task Time	Between Groups	10880.63	2	5440.317	25.255	.000
	Within Groups	4092.867	19	215.414		
	Total	14973.50	21			
Total Completed tasks	Between Groups	778.497	2	389.248	45.133	.000
	Within Groups	163.867	19	8.625		
	Total	942.364	21			
Total Access	Between Groups	1660.268	2	830.134	35.600	.000
	Within Groups	443.050	19	23.318		
	Total	2103.318	21			
Number of Times Assisted By Experimenter	Between Groups	952.152	2	476.076	56.652	.000
	Within Groups	159.667	19	8.404		
	Total	1111.818	21			

Table 5.8: Analysis of Variance Test (ANOVA) for 3 Independent Samples

5.6.2 Kruskal-Wallis H Test for K-Independent Samples

As a precaution we decided to use a non-parametric test for significance which is not restricted by the conditions of ANOVA. Such a test is the Kruskal-Wallis H Test for K Independent Samples. The K Independent Samples Test compares the distribution of a variable between two or more groups. Only limited assumptions are needed about the distributions from which the samples are selected. The Kruskal-Wallis test is an alternative to ANOVA, with the actual values of the data replaced by ranks. The Median test counts the number of cases in each group that are above and below the combined median and then performs a chi-square test.

This test is required to clear the questions that could be raised based on the multiple comparison tests that the data could not have come from a reasonably normal distribution. Kruskal-Wallis Test was run for all the groups as well as on all the variables. The results obtained are shown in Table 5.9a and 5.9b.

Ranks

	User Level	N	Mean Rank
Total Completion Time	Experts	5	3.00
	Intermediates	12	11.50
	Novices	5	20.00
	Total	22	
Help Search Time	Experts	5	3.80
	Intermediates	12	11.17
	Novices	5	20.00
	Total	22	
Exploration Time	Experts	5	3.00
	Intermediates	12	12.08
	Novices	5	18.60
	Total	22	
Total Task Time	Experts	5	3.60
	Intermediates	12	11.50
	Novices	5	19.40
	Total	22	
Total Access	Experts	5	3.20
	Intermediates	12	11.42
	Novices	5	20.00
	Total	22	
Total Completed tasks	Experts	5	19.30
	Intermediates	12	11.79
	Novices	5	3.00
	Total	22	
Successful hits	Experts	5	5.10
	Intermediates	12	13.04
	Novices	5	14.20
	Total	22	
Number of Times Assisted By Experimenter	Experts	5	3.00
	Intermediates	12	11.50
	Novices	5	20.00
	Total	22	

Table 5.9a: Kruskal-Wallis H Test for 3 Independent Samples

Test Statistics^{a, b}

	Total Completion Time	Help Search Time	Exploration Time	Total Task Time	Total Access	Total Completed tasks	Successful hits	Number of Times Assisted By Experimenter
Chi-Square	17.154	15.674	14.691	15.004	16.862	15.886	6.489	17.222
df	2	2	2	2	2	2	2	2
Asymp. Sig.	.000	.000	.001	.001	.000	.000	.039	.000

a. Kruskal Wallis Test

b. Grouping Variable: User Level

Table 5.9b: Kruskal-Wallis H Test Statistic for 3 Independent Samples

From the tables, it can be seen that all test variables have shown positive results, with significant level $p < 0.039$. It should be noted that the above Asymptotic Significance means the significance level based on the asymptotic distribution of a test statistic, assuming that the data set is large. This is used because it was not possible to obtain exact confidence intervals for each of the parameters.

These results are in conformity with the ones of Analysis of Variance, and hence clear the doubts about data.

5.6.3 Mann-Whitney Test

A second non-parametric test, similar to the Kruskal-Wallis H test is the Mann-Whitney U test. This test is the most popular of the two-independent-samples tests. It is equivalent to the Kruskal-Wallis test for two groups. Mann-Whitney tests that two sampled populations are equivalent in location. The observations from both groups are combined and ranked, with the average rank assigned in the case of ties. The number of ties should be small relative to the total number of observations. If the populations are identical in location, the ranks should be randomly mixed between the two samples. The number of times a score from group 1 precedes a score from group 2 and the number of times a score from group 2 precedes a score from group 1 are calculated. The Mann-Whitney U statistic is the smaller of these two numbers. The Wilcoxon rank sum W statistic, also displayed, is the rank sum of the smaller sample. If both samples have the same number of observations, W is the rank sum of the group named first in the Two-Independent-Samples Define Groups dialog box.

This test was found to be necessary because of the need to test the significance of the difference between the separate groups, two at a time. The results of the tests are shown below.

5.6.3.1 Expert Vs Intermediate Users

Tables 5.10a and 5.10b show the summary of the results of the comparison between the Expert and Intermediate users of the On-line Help system.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Total Completion Time	Experts	5	3.00	15.00
	Intermediates	12	11.50	138.00
	Total	17		
Help Search Time	Experts	5	3.80	19.00
	Intermediates	12	11.17	134.00
	Total	17		
Exploration Time	Experts	5	3.00	15.00
	Intermediates	12	11.50	138.00
	Total	17		
Total Task Time	Experts	5	3.60	18.00
	Intermediates	12	11.25	135.00
	Total	17		
Total Completed tasks	Experts	5	14.30	71.50
	Intermediates	12	6.79	81.50
	Total	17		
Total Access	Experts	5	3.20	16.00
	Intermediates	12	11.42	137.00
	Total	17		
Successful hits	Experts	5	5.00	25.00
	Intermediates	12	10.67	128.00
	Total	17		
Number of Times Assisted By Experimenter	Experts	5	3.00	15.00
	Intermediates	12	11.50	138.00
	Total	17		

Table 5.10a: Mann-Whitney U Test for 2 Independent Samples

Test Statistics^a

	Total Completion Time	Help Search Time	Exploration Time	Total Task Time	Total Completed tasks	Total Access	Successful hits	Number of Times Assisted By Experimenter
Mann-Whitney U	.000	4.000	.000	3.000	3.500	1.000	10.000	.000
Wilcoxon W	15.000	19.000	15.000	18.000	81.500	16.000	25.000	15.000
Z	-3.166	-2.749	-3.168	-2.889	-2.809	-3.082	-2.133	-3.180
Asymp. Sig. (2-tailed)	.002	.006	.002	.004	.005	.002	.033	.001
Exact Sig. [2*(1-tailed Sig.)]	.000 ^a	.004 ^a	.000 ^a	.002 ^a	.002 ^a	.001 ^a	.037 ^a	.000 ^a

a. Not corrected for ties.

b. Grouping Variable: User Level

Table 5.10b: Mann-Whitney U Test Statistic for 2 Independent Samples

5.6.3.2 Expert Vs Novice Users

Tables 5.11a and 5.11b show the summary of the results of the comparison between the Expert and Novice users of the On-line Help system.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Total Completion Time	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Help Search Time	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Exploration Time	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Total Task Time	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Total Completed tasks	Experts	5	8.00	40.00
	Novices	5	3.00	15.00
	Total	10		
Total Access	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Successful hits	Experts	5	3.10	15.50
	Novices	5	7.90	39.50
	Total	10		
Number of Times Assisted By Experimenter	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		

Table 5.11a: Mann-Whitney U Test for 2 Independent Samples

Test Statistics^a

	Total Completion Time	Help Search Time	Exploration Time	Total Task Time	Total Completed tasks	Total Access	Successful hits	Number of Times Assisted By Experimenter
Mann-Whitney U	.000	.000	.000	.000	.000	.000	.500	.000
Wilcoxon W	15.000	15.000	15.000	15.000	15.000	15.000	15.500	15.000
Z	-2.619	-2.619	-2.619	-2.643	-2.619	-2.619	-2.538	-2.643
Asymp. Sig. (2-tailed)	.009	.009	.009	.008	.009	.009	.011	.008
Exact Sig. (2*(1-tailed Sig.))	.008 ^a	.008 ^a	.008 ^a	.008 ^a	.008 ^a	.008 ^a	.008 ^a	.008 ^a

^a. Not corrected for ties.

^b. Grouping Variable: User Level

Table 5.11b: Mann-Whitney U Test Statistic for 2 Independent Samples

5.6.3.3 Intermediate Vs Novice Users

Tables 5.12a and 5.12b show the summary of the results of the comparison between the Intermediate and Novice users of the On-line Help system.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Total Completion Time	Intermediates	12	6.50	78.00
	Novices	5	15.00	75.00
	Total	17		
Help Search Time	Intermediates	12	6.50	78.00
	Novices	5	15.00	75.00
	Total	17		
Exploration Time	Intermediates	12	7.08	85.00
	Novices	5	13.60	68.00
	Total	17		
Total Task Time	Intermediates	12	6.75	81.00
	Novices	5	14.40	72.00
	Total	17		
Total Completed tasks	Intermediates	12	11.50	138.00
	Novices	5	3.00	15.00
	Total	17		
Total Access	Intermediates	12	6.50	78.00
	Novices	5	15.00	75.00
	Total	17		
Successful hits	Intermediates	12	8.88	106.50
	Novices	5	9.30	46.50
	Total	17		
Number of Times Assisted By Experimenter	Intermediates	12	6.50	78.00
	Novices	5	15.00	75.00
	Total	17		

Table 5.12a: Mann-Whitney U Test for 2 Independent Samples

Test Statistics ^a

	Total Completion Time	Help Search Time	Exploration Time	Total Task Time	Total Completed tasks	Total Access	Successful hits	Number of Times Assisted By Experimenter
Mann-Whitney U	.000	.000	7.000	3.000	.000	.000	28.500	.000
Wilcoxon W	78.000	78.000	85.000	81.000	15.000	78.000	106.500	78.000
Z	-3.164	-3.164	-2.432	-2.864	-3.176	-3.186	-.159	-3.172
Asymp. Sig. (2-tailed)	.002	.002	.015	.004	.001	.001	.874	.002
Exact Sig. [2*(1-tailed Sig.)]	.000 ^a	.000 ^a	.014 ^a	.002 ^a	.000 ^a	.000 ^a	.879 ^a	.000 ^a

a. Not corrected for ties.

b. Grouping Variable: User Level

Table 5.12b: Mann-Whitney U Test Statistic for 2 Independent Samples

In conclusion therefore, the behaviour of Experts, Intermediates and the Novices with the On-line Help system of Excel is different and is highly significant. This difference can be seen in all cases, especially in Help Search Time, Task Completion Time, Exploration Time, Total Tasks Completed, Total Access and Number of Times Assisted by the Experimenter. These results partially confirm hypothesis I – that the time taken to complete any given task will vary according to user experience, irrespective of aid mechanism.

Further, the results gave us a high level of confidence that our categorisation of users into Experts, Intermediates and Novices is a valid one, and this will be important in subsequent experiments.

5.6 Analysis of Task Completion Questionnaire

Most of the subjects had done similar tasks at one time or the other prior to the experiment. All subjects found exercises 1 and 2 to be “fairly easy”. 66% found question 3 “fairly easy”, 34% found it “difficult”. In question 4, the opposite was the case 34% found it “fairly easy” while 66% found it “difficult”. It was interesting to note that none found the whole exercise “extremely difficult”. All the subjects accessed the On-line Help system. Some Novice users accessed it on almost every occasion. All users commented that the On-line Help system in Version 7 of Microsoft Office had been improved.

Subjects were asked whether they would have preferred the User Manual only, or the User Manual together with the On-line Help System for the experiment. All subjects said they preferred having both. The reasons given for wanting both were – “Ease of reading from paper rather than from the screen”, “the problem of On-line Help information obscuring parts of the screen” and “having to scan through many screens”.

The subjects were also asked to rate the On-line Help System and the User Manual in terms of overall effectiveness to query response, both in content and quality of the response. All the subjects said that the User Manual was more effective than the On-line Help System. They were also asked to indicate their agreement or disagreement with certain statements about the On-line Help System of Excel. A summary of the results obtained is presented in table 5.13.

STATEMENT	STRONGLY AGREE	AGREE	PARTIALLY AGREE	DISAGREE	STRONGLY DISAGREE
The On-line Help System of Excel helps in learning how to use the application			23%	77%	
The On-line Help System is helpful only to those familiar with Excel		95%	5%		
It is always easy to find the help you are looking for with the On-line Help System			36%	64%	
The explanations given in the Excel On-line Help are usually easy to follow and understand			18%	82%	
The examples given in the On-line Help System are always sufficient			9%	91%	
The On-line Help System is not as useful as it should be	5%	95%			
The On-line Help System is useless in terms of error correction		91%	9%		
The On-line Help System distracts me from my work whenever I try to access it	5%	64%	13%	18%	

Table 5.13 Subjects Agreement with statements about On-line Help

From the above summary, it will be seen that the message is reasonably clear. On-line Help has some way to go before becoming acceptable.

5.7. Discussion of Results

The results presented above show that the On-line Help System of Microsoft Excel is still lacking in many respects. For instance, many subjects indicated their

dissatisfaction with the manner in which help information is given, that it is in most cases non-procedural, not concise and not specific, and generally irrelevant information is displayed. Others expressed their dissatisfaction with the inflexibility of the On-line Help System. Some felt that the On-line Help System assumed too much user knowledge about the system. Many users acknowledged that they had frequently abandoned use of the facility because they had failed to get appropriate assistance. However, it is also fair to point out that almost all respondents acknowledged the good aspects of the On-line Help system of Microsoft Excel, such as its index, search facility, cue cards and the fact that it is accessed within the application. Users also noted that the most recent version of the On-line Help was an improvement on previous versions, indicating that the designers at Microsoft are improving their understanding of On-line Help issues. Still, as Corrigan and Kennard puts it, 'for most people, despite modern technologies, the preferred presentation method is still the printed page' (Corrigan and Kennard, 1997). This is further supported by the high level of significance observed from both the analytical and the statistical results, and hence confirms hypothesis I.

A question that has to be addressed at this stage is whether similar results and discussed in Chapter III will be obtained for the second experiment outline in Chapter IV. This is discussed in Chapter VI.

Subject Expertise	Number
Expert	5
Intermediate	8
Novice	5

Table 6.1 Distribution of Subjects in the User Manual Experiment

None of the subjects of the present study participated in the On-line Help experiment reported in the preceding chapter, since having them participate in both experiments would have affected the results. This is so because previous experiment would have familiarised them with the tasks.

6.1.2 Procedure, Task and Task Completion Questionnaire

A similar procedure as discussed in Sections 5.1.2 of Chapter V is followed here. Similarly, the same set of tasks as outlined in Section 5.1.3 are used. However, the main source of assistance to be used by subjects in carrying out the tasks is the User Manual. The task completion questionnaire used is also similar to the one outlined and discussed in Section 5.1.4. The actual questionnaire used can be found in Appendix D

6.2. Results of the 'User Manual' Study

6.2.1 Seeking 'Help'

All subjects used the 'User Manual' at one stage or the other during the experiment. Generally, most of the users were able to get the information the needed easily for certain sub-tasks, while others had to browse through several pages before they found what they required. Yet again, others had considerable difficulty and had to be assisted by the experimenter. Table 6.3 shows the

percentage of those who used the 'User Manual' on a particular task, by level of expertise.

Sub Task Level	Novice	Intermediate	Expert
1	50%	13%	0%
2	72%	38%	16%
3	87%	60%	43%
4	100%	84%	70%

Table 6.3 Use of 'User Manual' by Task Difficulty and Experience

This table increases our confidence in the task ratings and the user classification schemes. As expected help is sought more by novices than experts, and increasingly by all classes as the tasks gets harder.

The book used, 'Running Microsoft Excel for Windows 95' (Dodge, Kinata, & Stinson, 1995), provided three basic ways of accessing information - Table of Contents placed at the beginning, a brief Table of Contents (index) at the beginning of each chapter, and an index at the end of the book.

6.2.2 Examples of User Activity When Accessing the 'User Manual'

Because of the nature of user activity during the experiment, out of many examples from the study, three will be given in this chapter. The subjects whose activities were presented in these examples were randomly selected, and not based on any criteria. The task chosen, however, was a common task where all users used the 'User Manual' to find out how to carry it out. The book 'Running Microsoft Excel for Windows 95' (Dodge, 1995) was used by the subjects as a reference. The researchers would have liked to use the Microsoft Excel's User Manual or User Guide as the reference material, however, Microsoft only include the 'Getting Results with Microsoft Excel for Windows 95' (Microsoft, 1995) manual in the shipment. When this is compared to the manuals of the previous

release of Microsoft Excel (version 5.0), it will be seen that it is much smaller (only 225 pages) than that of version 5.0. Microsoft Excel version 5.0 comes with five manuals, with the smallest having 168 pages and the largest having 786 pages.

It is interesting to find out what reasons Microsoft gave for this enormous change. Pete Higgins, the Group Vice President of Microsoft Applications and Content Group, said: '...The best way to answer this question is to about the goals we've set for ourselves in producing this book: make it relevant to the work you do; make it more graphical; make it easier to scan and digest; and make it fun too browse through, and more friendly overall....we've focused on documenting our products - that is, explaining how they work, often in intricate detail. However, you've told us that your primary focus is on getting your work done, not learning our products! This motivated us to rethink our approach....

'We realise that you have a job to do; you need to get from point A to point B. Our job is to provide you with a 'map' and steer you in the right direction so that you can get there as quickly and efficiently as possible. If you need more information along the way, it's right there at your fingertips in our new on-line user assistance system - all you have to do is ask the Answer Wizard!...' (Microsoft, Corp, 1995, pp v-vi).

These words sound convincing enough and one would expect the On-line Help system to be very helpful. However, as we have seen in the preceding chapter, we can safely say that the opposite is the case.

6.2.2.1 Task: Import a Dbase File (Using Microsoft Query)

This was a task where all the subjects experienced difficulties, and where access to the On-line Help system was highest. Using On-line Help, most of the experienced subjects were able to eventually solve the problem. However, the inexperienced users had to request assistance.

6.2.2.1.1 An Example: A Novice User

The Novice user turned the content page, flipped through and was able to see 'Chapter 27 Importing and Exporting 909', and further down, he saw 'Importing and Exporting .DBF files 923'. He then turned to page 923, and the following explanations were given:

IMPORTING AND EXPORTING .DBF FILES

Microsoft Excel can import .DBF from three versions of dBASE: dBASE II, dBASE III, and dBASE IV. Excel creates a list from the imported file, placing the dBASE field names in the first row as column headings. The dBASE records appear in rows immediately below the field names. Excel sets the worksheet column width to match the width of the corresponding dBASE fields.

Note that you can also use Microsoft Query to import information stored in .DBF files. When you use the Open command on the File menu to import a dBASE file, Excel imports the entire file, you can import only specific records or fields, or you can import the entire file.....

..... For more information about Microsoft Query, see Chapter 21,

He turned to Chapter 21 (page 757), and found a short index for the chapter. He scanned this (2 pages). He decided to follow the pages sequentially, trying to find any clue as to how to go about carrying out the task. Upon reaching page 761, he saw:

Connecting to a Data Source

To begin working with external data, choose Get External Data command from the Data menu. After Microsoft Query is activated, it presents the Select Data Source dialogue box. Here, you'll find a list of the data sources that you've been using. To reuse a data source, simply double-click its name, or select it and click the Use button. Query then displays the Add

Tables dialogue box, where you can tell Query which table you want to work with..... (761)

.... To work with a single table, double-click its name in the Add Tables dialog box and click Close button..... You can now work with your query window, which looks like the one shown in figure 21-2..... (page 763)

He *scanned* these sections (763 through 766), reading the instructions and interacting with the screen. He was then able to practically complete the task with little assistance from the experimenter. The assistance given was corrective rather than an assistance. The user entered the required data in the wrong order, and was guided on how to enter them in the right order. NOTE the importance of “scanning” here. One advantage of the Use Manual is that it supports scanning.

6.2.2.1.2 An Example: An Intermediate User:

In carrying out the task, the user turned the index page and flipped through, and was able to find ‘IMPORTING, 909-27...’ and further down, he saw: ‘dBASE files, 923-24’. He then turned to page 923. The following explanations were given:

IMPORTING AND EXPORTING .DBF FILES

Microsoft Excel can import .DBF from three versions of dBASE: dBASE II, dBASE III, and dBASE IV. Excel creates a list from the imported file, placing the dBASE field names in the first row as column headings. The dBASE records appear in rows immediately below the field names. Excel sets the worksheet column width to match the width of the corresponding dBASE fields.

Note that you can also use Microsoft Query to import information stored in .DBF files. When you use the Open command on the File menu to import a dBASE file, Excel imports the entire file, you can import only specific records or fields, or you can import the entire file.....

..... For more information about Microsoft Query, see Chapter 21,

He turned to Chapter 21 (page 757), and found a short index for the chapter. He scanned this (2 pages) and decided to examine "Installing the Microsoft Query Add-in" (on page 760). The first two lines of the section state:

"You can access Microsoft Query from within Microsoft Excel in two ways: by choosing Get External Data command from Excel's Data Menu or by choosing the Pivot Table...."

He immediately selected Get External Data on the Data Menu since he was not sure what a Pivot Table was. A menu appeared and the user then turned the User Manual page (763) and saw an identical menu on the page. He followed the section on "Adding Tables" reading the instructions and interacting with the screen. He was then able to complete the task without the assistance of the experimenter.

The manner in which this user browsed the manual to get the required information for carrying out the task is very interesting. He used an unexpected clue - 'Installing Microsoft Query'. The task did not require any installation, neither was he told to install any add-in. Yet, upon seeing this, he was able to establish an initial route towards the solution, and by browsing flipping through the book, he carried out the task without assistance. This is the power book – the writer(s) ensure(s) that the material contained within is of sound quality. There is the author/book relationship and such a relationship does not exist in the case of online information.

6.2.2.1.3 An Example: An Expert User

The expert user turned the index page and flipped through, and was able to find 'IMPORTING, 909-27...' and further down, he saw: 'dBASE files, 923-24'. He then turned to page 923. The following explanations were given:

IMPORTING AND EXPORTING .DBF FILES

Microsoft Excel can import .DBF from three versions of dBASE: dBASE II, dBASE III, and dBASE IV. Excel creates a list from the imported file, placing the dBASE field names in the first row as column headings. The dBASE records appear in rows immediately below the field names. Excel sets the worksheet column width to match the width of the corresponding dBASE fields.

Note that you can also use Microsoft Query to import information stored in .DBF files. When you use the Open command on the File menu to import a dBASE file, Excel imports the entire file, you can import only specific records or fields, or you can import the entire file.....

..... For more information about Microsoft Query, see Chapter 21,

He turned to Chapter 21 (page 757), and flipped through the small table of contents at the beginning of the chapter, and went straight to 'Connecting to a Data Source' (on page 761). The following explanations were given:

Connecting to a Data Source

To begin working with external data, choose Get External Data command from the Data menu. After Microsoft Query is activated, it presents the Select Data Source dialogue box. Here, you'll find a list of the data sources that you've been using. To reuse a data source, simply double-click its name, or select it and click the Use button. Query then displays the Add Tables dialogue box, where you can tell Query which table you want to work with..... (761)

With the book open, he turned to the Application, selected Get External Data from the Data menu and successfully carried out the task without the assistance of the experimenter. A notable approach of this user was that he was able to complete the

task at once, without having to carry out several 'iterations' of trying and re-trying as witnessed with others.

It is important to note that all the users given in the above examples accessed the same pages, even though their approaches towards reaching the desired information differ. This is in contrast to the manner in which the users in the On-line Help experiment accessed information on-line, where users frequently became stuck in dead-ends and had to backtrack to the highest level to try another access technique.

6.3 General Observations: Characterisation of User Behaviour

To allow a meaningful generalisation, further examples of user 'interaction' with the manual during the experiment are presented.

The first example presented is the one in which subjects were asked to add subtotals to the data (tasks 2 & 41). The subjects that accessed the manual in finding the information of how to carry out these tasks first accessed the Index (or Contents page in some cases). Those that accessed the index found

SUBTOTAL DIALOG BOX

- Creating subtotals 745-47
- Page Breaks Between Groups option, 747
- Remove All option, 748
- Replace Current Subtotals option, 748

While those that used the contents page as their first access point, found

- Using Subtotals to Analyse a List 743
- How Subtotal Formulas Are Built 747
- Using Automatic Page Breaks 747
- Removing or Replacing Subtotals 748.

It is interesting to note that both access methods pointed to the same position where the required information can be found. This gave the subjects a unified direction and, on reading this information, they opened these pages, and browsed both forward and backward trying to match their queries with the terms used on the written page. With the various illustrated examples within these pages, all users were able to solve their problem – completed the tasks, with less assistance from the experimenter, as opposed to what was observed in the case of the subjects that used the On-line Help system, reported in the previous chapter.

In the example given above, there was somewhat a 'direct' link to the location of the required information. However, in some cases, such a direct link was not there, but the subjects were still able to identify a keyword or phrase that enabled them to establish their first contact with the location where the required information can be found. One of such cases was the tasks that required users to filter the data (tasks 8, 24 & 38).

Those that used the index found

Filter Submenu, Data Menu, Show All command, 731

Filtering. See Also Lists; Microsoft Query...

This does not point directly to where the information about filtering is located, but it gives an indication of where a related information can be found. This enabled the users to establish first contact with the information. By browsing through the pages, flipping forward and backward, they were able to locate the required information. With similar examples within the pages, they were able to carry out these tasks.

Generally, from the experiments carried out with the User Manual, a characterisation of the nature in which humans behave when looking for information stored in a written documentation can be made. The first problem is that of the choice of the appropriate written documentation, in itself often

constitutes a problem. In this experiment, however, a specific manual was given, thereby solving the problem of deciding which manual to use. The next stage is to decide what mode of search to use. In the User Manual, the available choices are three: the index, contents, or browsing through the document. The user decides to browse the index (or contents page), searching for a 'keyword' or 'phrase' relevant to their problem.

Here, the users' search pattern (the 'keyword' or 'phrase') is not precise; they know the information they are looking for, but they do not know the words that have been used to describe it in the manual. They can only assume that a certain word must be part of the related text.

Consider the manner in which the subjects in the experiment searched for information on how to 'Put a double line border round the table' Their first assumption was that the relevant part of the manual would contain words like 'double line' or 'border' and they therefore scanned the index (or contents) for these. Furthermore, these words can be written in several different formats: capital letters, plurals and spaces. Also, many typing conventions can shape the same words in different ways. The traditional On-line Search Engines may never hit the words the user understands. It may issue near matches, or no match at all. In contrast, the human search strategy is much more efficient, since it can match an approximate pattern with the thousands of patterns within the index or table of contents, and often quickly spot the right occurrence.

Also, if the information is not found in the manual, the human mind is able to understand 'where to move'. The context directly or indirectly suggests where further information on the topic might be found. Therefore, the search is not entirely hierarchical, but usually takes the form of 'curved' path within a graph. Once the right manual is opened at the right chapter, the user starts another 'approximate' search for the information he is looking for, flipping pages forward and backward, trying to find the appropriate text that correctly match their requirement.

After several flips through the pages, the user finds the right page, and there is the right information that satisfies his needs. However, it is sometimes hidden within many other words and the user has no time to waste in reading all the text, much of which at that time is of less importance to him. Often, the page may contain suitable figures that in few sketches explains everything he needs.

What is observed here is typical of users who are being assisted by written information. Firstly, although they use indexes (or content pages) to effect primary access, they then often exploit the sequential nature of written material, browsing until they find information, which appears relevant. As discussed in the preceding chapter, one of the problems identified in the On-line Help experiment was that of Vocabulary. This human technique often solves these Vocabulary problems because the user is able to discover terminology differences, as evident in the examples presented above. Secondly, the fact that the book is in a separate place from the screen application is also exploited. Users appreciate the fact that the instructions do not clutter the screen, and that there is a clear separation between help source and application.

In the next section, analytical results of the performance of the subjects of this experiment are presented.

6.4 Analytical Results

As presented in the preceding chapter, the observations from the experiment are analysed according to the following measurement criteria:

- Total time taken during the experiment
- Time taken browsing the User Manual
- Time taken during exploration
- Time taken to perform actual tasks
- number of completed tasks

- Method(s) employed during search for information
- The number of successful hits
- The number of partially successful hits
- The number of unsuccessful hits
- Number of times assistance was given by the experimenter

The observations revealed that, generally, users took longer time in carrying out the tasks than those in the On-line Help experiment. Some inexperienced users took more than seven hours to complete the experiment, and there is no user who performs the overall experiment in less than three hours.

On average, Expert users took the least time (more than three hours) in completing the experiment while Novice users took the highest time (more than seven hours). The Intermediate users were between (more than five hours). If, on the other hand, the time spent browsing or flipping through the 'User Manual' is considered, a similar trend will be seen, with Expert users taking the least time (about an hour), the Intermediate users with about two hours, and the Novice users with about two and a half hours. This means that Intermediate users spent twice as much as Expert users while Novice users also spent twice as much as Intermediate users.

These observations are interesting in the sense that each user group again took twice the time of its immediate 'successor'. This is what was expected, because Expert users, based on their knowledge of the application, are suppose to complete these tasks faster than the Intermediate users, thereby taking less time in all activities than the Intermediate users. Similar situation is observed between Intermediate and Novice users.

If the time spent trying to find out how to perform the task without browsing through the 'User Manual' (Exploration) is considered, it will be seen that Expert users spent the least time (less than an hour), the Intermediate users spent twice as much as the Expert users (about an hour and a half) and the Novice users spent

about two hours. Overall, the Experts and the Intermediate users were more successful in exploration than the Novice users.

Similarly, if the time taken to carry out the actual task after finding out how to perform the task, either by using the 'User Manual' or Exploration, it will be seen that Expert users took about an hour and a half, Intermediate users about two hours and the Novice users took about two hours and a half. Table 6.4 gives the average distribution while figure 6.1 shows the actual distribution.

USER LEVEL	Total Time (mins)	Search Time (mins)	Exploration Time (mins)	Task Time (mins)
Expert	199.20	66.40	49.20	83.60
Intermediate	321.30	113.25	93.12	115.87
Novice	435.40	154.00	122.20	157.20

Table 6.4: Average User Performance based on Time

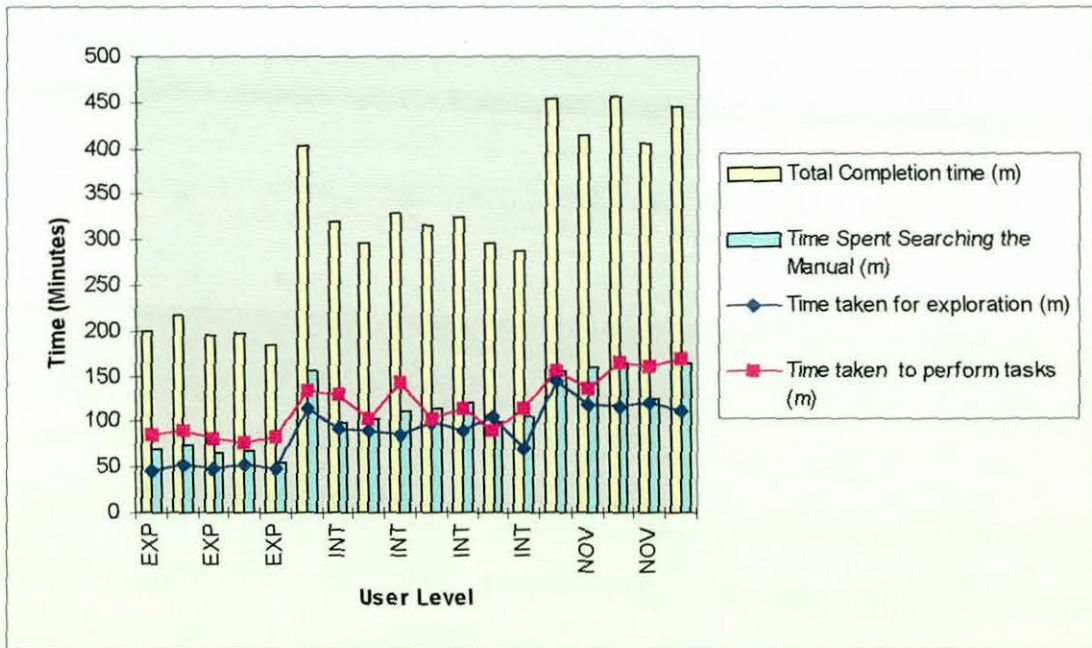


Figure 6.1: User Performance based on Time

Time is generally not considered as good measure of performance due to the effect of other factors such as Environmental Factors and Individual characteristics. However, in the case of these experiments, the different times taken to perform

separate activities were separated and distractions from the main tasks during the experiment were kept at a minimum level. Hence we can say that time has given us a good picture about the performance of different user levels, and hence increased our confidence in our user characterisations (Abdullahi & Alty, 1998).

In terms of the interaction with the 'User Manual', and whether the user achieved a successful hit - that is, the user was able to find what they were looking for and were able to use it in carrying out the task, or was partially successful or completely unsuccessful, the results did not present a clear picture of the distinction between users based on level of experience. On the average, Expert users achieved 68.33% success and 27.67% failure. Similarly, the Intermediate users achieved 68.75% success and 18.83% failure. On the other hand, the Novice users achieved 68.68% success and 23.51% failure. Table 6.5 gives the average distribution while figure 6.2 shows actual distribution.

USER LEVEL	Total Access (Average)	Successful Hits (%)	Partially Successful Hits (%)	Unsuccessful Hits (%)
Expert	5	68.33	4.00	27.67
Intermediate	11	68.75	9.64	18.83
Novice	23	68.68	15.82	23.51

Table 6.5: Average Success/Failure of User Manual Access

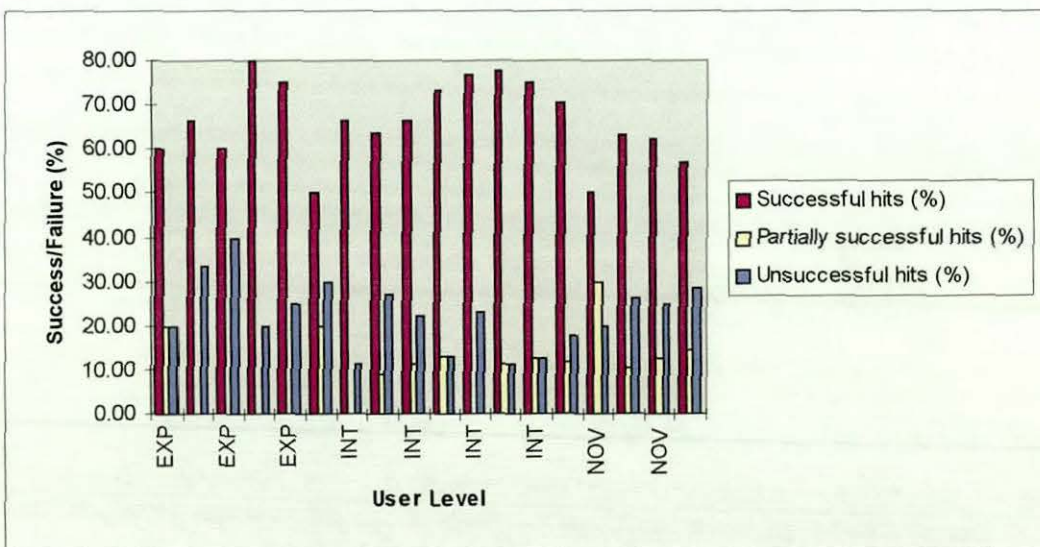


Figure 6.2: Actual Distribution of Success/Failure with 'User Manual'

It is interesting to note that success rates are similar across all user groups. In contrast in the On-line Help experiment, success rates differed across user groups. One possible explanation is that human ability to search for information through printed information may not differ greatly across the different user groups. The User Manual has enabled Novice and Intermediate users to improve their performance, but at a considerable time cost.

If we consider the average number of tasks completed using the various aids available to the subjects - the User Manual, By Exploration or Assistance from the experimenter, table 6.6 below gives the details.

User Level	Completed Tasks (/50)	With Manual	With Assistance	By Exploration	Ordinary
Expert	41	3	3	13	22
Intermediate	36	7	4	9	16
Novice	29	14	7	3	5

Table 6.6: Average distribution of task completion by aid mechanism

As can be seen from the above table, users, especially Expert users, carried out most of the tasks by exploration than by using the User Manual or employing the 'expertise' of the experimenter. However, if the average tasks carried out 'ordinarily', that is, tasks carried out either without assistance entirely or after learning out how to carry out such tasks through the subject's interaction with the manual, exploration or the assistance of the experimenter, we can see that this set of tasks equals the other three combined.

These are interesting results, as they confirm our initial hypothesis that there is likely going to be no meaningful difference between experienced users using On-line Help and those using the manual. Thus, experience played a great role since experienced users already know the advanced features of the application or can

pick them up easily with little or no assistance (Abdullahi and Alty, 1998), therefore the aid mechanism that is employed has little or no effect on this.

The performance of Novice subjects in the manual experiment, as seen above, achieved 50% more with the manual than those with the on-line help, also confirm our initial hypothesis that subjects will carry out more tasks using the manual than the on-line help. This, as stated earlier, is due to their ability to search and locate information stored in printed documentation.

A similar observation is seen in the case of the number of tasks completed with the assistance of the experimenter. Whereas no substantial difference is witnessed in the case of Expert subjects in either the Manual or On-line Help experiment, intermediate subjects of the On-line Help experiment completed twice the number of the tasks completed by their counterparts in the manual experiment (8 compared to 4). This shows that the Intermediate users were assisted more in the On-line Help experiment than in the manual experiment. There was no substantial difference between the Novice subjects in either the Manual or the On-line Help experiment (9 compared to 7).

One question that can be asked from the above result is: Is this decrease in the number of times assistance was given due to the users' knowledge about the application or is due to the familiarity or 'ease of use' of the 'User Manual'? A reasonable explanation to this phenomenon is that it is possibly due to human ability to find information within written documentation, as this is not likely to be affected by the level of experience of the user.

An interesting comparison is the one between the tasks completed ordinarily between the subjects' categories, in either the Manual or the On-line Help experiment. Whereas no substantial difference is witnessed in the case of expert subjects in either the Manual or On-line Help experiment (22 compared to 21), intermediate subjects of the Manual experiment completed 60% more tasks than their counterparts in the On-line Help experiment (16 compared to 10). The

difference between the two groups is more striking in the case of the Novice users, where those of the Manual experiment completed more tasks than their counterparts in the On-line Help experiment.

One obvious question that the above result raises is: Why this sharp difference between the two groups, especially the intermediate and novice categories? A possible explanation is either that the subjects in the Manual experiment are more experienced than their counterparts on the On-line Help experiment or they are faster in learning, due to the 'user friendliness' and ease of access of the information of the manual. In this experiment, the second reasoning holds; the difference between the two groups can be attributed to the 'User Friendliness' of the 'User Manual'. Humans are generally experts in looking for information buried within the pages of books, thereby finding what they want in order to perform the tasks. Once such an information is found and the task completed, the 'knowledge' acquired remains with the user, thereby enabling them to carry out similar tasks without further search.

Table 6.7 gives the actual averages of the number of times subjects were assisted in this experiment, as well as their overall performance, based on task scores (presented in table 6.2), while figure 6.3 shows the actual distribution.

USER LEVEL	Assisted (x times)	Completed Tasks (out of 50)	Overall performance (%)
Expert	3	41	88.92
Intermediate	4	36	75.89
Novice	9	29	54.78

Table 6.7: Average time assistance was given and performance

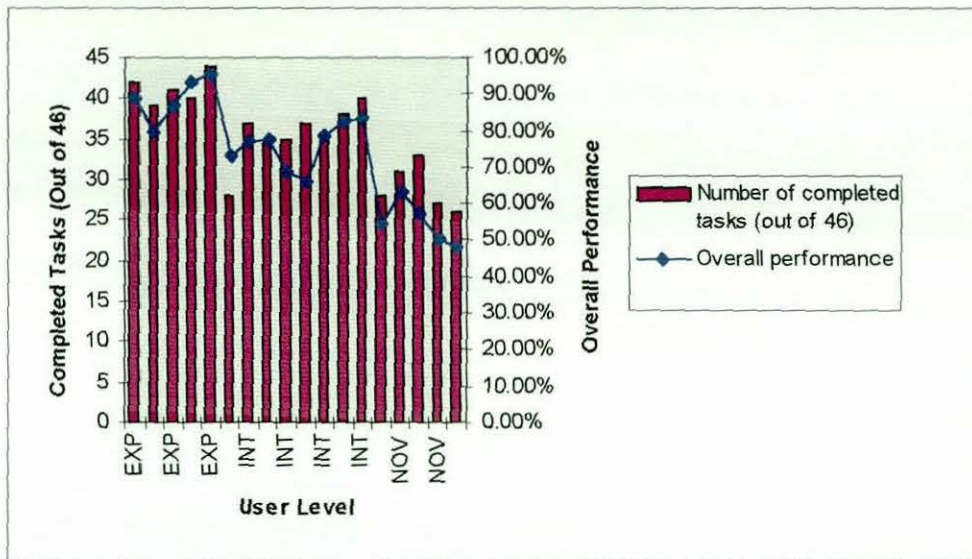


Figure 6.3: Actual Completed Tasks and Performance

In terms of the methods adopted in accessing the written information, all the available methods were used across the different user groups.

6.5 Test for Statistical Significance

Similar to what was observed in the On-line Help study, we carried out a number of statistical tests to check the significance of the results presented in the previous section. These tests are presented below.

6.5.1 Analysis of Variance (ANOVA)

The following is the analysis of variance results of the User Manual data. A detailed discussion of the numerous tests carried out to test the normality and homogeneity of the data is given in appendix G Section G.2.

The results of the test run are shown in Table 6.8. From the table, we can see that there exist significant difference between all the groups (Experts, Intermediates and Novices), with $p < 0.001$. Hence we can conclude that the overall results are

significantly different from each other, and this could not have happened by chance.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Number of Completed Tasks	Between Groups	373.325	2	186.662	20.486	.000
	Within Groups	136.675	15	9.112		
	Total	510.000	17			
Exploration Time	Between Groups	13567.52	2	6783.762	50.815	.000
	Within Groups	2002.475	15	133.498		
	Total	15570.00	17			
Manual Search Time	Between Groups	19225.74	2	9612.872	37.979	.000
	Within Groups	3796.700	15	253.113		
	Total	23022.44	17			
Total Access	Between Groups	864.444	2	432.222	26.142	.000
	Within Groups	248.000	15	16.533		
	Total	1112.444	17			
Task Time	Between Groups	13633.40	2	6816.701	33.319	.000
	Within Groups	3068.875	15	204.592		
	Total	16702.28	17			
Total Completion Time	Between Groups	139549.9	2	69774.95	86.100	.000
	Within Groups	12155.88	15	810.392		
	Total	151705.8	17			
Number of Times Assisted by Experimenter	Between Groups	126.678	2	63.339	23.992	.000
	Within Groups	39.600	15	2.640		
	Total	166.278	17			

Table 6.8: Analysis of Variance Test Results for User Manual Study

6.5.2 Kruskal Wallis Test for K-Independent Samples

Similar to what was observed in the On-line Help experiment, as a precaution, we decided to use a non-parametric test for significance, which is not restricted by the conditions of ANOVA.

This test is required to clear the questions that could be raised based on the multiple comparison tests – that the data could not have come from a reasonably normal distribution. Kruskal-Wallis Test was run for all the groups as well as on

all the variables. The results obtained are shown in Table 6.9a and 6.9b.

Ranks

	User Level	N	Mean Rank
Number of Completed Tasks	Experts	5	15.70
	Intermediates	8	9.38
	Novices	5	3.50
	Total	18	
Exploration Time	Experts	5	3.00
	Intermediates	8	9.63
	Novices	5	15.80
	Total	18	
Manual Search Time	Experts	5	3.00
	Intermediates	8	9.69
	Novices	5	15.70
	Total	18	
Number of Times Assisted by Experimenter	Experts	5	4.30
	Intermediates	8	8.69
	Novices	5	16.00
	Total	18	
Task Time	Experts	5	3.20
	Intermediates	8	9.50
	Novices	5	15.80
	Total	18	
Total Completion Time	Experts	5	3.00
	Intermediates	8	9.50
	Novices	5	16.00
	Total	18	

Table 6.9a: Kruskal-Wallis H Test for 3 Independent Samples

Test Statistics^{a,b}

	Number of Completed Tasks	Exploration Time	Manual Search Time	Number of Times Assisted by Experimenter	Task Time	Total Completion Time
Chi-Square	13.159	14.410	14.210	12.957	13.941	14.840
df	2	2	2	2	2	2
Asymp. Sig.	.001	.001	.001	.002	.001	.001

a. Kruskal Wallis Test

b. Grouping Variable: User Level

Table 6.9b: Kruskal-Wallis H Test Statistic for 3 Independent Samples

From the tables above, it can be seen that all test variables have shown positive results, with significant level $p < 0.002$. It should be noted that the above Asymptotic Significance means the significance level based on the asymptotic distribution of a test statistic, assuming that the data set is large. This is used because it was not possible to obtain exact confidence intervals for each of the parameters.

These results are in conformity with the ones of Analysis of Variance, and hence clear the doubts about data.

6.5.3 Mann-Whitney Test

A test similar to the Kruskal-Wallis H test is the Mann-Whitney test. This test was found to be necessary because of the need to test the significance of the difference between the three user groups, two at a time. The results of the tests are shown below.

6.5.3.1 Expert Vs Intermediate Users

Tables 6.10a and 6.10b show the summary of the results of the comparison between the Expert and Intermediate users of the User Manual.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Exploration Time	Experts	5	3.00	15.00
	Intermediates	8	9.50	76.00
	Total	13		
Manual Search Time	Experts	5	3.00	15.00
	Intermediates	8	9.50	76.00
	Total	13		
Task Time	Experts	5	3.20	16.00
	Intermediates	8	9.38	75.00
	Total	13		
Total Completion Time	Experts	5	3.00	15.00
	Intermediates	8	9.50	76.00
	Total	13		
Numer of Completed Tasks	Experts	5	10.70	53.50
	Intermediates	8	4.69	37.50
	Total	13		
Total Access	Experts	5	3.00	15.00
	Intermediates	8	9.50	76.00
	Total	13		

Table 6.10a: Mann-Whitney U Test for 2 Independent Variables

Test Statistics ^a

	Exploration Time	Manual Search Time	Task Time	Total Completion Time	Numer of Completed Tasks	Total Access
Mann-Whitney U	.000	.000	1.000	.000	1.500	.000
Wilcoxon W	15.000	15.000	16.000	15.000	37.500	15.000
Z	-2.936	-2.932	-2.785	-2.932	-2.731	-2.960
Asymp. Sig. (2-tailed)	.003	.003	.005	.003	.006	.003
Exact Sig. [2*(1-tailed Sig.)]	.002 ^a	.002 ^a	.003 ^a	.002 ^a	.003 ^a	.002 ^a

a. Not corrected for ties.

b. Grouping Variable: User Level

Table 6.10b: Mann-Whitney U Test Statistic for 2 Independent Variables

6.5.3.2 Expert Vs Novice Users

Tables 6.11a and 6.11b show the summary of the results of the comparison between the Expert and Novice users of the User Manual.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Exploration Time	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Manual Search Time	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Task Time	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Total Completion Time	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		
Numer of Completed Tasks	Experts	5	8.00	40.00
	Novices	5	3.00	15.00
	Total	10		
Total Access	Experts	5	3.00	15.00
	Novices	5	8.00	40.00
	Total	10		

Table 6.11a: Mann-Whitney U Test for 2 Independent Variables

Test Statistics^b

	Exploration Time	Manual Search Time	Task Time	Total Completion Time	Numer of Completed Tasks	Total Access
Mann-Whitney U	.000	.000	.000	.000	.000	.000
Wilcoxon W	15.000	15.000	15.000	15.000	15.000	15.000
Z	-2.619	-2.619	-2.611	-2.611	-2.611	-2.643
Asymp. Sig. (2-tailed)	.009	.009	.009	.009	.009	.008
Exact Sig. [2*(1-tailed Sig.)]	.008 ^a	.008 ^a	.008 ^a	.008 ^a	.008 ^a	.008 ^a

a. Not corrected for ties.

b. Grouping Variable: User Level

Table 6.11b: Mann-Whitney U Test Statistic for 2 Independent Variables

6.5.3.1 Intermediate Vs Novice Users

Tables 6.12a and 6.12b show the summary of the results of the comparison between the Intermediate and Novice users of the User Manual.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Exploration Time	Intermediates	8	4.63	37.00
	Novices	5	10.80	54.00
	Total	13		
Manual Search Time	Intermediates	8	4.69	37.50
	Novices	5	10.70	53.50
	Total	13		
Task Time	Intermediates	8	4.63	37.00
	Novices	5	10.80	54.00
	Total	13		
Total Completion Time	Intermediates	8	4.50	36.00
	Novices	5	11.00	55.00
	Total	13		
Numer of Completed Tasks	Intermediates	8	9.19	73.50
	Novices	5	3.50	17.50
	Total	13		
Total Access	Intermediates	8	4.50	36.00
	Novices	5	11.00	55.00
	Total	13		

Table 6.12a: Mann-Whitney U Test for 2 Independent Variables

Test Statistics^b

	Exploration Time	Manual Search Time	Task Time	Total Completion Time	Numer of Completed Tasks	Total Access
Mann-Whitney U	1.000	1.500	1.000	.000	2.500	.000
Wilcoxon W	37.000	37.500	37.000	36.000	17.500	36.000
Z	-2.785	-2.719	-2.785	-2.932	-2.583	-2.944
Asymp. Sig. (2-tailed)	.005	.007	.005	.003	.010	.003
Exact Sig. [2*(1-tailed Sig.)]	.003 ^a	.003 ^a	.003 ^a	.002 ^a	.006 ^a	.002 ^a

a. Not corrected for ties.

b. Grouping Variable: User Level

Table 6.12b: Mann-Whitney U Test Statistic for 2 Independent Variables

From the results presented above, the behaviour of Experts, Intermediates and the Novices with the User Manual of Excel is different and is highly significant. This difference can be seen in all cases. Hence these results further enhance our confidence on the categorisation of users into Experts, Intermediates and Novices.

They also confirm hypothesis I – that the time taken to complete any given task will vary according to user experience, irrespective of aid mechanism.

6.6 Discussion of Results

In terms of task achievement, the results presented above show that the User Manual of Microsoft Excel is more suited for assisting the users with their tasks than the On-line Help system. It enabled the users of this experiment to solve most of their task-related queries and has greatly improved their task completion rates when compared with those of the On-line Help. Although these users outperformed those of the On-line Help experiment in most of the variables measured, they have took longer times to complete the tasks than for the On-line Help experiments.

Thus, it appears that the User Manual is a more reliable source of help information, and although it takes longer to use this paper based approach, the users obviously consider this additional investment of their time worthwhile. One reason why the on-line assistance times were lower was because users gave up, deciding that a further investment in their time would be unproductive. In the case of paper-based help, the extra effort needed usually provided a reward.

The results of our studies are in agreement with previous research in this area. For example, Cohill and Williges (Cohill and Williges, 1982), in their study with 72 novice users of a text editor, and using various combinations of initiation, presentation and topic selection, found that control group with no on-line facilities achieved the minimum performance compared to the rest. The best performance was achieved by the user-initiated, user-selected and printed-manual group. Similarly, Emdad (Emdad, 1989), found that junior-year undergraduate students with no computer background, using a database management system, performed better when using printed manuals compared with On-line Help. Ryan (Ryan, 1992) studied the performance of a group of college students with no

previous computing knowledge on a word processing, spreadsheet and database management applications. She found that On-line Help was the least preferred medium and that attention needed to be given to its format and content.

The results suggest that, if we could improve the return on effort investment for the On-line approach, we might get the benefits of both approaches – the more highly valued assistance provided from paper together with the immediacy of On-line help. We have already tentatively identified what we consider to be the main problem with On-line help – the Vocabulary problem. The experiments with the User Manual have supported our view that the lack of a Vocabulary dialogue in On-line help, is the main cause of subsequent failure. The browsing capability offered by the User Manual acts as a vehicle for this dialogue.

These results therefore suggest that the On-line help database needs to be re-designed to allow users to browse at different levels. The specific problems identified from the study reported in this Chapter as well as the proposed re-design are discussed in Chapter VII.

CHAPTER VII

DESIGN OF AN INTEGRATED BASE ON-LINE HELP SYSTEM

7.0 Introduction

In Chapters V and VI, the performance of Microsoft Excel users in two separate but similar experiments was discussed. They examined the manner in which the two groups of users interacted with the supporting materials of Excel - the On-line Help System and the 'User Manual'. In each of these experiments, most anticipated behaviour was observed. To be able to carry out the third and final experiment as outlined in Chapter IV, there was need to design and implement the new system.

In this chapter, a summary of the problems identified in the course of these experiments, as well as some generalisations on the manner in which people search for information in written documentation is presented. The key output of this chapter is the design of an On-line Help System that will hopefully overcome many of the problems identified, and inform the design of On-line Help Systems in general.

7.1 Problems identified with the Microsoft Excel On-line Help system

The results of the two studies, particularly that conducted with users using the On-line Help System of Microsoft Excel and discussed in chapter V, show that the On-line Help System is still lacking in many respects. From the answers to the questionnaires filled in by users at the end of the experiment, many subjects indicated their dissatisfaction with the manner in which help information is given, that it is non-procedural, not concise and not specific, and that in many cases, irrelevant information is displayed. Others expressed their dissatisfaction with the

inflexibility of the On-line Help System. Some felt that the On-line Help System assumed too much user knowledge about the system. Many users acknowledged that they had frequently abandoned use of the facility because they had failed to get appropriate and relevant assistance.

The major reasons for user disaffection can be summarised as follows:

- The required information is not in the On-line Help System – in most cases, users search for task specific information but the On-line Help System fails to provide such information, not because of vocabulary problem but because the information is entirely not within the system's database.
- The required information is there but cannot be found – in most cases, the terminology users use differ from that of the system. This results from users' failure to formulate queries that the system can understand in order to give meaningful results.
- The required information is there but cannot be understood in context – users are always in a hurry, looking for information that they can use to solve their tasks. Because of their level of experience, the system may have provided the correct information but they may fail to understand it in context.
- The On-line Help System does not work as the user expected. This implies that users, irrespective of the category they fall in, have specific expectations from the On-line Help System. However, when these expectations are not met, they become dissatisfied with the system.

Examples of the above cases can be found in Chapter V. Similarly, a general observation on users interacting with the On-line Help System can also confirm the existence of these problems.

Two problems best described the difficulties noted above. These are the *Vocabulary problem*, and the *problem of Compartmentalisation*. These result in the lack of an *Integrated Information Base*. These are discussed in the following sections

7.1.1 The Vocabulary Problem

One of the major problems identified in the experiments was that of successfully identifying the problem to the system- what in this Thesis is called the *Vocabulary Problem*. Users (particularly Novices) cannot seem to find the right terms in which to express their problems to the system. Terminology, which seems perfectly acceptable to them, results in streams of unhelpful information. This tends to cause total dissatisfaction with the On-line Help System and yet further examination reveals that the information was often in the system. Microsoft have tried to attack this problem by offering four different ways into their system - "Topics", "Find", "Index" and "Answer Wizard." *Topics* are top-down, *Find* identifies help information related to a word or set of words, *Index* is simply an index of words in the system (in other words 'bottom up') and the *Answer Wizard* guide users through their queries, often providing examples of use. However, the Vocabulary difficulty usually occurs at the next step, after the Help system has offered a first line suggestion of possible topics. An example of this is given in chapter V. The Novice User on the dBASE problem, started with the 'Contents', went through a number of options spanning through 'Index' to the 'Wizard'. In the end, he commented that if left alone with the help system he might spend the rest of the time going forward and backward without success.

Thus the Vocabulary problem is characterised by a lack of matching between user definitions of the problem and the On-line Help System solutions even when the required information is contained in the On-line Help System. Users are unable to relate their description of the problem to the system's offerings.

7.1.2 The Compartmentalisation Problem

The second major problem is caused by the existence of small isolated sections of information – what in this Thesis is called the *Compartmentalisation problem*.

The help information is divided into several fragments, and paths lead vertically to single blocks of information, a long way down the Help tree. Although some cross-linking is provided, it often confuses. Better linkage may not be the answer since linkage can be very tiring and confusing particularly on a typical computer screen with its limited real estate. Limitations in Hypertext navigation are well known, and the use of more salient relationships has been proposed (Bloomfield and Johnson, 1993). This 'vertical' nature of the On-line Help information makes browsing almost impossible, yet we observed that the browsing was very common when the User Manual was accessed.

These result in the lack of an *Integrated Base* of information. This is where the User Manual, for all its faults, scored well. When users do not know what they want, they browse the manual seeking out relevant keywords, which match their problem. This is typical of the way users who are being assisted by written information behave. Firstly, although they use indexes (or content pages) to effect primary access, they then often exploit the sequential nature of written material, browsing until they find information, which appears relevant. This human technique often solves Vocabulary problems because the user is able to discover terminology differences, as evident in the examples presented in chapter six, where both Novice and Intermediate users were able to successfully find out the required information by getting an initial contact point, and then browsing through text, forward and backward. We suggest that this is the basic problem in On-line Help provision. In our approach presented in the next section, we exploit this capability and redesign the on-line help system.

7.2 Proposal: An Integrated Based Approach to the Design of On-line Help

Based on the two major problems discussed in the preceding section, the design and implementation of an Integrated Based Help System is proposed. The provision of such an information base, we hypothesise, will enable users to get

round the Vocabulary problem by having access to a rich set of terms in context which they can process, skip, or reread until a suitable match is found. The Integrated Base could also overcome many of the problems of hypertext links (compartmentalisation) by providing a flowing background text into which the hypertext can give access.

The idea is shown in figure 7.1. The corner stone of the On-line Help system is this Integrated Information Base. This is similar to a standard User Manual. It can be read from end to end, or browsed in any part. An Index points (as in a traditional manual) to occurrences of words and concepts in the base. As with the Microsoft approach, a Topics, top-down, approach is used to provide access to selected blocks of the Information Base, and hypertext links can be used to relate topics at this level. The user can, at any time convert from a topic-based view to an integrated base view, and vice versa. Traditional User Manuals can provide the source for the Integrated Information Base.

The essential difference of the Integrated Information Base with the existing On-line Help System is that, at the lowest level, the information can be read sequentially like a 'normal' book.

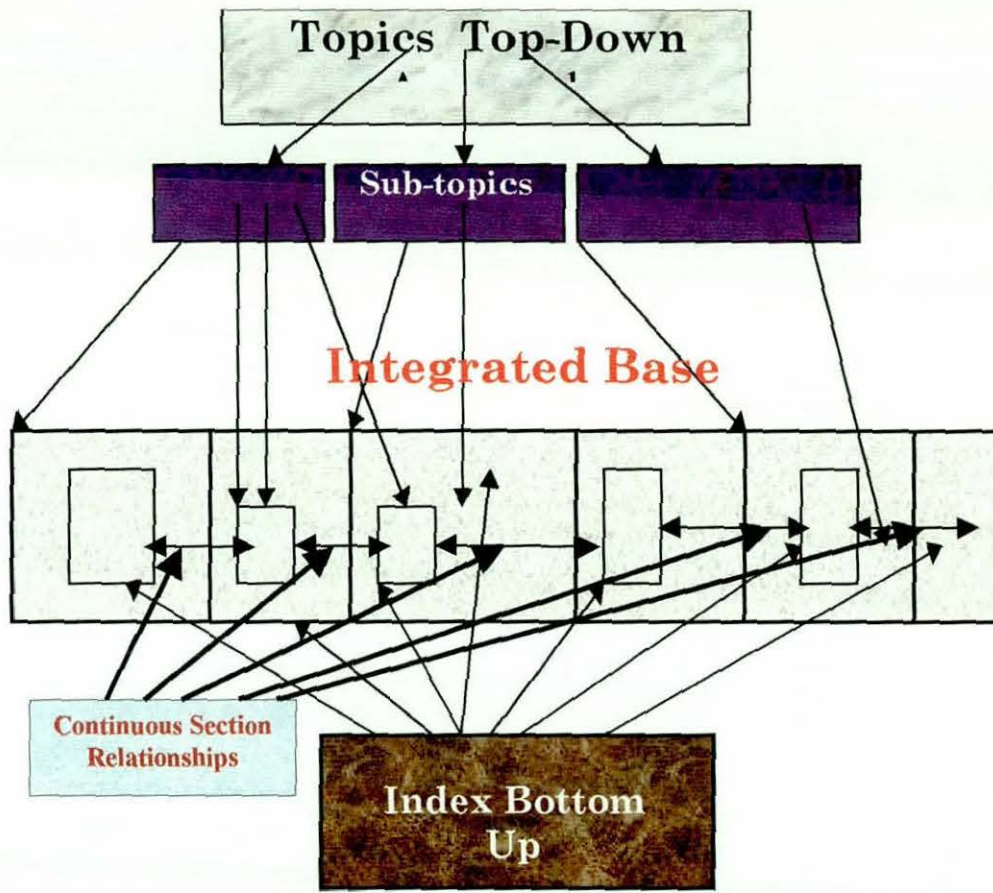


Figure 7.1 Conceptual Diagram Integrated Base Approach

7.3 Design & Implementation Considerations

There are a number of issues we considered when designing the Integrated Base Help System. The entire process was carried out in five basic phases:

1. The construction of the skeletal structure of the help system – what the researchers call the Contents Tree. This provided the ‘blueprint’ for the entire system. By focusing on design and interface issues early on, the researchers ensure that usability was a fundamental component of the integrated base on-line help system.

2. The identification of the source of the information for the Information Base. It is important that a standard information text is used. The following were identified as the major sources:

- Running Microsoft Excel for Windows 95 (Dodge, 1995)
- Using Microsoft Excel 97 (Special Edition) (Hallberg, 1997)
- Microsoft Excel 97 Developer's Handbook (Wells, & Harshbarger, 1997)

The first source, Running Microsoft Excel was found to be very appropriate because it was used in the experiment (version 7.0) reported in Chapter V. It was also the document used in place of the User Manual of Excel reported in Chapter VI. The bulk of the material for the Integrated Base was collected from this source, while examples and some concepts were collected from the other three sources. The other two possibilities were not considered as the main source because they related to a later version of the application (version 8.0).

The relevant portions were scanned and edited. Similarly, relevant examples were prepared and screen-shots of these examples were incorporated in to the text. The resulting text was then converted into a format used by the Microsoft Help Workshop called WinHelp, the On-line Help Compiler. This process includes removing page numbers, reformatting tables, and tagging page references for conversion into hyperlinks. Also, all essential graphics were converted to an image format supported by WinHelp.

3. The compilation of the resulting information using Microsoft Help Workshop. The help document was debugged until a "clean" compilation was achieved. Hyperlinks were then inserted to replace page references, allowing instant jumps between associated topics.
4. A Map file was then developed to link the Help buttons in the software application to the appropriate topics in the help file. Pop-up help topics and

other advanced features were also written in Visual Basic and inserted during this phase.

5. The Integrated Base On-line Help System was integrated with Microsoft Excel and a test run done to check the completeness of the help file as well as the functionality of all help buttons, pop-up topics and hyperlinks. This was carried out with a group of three users – an Expert user, an Intermediate user, and a Novice user. As a result, some improvements were made to the system before the start of the actual evaluation experiment.

In the next section, the main features of the system are discussed.

7.4 Features of the Integrated Base Help System

The Integrated Base Help System implemented has a number of features. These include those retained from the existing On-line Help System of Excel.

- “Context-Sensitive” ScreenTip
- "What's This?" pop-up help
- The TipWizard.

Also retained are the three major access mechanisms – Contents Tab, Index Tab, and the Find Tab access mechanisms. However, the Answer Wizard, although it was found to be useful to some users, was not retained. This was due to our inability to incorporate it in the system, due to access restrictions. Some of these are discussed in the succeeding sections.

7.4.1 The Contents Tab

The Contents Tab is similar to the table of contents of a book. A closed-book icon together with the corresponding title represents each ‘chapter’. When any of the titles is selected, a hierarchical sequence of the titles within it is displayed.

The figure below shows an extract from the 'Contents' tab of the System.

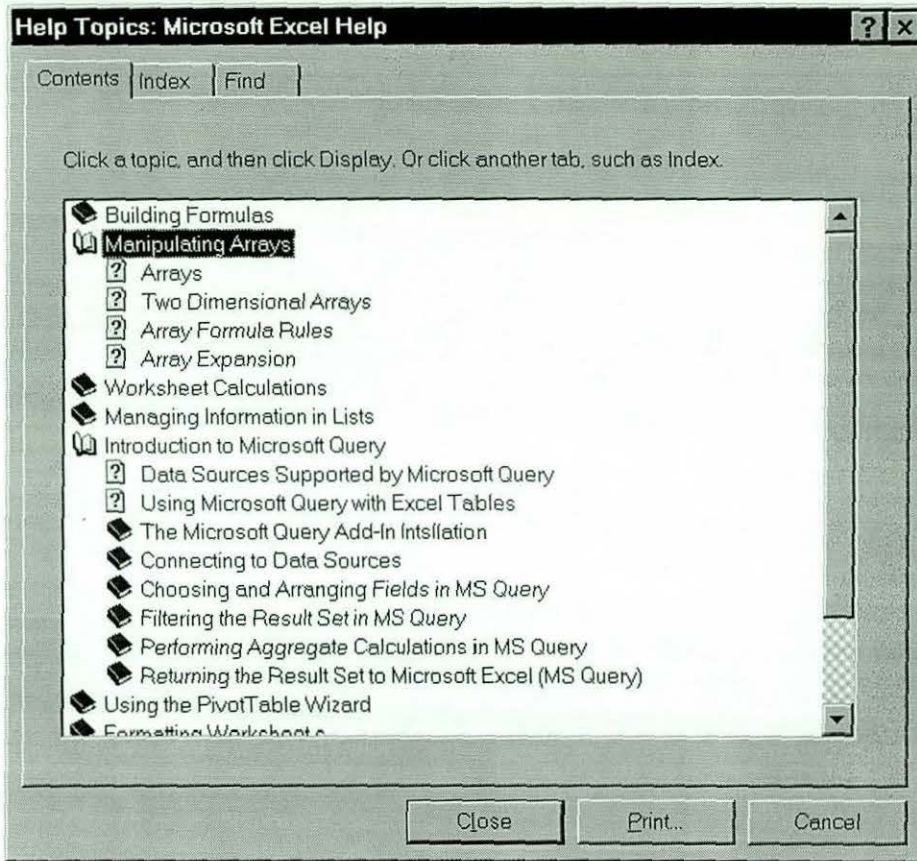


Figure 7.2: Contents Tab of the Hybrid On-line Help System

Depending on the nature of the 'chapter', the hierarchical sequence can contain basic information indicated with a question mark (?) icon or a group of sub-topics indicated with a closed book icon. The basic information is the lowest level in the hierarchy, and selecting that displays the information related to the selected topic. It should be realised that these were manually created.

7.4.2 The Index Tab

The next option in the sequence is the 'Index' Tab, an extract of which is shown in the figure below.

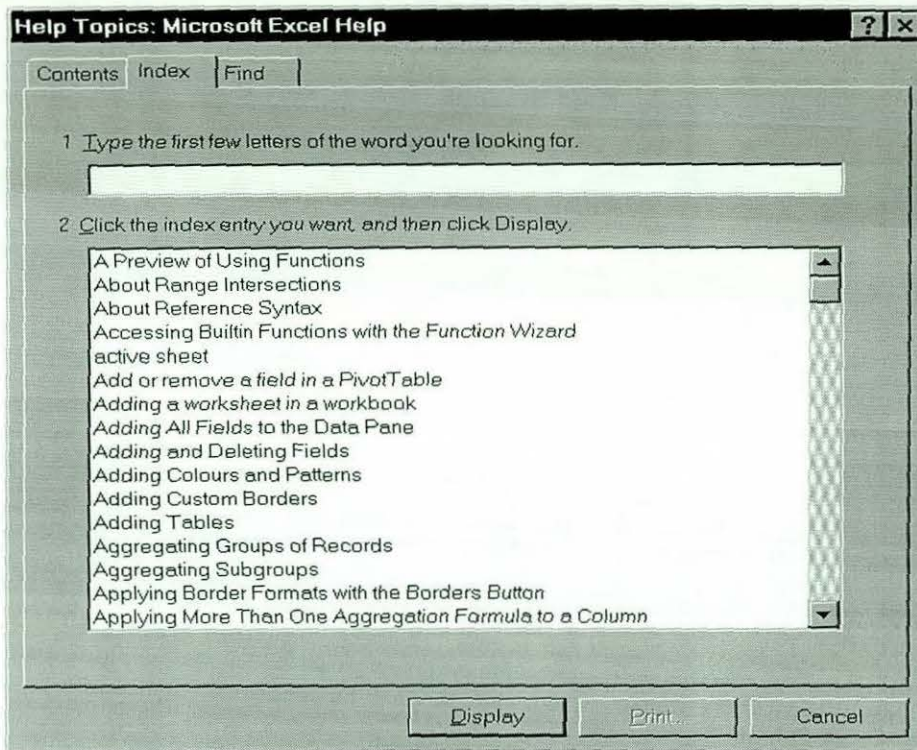


Figure 7.3: The Index Tab of the Hybrid On-line Help System

The Index tab is also similar to a book's index. When the user selects the index tab, all the keywords recognised by the system are displayed. As opposed to the existing Help system of Excel in which a user is forced to scan through multiple transitions before reaching the required information, the Index tab has no multiple transitions in topics. The keywords link to the lowest level of information, which may either be textual information or with step-by-step procedures. In some instances, it may be a graphic display with visual examples. Here also, all the required index entries were created manually. This feature is a re-implementation of the Index facility such that keywords are filtered and unnecessary ones are discarded.

7.4.3 The Find Tab

The next option is the 'Find' Tab, and an extract of which is shown in the figure below.

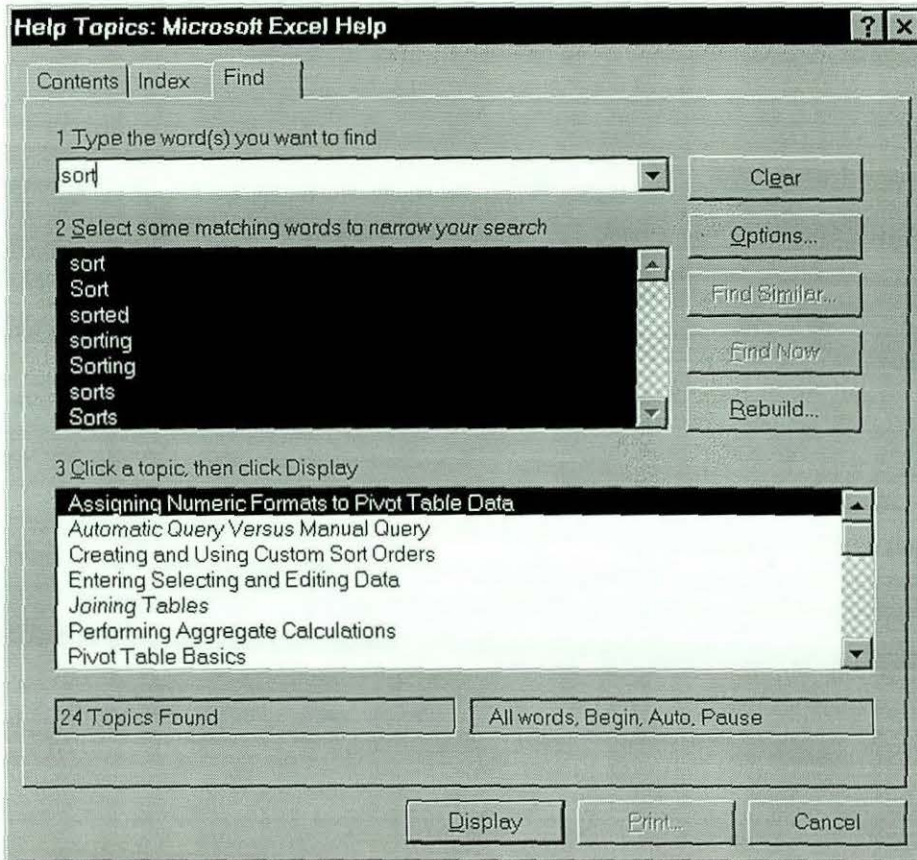


Figure 7.3: The Find Tab of the HyBrid On-line Help System

The 'Find' tab is similar to the Index tab. Keywords are used to establish access to the information base, but the span of keywords and topics keywords displayed are more than those in the 'Index'.

7.4.4 The "Browse" Facility

An important new feature of the Integrated Base Help System is the ability to 'browse' or navigate the Integrated Information Base. It facilitated the ability of browsing the information from end to end, or browsed in any part. The Contents Tab, which provided a hierarchical top-down approach, is used to provide access

to selected blocks of the Information Base, and hypertext links used to relate topics at this level. The user can, at any time convert from a topic-based view to an integrated base view, and vice versa.

This feature, based on the pilot test run carried with the three users, proved to be very useful.

The figure below shows a basic level information of the Integrated Base Help System, with the 'browse' buttons active.

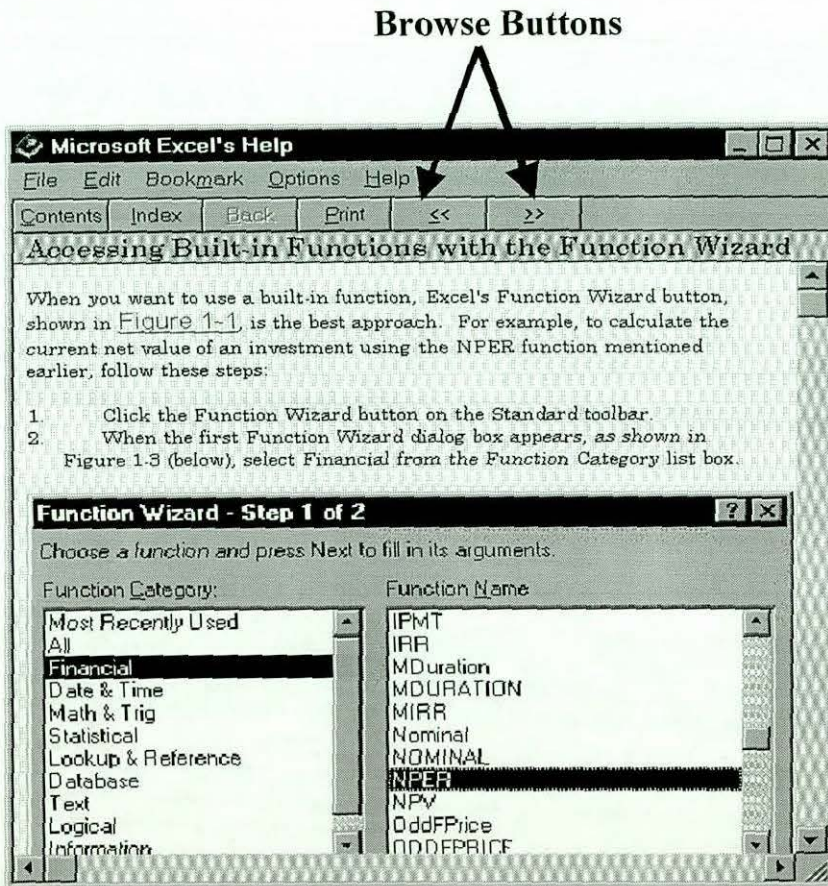


Figure 7.5: Basic Level Help Screen with Browse Buttons

7.4.5 Other Features

One piece of the information incorporated in the Integrated Base On-line Help system is information on how to use the system. All the existing On-line Help Systems, especially those of Microsoft Office applications, have no information

on how users can access information. This in itself is a design fault because the designers assume that any user must be familiar with these systems. Unfortunately, this is not the case, as was reported in the preceding chapters.

The first 'chapter' of the Integrated Base Help system contains information on how to use the system, as well as detailed descriptions of the buttons and their functions. The figure below shows this.

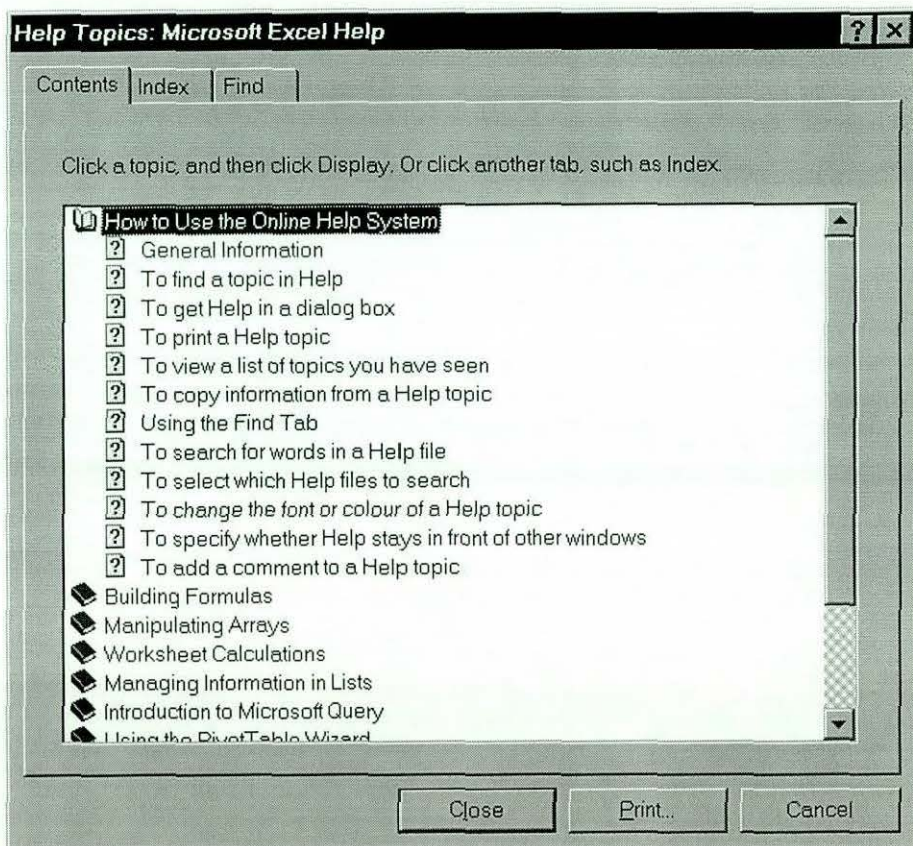


Figure 7.6: How to Use the Integrated Base Help System I

As can be seen from Figure 7.6, the 'chapter' covers all the aspects of the Integrated Base Help System. As an example, selecting the 'general information' option displays the window shown in Figure 7.7.

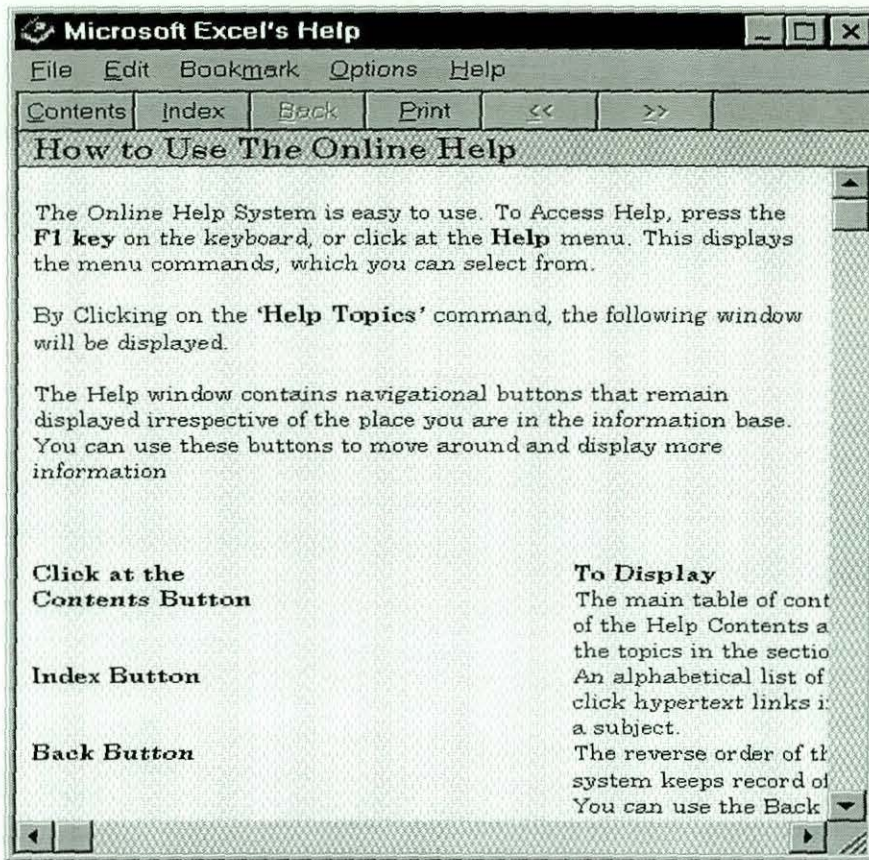


Figure 7.6: How to Use the Integrated Base Help System II

In addition, the information contained within the Integrated Base system has the following characteristics:

- **More Complete Information:** If the information provided on a particular topic is inadequate, or the need for further information is necessary, the user is instructed on where they may go to find such information. This is done through *For Further Information/See Also* links to such information.
- **Logical Organisation:** We ensured that topical information was grouped together within a single chapter or section. This made the creation cross-references to information much easier, as well as facilitating the identification of subjects in the index. Most importantly, it facilitated the ability to conveniently read the document from end to end, or to browse it in any part.

- **Step-by-step procedures.** As discussed in Chapter III, On-line Help Systems are often designed and implemented by document engineers, who have the tendency of designing from their own perspective instead of involving typical end users of the systems in the design process. As a result, one often gets paragraphs that are incomplete or too technical and hence beyond the comprehension of a typical end user, particularly the Novice user. Most tasks were broken down into step-by-step procedures that make it easier for any user, irrespective of their level of expertise, to follow. In essence, this relates to the structure of the contents tree discussed earlier.

Finally, the font type and size was chosen in such a way that it would be convenient for the on-line reader. Also, the contrast between the background and displayed text was put at a medium level to facilitate text readability. These features are discussed further in Chapter VIII.

7.5 Discussion and Conclusion

In this chapter, the major problems inherent in the On-line help System of Microsoft Excel, and by extension, in the Microsoft On-line Help System in general, have been discussed. Four basic problems have been identified:

- The required information is not in the On-line Help System.
- The required information is there but cannot be found.
- The required information is there but cannot be understood in context.
- The On-line Help System does not work as the user expected.

Two problems have been used to describe the difficulties noted above – the first being the Vocabulary problem - users particularly the inexperienced cannot seem to find the right terms in which to express their problems to the system. Terminology, which seems perfectly acceptable to them, results in streams of unhelpful information.

The second problem is that of compartmentalisation – dividing the help information into several fragments, and paths lead vertically to single blocks of information, a long way down the Help tree. Although some cross-linking is provided, it often confuses. As discussed, better linkage may not be the answer since linkage can be very tiring and confusing particularly on a typical computer screen with its limited real estate.

The result of these is the lack of an Integrated Base of information. This was considered as the basic problem in On-line Help Systems. In our approach we designed and implemented an Integrated Base On-line Help System that exploits some features of printed documentation. It is believed that users of the proposed system will find it more comfortable and convenient using this system than they will with the existing system, because of its unique features.

To substantiate this, an evaluation experiment was set up – the third experiment outlined in Chapter IV. The details of the experiment and the results are presented in Chapter VIII.

CHAPTER VIII
EXPERIMENT WITH MICROSOFT EXCEL III: USING THE
INTEGRATED BASE ON-LINE HELP SYSTEM

8.0 Introduction

The results presented in this chapter are based on experiments carried out with users of Microsoft Excel using the new Integrated Base On-line Help System, as the main source of assistance. As with other experiments discussed earlier, all interactions with the system were recorded and analysed. The results indicate a significant improvement in performance of the users in this experiment with those using the existing On-line Help system of Microsoft Excel. The results of the three experiments are also compared, and conclusions drawn.

8.1 Experimental Setting:

The software and the equipment used in the experiment were same as those in section 5.1 of chapter V. The experimental procedure was also identical. However, the On-line Help System was the Integrated Base Help System described in Chapter VII.

8.1.1 Subjects

In all, 12 subjects participated in the experiment. Users were asked to classify themselves as Experts, Intermediates and Novices using the criteria set out in chapter four. The resultant distribution is shown in Table 8.1.

Subject Expertise	Number
Expert	3
Intermediate	6
Novice	3

Table 8.1 Subjects on Integrated Base Help Experiment

None of the subjects of the present study participated in either the On-line Help or the Manual experiments reported in chapters V and VI respectively, since having them participate in the experiment would have affected the results. This is because previous experiment would have familiarised them with the tasks.

8.1.2 Procedure, Task and Task Completion Questionnaire

A similar procedure as discussed in Sections 5.1.2 of Chapter V is followed here. Similarly, the same set of tasks as outlined in Section 5.1.3 are used. However, the main source of assistance to be used by subjects in carrying out the tasks is the Integrated Based Help System. The task completion questionnaire used is also similar to the one outlined and discussed in Section 5.1.4. The actual questionnaire used can be found in Appendix E

8.2. Results of the Integrated Base Help System Study

8.2.1 Seeking Help

All subjects used the Integrated Base Help System at one stage or the other during the experiment. Generally, most of the users were able to get the information the needed easily for certain sub-tasks, while others had to browse through a number of screens before they found what they required. Interestingly, only a few had considerable difficulty and were assisted by the experimenter. Table 8.3 shows the

percentage of those who used the Integrated Base Help System on a particular task, by level of expertise.

Sub Task Level	Novice	Intermediate	Expert
1	60%	6%	0%
2	77%	25%	11%
3	100%	93%	68%
4	100%	89%	74%

Table 8.3 Use of Integrated Base Help System by Task Difficulty and Experience

8.2.2 Examples of User Activity When Accessing the Integrated Base Help System

Because of the nature of the user activity during the experiment, out of many examples from the study, three will be given in this chapter. The subjects whose activities were presented in these examples were randomly selected, and not based on any criteria. The task chosen, however, was a common task where all users accessed the On-line Help system to find out how to carry it out. A detailed characterisation of user activity is given in section 8.3.

8.2.2.1 Task: Import a Dbase File (Using Microsoft Query)

This was a task where all the subjects experienced difficulties, and where access to the On-line Help system was highest. Using the Integrated Base On-line Help, most of the experienced subjects were able to solve the problem without difficulty. However, the inexperienced users took sometime before eventually solving the problem.

8.2.2.1.1 An Example: A Novice User

The Novice user read the task and immediately tried to access the Integrated Base Help, and selected the “Help Topics” from the Help Menu. The system responded by displaying the Index Tab. The user typed ‘IMPORT’ as keyword, and the options in figure 8.1 were displayed.

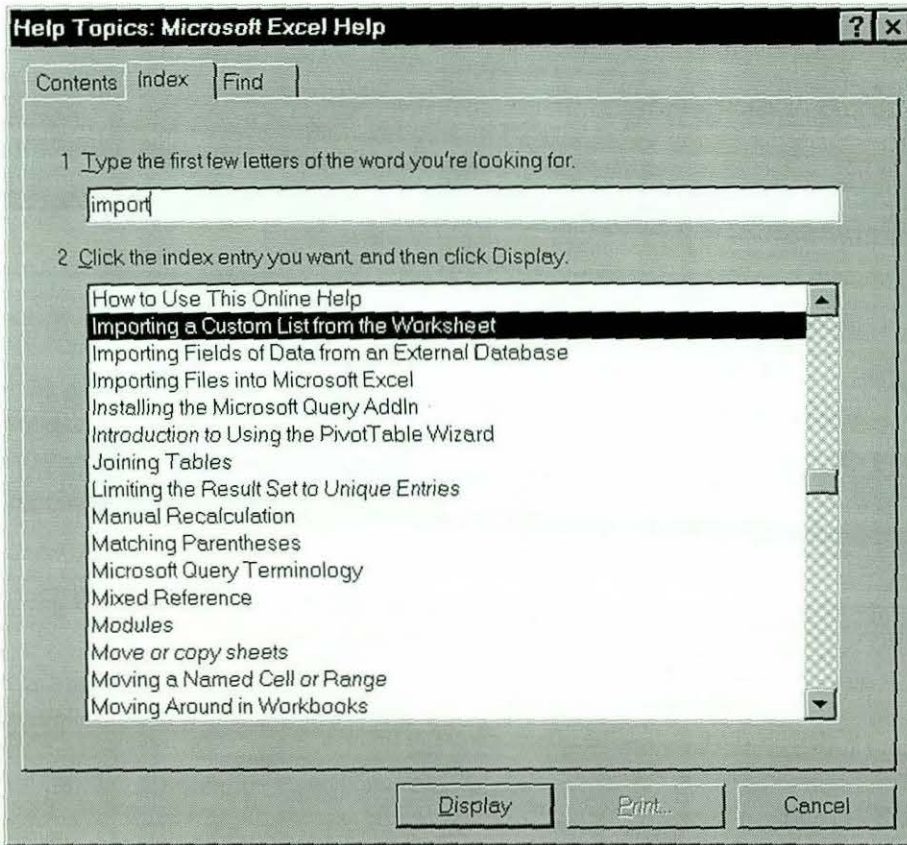


Figure 8.1: Novice User Searching ‘Index’

As can be seen from figure 8.1, three titles were closer to his selection, and he selected ‘Importing files into Microsoft Excel’ option and the window in figure 8.2 was displayed.

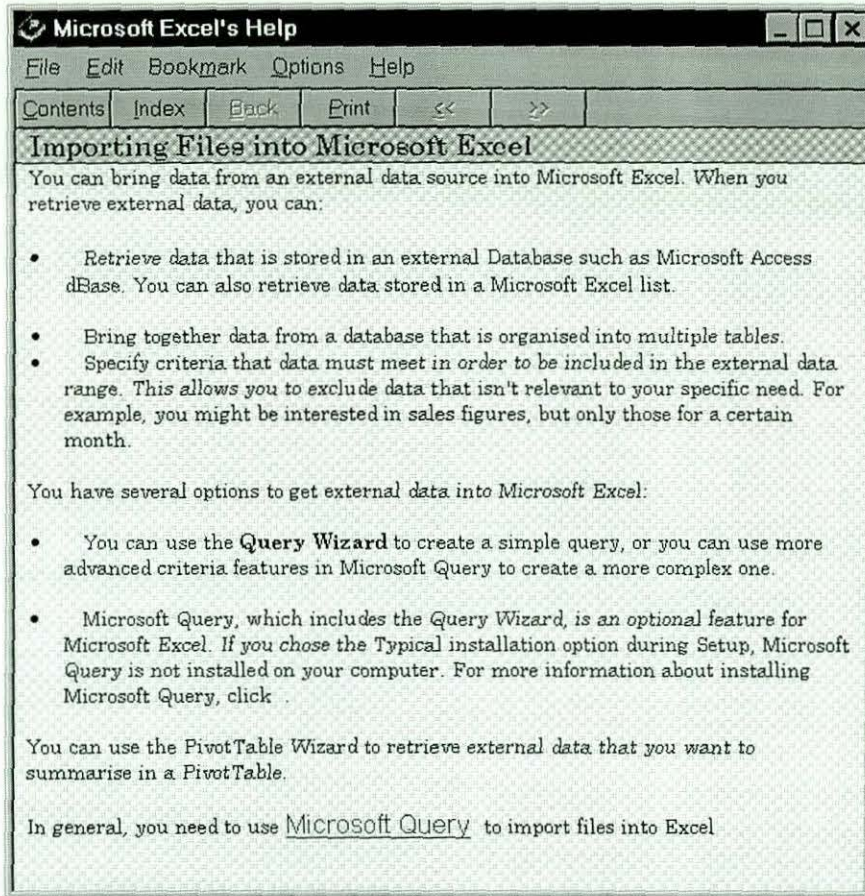


Figure 8.2: Novice User Using Hypertext Link

The user scanned through the information, and within it, realised that he needs to use the Microsoft Query add-In of Microsoft Excel, and with a hypertext link to the Query, he clicked at it. The Window in figure 8.3 was displayed.

The user scanned through the information in figure 8.3, and because he learnt how to use the browse button earlier on, and because the buttons are active in this window, the user was able to get to the 'page' shown in figure 8.4, after just one transition.

As can be seen from figure 8.4, the information directed the user to access the 'Microsoft Query' from the Data menu, which the user did.

Upon Loading the query, he realised that he needed further help on selecting and entering the required fields. Upon loading the Integrated Base Help window again, he was then able to carry out the task.

It is worth mentioning here that the manner in which this Novice user solved this 'problem' differed from the Novice user on the On-line Help System experiment, reported in chapter V. The user in the first experiment went through multiple transitions of help screens, but this user went through only a few. Also, as opposed to the inability of the first user to perform the task successfully, this user was able to perform the task. This indicates the usefulness of the new improved version of the On-line Help System, especially to the Novice users. Here, all Novice Users carried this task successfully where as none of the Novice Users in the existing On-line Help experiment was able to solve this task without assistance.

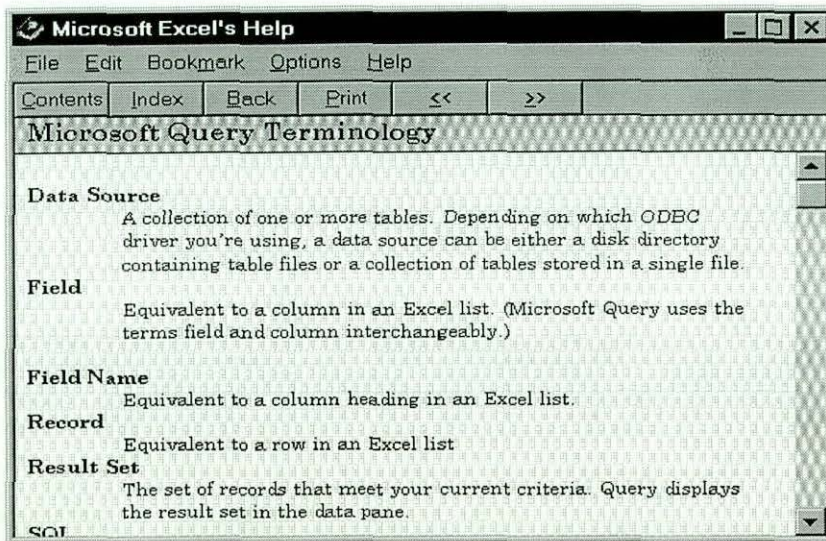


Figure 8.3: Novice User Using 'Find'

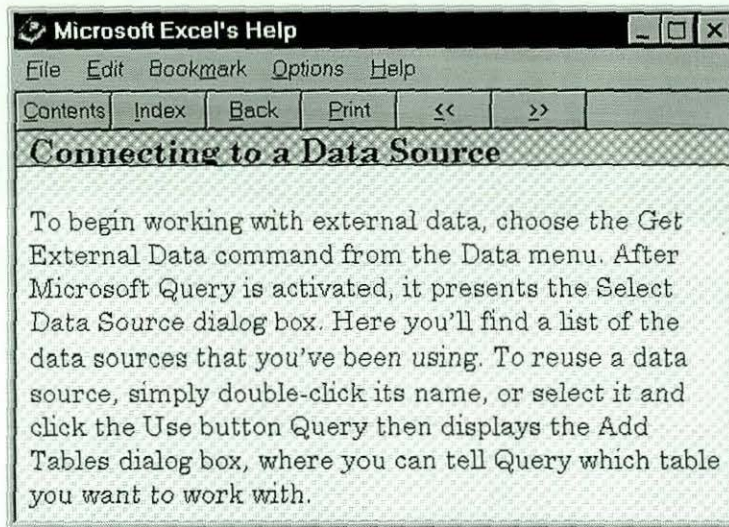


Figure 8.4: Novice User Using 'Browse'

8.2.2.1.2 An Example: An Intermediate User

The Intermediate user's initial access point to the help information was through the 'Contents' Tab of the Integrated Base Help System. Upon loading the 'Contents', he selected the 'Introduction to Microsoft Query' book icon (chapter) of the Contents tab, and the window in figure 8.5 was displayed.

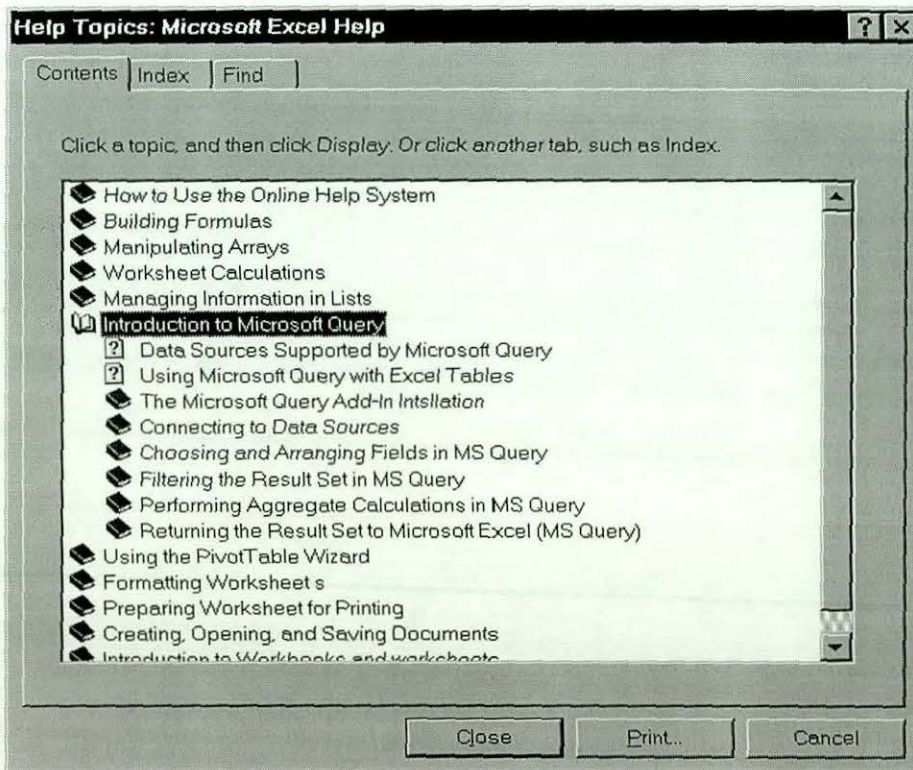


Figure 8.5: Intermediate User Using 'Contents' I

He then selected 'Connecting to Data Sources', book icon (section) and the window on Figure 8.6 was displayed.

He then selected the 'Connecting to a Data Source' option, and the window similar to that in figure 8.2 was displayed. He scanned the information and then he closed the help window and selected the 'Get External Data' option on the Data menu. This loaded the Microsoft Query. After loading the query, he realised he needed more information on using the query. He then activated the Integrated Base Help System again and, using the 'Contents' selected the 'Adding tables' option of figure 8.6, and the window in figure 8.7 was displayed. With the help window active, he followed a similar example within the help information and was able to successfully carry out the task.

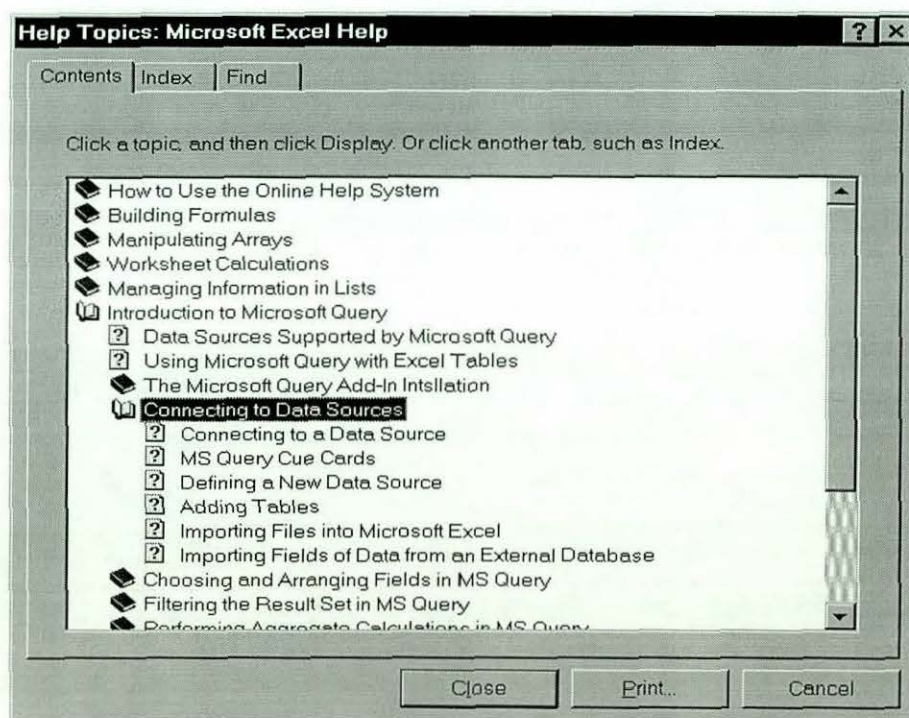


Figure 8.6: Intermediate User Using 'Contents' II

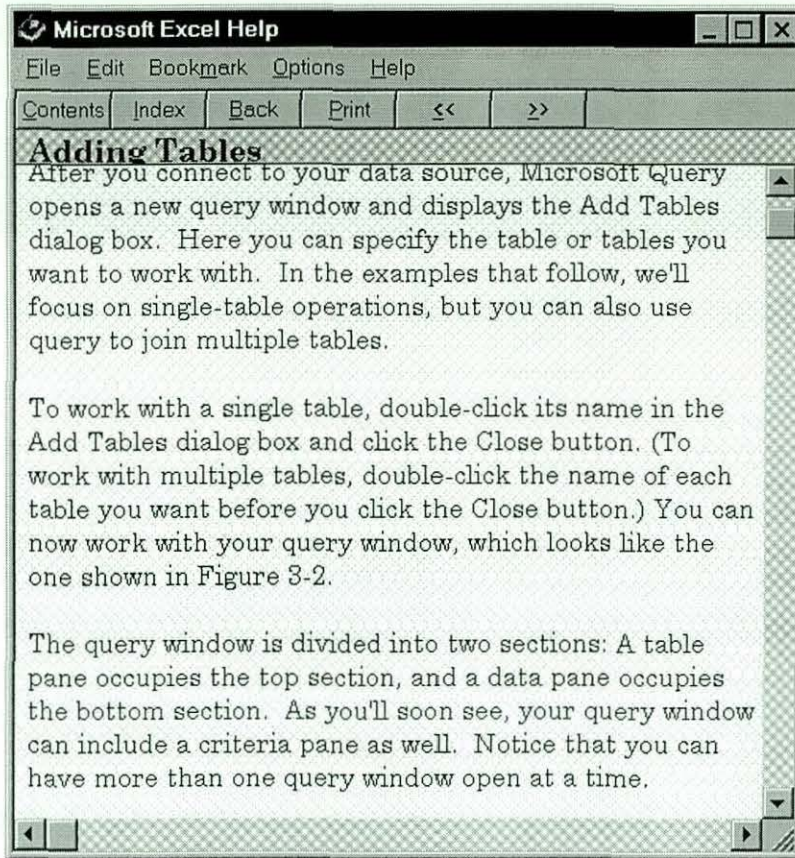


Figure 8.7: Intermediate User Using 'Contents' III

8.2.2.1.3 An Example: An Expert User

The Expert user started by using the 'Find' tab and typed 'Importing', and the window in figure 8.8 was displayed. He then selected "Importing and Exporting .DBF files" from the results displayed, and the window in figure 8.9 was displayed. He scanned through the information, and because the 'Browse' buttons are not activated here (due the non-contiguous nature of this information - added as a means of tackling some user-specific queries), he could not browse through the information. However, active hypertext links were given for 'Microsoft Query', which he selected. Upon selecting the hypertext link, the window in figure 8.10 was displayed.

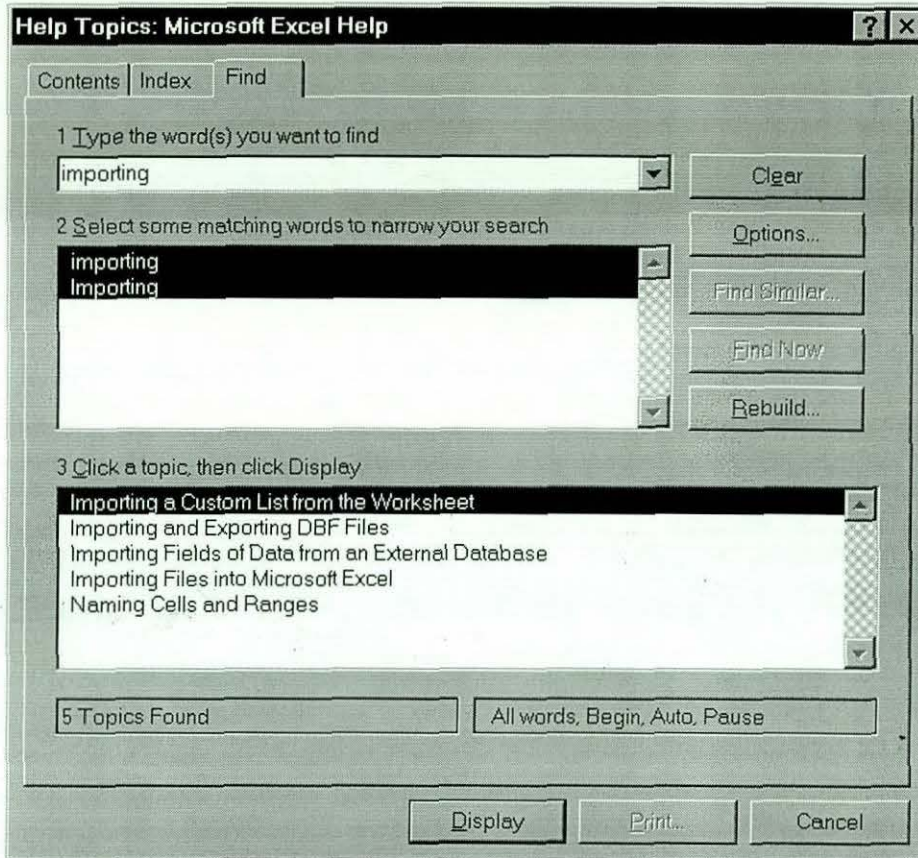


Figure 8.8: Expert User Using 'Find' I

The expert user then browsed through the information, going forward and backward. With the Help window opened, he selected the 'Get External Data' option from the Data menu, and was able to successfully carry out the task with no assistance from the experimenter.

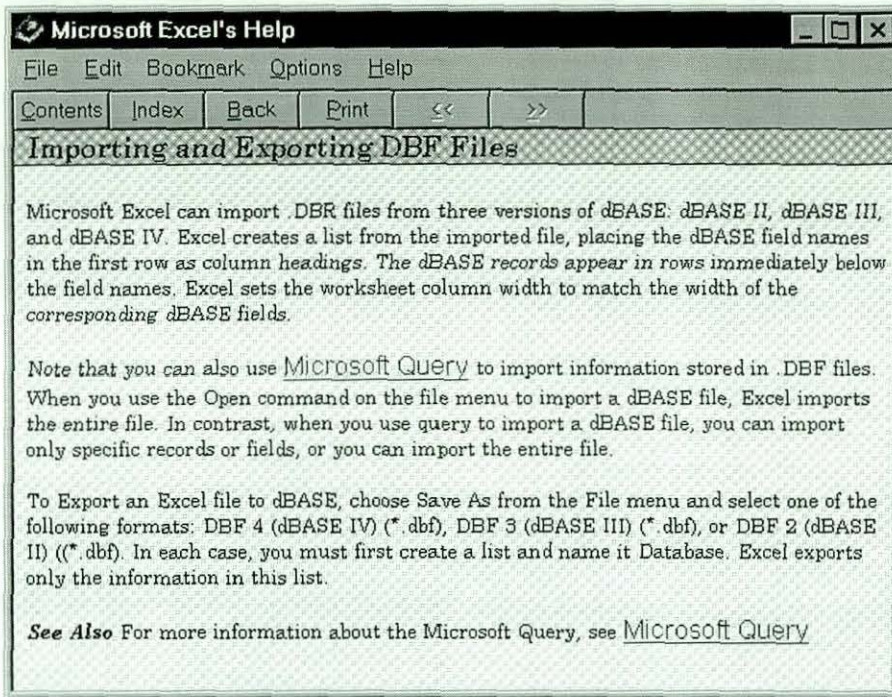


Figure 8.9: Expert User Using Find II

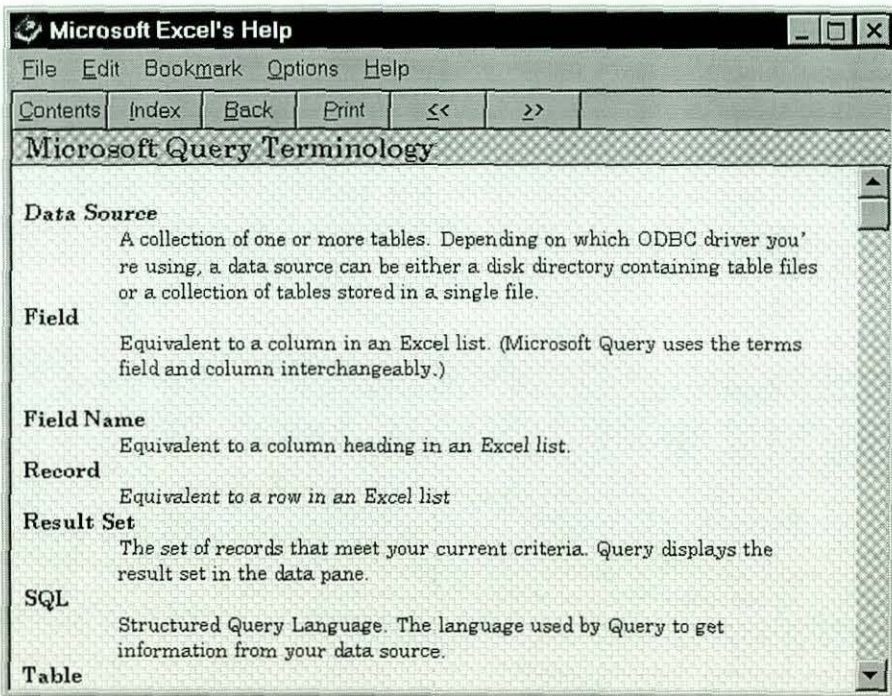


Figure 8.10: Expert User Using Find III

8.2.2.2 An Unsuccessful Attempt

There are only a few cases where users were unsuccessful in getting the right information from the Integrated Base On-line Help System. The group of users mostly affected here was the Novice class. One such instance is given here.

8.2.2.2 An Example: Reformatting Columns

The task required users to reformat three columns of an imported worksheet. The user in this example first accessed the Integrated Base Help System using the 'Contents' tab. He accessed the 'Formatting Worksheet' option and the screen-shot of Figure 8.11 was displayed.

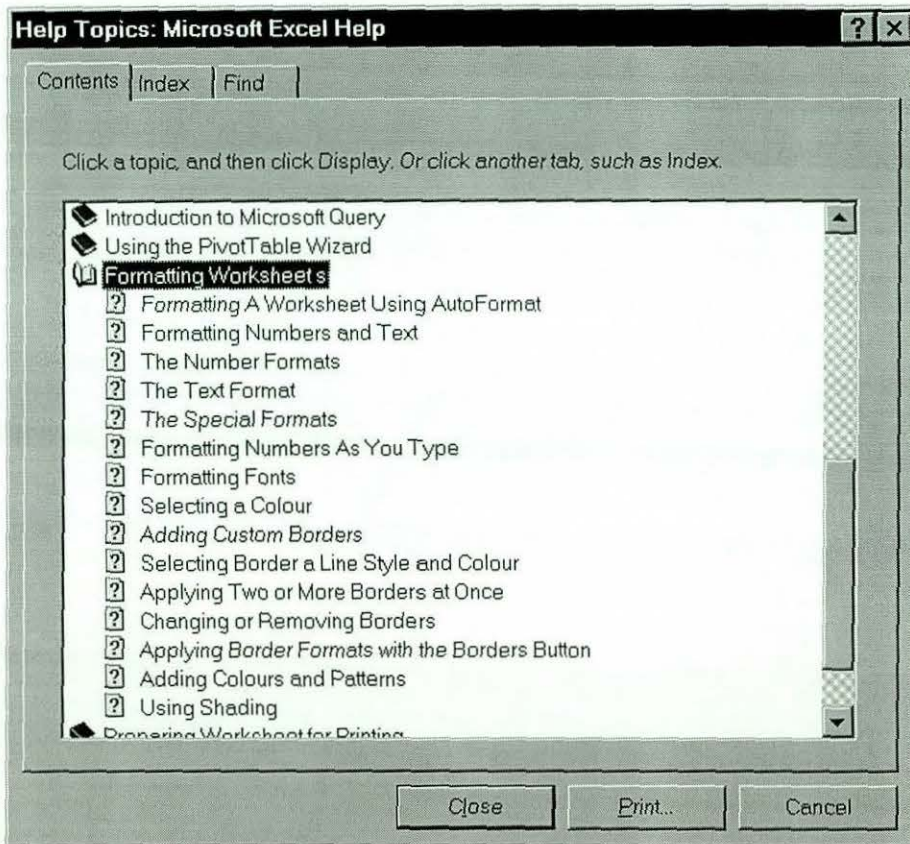


Figure 8.11: Accessing Contents Tab

However, since the keyword 'reformat' is not listed, the user could not select any option, but decided to use another option.

He then used the 'Index' tab and typed 'reformat' as keyword, but found that it was not listed in the index. The only keywords listed were those shown for the screen-shot of figure 8.12.

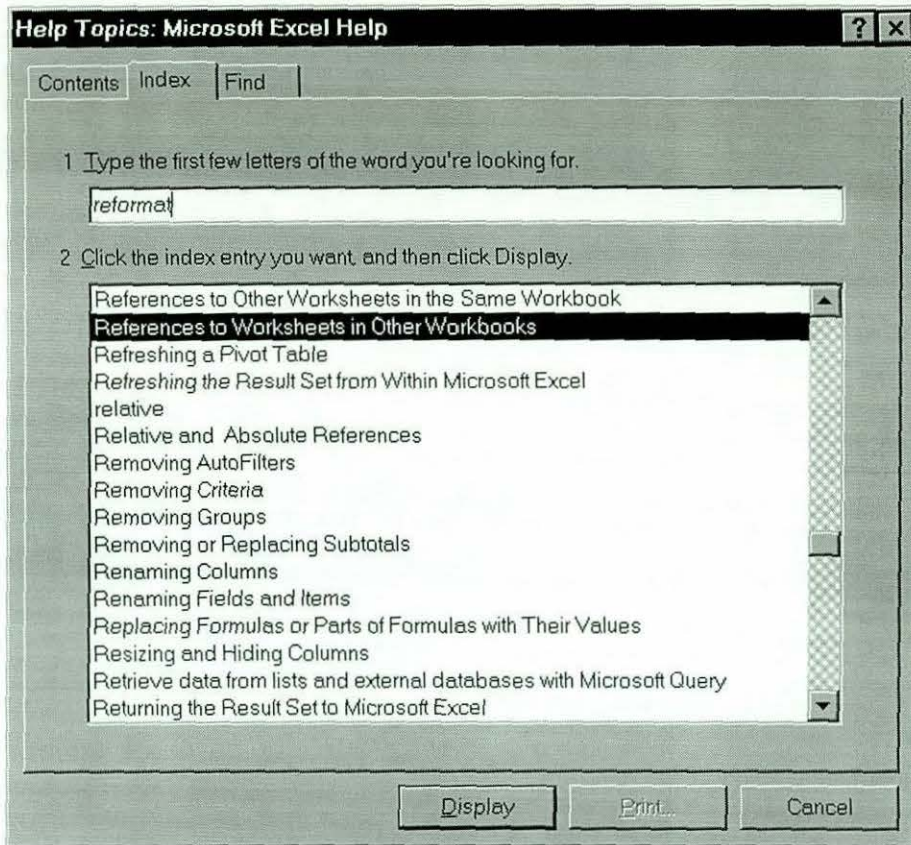


Figure 8.12: User Accessing Index for 'Reformat'

He then went on to use the 'Find' tab and typed same keyword 'reformat'. The search resulted in the options displayed in figure 8.13.

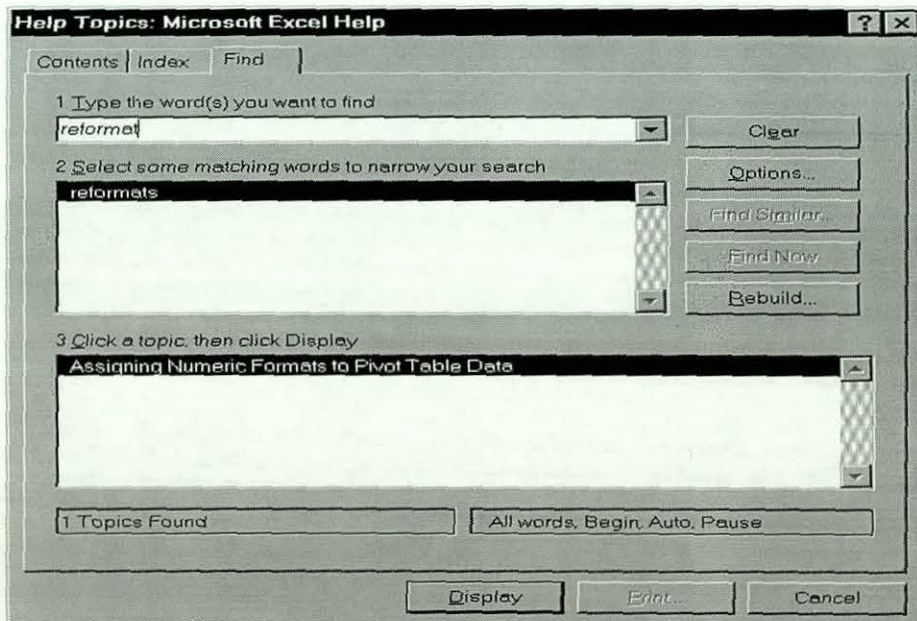


Figure 8.13: A User using the 'Find' for 'Reformat'

The example given above is one of the situations that arose during the experiment, especially with Novice users. The task required **formatting**, but because the question states '**reformat** the acc_date column to dd-mmm-yy format (e.g. 01-May-99), the ptax-profit and sales-emp columns to the currency format.....', the keyword 'Reformat' in the question was understood by this user as a keyword that should exist in the system. He was not able to carry out a successful access since the word was not in the index or contents. Unfortunately the user did not think to try "Format" so could not gain access. The Integrated Base Help System could not help in this situation because it is a misinterpretation of context on the side of the user. This illustrates that keyword choice is still important in the Integrated Information base. Fortunately, Also, this was a one-off case, observed only in this experiment, as all users in the other experiments including the pilot experiments were able to understand the keyword in context, hence gain access to the Base.

There were other cases where the required information was outside the context of the experiment – for example, information on charting and statistical analysis, which were not in the current limited implementation. This is discussed in chapter IX, as one of the limitations of the system.

In the next section, user behaviour in the experiment is generally characterised.

8.3 General Observation: Characterisation of User Behaviour

The example given above (importing Dbase a File) is just one of the many captured during the experiment. To enable us make a meaningful generalisation, we will present further examples of user interaction with the Integrated Base On-line Help System during the experiment.

A good example that will facilitate reasonable comparison between the Integrated Base Help System and the existing On-line Help System is the case where users

were asked to put double-line borders round created tables (tasks 4,11,16,29 & 48). Most of the subjects that accessed the Integrated Base On-line Help system used all the available access mechanisms – ‘Contents’, ‘Index’ and ‘Find’ to establish initial access point. Those that used the ‘Contents’ tab accessed the ‘Formatting Worksheets’ book icon on the Contents tab, and the system responded by displaying the screen-shot in figure 8.14 below.

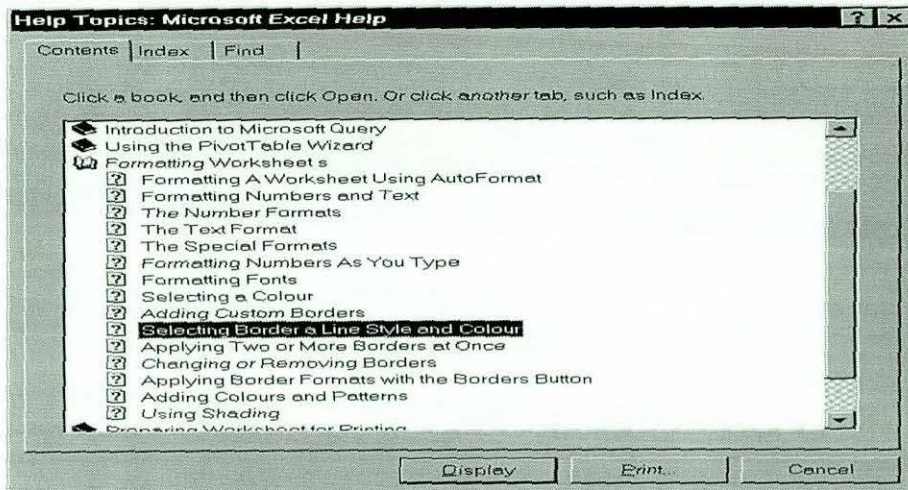


Figure 8.14: Users Accessing ‘Contents’ Tab I

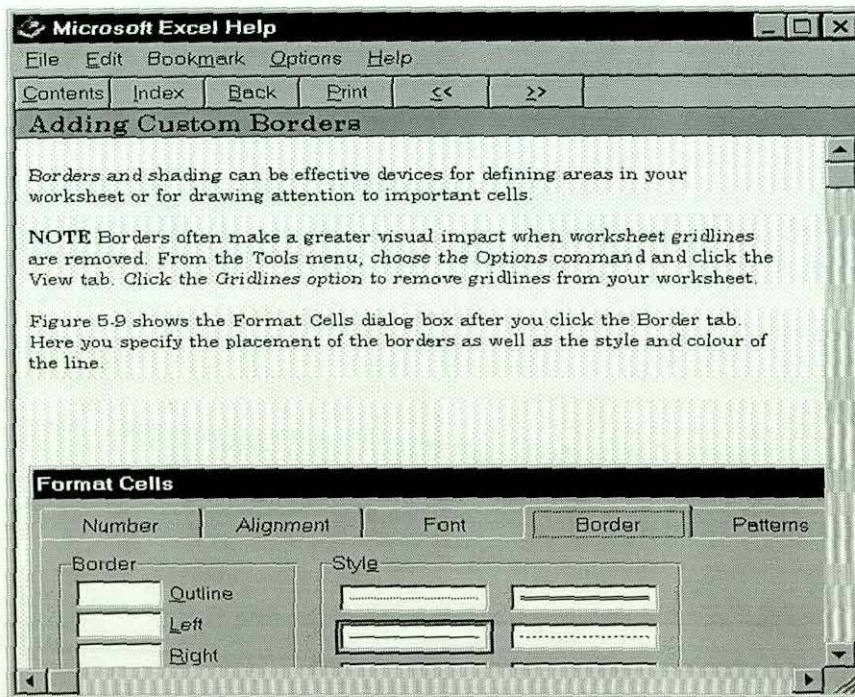


Figure 8.15: Users Accessing ‘Contents’ Tab II

In the instances where the users selected the 'Adding Custom Borders' option, the screen-shot in figure 8.15 was displayed. The users were able to apply the required format of borders by following the illustrated examples within the system, based on the sequential nature of the material that facilitated browsing forward and backward through the system.

Those that used the 'Find' tab, in most cases, used the keyword 'border' to find the occurrence of the word in the system. The system responded by displaying the screen-shot in figure 8.16. The subjects in most cases accessed the system by selecting the 'Applying Border Formats with the Borders Button' option of figure 8.16. The system responded by displaying the screen-shot in figure 8.17.

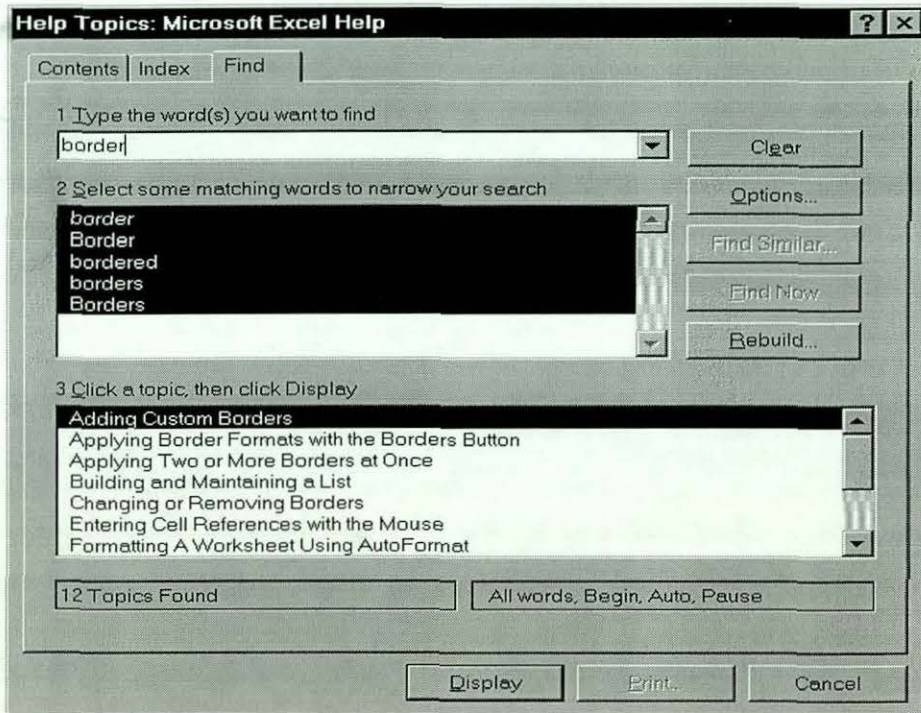


Figure 8.16: Users accessing the 'Find' Tab I

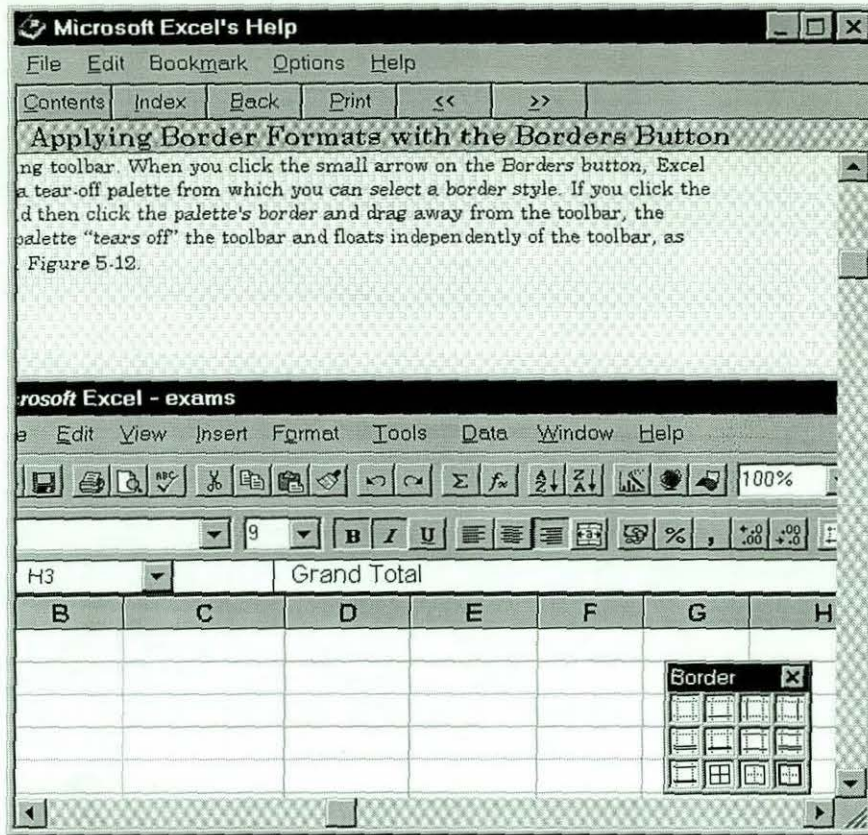


Figure 8.17: Users accessing the 'Find' Tab II

The information provided by the screen-shot above did not directly answer the query, and hence subjects had to browse forward and backward, eventually finding the required information within an annotated example. They were then able to carry out the tasks successfully.

This example shows how the Integrated Base On-line Help system contrasts with the current On-line Help System of Excel. In the current help system of Excel, users had difficulty in finding out how to carry out these tasks effectively. The example of user behaviour in the current help system given in chapter V and reproduced in Figure 8.18 below shows the trouble users went through in trying to solve the problem.

This example typifies the manner in which the Integrated Base Help System helps in solving the Vocabulary problem inherent in the current On-line Help System of Microsoft Excel.

Brief Description

As explained in the previous page, this figure shows a typical sequence of interaction with the Online Help System in trying to find out how to insert a double-line boarder. The user:

1. Started with the Index, first using Borders, then Lines, and then Double-Line Borders – all leading to a deadlock – crossed circle.
2. Explored, and decided to use Find with the keywords Double Line, Double Line Borders and Line Style – all leading to a deadlock.
3. He then used the Contents and selected Text & Cells, which also lead to a deadlock.
4. Turned to the Experimenter, and was asked to use the Wizard and the keyword Double Line Boarder – this also lead to a deadlock.
5. In the end, due to fatigue decided to give up!

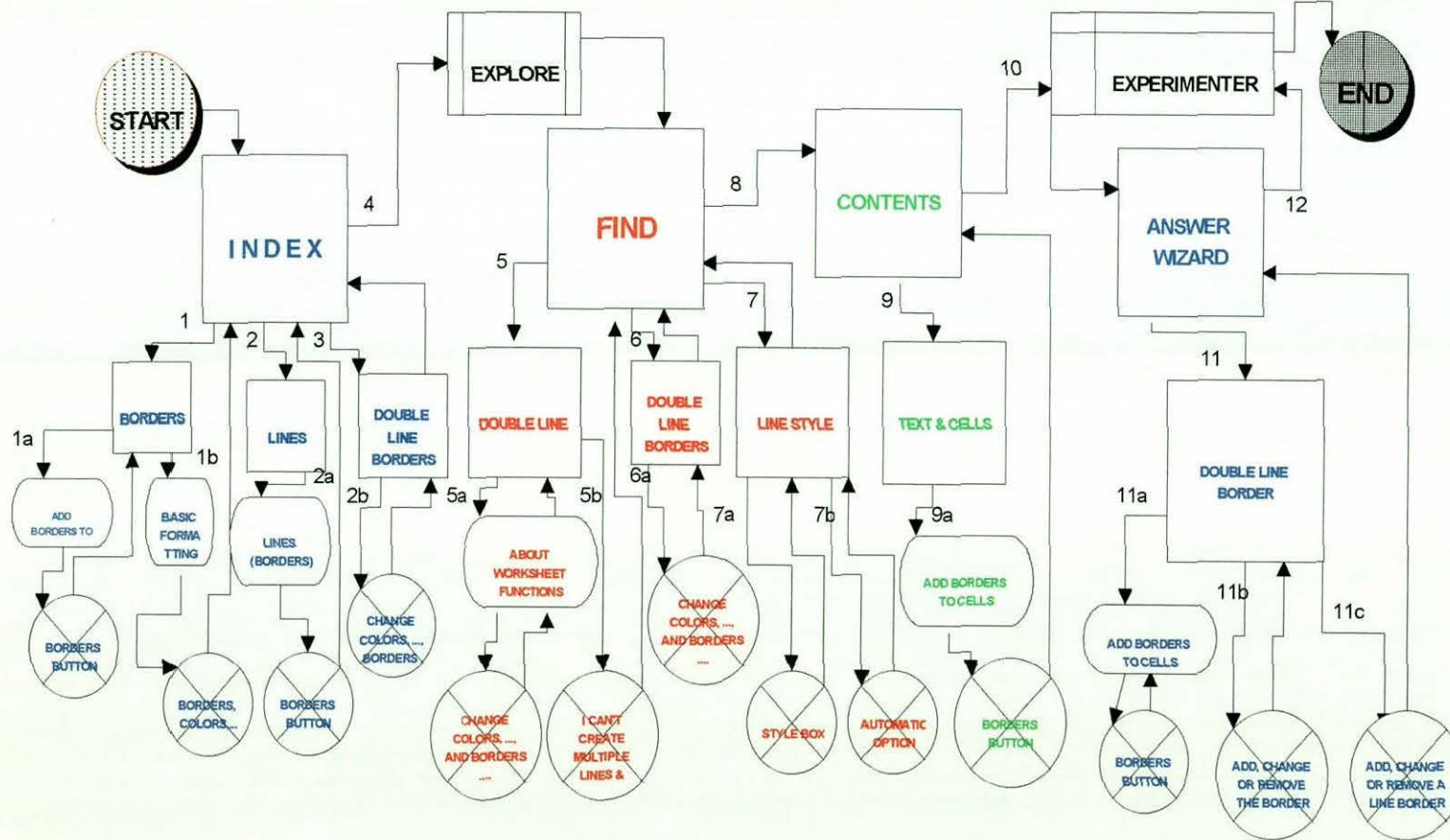


Figure 8.18: Vocabulary Problem Example In Current On-line Help (from Figure 5.12)

The user is repeatedly descending vertically into the information base and reaching dead-end information of no use to the problem being solved.

The Table below provides a summary of the average number of 'Browse' sequences used by subjects, based on their level of experience and task difficulty. A browse sequence is the number of times the Browse button was accessed by a user when trying to get the required information for his task.

Task Complexity Level	Novice Users	Intermediate Users	Expert Users
1	5	3	0
2	5	5	3
3	8	6	5
4	11	8	6

Table 8.4: Average Number of Times of Accessing the 'Browse' Button By Task Complexity

The table illustrates the increase use of Browsing with difficulty and lack of expertise. Note that Experts, even when uncertain and browsing, are able more quickly to make the Vocabulary connection.

In the next section, we provide a summary of the analytical results obtained when the data collected during the experiment was analysed.

8.4 Analytical Results

As presented in chapters five and six, the observations from the evaluation experiment were analysed according to the following measurement criteria:

- Total time taken during the experiment
- Total time taken accessing On-line help
- Total time taken during exploration

- Time taken to perform actual tasks
- number of completed tasks
- Method(s) employed during help access
- The number of successful hits
- The number of partially successful hits
- The number of unsuccessful hits
- Number of times assistance was given by the experimenter
- Errors made during the experiment.

On the average, Expert users took the least time (under two hours) in completing the experiment while Novice users took the highest time (more than four hours). The Intermediate users were between (about three hours). If we look at the time spent accessing The Integrated Base On-line Help, we see the same trend, with Expert users taking the least time (about half an hour), the Intermediate users with about an hour, and the Novice users with about one and a half hours. This means that Intermediate users spent of twice the time spent by Expert users while Novice users spent less than twice the time taken by Intermediate users.

USER LEVEL	Total Time (mins)	Help Time (mins)	Exploration Time (mins)	Task Time (mins)
Expert	110.00	28.33	16.67	65.00
Intermediate	181.00	57.50	46.83	78.33
Novice	254.33	94.33	50.00	110.00

Table 8.5: Average User Performance based on Time

These observations are interesting in the sense that each user group took considerably longer than the time of its immediate 'predecessor'. This is what we anticipated, because Expert users, based on their knowledge of the application, are expected to complete these tasks faster than the Intermediate users, thereby taking less time in all activities than the Intermediate users. Similar situation is observed between Intermediate and Novice users. These are just anticipations and need to be tested statistically. For the statistical tests of this and other results, these are discussed in the next section.

If we look at the time spent trying to find out how to perform the task without using the Integrated Base On-line Help System (Exploration), we see that Expert users spent the least time (about a quarter of an hour), the Intermediate users spent three times as much as the Expert users (about three quarters of an hour) and the Novice users spent about an hour.

Similarly, if the time taken to carry out the actual task after finding out how to perform the task, either by using the Integrated Base On-line Help System or by Exploration, we see that Expert users took about an hour, Intermediate users took an hour and a half and the Novice users took about two hours. Table 8.5 gives the average distribution while figure 8.19 shows the actual distribution.

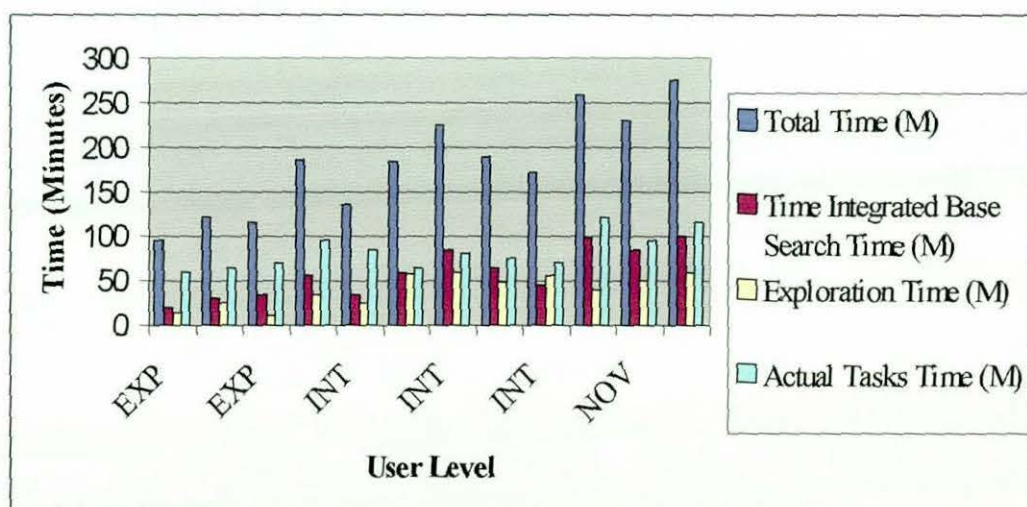


Figure 8.19: User Performance based on Time

Time has given us a reasonable measure of performance of the three groups of users. This is so because we separated the different times taken to perform separate activities and distractions from the main tasks during the experiment was kept to the minimum. Hence it can be said that time has provided a good picture about the performance of different user levels, and hence increased our confidence in our user definitions (Abdullahi & Alty, 1998).

In terms of the interaction with the Integrated Base On-line Help, and whether the user achieved a successful hit - that is, the user was able to find what he was looking for and was able to use it in carrying out the task, or was partially successful or completely unsuccessful, the results did not present a clear picture of the distinction between users. On the average, Expert users accessed the Integrated Base On-line Help System seven times and achieved 71.43% success and 0% failure. Similarly, the Intermediate users accessed the Integrated Base On-line Help twenty-two times and achieved a success rate of 72.73% and only 9.09% failure. On the other hand, the Novice users had the highest number of accesses; with average access of 28 times and achieved a success rate of 78.57% and only 7.14% failure. Table 8.6 shows the average distribution while figure 8.20 shows actual distribution

USER LEVEL	Total Access (Average)	Successful Hits (%)	Partially Successful Hits (%)	Unsuccessful Hits (%)
Expert	7	71.43	28.57	0
Intermediate	22	72.73	18.18	9.04
Novice	28	78.57	14.29	7.14

Table 8.6: Average Success/Failure of On-line Help Access

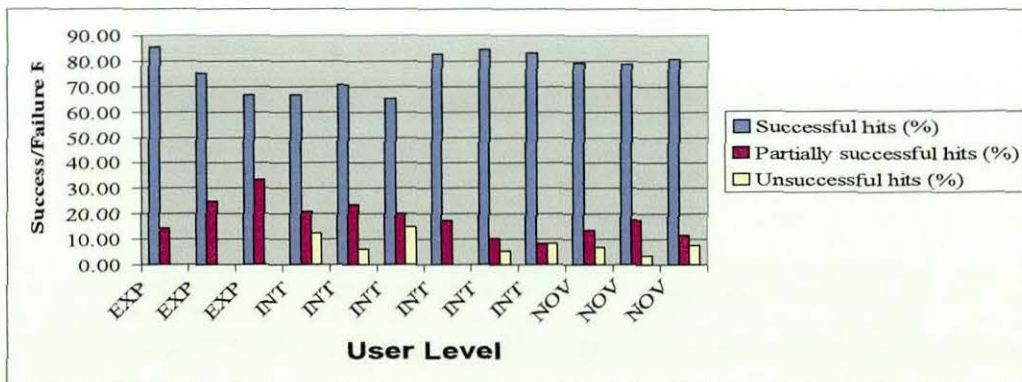


Figure 8.20: Actual Distribution of Success/Failure with On-line Help

If the total number of tasks completed by the users is considered, we find that on the average, Expert users completed 47 tasks, about 94% of the total tasks. Similarly, Intermediate users, on the average, completed 39 tasks which is about 78% of the total tasks and the Novice users completed about 31 tasks which is about 62% of the total tasks. As the results above indicated, all users completed

more than 50% of the tasks provided during the experiment. This shows that the tasks were generally of moderate complexity.

Similarly, if the break down of completed tasks is made by the aid mechanism used, we see an overall increase in the number of tasks completed by the Integrated Base On-line Help system. Table 8.7 shows the distribution

User Level	Completed Tasks (/50)	With Int. Base	With Assistance	By Exploration	No Assistance Whatsoever
Expert	47	5	2	17	23
Intermediate	39	16	4	9	10
Novice	31	22	5	2	2

Table 8.7: Average distribution of task completion by aid mechanism

As can be seen from the above table, expert users carried most of the tasks by exploration rather than by using the Integrated Base Help System or employing the expertise of the experimenter. This goes to confirm our hypothesis that Expert users either know the advanced feature of the application, or can easily pick them up when required without help (Abdullahi & Alty, 1998). A similar observation can be made by considering the number of tasks done ‘using assistance obtained from previous similar tasks, that is tasks carried out either without assistance entirely or after finding out how to carry out such tasks through the integrated base On-line help, exploration or the assistance of the experimenter. Figure 8.21 below shows the distribution of the actual results.

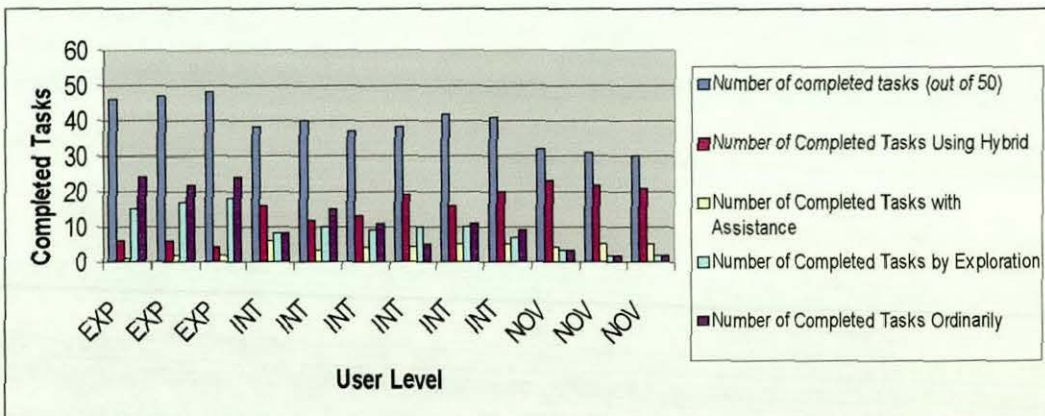


Figure 8.21: Actual distribution of task completion by aid mechanism

8.5 Test for Statistical Significance

Similar to what was observed in the On-line Help and the User Manual studies, we carried out a number of statistical tests to check the significance of the results presented in the previous section. These tests are presented below.

8.5.1 Analysis of Variance (ANOVA)

The following is the analysis of variance results of the Integrated Base Help System data. A detailed discussion of the numerous tests carried out to test the normality and homogeneity of the data is given in appendix G Section G.3.

The results of the test run are shown in Table 8.10. From the table we can see that there exist significant difference between all the groups (Experts, Intermediates and Novices), with $p \ll 0.011$. Hence we can conclude that the overall results are significantly different from each other, and this could not have happened by chance.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Number of Completed Taks	Between Groups	384.333	2	192.167	74.121	.000
	Within Groups	23.333	9	2.593		
	Total	407.667	11			
Exploration Time	Between Groups	2213.417	2	1106.708	7.665	.011
	Within Groups	1299.500	9	144.389		
	Total	3512.917	11			
Integrated Base Search Time	Between Groups	6578.083	2	3289.042	17.043	.001
	Within Groups	1736.833	9	192.981		
	Total	8314.917	11			
Total Task Completion Time	Between Groups	3289.583	2	1644.792	15.054	.001
	Within Groups	983.333	9	109.259		
	Total	4272.917	11			
Total Completion Time	Between Groups	31252.25	2	15626.12	25.003	.000
	Within Groups	5624.667	9	624.963		
	Total	36876.92	11			
Total Access	Between Groups	684.750	2	342.375	62.250	.000
	Within Groups	49.500	9	5.500		
	Total	734.250	11			
SHITS	Between Groups	433.000	2	216.500	35.643	.000
	Within Groups	54.667	9	6.074		
	Total	487.667	11			
Number of Times Assisted	Between Groups	66.667	2	33.333	15.517	.001
	Within Groups	19.333	9	2.148		
	Total	86.000	11			

Table 8.10: Analysis of Variance Test Results for the Integrated Base study

8.5.2 Kruskal-Wallis Test for K-Independent Samples

Kruskal-Wallis Test was run for all the groups as well as on all the variables. The results obtained are shown in Table 8.11a and 8.11b.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Number of Completed Taks	Between Groups	384.333	2	192.167	74.121	.000
	Within Groups	23.333	9	2.593		
	Total	407.667	11			
Exploration Time	Between Groups	2213.417	2	1106.708	7.665	.011
	Within Groups	1299.500	9	144.389		
	Total	3512.917	11			
Integrated Base Search Time	Between Groups	6578.083	2	3289.042	17.043	.001
	Within Groups	1736.833	9	192.981		
	Total	8314.917	11			
Total Task Completion Time	Between Groups	3289.583	2	1644.792	15.054	.001
	Within Groups	983.333	9	109.259		
	Total	4272.917	11			
Total Completion Time	Between Groups	31252.25	2	15626.12	25.003	.000
	Within Groups	5624.667	9	624.963		
	Total	36876.92	11			
Total Access	Between Groups	684.750	2	342.375	62.250	.000
	Within Groups	49.500	9	5.500		
	Total	734.250	11			
SHITS	Between Groups	433.000	2	216.500	35.643	.000
	Within Groups	54.667	9	6.074		
	Total	487.667	11			
Number of Times Assisted	Between Groups	66.667	2	33.333	15.517	.001
	Within Groups	19.333	9	2.148		
	Total	86.000	11			

Table 8.10: Analysis of Variance Test Results for the Integrated Base study

8.5.2 Kruskal-Wallis Test for K-Independent Samples

Kruskal-Wallis Test was run for all the groups as well as on all the variables. The results obtained are shown in Table 8.11a and 8.11b.

Ranks

	User Level	N	Mean Rank
Number of Completed Taks	Expert	3	11.00
	Intermediate	6	6.50
	Novice	3	2.00
	Total	12	
Exploration Time	Expert	3	2.17
	Intermediate	6	7.67
	Novice	3	8.50
	Total	12	
Integrated Base Search Time	Expert	3	2.17
	Intermediate	6	6.50
	Novice	3	10.83
	Total	12	
Number of Times Assisted	Expert	3	2.00
	Intermediate	6	6.75
	Novice	3	10.50
	Total	12	
SHITS	Expert	3	2.00
	Intermediate	6	6.50
	Novice	3	11.00
	Total	12	
Total Access	Expert	3	2.00
	Intermediate	6	6.50
	Novice	3	11.00
	Total	12	
Total Task Completion Time	Expert	3	2.67
	Intermediate	6	6.25
	Novice	3	10.83
	Total	12	
Total Completion Time	Expert	3	2.00
	Intermediate	6	6.50
	Novice	3	11.00
	Total	12	

Table 8.11a: Kruskal-Wallis H Test for 3 Independent Samples

Test Statistics^{a,b}

	Number of Completed Taks	Exploration Time	Integrated Base Search Time	Number of Times Assisted	SHITS	Total Access	Total Task Completion Time	Total Completion Time
Chi-Square	9.379	5.926	8.728	8.574	9.412	9.379	7.835	9.346
df	2	2	2	2	2	2	2	2
Asymp. Sig.	.009	.052	.013	.014	.009	.009	.020	.009

a. Kruskal Wallis Test

b. Grouping Variable: User Level

Table 8.11b: Kruskal-Wallis H Test Statistic for 3 Independent Samples

From the tables above, it can be seen that all test variables have shown positive results, with significant level $p < 0.052$. It should be noted that the above

Asymptotic Significance means the significance level based on the asymptotic distribution of a test statistic, assuming that the data set is large. This is used because it was not possible to obtain exact confidence intervals for each of the parameters.

These results are in conformity with the ones of Analysis of Variance, and hence clear the doubts about data.

8.5.3 Mann-Whitney Test

Here also, the Mann-Whitney test was carried out because of the need to test the significance of the difference between the three separate groups, two at a time. The results of the tests are shown below.

8.5.3.1 Expert Vs Intermediate Users

Tables 8.12a and 8.12b show the summary of the results of the comparison between the Expert and Intermediate users of the Integrated Base System.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Total Completion Time	Expert	3	2.00	6.00
	Intermediate	6	6.50	39.00
	Total	9		
Integrated Base Search Time	Expert	3	2.17	6.50
	Intermediate	6	6.42	38.50
	Total	9		
Exploration Time	Expert	3	2.17	6.50
	Intermediate	6	6.42	38.50
	Total	9		
Total Task Completion Time	Expert	3	2.67	8.00
	Intermediate	6	6.17	37.00
	Total	9		
Number of Completed Taks	Expert	3	8.00	24.00
	Intermediate	6	3.50	21.00
	Total	9		
SHITS	Expert	3	2.00	6.00
	Intermediate	6	6.50	39.00
	Total	9		
Total Access	Expert	3	2.00	6.00
	Intermediate	6	6.50	39.00
	Total	9		
Number of Times Assisted	Expert	3	2.00	6.00
	Intermediate	6	6.50	39.00
	Total	9		

Table 8.12a: Mann-Whitney U Test for 2 Independent Variables

Test Statistics^a

	Total Completion Time	Integrated Base Search Time	Exploration Time	Total Task Completion Time	Number of Completed Taks	SHITS	Total Access	Number of Times Assisted
Mann-Whitney U	.000	.500	.500	2.000	.000	.000	.000	.000
Wilcoxon W	6.000	6.500	6.500	8.000	21.000	6.000	6.000	6.000
Z	-2.324	-2.204	-2.204	-1.823	-2.334	-2.343	-2.334	-2.374
Asymp. Sig. (2-tailed)	.020	.028	.028	.068	.020	.019	.020	.018
Exact Sig. [2*(1-tailed Sig.)]	.024 ^a	.024 ^a	.024 ^a	.095 ^a	.024 ^a	.024 ^a	.024 ^a	.024 ^a

a. Not corrected for ties.

b. Grouping Variable: User Level

Table 8.12b: Mann-Whitney U Test Statistic for 2 Independent Variables

8.5.3.2 Expert Vs Novice Users

Tables 8.13a and 8.13b show the summary of the results of the comparison between the Expert and Novice users of the Integrated Base System.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Total Completion Time	Expert	3	2.00	6.00
	Novice	3	5.00	15.00
	Total	6		
Integrated Base Search Time	Expert	3	2.00	6.00
	Novice	3	5.00	15.00
	Total	6		
Exploration Time	Expert	3	2.00	6.00
	Novice	3	5.00	15.00
	Total	6		
Total Task Completion Time	Expert	3	2.00	6.00
	Novice	3	5.00	15.00
	Total	6		
Number of Completed Taks	Expert	3	5.00	15.00
	Novice	3	2.00	6.00
	Total	6		
SHITS	Expert	3	2.00	6.00
	Novice	3	5.00	15.00
	Total	6		
Total Access	Expert	3	2.00	6.00
	Novice	3	5.00	15.00
	Total	6		
Number of Times Assisted	Expert	3	2.00	6.00
	Novice	3	5.00	15.00
	Total	6		

Table 8.13a: Mann-Whitney U Test for 2 Independent Variables

Test Statistics^a

	Total Completion Time	Integrated Base Search Time	Exploration Time	Total Task Completion Time	Number of Completed Taks	SHITS	Total Access	Number of Times Assisted
Mann-Whitney U	.000	.000	.000	.000	.000	.000	.000	.000
Wilcoxon W	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Z	-1.964	-1.964	-1.964	-1.964	-1.964	-1.993	-1.964	-1.993
Asymp. Sig. (2-tailed)	.050	.050	.050	.050	.050	.046	.050	.046
Exact Sig. [2*(1-tailed Sig.)]	.100 ^a	.100 ^a	.100 ^a	.100 ^a	.100 ^a	.100 ^a	.100 ^a	.100 ^a

a. Not corrected for ties.

b. Grouping Variable: User Level

Table 8.13b: Mann-Whitney U Test Statistic for 2 Independent Variables

8.5.3.3 Intermediate Vs Novice Users

Tables 8.14a and 8.14b show the summary of the results of the comparison between the Intermediate and Novice users of the Integrated Base System.

Ranks

	User Level	N	Mean Rank	Sum of Ranks
Total Completion Time	Intermediate	6	3.50	21.00
	Novice	3	8.00	24.00
	Total	9		
Integrated Base Search Time	Intermediate	6	3.58	21.50
	Novice	3	7.83	23.50
	Total	9		
Exploration Time	Intermediate	6	4.75	28.50
	Novice	3	5.50	16.50
	Total	9		
Total Task Completion Time	Intermediate	6	3.58	21.50
	Novice	3	7.83	23.50
	Total	9		
Number of Completed Taks	Intermediate	6	6.50	39.00
	Novice	3	2.00	6.00
	Total	9		
SHITS	Intermediate	6	3.50	21.00
	Novice	3	8.00	24.00
	Total	9		
Total Access	Intermediate	6	3.50	21.00
	Novice	3	8.00	24.00
	Total	9		
Number of Times Assisted	Intermediate	6	3.75	22.50
	Novice	3	7.50	22.50
	Total	9		

Table 8.14a: Mann-Whitney U Test for 2 Independent Variables

Test Statistics^a

	Total Completion Time	Integrated Base Search Time	Exploration Time	Total Task Completion Time	Number of Completed Taks	SHITS	Total Access	Number of Times Assisted
Mann-Whitney U	.000	.500	7.500	.500	.000	.000	.000	1.500
Wilcoxon W	21.000	21.500	28.500	21.500	6.000	21.000	21.000	22.500
Z	-2.324	-2.204	-.389	-2.204	-2.334	-2.334	-2.334	-1.978
Asymp. Sig. (2-tailed)	.020	.028	.697	.028	.020	.020	.020	.048
Exact Sig. [2*(1-tailed Sig.)]	.024 ^a	.024 ^a	.714 ^a	.024 ^a	.024 ^a	.024 ^a	.024 ^a	.048 ^a

a. Not corrected for ties.
 b. Grouping Variable: User Level

Table 8.14b: Mann-Whitney U Test Statistic for 2 Independent Variables

These results further support our earlier conclusions about the three groups – experts, intermediates and the novices. This also partially confirms hypothesis I – that the time taken to complete any given task will vary according to user experience, irrespective of aid mechanism.

8.6. Discussion of Results

The experiment reported in this Chapter examined the performance of users while interacting with the Integrated Base On-line Help System in searching for task-specific queries. It started with the aim of seeing how the performance of users in this experiment will compare with the results of the first and the second experiment outlined in Chapter IV and conducted and reported in Chapters V and VI respectively.

The results presented here show a significant difference in the three categories of users – Expert, Intermediate and Novice users. Generally, users took less time in carrying out the tasks than in either of the two other experiments. The longest time taken during the Integrated Base On-line Help System was about four and a half hours – a 25% improvement over the On-line Help System experiment and 28% improvement over the User manual experiment. Comparatively, this is very significant, and, this has gone to show the efficacy of the approach.

Overall, the system enabled the users in this experiment to solve most of their task-related queries and has greatly improved their performance, both in terms of time taken and tasks completed. These are statistically shown to be significant. This improvement in both task completion and satisfaction was made possible by the unique features of the Integrated Base On-line Help System. It will be interesting to see how the system compares with the other two. In this regard, a comparative analysis and discussion of the three different experiments is presented in Chapter IX.

Chapter IX: Comparative Analysis of Results

9.0 Introduction

In the preceding chapter, the results of the 'improved' On-line Help System are discussed. In this chapter, a comparative examination of the entire experimental results is presented. The three experiments carried out were:

- Users with the current On-line Help system of Microsoft Excel
- Users with the User Manual of Microsoft Excel only
- Users with the Integrated Based On-line Help System

In all cases, three categories of users were employed – Experts, Intermediates and Novices. In all experiments, these three groups have been shown to groups with highly significant differences in their requirement for assistance, time taken, number of success in tasks, as well as other parameters. The key question is: how did user performance vary over these three systems, given that the tasks required to be carried out were identical, so that differences observed should be due to the different quality of help given, and different levels of expertise. The following sections discuss the comparative results

9.1 Analytical Results

To see how these users perform as far as time is concerned in comparison to those of the On-line Help and the User Manual experiments, table 9.1 below is presented.

Time (Mins)	Expert			Intermediate			Novice		
	Help	Manual	Int. Base	Help	Manual	Int. Base	Help	Manual	Int. Base
Total Time	123.60	199.20	110.00	232.42	321.30	181.00	362.66	435.00	254.33
Search Time	33.60	66.40	28.33	66.42	113.25	57.50	130.80	154.00	94.33
Exploration Time	23.00	49.20	16.67	75.50	93.12	46.83	99.40	122.20	50.00
Task Time	67.00	83.60	65.00	93.83	115.87	78.33	132.40	157.20	110.00

Table 9.1: Comparison of On-line Help, Manual and Integrated Base Help Experiment by Time

Table 9.1 above shows that in general, there is a noticeable reduction in the time taken by users of the Integrated Base On-line Help System experiment as compared to the other two experiments. The Novice users achieved a time reduction of about two hours when compared with the existing On-line Help, and about three hours when compared with the User Manual – in terms of total completion time. Similarly, Intermediate users achieved a time reduction of about one hour, when compared with the existing On-line Help, and about two hours when compared with the User Manual – in terms of total completion time. On the other hand, Expert users achieved a time reduction of only thirteen minutes, when compared with the existing On-line Help, and about one and a half hours when compared with the User Manual – in terms of total completion time.

Similarly, a noticeable improvement in subjects' performance using the Integrated Base Help System is observed in comparison to both the current On-line Help System and the User Manual. Table 9.2 shows the results of this comparison.

USER LEVEL	Total Access (Average)			Successful Hits (%)			Partially Successful Hits (%)			Unsuccessful Hits (%)		
	Help	Manual	Int. Base	Help	Manual	Int. Base	Help	Manual	Int. Base	Help	Manual	Int. Base
Expert	8	5	7	37.50	68.33	71.43	37.50	4.00	28.57	25.00	27.67	0
Intermediate	17	11	22	41.18	68.75	72.73	29.41	9.64	18.18	29.41	18.83	9.04
Novice	33	23	28	24.24	68.68	78.57	33.33	15.82	14.29	42.42	23.51	7.14

Table 9.2: Average Success/Failure Based on Assistance Mechanism.

As can be seen for table 9.2, all class of users achieved a noticeable improvement in performances with the Integrated Base Help System than any of the other two. Of importance is the rate of unsuccessful searches of the tool used. Where as Expert users were unsuccessful 25.00% in searching for task-related queries using the current On-line Help and 27.67% in using the User Manual, they were either successful or partially successful in using the Integrated Base On-line Help. This goes to show that the Information content of the Integrated Base Help System was

complete, logically organised and with step-by-step procedures. This is in addition to the ability to browse through the information base in all directions.

Also, when the number of completed tasks is analysed in relation to the assistance mechanism, it can be seen that the users in the Integrated Base Help System experiment performed better than those of the other two, although the difference is marginal in the case of the manual experiment. Table 9.3 below shows the results.

	Expert			Intermediate			Novice		
	Help	Manual	Int. Base	Help	Manual	Int. Base	Help	Manual	Int. Base
Completed Tasks (/50)	36	41	47	28	36	39	18	29	31
Help/Manual/Int. Base	3	3	5	6	7	16	7	14	22
With Assistance	3	3	2	8	4	4	9	7	5
By Exploration	9	13	17	4	9	9	1	3	2
Previous Help	21	22	23	10	16	10	1	5	2

Table 9.3: Comparison of the Three Experiments' Task Completion by Aid Mechanisms

From table 9.3 above, we can see that generally the users that interacted with the Integrated Base Help System solved more tasks using it than in the other two. The expert subjects completed 67% more tasks with the system than with either the On-line Help or the Manual, where the number of completed tasks was the same in both cases. The Intermediate users completed more tasks using the system than the other two combined (16 as compared to $6+7 = 13$). Similarly, Novice users completed almost twice as much as their counterparts in the On-line Help experiment and only 7% more than their counterparts in the manual experiment (31 as compared to 29).

If on the other hand, we consider the number of tasks completed with the assistance of the experimenter, we see that the difference is marginal in the case of Expert users, although the assistance was less in the Integrated Base Help experiment (about 33% less). Intermediate users were assisted more in the current On-line Help (twice more) than in either the User Manual or the Integrated Base Help system – where the number of tasks complete with assistance was the same. In the Novice users' category, the number of tasks completed with assistance

varied across the aid mechanisms, with the Integrated Base Help System having the 'least' (28% less than Manual and 44% less than current On-line Help experiments).

One question that be asked from the above result is: Is this decrease in the number of times assistance was given due to the users' knowledge about the application or is due to the familiarity or 'ease of use' of the Integrated Base Help System? A reasonable explanation to this phenomenon is that it is possibly due to the incorporation of the numerous navigational aids in the system that facilitated easier and smooth information access. These aids, the most important being the 'browse' facility, which was found to be similar to the manner in which books are browsed, enabled this achievement across all user class. It was established in earlier experiments that humans are generally experts in looking for information buried within the 'pages of books', thereby finding what they want in order to perform the tasks. Once such information is found and the task completed, the 'knowledge' acquired remains with the user, thereby enabling them to carry out out similar tasks without further search.

9.2 Test for Statistical Significance

In the previous chapters, the various user groups were shown to have compared favourably with considerable level of statistical significance. In this chapter, we are interested in testing the statistical significance of the three experimental conditions – On-line Help, User Manual, and the Integrated Base Help.

9.2.1 Analysis of Variance (ANOVA): Expert Users Across Applications

The following is the analysis of variance results of the data across the three systems. A detailed discussion of the numerous tests carried out to test the normality and homogeneity of the data is given in appendix G Section G.4.

The results of the test run are shown in Table 9.10. From the table we can see that there exist significant difference between all the groups (Experts, Intermediates and Novices), with $p < 0.011$. Hence we can conclude that the overall results are significantly different from each other, and this could not have happened by chance.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Number of Completed Tasks	Between Groups	249.077	2	124.538	41.513	.000
	Within Groups	30.000	10	3.000		
	Total	279.077	12			
Exploration Time	Between Groups	2587.610	2	1293.805	29.440	.000
	Within Groups	439.467	10	43.947		
	Total	3027.077	12			
'Help' Search Time	Between Groups	3772.933	2	1886.467	31.385	.000
	Within Groups	601.067	10	60.107		
	Total	4374.000	12			
Actual Task Time	Between Groups	933.723	2	466.862	12.183	.002
	Within Groups	383.200	10	38.320		
	Total	1316.923	12			
Total Completion Time	Between Groups	20385.23	2	10192.62	67.322	.000
	Within Groups	1514.000	10	151.400		
	Total	21899.23	12			
Unsuccessful Hits	Between Groups	9.077	2	4.538	22.692	.000
	Within Groups	2.000	10	.200		
	Total	11.077	12			

Table 9.8: Analysis of Variance Test Results for the Three Experiments

Similar results were obtained when the Intermediate and Novice users were considered across the three experimental conditions. The statistical results are shown in the appendix.

9.4 Discussion of Results

The comparative results presented in this chapter show how the Integrated Base On-line Help System compared with the two other systems – the current On-line Help system of Microsoft Excel and the User Manual, particularly in terms of providing the task-related assistance to users. As was discussed, the system enabled the users in this experiment to solve most of their task-related queries and has greatly improved their performance (both in terms of time taken and tasks completed) when compared with those of the On-line Help and the User Manual experiments.

It is clear that users of the Integrated Base Help System had little or no difficulty in obtaining the required information from the system. This sharply contrasts with the existing On-line help system where users experienced a series of difficulties due to terminology differences – the Vocabulary problem. Also, there was the problem of having small independent units of information, which made it difficult for users to browse in order to get what they required to perform the tasks. The Integrated Base Help system has successfully overcome these problems by allowing users (particularly inexperienced ones) to enter into an Vocabulary dialogue with the system using browsing facility.

These benefits resulted in the very significant improvements in performances seen in Chapter VIII. The users of the On-line Help Experiment solved few ‘problems’ with the On-line Help System, but the users of the Integrated Base Help System solved many. Also, whereas user of the User Manual experiment took more time to complete the required tasks, the users of the Integrated Base Help system took much less time in comparison to the others. These results confirmed the efficacy of our approach.

The implementation of the Integrated Information Base has enabled us to achieve better time performances than the On-line help System, and the increased accuracy

which users previously could only obtain with the User manual. Whilst it is difficult to compare the Integrated Base exactly with the previous On-line help system, the improvements are so striking as to lead us to believe that we have identified a key weakness in current On-line help systems. Further more, these results confirm the hypotheses stated in Chapter I, that:

1. the time taken to complete any given task will vary according to user experience, irrespective of aid mechanism
2. when compared, the performance of users on any two or more aid mechanisms will differ
3. an improvement in On-line information that uses printed documentation features will greatly improve user performance and satisfaction.

All these have been confirmed by the individual results discussed in Chapters V, VI, and VIII. They are further confirmed by the comparative analysis presented in this Chapter.

CHAPTER X
SUMMARY, CONCLUSION & CONTRIBUTIONS TO
KNOWLEDGE

10.0 Summary & Conclusion

The study discussed in this thesis began with a simple goal: to examine existing On-line Help systems with the aim of identifying their weaknesses, and to propose a means of approaching the problems identified. The approach adopted allowed for several discoveries to be made.

On-line Developers have differing views as to how to provide On-line Help Systems, so a comprehensive study of the underlying concepts was undertaken and was reported in chapter II. This resulted in a need for a classification both of On-line Help Systems and the users of such On-line Help Systems and these were presented in Chapter II also.

The research noted that the design of a perfect On-line Help System is difficult to achieve due to the diversity of users that such a system is expected to cater for. The literature review revealed that application users differ in many respects - computer background, task experience, application software experience, as well as other personality characteristics such as reading speed, attention span, learning style, or patience. As a result of such factors, each user may react differently to an application program and it may be difficult to predict what any particular individual's reactions might be. Understanding the physical, intellectual and personality differences among users could be important, as this will reflect the user's motivation to learn and become knowledgeable about the system. There are also cultural and language difficulties which may also affect understanding.

User diversity is a challenge to system designers, and when considered together with the possible range of situations, tasks, technologies and frequencies of use,

the resultant possibilities are great. Researchers have focused mainly on Gender, Experience, Age, Ethnic Culture, Cognitive Abilities, and Personality Traits, and these were carefully studied and documented. Despite this diversity, we believe that a good On-line help system will compensate for individual differences by allowing users to explore a system in whatever fashion is most suitable to them. However, a successful exploration of a system by users is only possible when the appropriate experience or expertise exists and can be exploited.

Many different approaches to designing On-line Help Systems have been attempted, usually in isolated settings. Yet, the designers appear to pay little attention to the needs of the users. In chapter II, the different approaches were presented, and their viability from the users' perspective was assessed. In keyword help systems for instance, the user simply specifies the keyword, which the system uses as an index to its database. Unfortunately in most of these systems, the only keywords acceptable to the system are the actual names of commands, and users have to know a specific command to be able to get help from the system, and this is not an easy task. Some systems attempt to tackle this problem by displaying a list of acceptable keywords, which the user can scan through. However, the keyword that the user understands might not be listed and hence the user has difficulty in getting any help from the system. We therefore proposed that each section of the help database should be properly indexed by relevant keywords, as this guarantees that any relevant keyword finds the required text and at the same time ensures that the system did not overwhelm the user with unnecessary information.

One important aspect of an On-line Help System's efficacy is its level of integration. As discussed in the thesis, many computer systems provide several On-line help mechanisms, each with its own database, operating completely independently. Similarly, some systems make On-line help an independent utility, accessible only when the user is not doing anything else, while others try to make the help available within the context of most other, larger tasks. These approaches tend to create unnecessary difficulties to the user when searching for relevant

information.

The advantages of integration are obvious: by providing uniform access to help, confusion for the user can be minimised and it makes it easier for the user to stay in context. By ensuring that the various mechanisms access a single help database, it is easier for the user to try all of the mechanisms provided. Of course, integrated help is more challenging than non-integrated help from an implementation perspective, but considered within the context of the user, we have shown that the problem is neither impossible nor particularly difficult.

From this chapter a number of research questions have been raised – issues such as that of taxonomy, user classification, system classification and the techniques of system evaluation, among others. These were carefully addressed in this thesis.

In chapter III, the relevant research in the area was reviewed. The research issues raised in Chapter II were used to guide the review. The review was grouped into studies that compared On-line and printed documentation, cognitive ability, Improved On-line Documentation and Human Vs Computer-based Instruction. In the category where On-line Help was compared with written documentation, the results indicated that users with written documentation performed better than those with the On-line Help. Similarly, it was found to be more effective in solving users' task-related queries as well as useful for long-term skill acquisition. There were two likely reasons for this improvement. The first concerned the issue of screen real estate. On-line Help often obscures important issues in the problem space. A second reason was related to the way in which information is extracted by users. Paper based assistance seemed to be more effective. One key question that necessitated further investigation was the issue of whether advancements in technology both printed and display screens caused a shift in this norm. This prompted a survey of the subjective views of users some software applications, reported in Chapter IV.

In Chapter IV, the results of the empirical survey conducted with a group of computer users who are professionals in their own areas, many of whom also have considerable experience in the applications, was presented. The survey centred on three applications – Word Processing, Spreadsheet, and Database Management applications. Although these are broad categories, most of the users that participated in the survey were using the Microsoft Office Applications – Word, Excel, and Access. The main aim of the study was to assess users' subjective views about current On-line Help Systems of these applications.

The results of the survey indicated that overall, over half the respondents in the survey either had never used, or rarely used the On-line Help systems though all of them knew of their existence. As one might expect, in the more established applications, all users had accessed On-line-help at some time, but this did not seem to encourage regular use. It was noted that less use was made of On-line help in the less well-established application package – Database Management.

Whilst there was evidence from the survey that On-line Help was found to be useful in some cases, a larger percentage of the users were not convinced of its value. Hence if On-line Help is the only source of help as current plans of many application package developers strongly indicate, users are not going to be satisfied with this lack of performance.

Similarly, a greater percentage of the users indicated their preference for User Manuals over On-line Help Systems because of their effectiveness in responding to tasks-related queries. This result further confirmed the results of earlier studies discussed in the literature survey of chapter III. Because of these findings, the need for further detailed research into specific issues was identified, and three different experiments were proposed and carried out. The results of each were discussed in Chapters V, VI, and VII.

In chapter V, a detailed and extensive study of Microsoft Excel users and their interactions with the On-line Help System was reported. The then current version

of Excel (version 7.0) was used because it was the most common application within the University where the subjects resided. A set of fifty tasks of varying complexity was created. The tasks were designed in a manner that made it likely that the users would seek help using the On-line help System of Excel. The interactions of users were captured on video as well as Lotus ScreenCam. Additionally many other performance factors were automatically captured.

The analysis of the results revealed that some simple tasks were carried out successfully without seeking for help, while others proved so difficult that even the Expert users had considerable difficulty in completing them successfully. This was seen to be the case despite extensive use of all the mechanisms provided by the On-line Help – the Contents, the Index, Find and the Wizard. This validated the appropriateness of the set of tasks for the study. They were neither too easy nor too hard.

Similarly, the analytical results revealed that experienced users completed most tasks without using the On-line Help System, while the inexperienced users completed more tasks with the assistance of the 'Human Expert'. The On-line Help System of Excel was found to be ineffective in task-related queries, and user comment further confirmed this.

The major problems with the On-line Help System of Excel, and by extension, the On-line Help System of Microsoft Office, were best described as an Vocabulary problem, and the problem of Compartmentalisation. Users - particularly the inexperienced ones, could not seem to find the right terms in which to express their problems to the system. Terminology, which seems perfectly acceptable to them, results in streams of unhelpful information. This caused dissatisfaction with the On-line Help System and yet the information was often in the system. We identified a lack of a Vocabulary dialogue to enable users to match their terms with system terms.

Secondly, the help information was divided into several fragments with vertical paths often leading to single blocks of information, a long way down the Help tree. Although occasional cross-linking was provided, it often confused. Better linkage was found not to be the answer since linkages can be very tiring and confusing, particularly on a typical computer screen with its limited real estate. This compartmentalisation resulted in the lack of an Integrated Base of information. Because of this, the user is always restricted to a small subset of the information that makes up the system's information base, and this made it difficult for users to use their expertise to browse for information in On-line help documentation. The problems uncovered suggested a re examination of users accessing On-line help so as to determine what characteristics improved the Vocabulary match.

Chapter VI reported a detailed and extensive experiment carried out with Excel users who interacted only with the User Manual.

A characterisation of the behaviour of those users that were assisted with the User Manual of Excel revealed that humans use several techniques when looking for information buried within printed pages. Firstly, a mode of search is often adopted – using contents, the index or browsing through the document.

Although users use indexes (or the content pages) to effect primary access, they then often exploit the sequential nature of the written material, browsing until they find information, which appears relevant, or which nearly matches their requirements. It is this technique is the solution to the Vocabulary problem of On-line Help users, because the users were able to discover terminology differences through a “dialogue” with the documentation which involved bi-directional browsing. The human browsing capability was found to be superior to Hypertext links.

The analytical results of the experiment revealed that less use was made of the User Manual, than expected. Despite this lower use, the success rate was very high

when compared with the success rate achieved in the On-line Help experiment. Surprisingly, users of this experiment spent more time using the User Manual than those in the On-line Help Experiment. This was probably because of two factors. Firstly, by its very nature, paper documentation takes longer to process than On-line documentation. Secondly, we believe that the higher success rate achieved using paper based assistance resulted in a higher confidence factor in using this assistance. Users were therefore prepared to invest more effort in accessing the material because the chance of success was much higher. Often in the On-line help case, users gave up simply because the chances of success were low, and their investment would be likely to be wasted. On-line help times were therefore often curtailed because of this reason.

These results led us to the conclusion that an On-line Help System could be redesigned to allow users to exercise their ability to exploit browsing so as to minimise Vocabulary difficulties. We decided to add a browsing capability to the On-line help database, and to base it upon a standard User text.

In Chapter VII, the design and implementation of this prototype system – the Integrated Base On-line Help System was developed and a design adopted. It was expected that the provision of this information base would enable users to get round the Vocabulary problem by having access to a rich set of terms in context which they can process, browse, or reread until a suitable match is found. The information base would also overcome many of the problems of hypertext links (compartmentalisation) by providing a flowing background text into which the hypertext can give access.

The Integrated Information Base, can be read from end to end, or browsed in any part. An Index points to occurrences of words and concepts in the base. A Topics, top-down, approach is also used to provide access to selected blocks of the Information Base, and hypertext links are used to relate topics at this level. The user can, at any time convert from a topic-based view to an integrated base view, and vice versa.

In Chapter VIII, an evaluation experiment was conducted with a group of Excel users. The observed user behaviour as well as the analytical results of this experiment revealed that users of the integrated base On-line help system performed better than the users of the other two experiments, across measured parameters. They took less time, used the system more, and had higher success rates as well as completing more tasks. This led us to the conclusion that the prototype Integrated Base On-line Help System satisfied its design objective.

Interestingly, the new approach provided task times which were superior to the original On-line help experiment, whilst at the same time, users achieved much higher success rates, rates even higher than those achieved with the User Manual. The approach therefore appears to obtain the benefits of On-line access with the superior Vocabulary properties of browsable documentation.

In Chapter IX, a comparative analysis and discussion of the three individual experiments was presented. The comparative results show how the Integrated Base On-line Help System compared with the two other systems – the current On-line Help system of Microsoft Excel and the User Manual, particularly in terms of providing the task-related assistance to users. The system enabled the users in this experiment to solve most of their task-related queries and has greatly improved their performance (both in terms of time taken and tasks completed) when compared with those of the On-line Help and the User Manual experiments.

It is clear that users of the Integrated Base Help System had little or no difficulty in obtaining the required information from the system. This sharply contrasts with the existing On-line help system where users experienced a series of difficulties due to terminology differences – the Vocabulary problem. Also, there was the *problem of having small independent units of information, which made it difficult for users to browse in order to get what they required to perform the tasks.* The Integrated Base Help system has successfully overcome these problems by

allowing users (particularly inexperienced ones) to enter into an Vocabulary dialogue with the system using browsing facility. In addition, statistical tests further confirmed these observations.

The implementation of the Integrated Information Base has enabled us to achieve better time performances than the On-line help System, and the increased accuracy which users previously could only obtain with the User manual. Whilst it is difficult to compare the Integrated Base exactly with the previous On-line help system, the improvements are so striking as to lead us to believe that we have identified a key weakness in current On-line help systems. Further more, these results confirm the hypotheses stated in Chapter I, that:

1. the time taken to complete any given task will vary according to user experience, irrespective of aid mechanism
2. when compared, the performance of users on any two or more aid mechanisms will differ
3. an improvement in On-line information that uses printed documentation features will greatly improve user performance and satisfaction.

This is an important breakthrough in this research. However, due to the limited scope of the Integrated Base On-line Help System and some few issues relating to the individual experiments, there are a number of limitations. These are outlined in the next section.

10.1 Limitations of the Study

During the period of this research, particularly the experimental stages, a compromise was made between involving sufficient numbers of subjects to achieve statistically significant results and using subjects representative of the population of the research focus. This, by implication, meant that the research was not able to employ as high a control population in the experiments as we desired. Although there were twenty two users in the On-line Help System experiment, and

eighteen users in the manual experiment, we were only able to muster twelve users in the final evaluation experiment. Similarly, only limited pilot studies were carried out to test the experimental methods before conducting the actual experiments due to the non-availability of subjects. It should be noted, however, that test runs were carried out in all cases with subjects but these were not always representative.

Another limiting factor was the time spent during the experiment. Some subjects were not willing to spend the desired time to carry out the experiments completely (a minimum of two hours), and this compelled us to discard incomplete results. There were six subjects who did not complete in the first experiment, six in the second and none (interestingly) in the final experiment.

Another limitation was the scope of the prototype system. The prototype Integrated Base On-line Help system was relatively simpler in terms of design complexity when compared to the existing help system of Excel. In addition, it was implemented for only a small portion of Excel's functionality, although most basic information for the tasks was included. This may occasionally have caused users to ask for fringe information, which was not available

10.2 Contributions to Knowledge

We present here the research's contributions to knowledge through the detailed study carried out. These are discussed in the following sub-sections:

10.2.1 Clearly Defined Taxonomy

One of the limitations of previous research on On-line Help systems was a lack of a clearly defined taxonomy. This research has provided a detailed taxonomy of On-line Help Systems, which covers many aspects from the concepts, types,

design, user classification and experimentation. Important aspects that are usually ignored, such as error messages, prompting and integration were included. This is considered to be a useful achievement as any future study will have access to a clearly defined direction, and hence a contribution to knowledge.

10.2.2. Detailed Literature Survey

Another problem that designers of On-line Help Systems usually encounter in the past has been the lack of detailed knowledge of what has been done. Most of the On-line Help Systems reviewed were created in an ad-hoc manner, and only few fully referenced the previous literature before implementing their systems. Hence, another important contribution to knowledge is the detailed review of literature presented in this thesis. This serves can serve as a 'knowledge base' for designers of On-line Help systems, detailing what approaches to the design of On-line Help systems have been tried. This will enable researchers to first try exploiting existing techniques before implementing new ones.

10.2.3 Detailed and Structured Experimental Study

The experiments undertaken and reported in this thesis are detailed and structured. To the best the knowledge of the researcher, it is the first detailed study of its kind in documented research.. The entire process – from the equipment employed to the procedure and tasks was unique, and this facilitated the measurement and analysis of several parameters that would otherwise be difficult to capture and analyse.

10.2.4 The Identification of the Vocabulary Problem

The experiments have confirmed the existence of the Vocabulary gap in current On-line help systems, and has shown how to address this problem using an Integrated base.

10.2.5 The Integrated Base Approach to Building Help Systems

The single most important contribution to the wealth of knowledge of the designers of On-line Help Systems is the concept of the Integrated Base approach. Although a number of approaches were proposed in the literature, such as the task-analytic approach based on the GOMS (Goals, Operators, Methods and Selection rules) model of human-computer interaction and the minimalist approach, non was found to be more effective in handling the Vocabulary and compartmentalisation problems of On-line Help Systems as the Integrated Base approach. We believe that with some extension and refinement of this method, many of the problems of On-line Help Systems can be solved.

10.3 Issues for Further Investigation

There is still a great deal of interesting work to be carried out, which was beyond the scope of this study. Particular areas of interest are outlined below.

10.3.1 Enhancement of the Integrated Base On-line Help System

The information base of the Integrated Base On-line Help System is constructed for only a small portion of the functionality of Microsoft Excel. One of the first enhancements that can be done to the system is to extend the information base to cater for the entire application. This will go a long way in showing the efficacy of the approach.

10.3.2 Enhancement of the System's Graphical User Interface Capability

The systems interface is based on the facilities provide by the Windows On-line Help Engine. Another possible extension of the work is to have more functionality

within the interface so that the users can have greater control on the manner in which the information is displayed. Literature in the review chapter did provide pointers to the enhanced effect of graphical interfaces.

10.3.3 Making the System Adaptive

As a result of the continuous increase in the complexity and sophistication of software applications, we feel that making the Integrated Base Help System adaptive will increase its usefulness. The central goal of an adaptive system is to tailor the interactive behaviour of the system to the individual needs of users and to varying conditions of the application environment. The system can either adapt itself or the user adapts the system according to their needs.



References

Aaronson, A. P., & Carroll, J.P. (1987a). Intelligent Help in a one-shot dialog: a protocol. Proceedings of ACM SIGCHI Conference: Human Factors in Computing Systems, ACM Press.

Aaronson, A. P., & Carroll, J.P. (1987b). "The answer is in the question: a protocol study of intelligent help." Behaviour and Information Technology 6: 393-402.

Abdullahi, U. G., & Alty, J.L. (1998). How Useful is On-line Help?: An Observational Study. OZCHI '98: Proceedings of the Australian Conference on Computer Human Interaction, Adelaide, Australia, IEEE Computer Society.

Agarwal, R. P., J. and Zanno, M.C. (1996). "Training Experiences and Usage Intentions: A Field Study of graphical User Interface." International Journal of Man-Machine Studies 45(3(?)): 215-241.

Allen, B. (1992). Cognitive Differences in End User Searching of a CD-ROM Index. SIGIR '92: Proceedings of the 15th International Conference on SIGIR, Denmark, ACM Press.

Allwood, C. M. (1984). "Error Detection Process in Statistical Problem Solving." Cognitive Science 8(4): 413-437.

Alty, J. L., & Coombs, M.J. (1980a). "Face-to-face guidance of University Computer Users - I: A Study of Advisory Services." International Journal of Man-Machine Studies 12: 189-199.

Alty, J. L., & Coombs, M.J. (1980b). "Face-to-face Guidance of University Computer Users - II: Characterising Advisory Interactions." International Journal of Man-Machine Studies 12: 407-429.

Alty, J. L., & Coombs, M.J (1981). Communicating with Computer Users: A Case Study. Computing Skills and the User Interface. M. J. C. J. L. Alty. London, Academic Press.

Anderson, T. H., & Armbruster, B.B. (1985). Studying Strategies and their Implications for Textbook Design. Designing Usable Texts. R. W. T.M. Duffy. Orlando, Academic Press: 165-173.

Ashton, L. (1993). Help Yourself. Personal Computer World. **16**: 260-4.

Baeg, J. W., HiraHara, A., & Fukazawa, Y. (1995). "An Adaptive User Navigation Mechanism and its Evaluation." International Journal of Software Engineering and Knowledge Engineering **5**(4): 541-558.

Baggett, P. (1984). "Role of Temporal Overlap of Visual and Auditory Material in Forming Dual Media Associations." Journal of Educational Psychology **76**(3): 408-417.

Baggett, P. (1988). "The Role of Practice in Videodisc-Based Procedural Instructions." IEEE Transactions on Systems, Man, and Cybernetics **18**(4): 487-496.

Bagnara, S., Stablum, F., Rizzo, A., Fontana, A., & Ruo, M. (1987). Error Detection and Correction: A Study on Human Computer Interaction in a Hot Strip Mill Planning and Production System. First European Meeting on Cognitive Engineering Approaches to Process Control, Marcoussis, France.

Bannon, L. J. (1988). Helping Users Help each other. Text, ConText, and Hypertext: Writing with and for the Computer. E. Barrett, MIT Press.

Barker, R. T., & Biers, D.W. (1994). Software Usability Testing: Do User Self-Consciousness and the Laboratory Environment Make Any Difference? Proceedings of the Human Factors & Ergonomics Society 38th Annual Meeting, Nashville, ACM Press.

Barnard, P. J., Hammond, N.V., Maclean, A. & Morton, J. (1982). Learning & Remembering Interactive Commands. Cambridge, MRC Applied Psychology Unit, Cambridge University.

Barrett, J., Williams, M., Goodwins, R., & Raouf, A. (1998). Dialogue Boxes. PC Magazine. 7: 172-188.

Baxter, I., & Oatley, K. (1991). "Measuring the learnability of Spreadsheets in inexperienced users and those with previous spreadsheet experience." Behaviour and Information Technology 10(6): 257-266.

Bloomfield, H., & Johnson, P. (1993). Towards Cognitively Salient Relations for Hypertext Navigation. People & Computers VIII: Proceedings of HCI '93, Cambridge University Press, Cambridge.

Borenstein, N. S. (1985). Design and Evaluation of On-line Help Systems. Computer Science Department. Pittsburg, Pennsylvania, Carnegie Mellon University.

Bovair, S., & Kieras, D.E. (1991). Toward a Model of Acquiring Procedures for Text. Handbook of Reading Research. R. Barr, Kamil, M.L., Monsenthal, P.B., & Pearson, P.D. White Plains, New York, Longman. II: 206-229.

Bradford, J. D. M., W.D.; & Carey, T.T. (1990). What Kind of Errors do UNIX Users Make? IFIP TC 3 Third International Conference on Human Computer Interaction, Cambridge, UK.

Briggs, K. C., & Myers, I.B. (1983). Myers-Briggs Type Indicator. Palo Alto, CA, Consulting Psychologist Press, Inc.

Briggs, P. (1988). "What we know and what we need to know: the user model versus the users' model in Human Computer Interaction." Behaviour & Information Technology 7: 431-442.

Briggs, P. (1990). "Do they know what they are doing? An evaluation of word processors users' implicit and explicit task relevant knowledge, and its role in self-directed learning." International Journal of Man-Machine Studies 32: 385-398.

Brockmann, R. J. (1990). Writing Better Computer User Documentation: From Paper to Hypertext. New York, John Willey & Sons.

Buchan, A. (1994). "Have you looked in the Manual?" Management Services 38(3): 8-10.

Card, S. K., Moran, J.P., & Newell A. (1983). The Psychology of Human Computer Interaction. Hillsdale, N.J., Erlbaum.

Carlson, P. A. (1989). Hypertext and Intelligent Interfaces for Text Retrieval. Text, Context, and HyperText: Writing with and for the Computer. E. Barrette: 59-76.

Carroll, J. M., & Mack, R.L. (1984). Learning to use a wordprocessor. Human Factors in Computer Systems. C. C. S. Thomas, M. Norwood, Ablex Publishing.

Carroll, J. M., & Rosson, M.B. (1987). Paradox of the Active User. Interfacing Thought: Cognitive Aspects of Human-Computer Interaction. J. M. Carroll, Bradford Books/MIT Press: 80-111.

Carroll, J. M., & Aaronson, A. (1988). "Learning By Doing with Simulated Intelligent Help." Communications of the ACM **31**(9): 1064-1079.

Chin, J. P. (1996). Personality Trait Attributions to Voice Mail User Interfaces. Proceeding of CHI '96: Conference on Human Factors in Computing Systems, Vancouver, BC Canada, ACM Press.

Cohill, A. M., & Williges, R.C. (1982). Computer Augmented Retrieval of HELP Information for Novice Users. Proceedings of Human Factors Society, Twenty-Sixth Annual Meeting.

Cohill, A. M., & Willigews, R.C. (1985). "Retreival of Help Information for Novice Users of Interactive Computer Systems." Human Factors **27**: 335-344.

Cook, L. A., Heibert, S.P. & Wilson, M.R. (1996). "A Media-Rich On-line Help System." HP Journal **47**(2): 38-49.

Corrigan, D., & Kennard, R. (1997). "Computer-Mediated Learning Systems: A New Perspective." Computing and Control Journal **8**(3): 100-106.

Coventry, L. M. (1991). Helping UNIX Users: An Assessment of the Effectiveness of Various Forms of On-line Help. Computer Science Department. Sterling, Sterling University.

Creed, A., Dennis, I., & Newstead, S. (1988). "Effects of Display Format on Proof-Reading on VDUs." Behaviour & Information Technology **7**(4): 467-478.

Czaja, S. J., Hammond, K., Blascovich, J.J., & Swede, H. (1986). "Learning to Use Word Processing System as a Function of Training Strategy." Behaviour & Information Technology **5**: 203-216.

DeHaemer, M. J. (1991). Vulcans, Klingons and Humans: The Relevance of Individual Differences for Information Systems Interfaces. SIGPR '91: Proceedings of the ACM SIGPR Conference on Management of Information Systems Personnel, ACM Press.

DeVries, G. J., G.I. (1997). "Spoken Help for a Car Stereo: An Exploratory Study." Behaviour & Information Technology 16(2): 79-87.

Dillon, A. W., C. (1996). "User Analysis in HCI - the Historical Lessons from Individual Differences research." International Journal of Man-Machine Studies 45(4(?)): 619-637.

Dix, A., Finlay, J., Abowd G., & Beale, R. (1993). Human Computer Interaction, Prentice Hall.

Dixon, P. (1987). "The Processing of Organisational and Component Step Information in Written Directions." Journal of Memory and Languages 26(1): 24-35.

Dixon, P., Feries, J. & Gabrys, G. (1988). "The Role of Explicit Action Statements in Understanding and Using Written Directions." Journal of Memory and Languages 27(6): 649-667.

Dodge, M., Kinata, C., Stinson, C. (1995). Running Microsoft Excel for Windows 95. Washington, Microsoft Press.

Dormann, C. (1996). "Designing On-line Animated Help for Multimedia Applications." Lecture Notes In Computer Science 1977: 73-84.

Draper, S. W. (1984). The Nature of Expertise in UNIX. INTERACT '84: First IFIP Conference on Human-Computer Interaction, Elsevier Science Publishers.

Dunsmore, H. E. (1980). Designing an Interactive Facility for Non-programmers. Proceedings of the ACM National Computer Conference, ACM Press.

d'Ydewalle, G. L., J., & Van Rensbergen J. (1995). "Graphical Versus Character-based Word Processors: An Analysis of User Performance." Behaviour & Information Technology **14**(4): 208-214.

Egan, D. E., & Gomez, L.M. (1985). Assaying, Isolating and Accommodating Individual Differences in Learning a Complex Skill. Individual Differences in Cognition. R. F. Dillon. Orlando, FL, Academic Press. **II**: 174-217.

Elkerton, J., & Williges, R.C. (1984). The Effectiveness of a Performance-Based Assistant in an Information Retrieval Environment. Proceedings of the Human Factors Society 28th Annual Meeting, Santa Monica, CA, Human Factors Society Press.

Elkerton, J. (1988). On-line Aiding for Human-Computer Interfaces. Handbook of Human Computer Interaction. M. Helander, Elsevier: 345-364.

Emdad, A. (1989). Relationships between On-line Help Systems and Print Documentation: An Empirical Investigation. Proceedings of the Conference of Special Interest Group on Documentation, ACM, ACM.

Emdad, A. (1991). "An Empirical Investigation of the Effectiveness of Software Documentation Delivery Systems." Journal of Systems Software: 129-134.

Enca-naCao, L. M. (1995). "Adaptability in Graphical User Interfaces." Computers & Graphics **19**(6): 873-884.

Fall, A., & Mineau, G (1999). "Knowledge Retrieval, Use and Storage for Efficiency." Computational Intelligence **15**(1): 1-10.

Fischer, G., Lemke, A., & Schwab, T. (1985). Knowledge-Based Help Systems. Proceedings of CHI '85 Conference on Human Factors in Computing Systems, San Francisco, ACM Press.

Fisher, J. (1991). "Defining the Novice User." Behaviour & Information Technology **10**(5): 437-441.

Foulis, P. R. (1997). "The Use and Creation of Windows Help Files in the Laboratory." Laboratory Medicine **28**(3): 197-202.

Fowler, C. J. H., & Murray, D. (1987). Gender and Cognitive Style Differences at the Human-Computer Interface. INTERACT '87 - Second IFIP Conference on Human-Computer Interaction, Elsevier Science Publishers.

Frokjer, M. H. a. E. (1996). "Browsing and Querying in On-line Documentation: A Study of User Interfaces and the Interaction Process." ACM Transactions on Human-Computer Interaction **3**(2): 136-161.

Furnas, T. K., Landauer, L.M. Gomez, and S.T. Dumais (1987). The Vocabulary Problem in Human-System Communication. Communications of the ACM. **30**: 964-971.

Gomez, L. M., Egan, D.E, & Bowers, C. (1986). "Learning to Use a Text Editor: Some Learner Characteristics that Predict Success." Human Computer Interaction **2**: 1-23.

Goodall, S. D. (1991). On-line Help in The Real World. ACM's Ninth International Conference on System Documentation, ACM Press.

Gould, J., & Grischkowsky, N. (1984). "Doing the same Work with Hardcopy and with Cathode Ray Tube (CRT) Terminals." Human Factors **26**: 323-337.

Gould, J., Alfaro, L., Barnes, V., Finn, R., Grischkowsky, N., & Minuto, A. (1987a). "Reading is Slower from CRT Displays than from Paper: Attempts to Isolate a Single-Variable Explanation." Human Factors **29**(3): 269-299.

Gould, J., Alfaro, L., Finn, R., Haupt, B., & Minuto, A. (1987b). "Reading from CRT can be as Fast as Reading from Paper." Human Factors **29**(5): 497-517.

Grant, A., Homo-quintadus (1990). "Computers and ROOMS (Repetitive Ocular Orthopedic Motion Stress)." Optometry & Vision Science **67**(4): 297-305.

Greene, S. L., Devlin, S.J., Cannata, P.E., & Gomez, L.M. (1990). "No IFs, ANDs or ORs: A Study of Database Querying." International Journal of Man-Machine Studies **32**: 303-326.

Grice, R. A. (1989). On-line Information; What Do People Want? What Do People Need? Text, ConText, and HyperText: Writing with and for the Computer. E. Barrett: 22-44.

Hansen, W. J., & Haas, C. (1988). Reading and Writing with Computers: A Framework for Explaining Differences in Performance. Communications of the ACM. **31**: 1080-1089.

Harris, R. A., & Hosier, W.J. (1991). "A Taxonomy of On-line Information." Technical Communication **38**(2): 197-210.

Harrison, S. M. (1995). A Comparison of Still, Animated, or Nonillustrated On-Line Help with Written or Spoken Instructions in a Graphical User Interface. Proceeding of CHI '95: Human Factors in Computing Systems, Denver, ACM Press.

Heise, D. R. (1970). The Semantic Differential and Attitude Research. Attitude Measurement. G. F. Summers. Chigago, Rand McNally: 235-253.

Hertzum, M., & Frokjaer, E. (1996). "Browsing & Querying in On-line Documentation: A Study of User Interfaces and the Interaction Process." ACM Transactions on Computer Human Interaction **3**(2): 136-161.

Hicks, J. O., Hicks, S.A., & Sen, T.K. (1991). "Learning Spreadsheets: Human Instruction Vs Computer-Based Instruction." Behaviour & Information technology **10**(6): 491-500.

Horton, W. (1993). "Let's Do Away With Manuals Before They Do Away With Us." Journal of the Society Of Technical Communications **40**(1): 26-34.

Horton, W. K. (1990). Designing and Writing On-line Documentation: Help Files to Hypertext. New York, John Willey & Sons.

Houghton, R. C. (1984). "On-line Help Systems: A Conspectus." Communications of the ACM **27**: 126-133.

Jeffries, R., Miller, J.R., Wharton, C., & Uyeda, K.M. (1992). User Interface Evaluation in the Real World: A Comparison of Four Techniques. In Proceedings of the ACM Conference on Human Factors in Computing Systems, New Orleans, L.A., ACM Press.

Jerrams-Smith, J. (1987). "An Expert System within a Supportive Interface for UNIX." Behaviour & Information Technology **6**: 37-41.

Jerrams-Smith, J. (1989). "AN Attempt to Incorporate Expertise about Users into an Intelligent Interface for UNIX." International Journal of Man-Machine Studies **31**: 269-292.

Kearsley, G. (1988). On-line Help Systems: Design and Implementation. Norwood, NJ, Ablex Publishing.

Keister, R. S. (1989). The Content of Help Screens: Users Versus Developers. Proceedings of the Human Factors Society 33rd Annual Meeting, Denver.

Kieras, D. E., & Polson P.G. (1985). "An Approach to the Formal Analysis of User Complexity." International Journal of Man-Machine Studies **22**: 365-394.

Kiesler, S., Kraut, R., Lundmark, V., Scherlis, W., & Mukopadhyay (1997). Usability, Help Desk Calls, and Residential Internet Usage. Proceedings of CHI '97: Human Factors In Computing Systems, Atlanta, GA, ACM Press.

Kloster, A. M., & Winne, P.H. (1989). "The Effects of Different Types of Organisers on Student's Learning From Text." Journal of Educational Psychology **81**: 9-15.

Lamberti, D. M., & DeHaemer, M.J. (1990). Methodological Issues in Intelligent Interfaces for Expert Systems. Advances in Expert Systems and Artificial Intelligence for Management. W. Grabowski. New York, JAI Press. I.

Lansdale, M. W., & Ormerod, T.C (1994). Understanding Interfaces: A Handbook of Human Computer Dialogue, Academic Press.

LeFevre, J. A., & Dixon, P. (1986). "Do Written Instructions Need Examples?" Cognition and Instruction **3**(1): 1-30.

M., G. (1985). The Use of Logging Data in the Design of a New Text Editor. In Proceedings of the ACM Conference on Human Factors in Computing Systems, ACM Press.

Maclean, A., Carter, K., Loustrand, L., & Moran, T. (1990). User-Tailorable Systems: Pressing the Issues with Buttons. Proceedings of ACM SIGCHI Conference: Human Factors in Computing Systems, ACM Press.

Maes, A., Goutier, S., & Erik-Jan van der Linden (1992). On-line Reading and Offline Tradition: Adapting On-line Help Facilities to Offline Reading Strategies. ACM SIGDOC '92, ACM Press.

Magers, C. S. (1983). An Experimental Evaluation of On-line Help for Non-programmers. Proceedings of the ACM SIGCHI Conference: Human Factors in Computing Systems, ACM Press.

Mallen, C. (1996). "Designing Intelligent Help for Information Processing Systems." International Journal of Man-Machine Studies 45(3): 349-377.

Mason, M. V., & Thomas, R.C. (1984). "Experimental Adaptive Interface." Information Technology: Research Development Applications 3(3): 162-167.

Massey, D. S. H. a. D. G. (1989). Hypertext in Context. Text, ConText and HyperText: Writing with and for the Computer. E. Barrett: 45-58.

Mayer, R. E., & Anderson, R.B. (1991). "Animations Need Narrations: An Experimental Test of Dual-Coding Hypothesis." Journal of Educational Psychology 83(4): 484-490.

Mayhew, D. J. (1992). Principles and Guidelines in Software Interface Design. London, Englewood Cliffs, Prentice-Hall.

McKendree, J., & Carroll, J.M. (1986). Advising Roles of a Computer Consultant. Proceedings of ACM SIGCHI Conference: Human Factors in Computing Systems, ACM Press.

Nass, C., Moon, Y., Fogg, B.J., Reeves, B., & Dryer, C. (1995). Can Computer Personalities be Human Personalities? CHI '95 Conference Companion, ACM Press.

Nickerson, R. S. (1981). "Why Interactive Computer Systems are Sometimes not Used by People Who Might Benefit from Them." International Journal of Man-Machine Studies **15**: 469-483.

Nielsen, J., & Molich, R. (1990). Heuristic Evaluation of User Interfaces. In Proceedings of CHI'90 Empowering People, New York, ACM Press.

Nielsen, J., & Mack, R. (1994). Usability Inspection Methods. New York, John Wiley & Sons.

Osborne, D. J., & Holton, D. (1988). "Reading from Screen Versus Paper: There is no Difference." International Journal of Man-Machine Studies **28**: 1-9.

O'Hara, K., & Sellen, A. (1997). A Comparison of Reading Paper and On-line Documents. Proceedings of CHI '97: Human Factors on Computing Systems, Atlanta, GA, ACM Press.

Olson, J. R., & Olson, G.M. (1990). "The Growth of Cognition in Human Computer Interaction Since GOMS." Human Computer Interaction **5**: 221-266.

Oppermann, R., & Reiterer, H. (1997). "Software Evaluation Using The 9241 Evaluator." Behaviour & Information Technology **16**(4): 232-245.

Osgood, C. E., Tannenbaum, P.H. & Suci, J.G. (1957). The Measurement of Meaning. Urbana, University of Illinois Press.

Palmiter, S., Elkerton, J., & Baggett, P. (1991). "Animated Demonstrations versus Written Instructions for Learning Procedural Tasks: A Preliminary Investigation." International Journal of Man-Machine Studies **34**: 687-701.

Palmiter, S., & Elkerton, J. (1991). An Evaluation of Animated Demonstrations for Learning Computer-Based Tasks. Proceedings of CHI '91: Human Factors in Computing Systems, New Orleans, LA, ACM Press.

Panko, R. R., & Halverson, R.P.,Jnr. (1994). Individual & Group Spreadsheet Design: Patterns of Errors. Proceedings of the Twenty-Seventh Hawaii Intrnation Conference on System Sciences, Maui, Hawaii.

Panko, R. R., & Sprague, R.H., Jnr., (1996). Hitting The Wall: Errors in Developing and Code-Inspecting a 'Simple' Spreadsheet Model. Honolulu, Hawaii, University of Hawaii.

Panko, R. R., & Halverson, R.P., Jnr. (1996). Spreadsheet on Trial: A Framework for Research on Spreadsheet Risks. Proceedings of the Twenty-Seventh Hawaii International Conference on System Sciences, Maui, Hawaii.

Panko, R. R., & Halverson, R.P., Jnr. (1997). "Are Two Heads Better Than One (At Reducing Errors in Spreadsheet Modelling?)." Office Systems Research Journal **15**(1): 21-32.

Panko, R. R., & Sprague, R.H., Jnr., (1997). Experiments in Spreadsheet Development: Task Difficulty, Level of Expertise, and Error Rate. Honolulu, Hawaii, University of Hawaii.

Panko, R. R. (1998). What We Know About Spreadsheet Errors. Honolulu, University of Hawaii.

Payne, J. W. (1980). Information Processing Theory: Some Concepts and Methods Applied to Decision Research. Cognitive Processes in Choice and Decision Behaviour. T. Wallsten. Hillsdale, NJ, Lawrence Erlbaum Associates: 95-115.

Payne, S. J., & Green, T.R.G. (1986). "Task Action Grammar: A Model for Mental Representation of Task Languages." Human Computer Interaction **2**: 93-133.

Pollack, M. E. (1985). Information Sought and Information Provided: An Empirical Study of User/Expert Dialogues. Proceedings of ACM SIGCHI Conference: Human Factors in Computing Systems, ACM Press.

Polson, P. G. (1987). A Quantitative Theory of Human Computer Interaction. Interfacing Thought: Cognitive Aspects of Human Computer Interaction. J. M. Carroll. Cambridge, M.A., Bradford Books/MIT Press.

Potosnak, K. M. (1984). Choice of Interface Modes by Empirical Groupings on Computer Users. INTERACT '84: First IFIP Conference on Human-Computer Interaction, Elsevier Science Publishers.

Preece, J. (1993). A Guide to Usability - Human Factors in Computing, Addison Wesley.

Relles, N. (1979). The Design and Implementation of User-Oriented Systems. Madison, Department of Computer Sciences, University of Wisconsin.

Relles, N., & Price, L.A. (1981). A User Interface for On-line Assistance. Proceedings of the 5th International Conference on Software Engineering, Silver Spring, IEEE.

Rieber, L. P. (1989). "The Effects of Computer Animated Elaboration Strategies and Practice on Factual and Application Learning in an Elementary Science Lesson." Journal of Educational Computing Research **5**(4): 431-444.

Rieber, L. P. (1991). "Animation, Incidental Learning, and Continuing Motivation." Journal of Educational Psychology **83**(3): 318-328.

Rieman, J. (1996). "A Field Study of Exploratory Learning Strategies." ACM Transactions on Computer-Human Interaction 3(3): 189-218.

Roesler, A. W., & Mclellan, S.G. (1995). What Help Do Users Need?: Taxonomies for On-Line Information Needs & Access Methods. CHI '95 Proceedings: Human factors in Computing Systems, Denver, ACM Press.

Ross, E. H. (1987). Findings in Measuring the Usage of On-line Documentation. Proceedings of the Human Factors Society - 31st Annual Meeting.

Rubens, B. K. (1988). Similarities and Differences in Developing Effective On-line and Hardcopy Tutorials. Effective Documentation: What we have learnt from Research. Doheny-Farina. Cambridge, Massachusetts, MIT Press: 159-184.

Ryan, C. (1992). Usefulness of On-line Help to Novice Users in a Supportive Learning Environment. OZCHI '92: Proceedings of the Australian CHISIG Annual Conference on Human Computer Interaction.

Shackel, B. (1986). Ergonomics in Design for Usability. People & Computers: Designing for Usability. M. D. Harrison, & Monk, A.F. Cambridge, Cambridge University Press.

Shneider, M. L., & Thomas, J.C. (1983). "The Humanization of Computer Interfaces." Communications of the ACM 26(4).

Shneiderman, B. (1976). "Exploratory Experiments in Programmer Behaviour." International Journal of Computer and Information Sciences 5(2): 123-143.

Shneiderman, B. (1978). "Improving the Human Factors Aspects of Database Interactions." ACM Transactions on Database Systems 3(4): 417-439.

Shneiderman, B. (1983). "Direct Manipulation: A Step beyond Programming Languages." IEEE Computetr **16**(8): 57-69.

Shneiderman, B. (1998). Designing the User Interface: Strategies for Effective Human Computer Interaction. Reading, Massachussets, Addison-Wesley.

Smith, D. (1994). "Developing On-line Application Help." HP Journal **45**(2): 90-95.

Sondheimer, N. K., & Relles, N. (1982). "Human Factors and User Assistance in Interactive Computing Systems: An Introduction." IEEE Transactions on Systems, Man & Cybernetics **12**(2): 102-107.

Spangenberg, R. W. (1973). "The Motion Variable in Procedural Learning." Audio Visual Communication Review **21**(4): 419-436.

Stone, D. E., & Glock, M.D. (1981). "How Do Young Adults Read Directions With and Without Pictures?" Journal of Educational Psychology **73**(3): 419-426.

Sudwarts, J. (1989). Between the Sheets. MacUser. **44**: 47-56.

Teo, T. S. H., & Tan, M. (1997). Quantitative & Qualitative Errors in Spreadsheet Development. Proceedings of the Thirtieth Hawaii Internation Conference On System Sciences, Maui, Hawaii.

Thies, M. A. (1994). "Adaptive User Interfaces." IFIP Transactions A - Computer Science & Technology **52**: 196-202.

Valauskas, E. J. (1996(?)). "Creating an On-line Help System." On-line **18**(2): 86-87.

Van Der Veer, G. C., Tauer, M.J., Waren, Y, & Muylwuk, B.V. (1985). "On the Interaction Between System and User Characteristics." Behaviour & Information Technology 4: 289-308.

Vincente, K. J., Hayes, B.C., & Williges, R.C. (1987). "Assaying and Isolating Individual Differences in Searching a Hierarchical File System." Human Factors 29: 349-359.

White, F. (1994). "An Evaluation of On-line Help for the NOTIS OPAC." Library Software Review 13(1): 4-17.

Wiedenbeck, S., Patti, L.Z., and McConnell, D.S. (1995). End-User Training: An Empirical Study Comparing On-line Practice Methods. CHI '95 Proceedings: Human Factors in Computing Systems, Denver, ACM Press.

Wilson, M. R., Cook, L.A., & Hieber, S.P. (1994). "A Fast and Intuitive On-line Help System." HP Journal 45(2): 79-89.

Woods, D. D. (1984). Some Results on Operator Performance in Emergency Events. Institute of Chemical Engineers Symposium Series.

Wright, P., & Lickorish, A. (1983). "Proof-Reading Texts on Screen and Paper." Behaviour & Information Technology 2(3): 227-235.

Yoder, C. M. (1986). An Expert System for Providing On-line Information Based Upon Knowledge of Individual User Characteristics. Depart of Computer Science. Syracuse, Syracuse University.

Young, R. M., Green, T.R.G., & Simon, T. (1989). Programmable User Models for Predictive Evaluation of Interface Designs. Proceedings of the ACM Conference on Human Factors in Computing Systems, Seattle, W.A., ACM Press.

Zmud, R. W. (1979). "Individual Difference and MIS Success: A Review of the Empirical Literature." Measurement Sciences **25**(10): 966-979.

APPENDIX A: INITIAL SURVEY QUESTIONNAIRE

USABILITY OF ONLINE DOCUMENTATION

The aim of this survey is to investigate the usability of On-line Documentation of Applications commonly used by users. Feel free to answer these questions, and make comments where necessary. Thank you for accepting to participate.

1. Your Organisation: _____
2. Department/Section: _____

3. Which of the following best describes your responsibility within the organisation?

- Administrative
- Secretarial
- Academic (Teaching & Research)
- Student (College, University - Undergraduate, Postgraduate)
- Technical Staff
- Support Staff
- Other (please specify) _____

4. Which of the following categories of applications are you familiar with and how can you rate yourself on the following scales?:

- | | Expert | Intermediate | Beginner | Novice |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Word Processing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Spreadsheet | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Database Management | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Other (specified above) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

5. Do you sometimes use the On-line help system any of these applications?

- | | Often | Sometimes | Rarely | Never |
|---|--------------------------|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Word Processing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Spreadsheet | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Database Management | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Other (please specify) _____ | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

6. How useful are the On-line help systems?

- | | Very Useful | Useful | Occasionally | Not Useful |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Word Processing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Spreadsheet | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Database Management | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Other (specified above) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

7. For those applications you don't use their On-line help systems (if any), what are the reasons for your not using them?

8. What sort of queries do you find On-line help systems useful for?

9. What sort of queries do you find On-line help systems unhelpful for?

10. What do you consider to be the best aspects of the On-line help systems of your applications?

11. What do you consider to be the worst aspects of the On-line help systems of your applications?

12. Are there parts of the help system you find confusing or difficult to fully understand?

- Yes
- No

13. If yes, which are they?

14. Are there parts of the help system you find very irritating?

- Yes
- No

15. If yes, which are they?

16. What are the most common mistakes you often make when using the On-line help systems?

17. Did you previously use User Manuals to answer queries?

- Yes
- No

18. Which of the two do you find more effective: On-line Help Systems or User Manuals?

- On-line Help Systems
- User Manuals

19. Give reasons for your response in 22 above:

20. What additional comments/suggestions you would like to give as to how the systems can be improved?

21. Would you be interested in taking part in an experimentation that would include practical sessions with Microsoft Excel?

- Likely
- Not likely

22. If your answer to question 21 is to the affirmative, kindly fill in your name and contact address below:

Name: _____
Address: _____
e-mail address (if any): _____

Once again, thank you for your time. Please forward the completed questionnaire to the address below:

U.G. Abdullahi
Computer Studies Department
Loughborough University
Loughborough, Leics. LE11 3TU
e-mail: U.G.Abdullahi@lboro.ac.uk.

APPENDIX B: ONLINE HELP EXPERIMENT TASKS

MS EXCEL EXPERIMENT USING ONLINE HELP

Introduction

The Aim of this experiment is to find out how useful the On-line help system of MS Excel is to users. It is divided into two parts, the first part involves having a hands-on practice with MS Excel, and the other involves answering some questions in a questionnaire. In the course of the practice session, you are expected to invoke the On-line help facility, if there is need, to find out about how to perform a certain task or carry out a function. However if you are stuck after trying the help, please ask.

Practice Session

This practice session deals with a particular aspect of Excel - Using Excel as a Database. It is hoped that you will find the session useful, and know a few more aspects of Excel.

1. Excel can store data on a worksheet as a list. As an instance, a list can be a listing of countries and certain statistics relating to each country. Here is a subset of a large list called "original countries' file", which will be used in one of the experiments.

Code	CONTRY	REGION	GDP(B)	Population(M)	GNP
C01	Algeria	Africa	£42.00	27.4	£1,650.00
C02	Argentina	Latin America	£281.00	34.2	£8,110.00
C03	Australia	Asia	£332.00	17.8	£18,000.00
C04	Austria	Western Europe	£196.00	8	£24,630.00
C05	Belgium	Western Europe	£227.00	10.1	£22,870.00
C06	Brazil	Latin America	£554.00	159.1	£2,970.00
C07	Bulgria	Cent. & East. Europe	£10.00	8.4	£1,250.00
C08	Canada	North America	£542.00	29.2	£19,510.00
C09	Chile	Latin America	£51.00	14	£3,520.00
C10	China	Asia	£522.00	1190.9	£530.00
C11	Colombia	Latin America	£67.00	36.3	£1,670.00
C12	Cote d'Ivoire	Africa	£7.00	13.8	£610.00
C13	Czech Rep.	Cent. & East. Europe	£36.00	10.3	£3,200.00

The above is regarded as a list, and you do not have to do anything special to it to make it a database. When performing most database tasks - such as finding,

sorting, or subtotalling data, Excel automatically recognises your list as a database.

First of all, load the file named "ORIGINAL COUNTRIES' FILE".

- Use the data contained in this file to:
 - Sort the data in ascending order of regions.
 - Add subtotals of population of each region and the grand total of population to the data.
 - copy the resulting data to a new workbook
 - Put a double-line border round the table, and a single line cell border. Colour the text of the headings red and make the heading background blue, and colour the remaining background yellow. The resulting table should look like:

C01	Algeria	Africa	42	27.4	1650
C12	Cote d'Ivoire	Africa	7	13.8	610
C15	Egypt	Africa	43	56.8	720
C19	Ghana	Africa	5	16.6	410
C31	Kenya	Africa	7	26	250
C36	Morocco	Africa	31	26.4	1140
C39	Nigeria	Africa	35	108	280
C50	South Africa	Africa	122	40.5	3040
C57	Tunisia	Africa	16	8.8	1790
C63	Zambia	Africa	3	9.2	350
C64	Zimbabwe	Africa	5	10.8	500
		Africa Total		344.3	
C03	Australia	Asia	332	17.8	18000
C10	China	Asia	522	1190.9	530
C21	Hong Kong	Asia	131	6.1	21650
C24	India	Asia	293	913.6	320
C25	Indonesia	Asia	174	190.4	880
C30	Japan	Asia	4591	125	34630
C34	Malaysia	Asia	70	19.7	3480
C38	New Zealand	Asia	51	3.5	13350
C41	Pakistan	Asia	52	126.3	430
C43	Philippines	Asia	64	67	950
C49	Singapore	Asia	69	2.9	22500
C51	South Korea	Asia	376	44.5	8260
C55	Taiwan	Asia	241	21	11600
C56	Thailand	Asia	143	58	2410
		Asia Total		2786.7	
C22	Hungry	Cent. & East. Europe	41	10.3	3840

C44	Poland	Cent. & East. Europe	93	38.5	2410
C46	Romania	Cent. & East. Europe	30	22.7	1270
C47	Russia	Cent. & East. Europe	377	148.3	2650
		Cent. & East. Europe Total		238.5	

- Add titles at the top and bottom of the resulting table, to appear on each page when printed, such as

Population Distribution By Region

C01	Algeria	Africa	42	27.4	1650
C12	Cote d'Ivoire	Africa	7	13.8	610
C15	Egypt	Africa	43	56.8	720
C19	Ghana	Africa	5	16.6	410
C31	Kenya	Africa	7	26	250
C36	Morocco	Africa	31	26.4	1140
C39	Nigeria	Africa	35	108	280
C50	South Africa	Africa	122	40.5	3040
C57	Tunisia	Africa	16	8.8	1790
C63	Zambia	Africa	3	9.2	350
C64	Zimbabwe	Africa	5	10.8	500
		Africa Total		344.3	

Population Distribution Page 1 of 4

- Make the first row to appear on every printed page
- Change the paper orientation from portrait to landscape
- Save the workbook as
“REGIONAL POPULATION DISTRIBUTION”
- close this file.
- Use the previously sorted data to
 - Remove the subtotals from the data
 - Filter out the data for countries whose GDP is less than 6 billion pounds. You should now have a list of all countries with GDP greater than or equal to 6 billion pounds.
 - Copy the filtered data to a new workbook
 - Format the resulting data using text styles and colours.
 - Add appropriate titles to the table as done above.
 - Use print preview to view the data and when satisfied with the settings, save it as

“ COUNTRIES WITH GDP GREATER THAN £6B ”

- Close this file.
- Use the previous file again to
 - Bring back the data filtered out in the previous exercise
 - Select those countries whose population is greater than or equal to 1 million, (AND exports greater than 10 units AND services greater than 40 units).
 - Copy the resulting data to a new workbook
 - Format the resulting data using text styles and colours.
 - Add appropriate titles to the table as done above
 - Save the file as
- **“POPULATION GREATER THAN SIX MILLION”**
 - Close this file.
- Close the “ORIGINAL COUNTIRES’ FILE” file without saving changes to it.

2. You can also use Excel to analyse a database file created using any of the major Dbase applications. This is what you are expected to do in the following exercise.

- Import all the fields of the file named **company.dbf**, a Dbase file, from the floppy disk into a new workbook.
 - Reformat the **ACCT_DATE** column to dd-mmm-yy format (e.g. 01-May-97), the **PTAX_PROFIT** and **SALES/EMPL** to the currency format, with two places of decimal.
 - Add another column at the end of the data and call it **TOTAL_SALES**. Compute the values of this column by multiplying the **NO_OF_EMPS** column with the **SALES/EMPL** column.
 - Add two more columns called **TAX_RATE** and **TAX_PAID**.
 - Assuming that the tax paid by each company is 10% of its total sales, compute the tax paid by each company. Use the **absolute** reference for the tax rate and **relative** reference for the total sales in this calculation.
 - Copy and paste the data onto itself, but paste only values.
 - Sort the data in ascending order of company names.
 - Filter out those companies that reported their performances before 1st May, 1995, and whose pre-tax profit is less than 6 million pounds.
 - Copy the filtered data to a new workbook, put a boarder round the table, colour the headings blue and the remaining green.
 - Add appropriate titles as done above.
 - Save the file as
- **“LOCAL COMPANIES’ PERFORMANCE”**
 - Close the file.
- Close the imported file.

3. Another way of analysing a list (as a database) in Excel is to create a report interactively using the **Pivot Table** - an interactive worksheet table that quickly summarises large amounts of data using a format, and calculation methods you choose. It provides an easy way for displaying and analysing summary information about an already created data.

- Use the Pivot Table Wizard to create a summary report, using an external data source (stored in a file called **county.dbf**). The report should be on the performance of the towns in terms of employment figures per quarter.
- Format the resulting report by selecting the appropriate formats
- Add appropriate titles to the report as done above
- save the file as

“C:EMPLOYMENTS PER QUARTER.XLS”

4. **XYZ** Company sells Computers, Word Processors, Printers, Scanners, Modems, Stationary and Software. It has sales representatives called **John, Adam, Mark, Helen, Scott, Smith and Mike**, each selling a particular item - John sells **Computers**, Adam **Word Processors**, Mark **Printers**, and so on. They report their sales weekly, a person per day.

- Your task is to simulate their performance last year (1996) by generating the data automatically for each day of the week and for the whole year, by
- defining the following columns:

Date	Product	Sales_Person	Gross_Cost	Net_Cost	Profit
-------------	----------------	---------------------	-------------------	-----------------	---------------

- Fill the date column automatically with days of the year starting from 01-Jan-96 and end with 31-Dec-96.
- Use the custom lists created (already in the system) to fill both the Product and Sales_Person columns
- Use the random number generator function and the truncation function to generate the Gross_Cost and the Net_Cost columns.

NOTE:

The random number generator of Excel generates numbers between 0 and 1. To make your numbers larger, multiply the generated number by 1000 and 500 for the Gross_Cost and the Net_Cost respectively. Use the Truncation function to remove the fractional part of the numbers.

- Calculate the Profit reported each day by subtracting Net_Cost from Gross_Cost.
- The resulting data should look like:

DATE	PRODUCT	SALES_PERSON	GROSS_COST	NET_COST	PROFIT
01-Jan-96	Computers	John	£149.00	£49.00	£100.00
02-Jan-96	Word Processors	Adam	£638.00	£82.00	£556.00
03-Jan-96	Printers	Mark	£408.00	£28.00	£380.00
04-Jan-96	Scanners	Helen	£951.00	£39.00	£912.00
05-Jan-96	Modems	Scott	£860.00	£94.00	£766.00
06-Jan-96	Stationary	Smith	£929.00	£50.00	£879.00
07-Jan-96	Software	Mike	£929.00	£14.00	£915.00
08-Jan-96	Computers	John	£790.00	£89.00	£701.00
09-Jan-96	Word Processors	Adam	£438.00	£17.00	£421.00
10-Jan-96	Printers	Mark	£491.00	£72.00	£419.00
11-Jan-96	Scanners	Helen	£680.00	£13.00	£667.00
12-Jan-96	Modems	Scott	£955.00	£37.00	£918.00
13-Jan-96	Stationary	Smith	£330.00	£94.00	£236.00
14-Jan-96	Software	Mike	£833.00	£79.00	£754.00
15-Jan-96	Computers	John	£765.00	£17.00	£748.00
16-Jan-96	Word Processors	Adam	£86.00	£52.00	£34.00
17-Jan-96	Printers	Mark	£313.00	£9.00	£304.00
18-Jan-96	Scanners	Helen	£298.00	£51.00	£247.00
19-Jan-96	Modems	Scott	£348.00	£21.00	£327.00
20-Jan-96	Stationary	Smith	£720.00	£36.00	£684.00
21-Jan-96	Software	Mike	£157.00	£26.00	£131.00
22-Jan-96	Computers	John	£959.00	£62.00	£897.00
23-Jan-96	Word Processors	Adam	£370.00	£79.00	£291.00
24-Jan-96	Printers	Mark	£418.00	£38.00	£380.00
25-Jan-96	Scanners	Helen	£610.00	£33.00	£577.00
26-Jan-96	Modems	Scott	£244.00	£8.00	£236.00
27-Jan-96	Stationary	Smith	£500.00	£79.00	£421.00
28-Jan-96	Software	Mike	£774.00	£91.00	£683.00
29-Jan-96	Computers	John	£21.00	£1.00	£20.00

- Copy the entire data on the worksheet and paste it onto itself, but paste only the values.
- Filter out the data of those who recorded negative profit
- Copy the filtered data to another sheet.
- Use the filtered data to answer the following questions:
 - Sort the data by Sales Person
 - Add subtotals of the profits realised by each Sales Person and the Grand Total of the profits to the data.
 - collapse the details of Helen, Mark and Scott, leaving only their totals.
 - Copy the result to a new workbook
 - Format and save it as
“PROFIT REALISED BY XYZ”.
 - Close this file to return to the filtered data
- Remove the subtotals from the data
- Create a summary report of the monthly profits realised by each Sales Person, using the Pivot Table - put the result on a new workbook.
- Format save this into a file called
“SALES PERSON’S PROFITS”

APPENDIX C:
ONLINE HELP EXPERIMENT QUESTIONNAIRE

QUESTIONNAIRE

You are expected to fill in the questionnaire after completion of the experiment. However, you may wish to complete it while performing the experiment. Kindly answer all the questions and make comments where necessary.

1. How long have you been using Microsoft Excel?

- Less than a year
- 1 - 3 years
- More than 3 years

2. Generally, Computer users can be categorised into the following:

Novice: Can use very basic elements of the package. Often has to seek help with anything slightly away from his experience. May have used the package intermittently for some time, or for more continuous usage for few weeks (or may have recently come off a first course).

Intermediate: Confident with straightforward usage. Occasionally extends experience without help. Does not use advanced features. Probably used the package for some time. Uses it routinely. Might help a novice.

Expert: Uses the package to his own advantage. Either knows advanced features or can usually pick them up when required without help. Advises others.

Note that time alone is not a good measure.

Based on the above categorisation, which of these best describes you with respect to Microsoft Excel?

- Expert
- Intermediate
- Novice

3. Have you done some similar tasks as those in the experiment before?

- | | Yes | No | Partly |
|---------------------------------------|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Question 1 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 2 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 3 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 4 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

4. How did you find the four questions in the experiment?

	Easy	Fairly Easy	Difficult	Very Difficult	Couldn't do it
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. In the course of the experiment, did you use the On-line help system of Excel?

	No	A little	Frequently	Extensively
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. If any of your answers to question 5 is yes, how useful was the On-line help to your needs?

	Very Useful	Useful	Occasionally Useful	Not Useful
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. Generally, do you sometimes use the On-line help system of Excel?

- Yes
- No

8. Which versions of Excel have you used to date?

- Version 2.0
- Version 3.0
- Version 4.0
- Version 5.0
- Version 7 for Office '95
- Version 8 for Office 97

9. How can you relate the improvements in the On-line help systems of these versions to your needs?

	Very Useful	Useful	Occasionally Useful	Not Useful
• <input type="checkbox"/> Version 3.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Version 4.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Version 5.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Version 7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Version 8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10. What sort of queries do you find the On-line help system useful for?

11. What sort of queries do you find the On-line help system unhelpful for?

12. What do you consider to be the best aspects of the On-line help system of Excel?

13. What do you consider to be the worst aspects of the On-line help system of Excel?

14. In the experiment, were there parts of the On-line help system you found confusing or difficult to fully understand?

- Yes
- No

15. If yes, which were they?

16. Were there parts On-line help system you found very irritating?

- Yes
- No

17. If yes, which were they?

18. What are the most common mistakes you often make when using the On-line help system of Excel?

19. Did you previously use the User Manuals of Excel to answer queries?

- Yes
- No

20. Would you have preferred having the Excel Manual for this experiment than the On-line Help System?

- Yes
- No
- Both

21. What action do you normally take when you are stuck while using Excel? (please tick only one)

- Consult the manual
- Repeat the steps just taken
- Consult an expert
- Use the On-line Help facility
- Other (please specify) _____

22. Is this method of problem rectification usually fruitful?

- | | Always | Sometimes | Rarely |
|--|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Consulting the manual | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Repeating the steps just taken | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Consulting an expert | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Using the On-line Help facility | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Other (specified above) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

23. What do you do next when your preferred method(s) of impasse resolution fails?

- Consult the manual
- Repeat the steps just taken again
- Consult an expert
- Try out other things
- Use the On-line Help facility
- Take a break
- Abandon the task
- Other (please specify) _____

24. In General, which of the two do you find more effective: the On-line Help System or the User Manuals?

- On-line Help System
- User Manuals

25. Give reasons for your response in 24 above:

26. What additional comments/suggestions you would like to give as to how the systems can be improved?

27. Kindly indicate your agreement/disagreement with the following statements:

- The On-line Help System helps in learning how to use the application
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The On-line Help System is only helpful to those familiar with the application
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- It is usually easy to find the help you are looking for using the On-line Help System
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The Explanations given by the On-line Help System are usually easy to follow and understand
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The examples illustrated in the help system are always sufficient
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The On-line Help System is not as useful as it should be
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The On-line Help System is useless in terms of error correction
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- One gets distracted from his task while using the On-line Help System
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree

25. Would you be interested in taking part in a further experiment?

- Likely
- Not likely

Once again, thank you for your time and we hope that you found the sessions useful.

APPENDIX D: USER MANUAL QUESTIONNAIRE

QUESTIONNAIRE

You are expected to fill in the questionnaire after completion of the experiment. However, you may wish to complete it while performing the experiment. Kindly answer all the questions and make comments where necessary.

1. How long have you been using Microsoft Excel?

- Less than a year
- 1 - 3 years
- More than 3 years

2. Generally, Computer users can be categorised into the following:

Novice: Can use very basic elements of the package. Often has to seek help with anything slightly away from his experience. May have used the package intermittently for some time, or for more continuous usage for few weeks (or may have recently come off a first course).

Intermediate: Confident with straightforward usage. Occasionally extends experience without help. Does not use advanced features. Probably used the package for some time. Uses it routinely. Might help a novice.

Expert: Uses the package to his own advantage. Either knows advanced features or can usually pick them up when required without help. Advises others.

Note that time alone is not a good measure.

Based on the above categorisation, which of these best describes you with respect to Microsoft Excel?

- Expert
- Intermediate
- Novice

3. Have you done some similar tasks as those in the experiment before?

- | | Yes | No | Partly |
|---------------------------------------|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Question 1 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 2 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 3 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 4 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

4. How did you find the four questions in the experiment?

	Easy	Fairly Easy	Difficult	Very Difficult	Couldn't do it
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. In the course of the experiment, did you use the 'User Manual' of Excel?

	No	A little	Frequently	Extensively
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. If any of your answers to question 5 is yes, how useful was it to your needs?

	Very Useful	Useful	Occasionally Useful	Not Useful
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. Generally, do you sometimes use the User Manual of Excel?

- Yes
- No

8. Which versions of Excel have you used to date?

- Version 2.0
- Version 3.0
- Version 4.0
- Version 5.0
- Version 7 for Office '95
- Version 8 for Office 97

9. What sort of queries do you find the User Manual useful for?

10. What sort of queries do you find the User Manual unhelpful for?

11. What do you consider to be the best aspects of the User Manual of Excel?

12. What do you consider to be the worst aspects of the User Manual of Excel?

13. Did you previously use the On-line Help System of Excel to answer queries?

- Yes
- No

14. Would you have preferred having the On-line Help for this experiment than the User Manual?

- Yes
- No
- Both

15. What action do you normally take when you are stuck while using Excel?
(please tick only one)

- Consult the manual
- Repeat the steps just taken
- Consult an expert
- Use the On-line Help facility
- Other (please specify) _____

16. Is this method of problem rectification usually fruitful?

- | | Always | Sometimes | Rarely |
|--|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Consulting the manual | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Repeating the steps just taken | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Consulting an expert | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Using the On-line Help facility | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Other (specified above) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

17. What do you do next when your preferred method(s) of impasse resolution fails?

- Consult the manual
- Repeat the steps just taken again
- Consult an expert
- Try out other things

- Use the On-line Help facility
- Take a break
- Abandon the task
- Other (please specify) _____

18. In General, which of the two do you find more effective: the On-line Help System or the User Manuals?

- On-line Help System
- User Manuals

19. Give reasons for your response in 24 above:

20. What additional comments/suggestions you would like to give as to how the systems can be improved?

24. Kindly indicate your agreement/disagreement with the following statements, based on your previous experiences with Excel's On-line Help System:

- The On-line Help System helps in learning how to use the application
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The On-line Help System is only helpful to those familiar with the application
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- It is usually easy to find the help you are looking for using the On-line Help System
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The Explanations given by the On-line Help System are usually easy to follow and understand
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The examples illustrated in the help system are always sufficient
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The On-line Help System is not as useful as it should be
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The On-line Help System is useless in terms of error correction

Strongly Agree Agree Partially Agree Disagree Strongly Disagree

- One gets distracted from his task while using the On-line Help System

Strongly Agree Agree Partially Agree Disagree Strongly Disagree

25. Would you be interested in taking part in a further experiment?

- Likely
- Not likely

Once again, thank you for your time and we hope that you found the sessions useful.

APPENDIX E:
INTEGRATED BASED HELP SYSTEM QUESTIONNAIRE

QUESTIONNAIRE

You are expected to fill in the questionnaire after completion of the experiment. However, you may wish to complete it while performing the experiment. Kindly answer all the questions and make comments where necessary.

1. How long have you been using Microsoft Excel?

- Less than a year
- 1 - 3 years
- More than 3 years

2. Generally, Computer users can be categorised into the following:

Novice: Can use very basic elements of the package. Often has to seek help with anything slightly away from his experience. May have used the package intermittently for some time, or for more continuous usage for few weeks (or may have recently come off a first course).

Intermediate: Confident with straightforward usage. Occasionally extends experience without help. Does not use advanced features. Probably used the package for some time. Uses it routinely. Might help a novice.

Expert: Uses the package to his own advantage. Either knows advanced features or can usually pick them up when required without help. Advises others.

Note that time alone is not a good measure.

Based on the above categorisation, which of these best describes you with respect to Microsoft Excel?

- Expert
- Intermediate
- Novice

3. Have you done some similar tasks as those in the experiment before?

- | | Yes | No | Partly |
|---------------------------------------|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Question 1 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 2 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 3 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Question 4 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

4. How did you find the four questions in the experiment?

	Easy	Fairly Easy	Difficult	Very Difficult	Couldn't do it
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. In the course of the experiment, did you use the 'Integrated Base Help System'?

	No	A little	Frequently	Extensively
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. If any of your answers to question 5 is yes, how useful was it to your needs?

	Very Useful	Useful	Occasionally Useful	Not Useful
• <input type="checkbox"/> Question 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
• <input type="checkbox"/> Question 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. Generally, do you sometimes use the On-line Help System of Excel?

- Yes
- No

8. Which versions of Excel have you used to date?

- Version 2.0
- Version 3.0
- Version 4.0
- Version 5.0
- Version 7 for Office '95
- Version 8 for Office 97

9. What sort of queries do you find the Integrated Base Help System useful for?

10. What sort of queries do you find the Integrated Base Help System unhelpful for?

11. What do you consider to be the best aspects of the Integrated Base Help System?

12. What do you consider to be the worst aspects of the Integrated Base Help System?

13. Did you previously use the On-line Help System of Excel to answer queries?

- Yes
- No

14. Would you have preferred having the current On-line Help System of Excel or the User Manual for this experiment than the Integrated Base Help System?

- Current On-line Help System of Excel
- User Manual of Excel
- No

15. What action do you normally take when you are stuck while using Excel? (please tick only one)

- Consult the manual
- Repeat the steps just taken
- Consult an expert
- Use the On-line Help facility
- Other (please specify) _____

16. Is this method of problem rectification usually fruitful?

- | | Always | Sometimes | Rarely |
|--|--------------------------|--------------------------|--------------------------|
| • <input type="checkbox"/> Consulting the manual | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Repeating the steps just taken | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Consulting an expert | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Using the On-line Help facility | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| • <input type="checkbox"/> Other (specified above) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

17. What do you do next when your preferred method(s) of impasse resolution fails?

- Consult the manual
- Repeat the steps just taken again

- Consult an expert
- Try out other things
- Use the On-line Help facility
- Take a break
- Abandon the task
- Other (please specify) _____

18. In General, how can you relate improvements in both access mechanisms and the content of the Integrated Base Help System with the current On-line Help System of Excel, based on your previous experience?

- Very Useful
- Useful
- Occasionally Useful
- Not Useful

19. Give reasons for your response in 24 above:

20. What additional comments/suggestions you would like to give as to how the Integrated Base Help system can be improved?

21. Kindly indicate your agreement/disagreement with the following statements, based on your previous experience with Excel's On-line Help System:

- The On-line Help System helps in learning how to use the application
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The On-line Help System is only helpful to those familiar with the application
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- It is usually easy to find the help you are looking for using the On-line Help System
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The Explanations given by the On-line Help System are usually easy to follow and understand
 Strongly Agree Agree Partially Agree Disagree Strongly Disagree
- The examples illustrated in the help system are always sufficient

Strongly Agree Agree Partially Agree Disagree Strongly Disagree

- The On-line Help System is not as useful as it should be

Strongly Agree Agree Partially Agree Disagree Strongly Disagree

- The On-line Help System is useless in terms of error correction

Strongly Agree Agree Partially Agree Disagree Strongly Disagree

- One gets distracted from his task while using the On-line Help System

Strongly Agree Agree Partially Agree Disagree Strongly Disagree

22. Would you be interested in taking part in a further experiment?

- Likely
- Not likely

Once again, thank you for your time and we hope that you found the sessions useful.

APPENDIX F:
PUBLISHED PAPER:

How Useful is On-line Help?: An Observational Study.

Usman G. Abdullahi & James L. Alty

LUTCHI Research Centre, Dept. of Computer Studies,

Loughborough University, Loughborough, UK

Email: {u.g.abdullahi & j.l.alty}@lboro.ac.uk

(Proceedings of OZCHI98, Calder, P and Thomas, B. (eds), IEEE Computer Society, California, Australia, 1998, pp 94-105, ISBN 0-8186-9206-5.)

Keywords.

Ontology, Hypertext, On-line Help, User Manuals, Expert, Intermediate, Novice.

Abstract

This paper reports results from on-going research into the usefulness of On-line Help Systems for application software users. The results are based on an empirical study conducted with a group of computer users who are professionals in their own areas, with variable experience in the applications examined. The study reveals that even experienced users find some aspects of existing On-line Help Systems difficult to use, and that, in general current versions are not well received. We identify three problems with On-line help - Ontology, Compartmentalisation, and the lack of an Integrated Base, and suggest how these problems might be approached.

1. Introduction.

There is an increasing number of users with a limited computing experience who need easy-to-understand assistance. Current aids include, access to human experts, printed manuals and, more recently, interactive on-line help systems. Yet research (see Shneiderman[12]) has suggested that computer users, especially novice users still find information, about the application they are using, more quickly using printed documentation and/or

human experts, than from on-line help systems. In contrast, many application developers are now not even giving users the option of selecting between printed manuals or on-line help (that is, they assume that the on-line help system problems have been solved, Briggs[4]). This has prompted us to re-examine the situation.

We also wanted to include users with considerable experience (as well as novices) since many previous studies of help systems have concentrated upon novices alone. A further reason for using more experienced users and less novice/naïve users was the need to assess the efficacy of the systems in responding to task-related queries rather than their usefulness as tools for learning about the applications.

2. A Survey of On-line Help System Usage.

We initially conducted a survey among a group of computer users (who are professionals in their own fields) ranging from departmental secretaries to professors, many of whom have had considerable experience in using certain computer applications (Word Processing, Spreadsheets and Databases). We wished to determine if these users considered that current on-line help systems now served as effective substitutes for user manuals.

Users were asked to fill a questionnaire that was designed to determine their familiarity with the software applications and use of the applications' interactive on-line help system, the usefulness of

interactive on-line help systems in general and their effectiveness in comparison with user manuals. The survey was not intended to be exhaustive, rather, it was carried out to determine if there still was a perceived problem with current on-line help systems.

3. Results of the Survey.

In classifying users of an application package, time used is not always a good measure (see Fisher[9]). Thus users were asked to classify themselves as Expert, Intermediates or Novice Users according to the following criteria:

Novice Users: Can use very basic elements of the package. Often seek help with any task slightly away from their experience. May have used the package intermittently, or for more continuous usage for a few weeks (may have recently finished a first course).

Intermediate Users: Are confident with straightforward usage. Occasionally extend their experience without help. Do not use advanced features. Routine use for some time. Might help a Novice.

Expert Users: Use the package to their own advantage. Either knows most advanced features or can pick them up when required without help. Expert users advise both Novices and Intermediates.

250 questionnaires were sent to staff at various levels in the University who had undergone organised training on the use of these applications. There were 80 replies in total. All 80 respondents were familiar with, and currently used, Word Processing software, 73 (91%) were familiar with Spreadsheet software, while 63 (79%) were familiar with Database Management software. Figure 1 shows the user population distribution across application packages. Users were also asked about their usage of the on-line help systems of the three software applications. A summary of the results is given in Table 1.

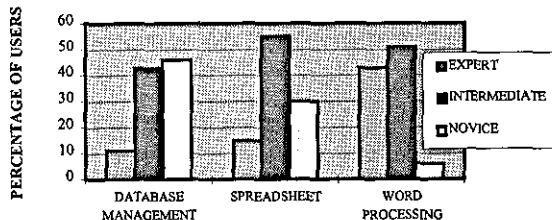


Figure 1 Subjects by Level of Expertise

Table 1 Use of on-line help

SOFTWARE	Often %	Sometimes %	Rarely %	Never %
WORD PROCESSOR	10	41	41	8
SPREADSHEET	8	43	38	11
DATABASE	8	33	37	22
Overall	9	39	39	14

Overall, over half the respondents in the survey either had never used, or rarely used the on-line help system though all of them knew of its existence. For Word Processing, all users had accessed on-line-help at some time, but this did not seem to encourage regular use. It is possible that the distribution simply reflects the usability of the package, in other words, if a package is easy to use, then users will not often need to use the on-line help facility. However, with such a different distribution of experience with the three packages, one would not expect such a uniform response.

To probe whether users might not use on-line help because it was not needed rather than because it did not provide the assistance they required, we checked the users' opinion of on-line help services in the three packages. They were asked if they found the service Very Useful, Useful, Marginal (Occasionally Useful) or Not Useful. The overall result is shown in Figure 2.

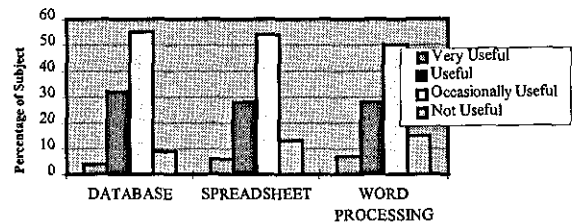


Figure 2 Usefulness of on-line help across applications

Whilst on-line help was found to be useful in some cases (over all three applications 7% found it Very Useful, and 28% Useful), this still leave a massive 65% not sure of its value. If on-line help is the only source of help (as current plans strongly indicate), users are not going to be satisfied with this lack of effectiveness.

The similarities in the distributions across all packages indicate that the response has more to do with a common problem in using On-line Help systems rather than that for a particular package or

user level. In other words there does seem to be a general problem in current on-line help provision.

The responses above are from a mix of users. It is possible that the on-line help system might be better suited to Experienced Users than to Novices. We therefore divided the sample into two groups - Expert/Intermediate and Novice users, and counted those who found the systems supportive (i.e. Very Useful or Useful) compared with the rest (Occasionally Useful or Not Useful). The results are in Table 3.

Table 3 Degree of Supportiveness of On-line Help and Actual Use, with Experience

	Supportiveness		Actual Usage		
	Supportive	Unhelpful	Often	Sometimes	Rarely/Never
Experts + Intermediates	36%	64%	7%	45%	48%
Novices	29%	71%	3%	39%	58%

Comments from users in the survey indicated that whilst Experts blamed the system for failing to provide proper assistance, the Intermediates and the Novices often blamed themselves for the lack of usefulness of on-line help systems. Experienced users get more out of on-line-help because they are more familiar with the syntax and the semantics of the applications, making it easier for them to formulate meaningful queries which can be recognised by the system (see Elkerton[8]). However, Even the Experts found on-line help unresponsive by a ratio of 2:1.

This is observation is similar to that of Roesler and McLellan [11], who found that only 32% of the help requests from users could be answered or found in the on-line help of the application studied. Another reason for the similarity in responses from the three applications is that all applications used Microsoft on-line help systems which have been built using the same principles.

4. Comparison with User Manuals.

84% of the total population were familiar with, and had used manuals, in answering queries. These users were asked to rate the effectiveness of user manuals and on-line help systems in solving problems. The results are shown in Table 4. Each of these responses was backed by a series of reasons as to why that choice had been made. The clear preference for user manuals is interesting since many users in the past have also criticised user manuals as being unhelpful (See Alty & Coombs[1],[2]). The result is also in agreement with

Table 4 Degree of Effectiveness of Manual compared to On-line Help

Manuals	On-line Help	Both
75%	18%	7%

that of Corrigan and Kennard [6], as well as O'Hara and Sellen [10].

The other important difference noted between on-line help and user manuals was ontological. Often users posed queries to the on-line help system to which it gave a blank or unintelligible reply and it can take many attempts before a successful hit is made. Although this happens with user manuals as well (such as no entry in the index), the user is able to browse through the manual pages and often finds (or stumbles upon) a suitable match to the query. On-line help information is not usually organised in this way, since it cannot easily be browsed.

Subjects gave several reasons why they preferred user manuals. User manuals were more descriptive, more technical, and offered detailed examples. User manuals gave clear and detailed explanations of concepts, they were easier to scan through, had no restricted pattern of response, and were more procedural. Subjects also pointed out that user manuals did not compete with the application for screen area in contrast to on-line help.

5. A More Detailed Experiment.

We then carried out a more detailed experiment, taking videos of users whilst using on-line help, in the Spreadsheet application. Most of the subjects that participated were postgraduate research students from various departments of Loughborough University who had considerable experience in using Microsoft Excel. The objective of the experiment was to examine in more detail ways in which these users accessed Microsoft Excel's on-line help facility.

5.1. Experimental Setting.

A Pentium 166 system was used (16MB RAM, 1.2GB Hard Disk,). DeltaScan Pro, Computer-to-Video Conversion Equipment (resolution of 1600x1200) was used to capture user screen activity and transmit video signals to a Panasonic Multi-System video cassette recorder. A Shure Mixer was used for capturing the verbal exchanges.

The software chosen was Microsoft Excel for Office 95 (version 7.0) because Excel is the most common spreadsheet application within the University, where the largest number of proposed subjects reside.

Twelve subjects participated in the experiment, ten of whom were Postgraduate Research Students and two were Technical Staff at Loughborough University. Users were asked to classify themselves as Experts, Intermediates and Novices using the criteria set out in section 3. The resultant distribution was 2 Experts, 8 Intermediates and 2 Novices.

Each subject was briefed on the purpose of the experiment and was told what they should do if, at any time during the experiment, they did not know how to proceed. They were asked to use the On-line Help systems to sort out queries or misunderstandings, but that if after doing this they remained confused, they were to seek help from the experimenter. They were also asked to seek the help of the experimenter at any time if they did not understand the goals of the task.

5.1.2. Task.

A set of tasks was constructed to test users' understanding of both basic and advanced concepts in spreadsheets. These tasks involved using Excel as a Database Management Application. This set of tasks were chosen because, during the survey reported in the preceding sections, it became clear that only few of the Spreadsheet users were aware of the fact that they could use it as a Database Management Application and were thus more likely to seek help.

The tasks required answers to four questions, each question being divided into a set of sub-tasks. Early sub-tasks had samples of the output expected to enable subjects to fully understand what was required. The experimenter discussed any concept that seemed unclear to the subjects thus ensuring that subjects fully understood what was required of them.

A scoring scheme was designed to enable the experimenter to assign scores to the tasks carried out. Each sub-task in a question had a maximum mark (between 1 and 4) allocated to it. The mark represented the number of different operations in the task. Thus carrying out a SORT operation requires two operations, whilst putting a double border round cells, or changing the paper orientation, is one operation. Importing a Dbase file, on the other hand, is more difficult requiring 4 operations. The tasks and the scores assigned are shown in Table 6.

Table 6 Scores Allocated to Sub-Tasks

	TASK	SCORE
1 (a)	Sort data in ascending order of regions.	2
(b)	Add subtotals of population to the data.	2
(c)	Copying resulting data to new workbook	2
(d)	Put a double-line boarder round the table.	1
(e)	Colour the headings and the background	2
(f)	Adding titles to the table,	2
(g)	changing paper orientation	1
(h)	Removing the subtotals from the data	1
(i)	Filtering out the required data	2
(j)	Copying filtered data to new workbook	2
(k)	Formatting the resulting data	2
(l)	Adding titles to the data	2
(m)	modifying page set-up	1
(n)	Filtering the required data	2
(o)	Copying resulting data to new workbook	1
(p)	Formatting the resulting data	2
(q)	Adding titles to the data	1
2 (a)	Importing the Dbase file	4
(b)	Reformatting the three columns	3
(c)	Adding the TOTAL SALES column	1
(d)	Computing the values of the added col	2
(e)	Adding TAX RATE & TAX PAID cols	2
(f)	Computing tax paid by each company	4
(g)	Copying and pasting the values of sheet	3
(h)	Sorting the data appropriately	1
(i)	Filtering the required data	1
(j)	Copying filtered data to new workbook	1
(k)	Putting a boarder round the table	1
(l)	Formatting the table	2
(m)	Adding titles to the table	1
3 (a)	Invoking the Pivot Table Wizard	1
(b)	Defining the Data	3
(c)	Using appropriate data values	2
(d)	Formatting the report	1
(e)	Adding a title to the report	1
4 (a)	Defining the appropriate columns	1
(b)	Fill the date column	2
(c)	Fill Product and SALES PERSON cols	2
(d)	Generate Gross Cost and Net Cost	4
(e)	Calculating the Profit column	3
(f)	Copying and pasting the data onto itself	3
(g)	Filtering out negative profit	2
(h)	Copying the filtered data to another sheet.	1
(i)	Sorting the data by Sales Person	1
(j)	Adding subtotals	1
(k)	Collapse details of Helen, Mark & Scott	3
(l)	Copying the result to a new workbook	1
(m)	Formatting the table	2
(n)	Removing the subtotals	1
(o)	Creating report using the pivot table	4

Some tasks were repeated several times, to see the effect of the on-line help information on learning. Tasks repeated were - sorting, filtering, formatting in general, and using the pivot table. We

recorded if a user sought help, or not, on a particular task.

5.1.6. Task Completion Questionnaire.

Each subject completed a questionnaire at the end of the experiment, designed to determine the subject's view on:

- the ease/difficulty of the experiment
- their use of the On-line help system of Excel
- level of use of On-line Help during the experiment
- their satisfaction/dissatisfaction with the answers they got from the On-line Help
- general questions regarding On-line Help

6. Results of the Second Study.

6.1. Seeking Help.

Table 8 Use of On-line Help by Task Difficulty and User

Sub Task Level	Novice	Intermediate	Expert
1	60%	4%	0%
2	77%	19%	9%
3	100%	100%	75%
4	100%	94%	75%

All subjects used the On-line Help system at one stage or the other during the experiment. Some were able to get the needed help on-line easily for certain sub-tasks, while others had to scan through several screens of information before they accessed what they required. Yet again, others had considerable difficulty and had to be assisted by the experimenter. Table 8 shows the percentage of those who sought On-line Help on a particular task, by level of expertise.

This table increases our confidence in the task ratings and the user classifications. As expected help is sought more by novices than experts, and increasingly by all classes as the tasks gets harder.

On-line Help provides four ways in which to access information - Contents, Find, an Index and A Help Wizard. No clear guidance is given as to which to use in what situation. Contents (or Help Topics) provides a top-down approach (often ending with the Help Wizard). In Find, the user supplies a word and a set of topics are presented. The Index allows the user to scan the words in the help system, and the Answer Wizard takes the user through a worked example.

6.2. Examples of User Activity When Accessing on-line Help.

Because of space limitations, out of many examples from the study, two will be given in this paper. One example of an exercise which caused no difficulty was SORTing. Those who had to access On-line Help for assistance had no difficulty in solving their problem. In addition, all other sorting exercises were done without further help, so users learned rapidly. The On-line help for SORT is usable because there is no ontological problem (SORT is understood by subjects, is in the question itself, and is in the help menu). Secondly, the help information is unidirectional and fans out to a number of clear answers.

6.2.1. Import a Dbase File Using Microsoft Query.

All the subjects had difficulties here. Access to the On-line Help system was high. Using On-line Help, most of the experienced subjects were able to eventually solve the problem. However, the inexperienced users had to request assistance.

6.2.1.1. An Example: A Novice User. The Novice User read the task and immediately tried to access On-line Help "Help Topics" was initially selected from the Help Menu. Several options were displayed. The topic the user thought was closest to his need was "Creating, Opening, and Saving Documents". Selection provided the following options:

- Creating and Opening Documents
- Saving and Closing Documents
- Finding Files
- Using Find Fast
- Previewing Documents and their properties.

The only item which has relevance is the first, so the user selected this and received the following:

- Create a New Workbook
- Open Workbooks when Microsoft Excel Starts
- Specify or Change your User Name
- Open a Document
- Display or Hide the Recently Used Documents on the File Menu
- The Favorites Folder and the My Documents Folder

None looked promising. So the user tried "Find".

- Import a Microsoft Excel File into Lotus
- Import a text file into Microsoft Excel
- Import a worksheet or a range of cells into Lotus Notes view

- Import Method
- Import Microsoft Access Data into Microsoft Excel
- Import worksheet data into a rich-text field in Lotus Notes form
- Importing Graphics
- Importing or converting files from another Office application.

Again, none seemed to satisfy the user's need so he used the "Index". He typed "Dbase file" and help responded with:

- dBASE
- dBASE file format
- dBASE Files
- dBASE
- accessing data with DAO
- initialising database driver

dBASE format yielded a highly technical screen so the user selected the second item which provided a detailed list of File Format Converters. The user did not select the two others because "they did not have the word *file* in them". The user appealed to the experimenter for help. The experimenter suggested he might try the Answer Wizard and, as a result he typed in "Import a dBASE file" received the following:

- How do I
- Retrieve data from lists and external databases with Microsoft Query
- Close Microsoft Query and return the results of a query to Microsoft Excel
- Tell me about
- retrieving data from external databases
- Databases you can access with Microsoft Query

The user selected the first topic which provided a screen with 7 action points. One had an active link to "data source". He followed this to a pop-up fact sheet. However, by this time fatigue was setting in and the user demanded. Ironically the user was close to the solution with the Wizard.

6.2.1.2. An Example: An Expert User. The Expert first selected "Retrieving and analysing data" from "Contents" and was given:

- Retrieving and Analysing Data
- Retrieving data
- Consolidating Data
- managing lists
- Analysing data with Pivot Tables
- Solving what-if problems
- Managing What-if sessions
- Analysing multiple variable problems
- Statistical analysis of data

Selection of the first item resulted in:

- Retrieving data from external sources
- Choosing between Microsoft Excel and Microsoft Query
- The difference between the Microsoft Query add-in and application
- Databases you can access with Microsoft Query
- Retrieve data from lists and external databases with Microsoft Query
- Specify a source to retrieve the data from

- Change the query definition with the result set
- Save the query definition with the result set
- Remove a query definition from a worksheet
- Copy data and the query definition to another worksheet
- Update Query results
- Creating macros to access lists and external data bases
- Close Microsoft Query and return to the results of a query to Microsoft Excel
- Troubleshoot problems with retrieving data from lists and external databases

The first option was selected Help responded with a Graphical illustration of the operation required containing three highlighted texts:

- Get data from external databases and tables
- Filter the data in Microsoft Query
- Return the data in Microsoft Excel for analysis

As a result the expert completed the task.

7. Analysis of Task Completion Questionnaire.

Most of the subjects had done similar tasks at one time or the other prior to the experiment. All subjects found exercises 1 and 2 to be "fairly easy". 66% (2 Experts / 6 Intermediates) found question 3 "fairly easy", 34% (2 Intermediates / 2 Novices) found it "difficult". In question 4, the opposite was the case 34% (2 Experts / 2 Intermediates) found it "fairly easy" while 66% (6 Intermediates / 2 Novices) found it "difficult". It was interesting to note that none found the whole exercise "extremely difficult". All the subjects accessed the On-line Help system. Some Novice users accessed it on almost every occasion. All users commented that the On-line Help system in Version 7 of Microsoft Office had been improved.

Subjects were asked whether they would have preferred the User Manual only, or the User Manual together with the On-line Help System for the experiment. All subjects said they preferred having both. The reasons given for wanting both were- "Ease of reading from paper rather than from the screen", "the problem of On-line Help information obscuring parts of the screen" and "having to scan through many screens".

The subjects were also asked to rate the On-line Help System and the User Manual in terms of overall effectiveness to query response, both in content and quality of the response. All the subjects said that the User Manual was more effective than the On-line Help System.

Table 9 Subjects Agreement with statements about On-line Help (N/Novice, In/Intermediate, E/Expert)

Statement	Agree		Disagree		
	St r o n g l y	Yes	In Part	Yes	Stron gly
The On-line Help System of Excel helps in learning how to use the application			1 In	2 N 7 In 2 E	
The On-line Help System is helpful only to those familiar with Excel		All (12)			
It is always easy to find the help you are looking for with the On-line Help System			1 N 1 In	1 N 7 In 2 E	
The explanations given in the Excel On-line Help are usually easy to follow and understand			1 E	2 N 8 In 1 E	
The examples given in the On-line Help System are always sufficient				All (12)	
The On-line Help System is not as useful as it should be		All (12)			
The On-line Help System is useless in terms of error correction		All (12)			
The On-line Help System distracts me from my work whenever I try to access it		2 N 7 In 1 E		1 E 1 In	

They were also asked to indicate their agreement or disagreement with certain statements about the On-line Help System of Excel (see table 9). Even with this relatively small sample (12), the message is clear. On-line Help systems have some way to go.

8. Using the Manual Alone.

We also observed a subject carrying out the same experiment using printed Information alone. We would have liked to use the Excel 'User Manual' as the reference material. However, Microsoft only include the 'Getting the Results with Microsoft Excel for Windows 95' manual in the shipment but they recommend the book 'Running Microsoft Excel for Windows 95' [7]. The subject therefore used this book as a reference.

8.1. Example of User Activity: Import dBASE File.

The same tasks were used in this experiment, as previously discussed in section 5. The user in this example, was an Intermediate user. In carrying out the above task, the user turned the index page and flipped through, and was able to find 'IMPORTING, 909-27...' and further down, he saw: 'dBASE files, 923-24'. He then turned to page 923. The following explanations were given:

IMPORTING AND EXPORTING .DBF FILES

Microsoft Excel can import .DBF from three versions of dBASE: dBASE II, dBASE III, and dBASE IV. Excel creates a list from the imported file, placing the dBASE field names in the first row as column headings. The dBASE records appear in rows immediately below the field names. Excel sets the worksheet column width to match the width of the corresponding dBASE fields.

Note that you can also use Microsoft Query to import information stored in .DBF files. When you use the Open command on the File menu to import a dBASE file, Excel imports the entire file, you can import only specific records or fields, or you can import the entire file.....

..... For more information about Microsoft Query, see Chapter 21,

He turned to Chapter 21 (page 757), and found a short index for the chapter. He scanned this (2 pages) and decided to examine "Installing the Microsoft Query Add-in" (on page 760). The first two lines of the section state

"You can access Microsoft Query from within Microsoft Excel in two ways: by choosing Get External Data command from Excel's Data Menu or by choosing the Pivot Table...." He immediately selected Get External Data on the Data Menu since he was not sure what a Pivot Table was. A menu appeared and the user then turned the page (763) and saw an identical menu on the page. He followed the section on "Adding Tables" reading the instructions and interacting with the screen. He was then able to complete the task without the assistance of the experimenter.

What we observe here is typical of users who are being assisted by written information. Firstly, although they use indexes to effect primary access, they then often exploit the sequential nature of written material, browsing until they find information which appears relevant. This technique often solves ontological problems because the user is able to discover terminology differences. The human browsing capability is superior to Hypertext links. Secondly, the fact that the book is in a separate place from the screen application is also exploited. Users appreciate the fact that the instructions do not clutter the screen, and that there is a clear separation between help source and application.

9. Discussion and Conclusion.

The results presented above show that the on-line help systems of the applications in the study are still lacking in many respects. For instance, many subjects indicated their dissatisfaction with the manner in which help information is given, that it is non-procedural, not concise and not specific, and that in many cases, irrelevant information is displayed. Others expressed their dissatisfaction with the inflexibility of the on-line help systems. Some felt that such systems assumed too much user knowledge. Many users acknowledged that they had frequently abandoned use of the facility because they had failed to get appropriate assistance and we observed this many times in the study. However, it is also fair to point out that almost all respondents acknowledged some good aspects of the on-line help systems of these applications, such as their rich indexes, search facilities, cue cards and the fact that they are accessed within the application. Users also noted that the most recent versions of on-line help were improvements on previous versions, indicating that the designers at Microsoft are improving their understanding of on-line help issues. Still, as Corrigan and Kennard puts it, 'for most people, despite modern technologies, the preferred presentation method is still the printed page' [6].

The results of our studies are in agreement with previous research in this area. For example, Cohill and Williges[5], in their study with 72 novice users of a text editor, and using various combinations of initiation, presentation and topic selection, found that control group with no on-line facilities achieved a minimum performance compared to the rest. The best performance was achieved by the user-initiated, user-selected and printed-manual group.

From our observations of users interacting with on-line help systems and using printed support, we can make some tentative suggestions as to why there are problems and what might be done to minimise them. Firstly, there is a problem of access - what we will call the *Ontological Problem*. Users (particularly Novices) cannot seem to find the right terms in which to express their problems to the system. Terminology, which seems perfectly acceptable to them, results in streams of unhelpful information. Microsoft have tried to attack this problem by offering four different ways into their system - "Topics", "Find", "Index" and Answer Wizards. *Topics* are top-down, *Find* identifies help information related to a word or set of words, *Index* is simply an index of words in the system and the *Answer Wizards* guide users through their queries often providing examples of use. However, the Ontological difficulty often occurs at the next step,

when the Help system offers a first line suggestion of possible topics. The example of the Novice User on the dBASE problem exemplifies this Ontological problem, but in our data there were many more examples.

The second problem is one of *Compartmentalisation*. Paths lead to single blocks of information, a long way down the Help tree, and Ontological problems, on the way down, only make things worse. Although some cross linking is provided, it often confuses. A high level of linkage can be very tiring and confusing particularly on a typical computer screen with its limited real estate. Limitations in Hypertext navigation are well-known, and the use of more salient relationships has been proposed[3].

The third problem is the lack of an *Integrated Base* of information. This is where the user manual, for all its faults, scores well. When users do not know what they want, they browse the manual seeking out relevant keywords which match their problem. This is almost certainly the basic problem in on-line help. The provision of such a base would enable users to get round the ontological problem by having access to a rich set of terms in context which they can process, skip, or reread until a suitable match is found. The idea is shown in figure 3. The corner stone of the on-line help system should be this Integrated Information Base. This is similar to a standard User Manual. It can be read from end to end, or browsed in any part. An Index points (as in a traditional manual) to occurrences of words and concepts in the base. As with the Microsoft approach, a Topics, top-down, approach is used to provide access to selected blocks of the Information Base, and

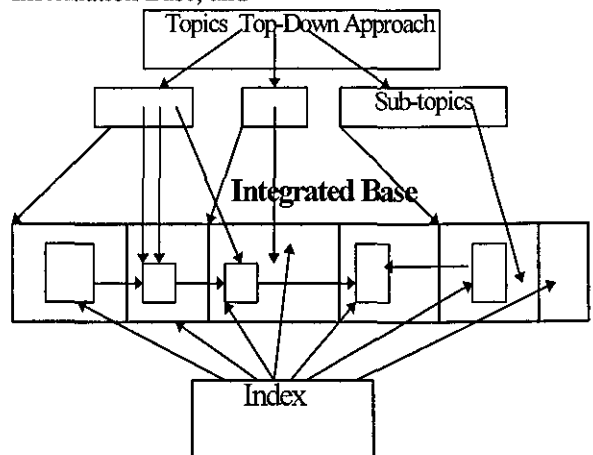


Figure 3 Using An Integrated Base Approach

hypertext links can be used to relate topics at this level. The user can, at any time convert from a topic-based view to an integrated base view, and vice versa. Traditional user manuals can provide the source for the Integrated Information Base.

Finally, the lessons learned from this study should contribute to the knowledge base use by designers to guide their development of on-line help systems, and ultimately help the end users of these systems.

The results obtained indicate that there is still more to be done on the design of the on-line Excel help system to make it compete with the user manuals. We intend to carry out more experiments and put our ideas on organisation of On-line Help material to the test.

10. Acknowledgements.

One author (UGA) wishes to record his appreciation to the Commonwealth Scholarship Commission for funding his PhD study. We wish to acknowledge the work of the designers of the on-line help systems at Microsoft. Our work is not meant in any way to denigrate their efforts. This is a very new area where the chances of failure are high, but considerable progress has already been made. Their systems have provided us with the basic test beds on which to carry out our research.

11. References.

- [1] Alty, J.L. & Coombs, M.J., (1980), Face-to-face guidance of University Computer Users - 1: A study of Advisory Services, *International Journal of Man-Machine Studies*, Vol. 12, pp. 189-199.
- [2] Alty, J.L. & Coombs, M.J., (1981), Communicating with Computer Users: A Case Study, in *Computing Skills and the User Interface*, M.J. Coombs & J.L. Alty (eds.), Academic Press, London.
- [3] Bloomfield, H., and Johnson, P., (1993), Towards cognitively salient relations for Hypertext navigation, in *People and Computers VIII, Proc. HCI'93*, (Alty, J.L., Diaper, D., and Guest, S.P., (eds.)), Cambridge Univ. Press, Cambridge, pp 463 - 478.
- [4] Briggs, P. (1990), Do they know what they are doing? An evaluation of word processor users' implicit and explicit task relevant knowledge, and its role in self-directed learning, *International Journal of Man-Machine Studies*, Vol. 32, pp. 385-398.
- [5] Cohill, A.M. and Williges, R.C. (1982), Computer-augmented retrieval of HELP information for Novice Users, *Proceedings of Human Factors Society - Twenty-sixth Annual Meeting*, pp. 19-82.
- [6] Corrigan, D. and Kennard, R. (1997), Computer-Mediated Learning Systems: A New Perspective, *Computing & Control*, Vol. 8, No. 3, pp. 100-106.
- [7] Dodge, M., Kinata, C., & Stinson, C. (1995), Running Microsoft Excel for Windows 95, The Cobb Group & Microsoft Press.
- [8] Elkerton, J. (1988), On-line Aiding for Human-Computer Interfaces in *Handbook of Human-Computer Interaction*, M. Helander (ed.), Elsevier.
- [9] Fisher, J. (1991), Defining The Novice User, *Behaviour and Info. Technology*, Vol. 10, No. 5, pp. 437-441.
- [10] O'Hara, K. and Sellen, A. A. (1997), Comparison of Reading Paper and On-line Documents *Proceedings of the Ninth International Conference on HCI*, pp. 335-342.
- [11] Roesler, A.W. and Mclellan, S.G. (1997), What Help Do Users Need?: Taxonomies for On-line Information Needs and Access Methods *Proceedings of the Seventh International Conference on Human Computer Interaction*, pp. 335-342
- [12] Shneiderman, B. (1998), *Designing the User Interface: Strategies for Effective Human Computer Interaction*, Addison-Wesley Publishing Company, Mass.

APPENDIX G:
TEST FOR STATISTICAL SIGNIFICANCE

G.1 Statistical Significance test for Chapter V.

Test for Homogeneity of Variances

Table G1 shows the results of Levene test. From the table, we can see that the Levene's statistics based on all the variables is sufficiently large ($\gg 0.05$). This means that we do not have enough evidence to suspect that the variances are unequal.

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Total Completion Time	1.535	2	19	.241
Help Search Time	2.908	2	19	.079
Exploration Time	.797	2	19	.465
Total Task Time	1.780	2	19	.196
Total Completed tasks	.748	2	19	.487
Total Access Number of Times Assisted By Experimenter	2.500	2	19	.109
	2.686	2	19	.094

Table G1: Levene's Test for Homogeneity of Variances

Test for Normality

Table G2 gives a summary of the results of the tests for the same variables as in Table G1. From the table, it will be seen that all the tests (Least Significant

Difference (LSD), Bonferroni and Dunnett) indicate that the data did not come from normal distribution.

However, the histogram shown in Figure G1 for each of the variables show a normal distribution. Based on this, we can assume that the data is from a reasonably normal distribution.

Similarly, the normal probability plot graphs shown in Figure G2, a straight line through the plots indicates that the data is from a normal distribution. Hence this further confirms our assumption that the data comes from a reasonably normal distribution.

Multiple Comparisons

LSD

Dependent Variable	(I) User Level	(J) User Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Total Completed tasks	Experts	Intermediates	7.93*	1.563	.000	4.66	11.21
		Novices	17.60*	1.857	.000	13.71	21.49
	Intermediates	Experts	-7.93*	1.563	.000	-11.21	-4.66
		Novices	9.67*	1.563	.000	6.39	12.94
	Novices	Experts	-17.60*	1.857	.000	-21.49	-13.71
		Intermediates	-9.67*	1.563	.000	-12.94	-6.39
Exploration Time	Experts	Intermediates	-52.50*	6.988	.000	-67.13	-37.87
		Novices	-76.40*	8.302	.000	-93.78	-59.02
	Intermediates	Experts	52.50*	6.988	.000	37.87	67.13
		Novices	-23.90*	6.988	.003	-38.53	-9.27
	Novices	Experts	76.40*	8.302	.000	59.02	93.78
		Intermediates	23.90*	6.988	.003	9.27	38.53
Help Search Time	Experts	Intermediates	-32.82*	10.232	.005	-54.23	-11.40
		Novices	-97.20*	12.158	.000	-122.65	-71.75
	Intermediates	Experts	32.82*	10.232	.005	11.40	54.23
		Novices	-64.38*	10.232	.000	-85.80	-42.97
	Novices	Experts	97.20*	12.158	.000	71.75	122.65
		Intermediates	64.38*	10.232	.000	42.97	85.80
Number of Times Assiste By Experimenter	Experts	Intermediates	-7.23*	1.543	.000	-10.46	-4.00
		Novices	-19.20*	1.833	.000	-23.04	-15.36
	Intermediates	Experts	7.23*	1.543	.000	4.00	10.46
		Novices	-11.97*	1.543	.000	-15.20	-8.74
	Novices	Experts	19.20*	1.833	.000	15.36	23.04
		Intermediates	11.97*	1.543	.000	8.74	15.20
Successful hits	Experts	Intermediates	-3.87*	1.686	.033	-7.40	-34
		Novices	-4.80*	2.004	.027	-8.99	-61
	Intermediates	Experts	3.87*	1.686	.033	.34	7.40
		Novices	-.93	1.686	.586	-4.46	2.60
	Novices	Experts	4.80*	2.004	.027	.61	8.99
		Intermediates	.93	1.686	.586	-2.60	4.46
Total Access	Experts	Intermediates	-8.95*	2.570	.002	-14.33	-3.57
		Novices	-25.20*	3.054	.000	-31.59	-18.81
	Intermediates	Experts	8.95*	2.570	.002	3.57	14.33
		Novices	-16.25*	2.570	.000	-21.63	-10.87
	Novices	Experts	25.20*	3.054	.000	18.81	31.59
		Intermediates	16.25*	2.570	.000	10.87	21.63
Total Task Time	Experts	Intermediates	-26.83*	7.812	.003	-43.18	-10.48
		Novices	-65.40*	9.283	.000	-84.83	-45.97
	Intermediates	Experts	26.83*	7.812	.003	10.48	43.18
		Novices	-38.57*	7.812	.000	-54.92	-22.22
	Novices	Experts	65.40*	9.283	.000	45.97	84.83
		Intermediates	38.57*	7.812	.000	22.22	54.92
Total Completion Time	Experts	Intermediates	-108.82*	10.881	.000	-131.59	-86.04
		Novices	-239.00*	12.928	.000	-266.06	-211.94
	Intermediates	Experts	108.82*	10.881	.000	86.04	131.59
		Novices	-130.18*	10.881	.000	-152.96	-107.41
	Novices	Experts	239.00*	12.928	.000	211.94	266.06
		Intermediates	130.18*	10.881	.000	107.41	152.96

*. The mean difference is significant at the .05 level.

Table G2a: The LSD Test for Normality of Data

Multiple Comparisons

Bonferroni

Dependent Variable	(I) User Level	(J) User Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Total Completed tasks	Experts	Intermediates	7.93*	1.563	.000	3.83	12.04
		Novices	17.60*	1.857	.000	12.72	22.48
	Intermediates	Experts	-7.93*	1.563	.000	-12.04	-3.83
		Novices	9.67*	1.563	.000	5.56	13.77
	Novices	Experts	-17.60*	1.857	.000	-22.48	-12.72
		Intermediates	-9.67*	1.563	.000	-13.77	-5.56
Exploration Time	Experts	Intermediates	-52.50*	6.988	.000	-70.84	-34.16
		Novices	-76.40*	8.302	.000	-98.19	-54.61
	Intermediates	Experts	52.50*	6.988	.000	34.16	70.84
		Novices	-23.90*	6.988	.009	-42.24	-5.56
	Novices	Experts	76.40*	8.302	.000	54.61	98.19
		Intermediates	23.90*	6.988	.009	5.56	42.24
Help Search Time	Experts	Intermediates	-32.82*	10.232	.014	-59.68	-5.96
		Novices	-97.20*	12.158	.000	-129.12	-65.28
	Intermediates	Experts	32.82*	10.232	.014	5.96	59.68
		Novices	-64.38*	10.232	.000	-91.24	-37.52
	Novices	Experts	97.20*	12.158	.000	65.28	129.12
		Intermediates	64.38*	10.232	.000	37.52	91.24
Number of Times Assisted By Experimenter	Experts	Intermediates	-7.23*	1.543	.000	-11.28	-3.18
		Novices	-19.20*	1.833	.000	-24.01	-14.39
	Intermediates	Experts	7.23*	1.543	.000	3.18	11.28
		Novices	-11.97*	1.543	.000	-16.02	-7.92
	Novices	Experts	19.20*	1.833	.000	14.39	24.01
		Intermediates	11.97*	1.543	.000	7.92	16.02
Successful hits	Experts	Intermediates	-3.87	1.686	.100	-8.29	.56
		Novices	-4.80	2.004	.081	-10.06	.46
	Intermediates	Experts	3.87	1.686	.100	-.56	8.29
		Novices	-.93	1.686	1.000	-5.36	3.49
	Novices	Experts	4.80	2.004	.081	-.46	10.06
		Intermediates	.93	1.686	1.000	-3.49	5.36
Total Access	Experts	Intermediates	-8.95*	2.570	.007	-15.70	-2.20
		Novices	-25.20*	3.054	.000	-33.22	-17.18
	Intermediates	Experts	8.95*	2.570	.007	2.20	15.70
		Novices	-16.25*	2.570	.000	-23.00	-9.50
	Novices	Experts	25.20*	3.054	.000	17.18	33.22
		Intermediates	16.25*	2.570	.000	9.50	23.00
Total Task Time	Experts	Intermediates	-26.83*	7.812	.008	-47.34	-6.32
		Novices	-65.40*	9.283	.000	-89.77	-41.03
	Intermediates	Experts	26.83*	7.812	.008	6.32	47.34
		Novices	-38.57*	7.812	.000	-59.08	-18.06
	Novices	Experts	65.40*	9.283	.000	41.03	89.77
		Intermediates	38.57*	7.812	.000	18.06	59.08
Total Completion Time	Experts	Intermediates	-108.82*	10.881	.000	-137.38	-80.25
		Novices	-239.00*	12.928	.000	-272.94	-205.06
	Intermediates	Experts	108.82*	10.881	.000	80.25	137.38
		Novices	-130.18*	10.881	.000	-158.75	-101.62
	Novices	Experts	239.00*	12.928	.000	205.06	272.94
		Intermediates	130.18*	10.881	.000	101.62	158.75

*. The mean difference is significant at the .05 level.

Table G2b: The Bonferroni Test for Normality of Data

Multiple Comparisons

Dunnett (2-sided)

Dependent Variable	(I) User Level	(J) User Level	Mean difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Total Completed Tasks	Experts	Novices	17.60*	1.857	.000	13.19	22.01
	Intermediate	Novices	9.67*	1.563	.000	5.96	13.37
Exploration Time	Experts	Novices	-76.40*	8.302	.000	-96.09	-56.71
	Intermediate	Novices	-23.90*	6.988	.005	-40.48	-7.32
Help Search Time	Experts	Novices	-97.20*	12.158	.000	-126.04	-68.36
	Intermediate	Novices	-64.38*	10.232	.000	-88.66	-40.11
Number of Times Assisted By Expert	Experts	Novices	-19.20*	1.833	.000	-23.55	-14.85
	Intermediate	Novices	-11.97*	1.543	.000	-15.63	-8.31
Successful hits	Experts	Novices	-4.80*	2.004	.048	-9.55	74E-02
	Intermediate	Novices	-.93	1.686	.794	-4.93	3.07
Total Access	Experts	Novices	-25.20*	3.054	.000	-32.44	-17.96
	Intermediate	Novices	-16.25*	2.570	.000	-22.35	-10.15
Total Task Time	Experts	Novices	-65.40*	9.283	.000	-87.42	-43.38
	Intermediate	Novices	-38.57*	7.812	.000	-57.10	-20.03
Total Completion Time	Experts	Novices	-239.00*	12.928	.000	-269.67	-208.33
	Intermediate	Novices	-130.18*	10.881	.000	-155.99	-104.37

*. The mean difference is significant at the .05 level.

a. Dunnett t-tests treat one group as a control, and compare all other groups against

Table G2c: The Dunnett Test for Normality of Data

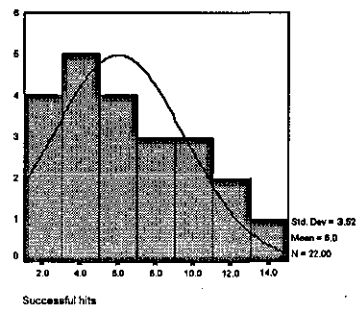
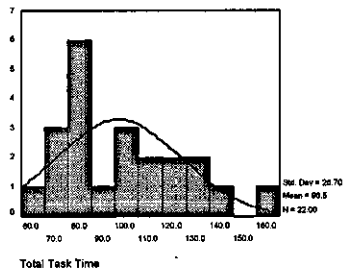
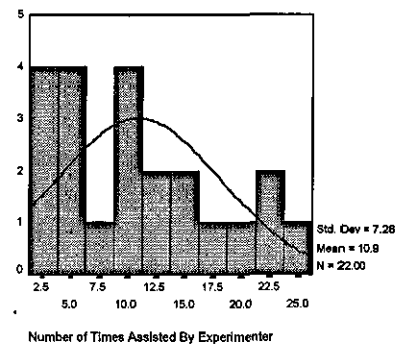
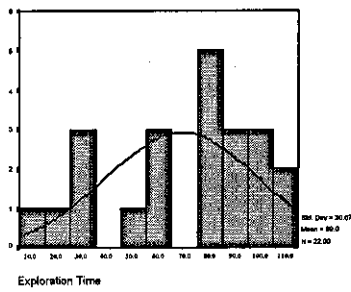
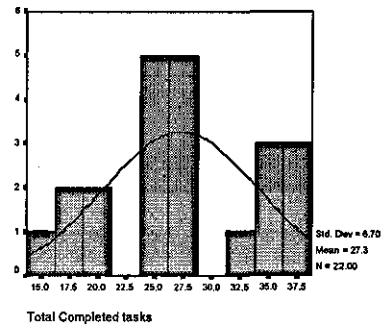
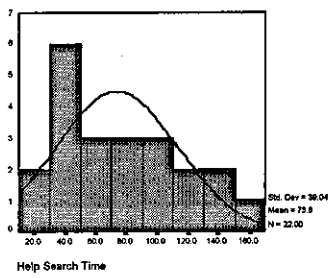
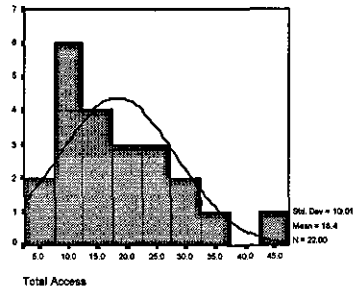
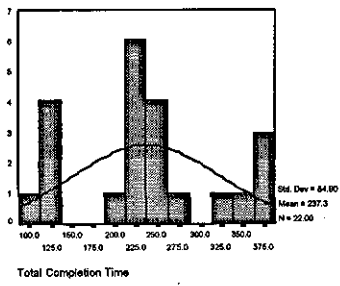
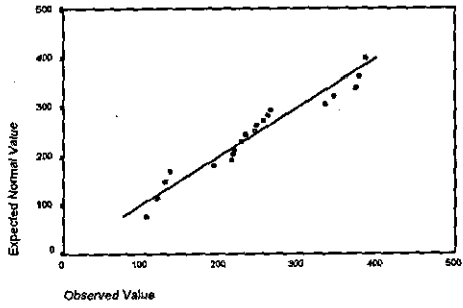
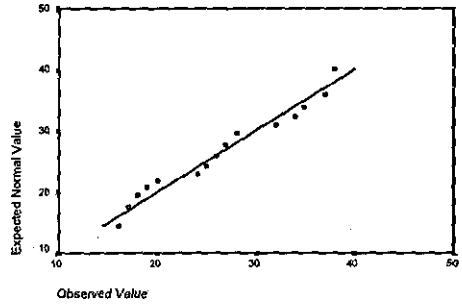


Figure G1: Histogram showing Normality of On-line Help Data

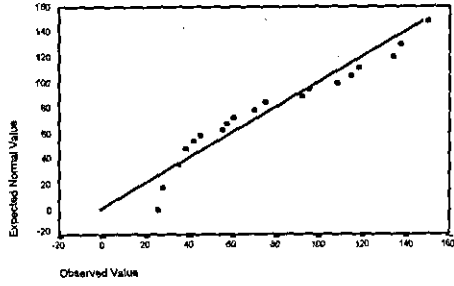
Normal Q-Q Plot of Total Completion Time



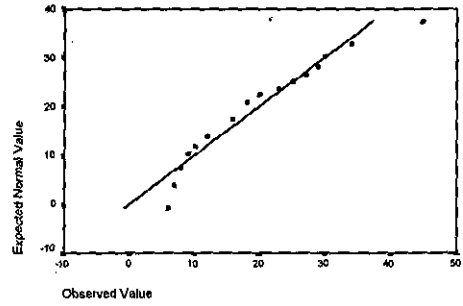
Normal Q-Q Plot of Total Completed tasks



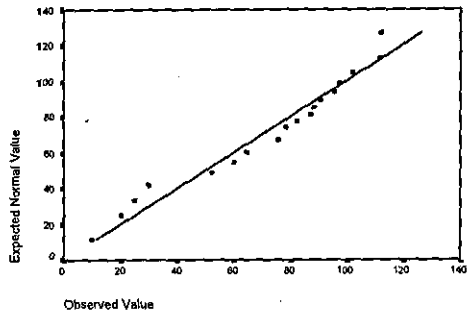
Normal Q-Q Plot of Help Search Time



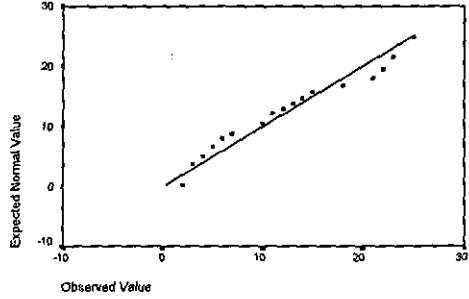
Normal Q-Q Plot of Total Access



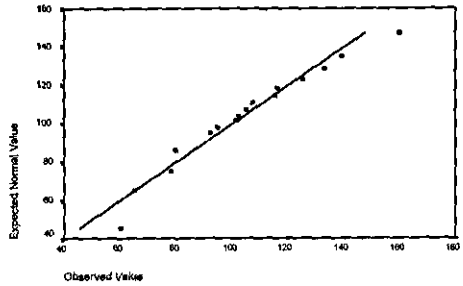
Normal Q-Q Plot of Exploration Time



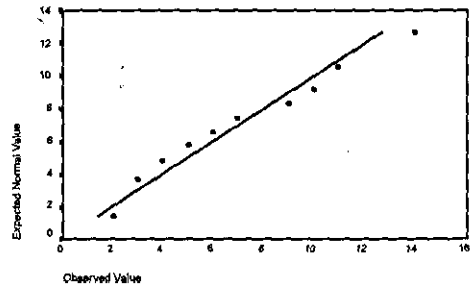
Normal Q-Q Plot of Number of Times Assisted By Experimenter



Normal Q-Q Plot of Total Task Time



Normal Q-Q Plot of Successful hits



G.2 Statistical Significance test for Chapter VI.

Test for homogeneity of Variances

Table G3 shows the results of Levene's Test. From the table, we can see that the Levene's statistics based on all the variables is sufficiently large ($\gg 0.05$). This means that we do not have enough evidence to suspect that the variances are unequal.

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Total Completion Time	1.089	2	15	.362
Manual Search Time	.718	2	15	.504
Exploration Time	1.567	2	15	.241
Task Time	3.195	2	15	.070
Numer of Completed Tasks	.462	2	15	.639

Table G3: Levene's Test for Homogeneity of Variances

Test for Normality

Table G4 gives a summary of the results of some of these tests. From the table, it will be seen that all the tests (Least Significant Difference (LSD), Bonferroni and Dunnett) indicate that the data did not come from normal distribution.

However, the histogram shown in Figure G3 for each of the variables show a normal distribution. Based on this, we can assume that the data is from a reasonably normal distribution.

Similarly, the normal probability plot graphs shown in Figure G4, a straight line through the plots indicates that the data is from a normal distribution. Hence this further confirms our assumption that the data comes from a reasonably normal distribution.

Multiple Comparisons

LSD

Dependent Variable	(I) User Level	(J) User Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Experts	Intermediates	5.58*	1.721	.005	1.91	9.24
		Novices	12.20*	1.909	.000	8.13	16.27
	Intermediates	Experts	-5.58*	1.721	.005	-9.24	-1.91
		Novices	6.63*	1.721	.002	2.96	10.29
	Novices	Experts	-12.20*	1.909	.000	-16.27	-8.13
		Intermediates	-6.63*	1.721	.002	-10.29	-2.96
Exploration Time	Experts	Intermediates	-43.93*	6.587	.000	-57.96	-29.89
		Novices	-73.00*	7.307	.000	-88.58	-57.42
	Intermediates	Experts	43.93*	6.587	.000	29.89	57.96
		Novices	-29.08*	6.587	.001	-43.11	-15.04
	Novices	Experts	73.00*	7.307	.000	57.42	88.58
		Intermediates	29.08*	6.587	.001	15.04	43.11
Manual Search Time	Experts	Intermediates	-46.85*	9.070	.000	-66.18	-27.52
		Novices	-87.60*	10.062	.000	-109.05	-66.15
	Intermediates	Experts	46.85*	9.070	.000	27.52	66.18
		Novices	-40.75*	9.070	.000	-60.08	-21.42
	Novices	Experts	87.60*	10.062	.000	66.15	109.05
		Intermediates	40.75*	9.070	.000	21.42	60.08
Number of Times Assisted by Experimenter	Experts	Intermediates	-1.30	.926	.181	-3.27	.67
		Novices	-6.60*	1.028	.000	-8.79	-4.41
	Intermediates	Experts	1.30	.926	.181	-.67	3.27
		Novices	-5.30*	.926	.000	-7.27	-3.33
	Novices	Experts	6.60*	1.028	.000	4.41	8.79
		Intermediates	5.30*	.926	.000	3.33	7.27
Successful Hits	Experts	Intermediates	-3.85*	1.423	.016	-6.88	-.82
		Novices	-10.40*	1.579	.000	-13.77	-7.03
	Intermediates	Experts	3.85*	1.423	.016	.82	6.88
		Novices	-6.55*	1.423	.000	-9.58	-3.52
	Novices	Experts	10.40*	1.579	.000	7.03	13.77
		Intermediates	6.55*	1.423	.000	3.52	9.58
Total Access	Experts	Intermediates	-5.50*	2.318	.031	-10.44	-.56
		Novices	-18.00*	2.572	.000	-23.48	-12.52
	Intermediates	Experts	5.50*	2.318	.031	.56	10.44
		Novices	-12.50*	2.318	.000	-17.44	-7.56
	Novices	Experts	18.00*	2.572	.000	12.52	23.48
		Intermediates	12.50*	2.318	.000	7.56	17.44
Task Time	Experts	Intermediates	-32.28*	8.154	.001	-49.66	-14.89
		Novices	-73.60*	9.046	.000	-92.88	-54.32
	Intermediates	Experts	32.28*	8.154	.001	14.89	49.66
		Novices	-41.32*	8.154	.000	-58.71	-23.94
	Novices	Experts	73.60*	9.046	.000	54.32	92.88
		Intermediates	41.32*	8.154	.000	23.94	58.71
Total Completion Time	Experts	Intermediates	-122.18*	16.229	.000	-156.77	-87.58
		Novices	-236.20*	18.004	.000	-274.58	-197.82
	Intermediates	Experts	122.18*	16.229	.000	87.58	156.77
		Novices	-114.02*	16.229	.000	-148.62	-79.43
	Novices	Experts	236.20*	18.004	.000	197.82	274.58
		Intermediates	114.02*	16.229	.000	79.43	148.62

*. The mean difference is significant at the .05 level.

Table G4a: The LSD Test for Normality of Data

Multiple Comparisons

Bonferroni

Dependent Variable	(I) User Level	(J) User Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Experts	Intermediates	5.58*	1.721	.016	.94	10.21
		Novices	12.20*	1.909	.000	7.06	17.34
	Intermediates	Experts	-5.58*	1.721	.016	-10.21	-.94
		Novices	6.63*	1.721	.005	1.99	11.26
	Novices	Experts	-12.20*	1.909	.000	-17.34	-7.06
		Intermediates	-6.63*	1.721	.005	-11.26	-1.99
Exploration Time	Experts	Intermediates	-43.93*	6.587	.000	-61.67	-26.18
		Novices	-73.00*	7.307	.000	-92.68	-53.32
	Intermediates	Experts	43.93*	6.587	.000	26.18	61.67
		Novices	-29.08*	6.587	.002	-46.82	-11.33
	Novices	Experts	73.00*	7.307	.000	53.32	92.68
		Intermediates	29.08*	6.587	.002	11.33	46.82
Manual Search Time	Experts	Intermediates	-46.85*	9.070	.000	-71.28	-22.42
		Novices	-87.60*	10.062	.000	-114.70	-60.50
	Intermediates	Experts	46.85*	9.070	.000	22.42	71.28
		Novices	-40.75*	9.070	.001	-65.18	-16.32
	Novices	Experts	87.60*	10.062	.000	60.50	114.70
		Intermediates	40.75*	9.070	.001	16.32	65.18
Number of Times Assisted by Experimenter	Experts	Intermediates	-1.30	.926	.543	-3.80	1.20
		Novices	-6.60*	1.028	.000	-9.37	-3.83
	Intermediates	Experts	1.30	.926	.543	-1.20	3.80
		Novices	-5.30*	.926	.000	-7.80	-2.80
	Novices	Experts	6.60*	1.028	.000	3.83	9.37
		Intermediates	5.30*	.926	.000	2.80	7.80
Successful Hits	Experts	Intermediates	-3.85*	1.423	.049	-7.68	-1.60E-02
		Novices	-10.40*	1.579	.000	-14.65	-6.15
	Intermediates	Experts	3.85*	1.423	.049	1.60E-02	7.68
		Novices	-6.55*	1.423	.001	-10.38	-2.72
	Novices	Experts	10.40*	1.579	.000	6.15	14.65
		Intermediates	6.55*	1.423	.001	2.72	10.38
Total Access	Experts	Intermediates	-5.50	2.318	.094	-11.74	.74
		Novices	-18.00*	2.572	.000	-24.93	-11.07
	Intermediates	Experts	5.50	2.318	.094	-.74	11.74
		Novices	-12.50*	2.318	.000	-18.74	-6.26
	Novices	Experts	18.00*	2.572	.000	11.07	24.93
		Intermediates	12.50*	2.318	.000	6.26	18.74
Task Time	Experts	Intermediates	-32.28*	8.154	.004	-54.24	-10.31
		Novices	-73.60*	9.046	.000	-97.97	-49.23
	Intermediates	Experts	32.28*	8.154	.004	10.31	54.24
		Novices	-41.32*	8.154	.000	-63.29	-19.36
	Novices	Experts	73.60*	9.046	.000	49.23	97.97
		Intermediates	41.32*	8.154	.000	19.36	63.29
Total Completion Time	Experts	Intermediates	-122.18*	16.229	.000	-165.89	-78.46
		Novices	-236.20*	18.004	.000	-284.70	-187.70
	Intermediates	Experts	122.18*	16.229	.000	78.46	165.89
		Novices	-114.02*	16.229	.000	-157.74	-70.31
	Novices	Experts	236.20*	18.004	.000	187.70	284.70
		Intermediates	114.02*	16.229	.000	70.31	157.74

*. The mean difference is significant at the .05 level.

Table G4b: The Bonferroni Test for Normality of Data

Multiple Comparisons

Dunnnett (2-sided)^a

Dependent Variable	(I) User Level	(J) User Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Experts	Novices	12.20*	1.909	.000	7.56	16.84
	Intermediates	Novices	6.63*	1.721	.003	2.44	10.81
Exploration Time	Experts	Novices	-73.00*	7.307	.000	-90.76	-55.24
	Intermediates	Novices	-29.08*	6.587	.001	-45.08	-13.07
Manual Search Time	Experts	Novices	-87.60*	10.062	.000	-112.05	-63.15
	Intermediates	Novices	-40.75*	9.070	.001	-62.79	-18.71
Number of Times Assisted by Experimenter	Experts	Novices	-6.60*	1.028	.000	-9.10	-4.10
	Intermediates	Novices	-5.30*	.926	.000	-7.55	-3.05
Successful Hits	Experts	Novices	-10.40*	1.579	.000	-14.24	-6.56
	Intermediates	Novices	-6.55*	1.423	.001	-10.01	-3.09
Total Access	Experts	Novices	-18.00*	2.572	.000	-24.25	-11.75
	Intermediates	Novices	-12.50*	2.318	.000	-18.13	-6.87
Task Time	Experts	Novices	-73.60*	9.046	.000	-95.58	-51.62
	Intermediates	Novices	-41.32*	8.154	.000	-61.14	-21.51
Total Completion Time	Experts	Novices	-236.20*	18.004	.000	-279.95	-192.45
	Intermediates	Novices	-114.02*	16.229	.000	-153.46	-74.59

*. The mean difference is significant at the .05 level.

a. Dunnnett t-tests treat one group as a control, and compare all other groups against it.

Table G4c: The Dunnnett Test for Normality of Data

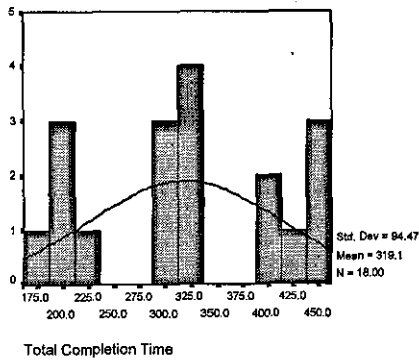


Figure G3a

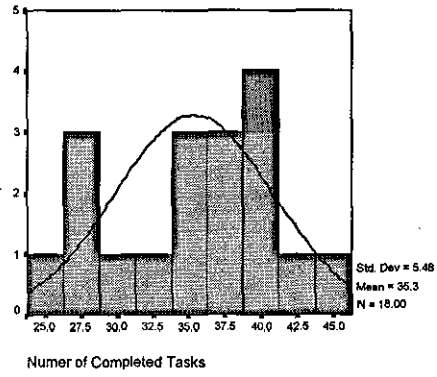


Figure G3e

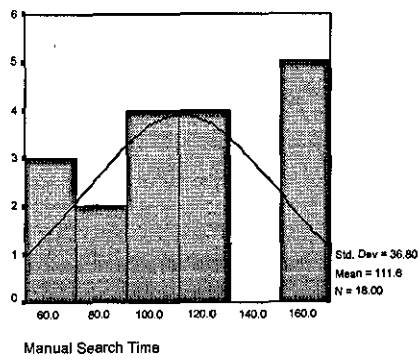


Figure G3b

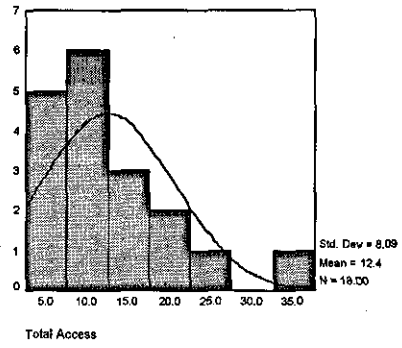


Figure G3f

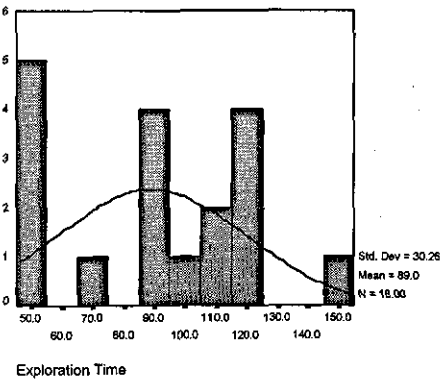


Figure G3c

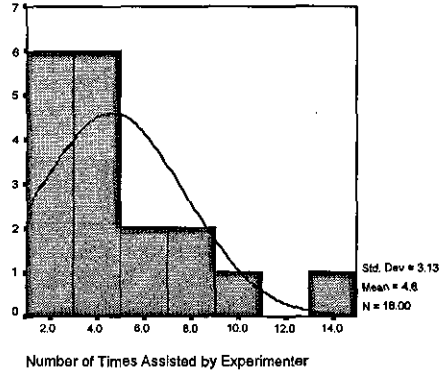


Figure G3g

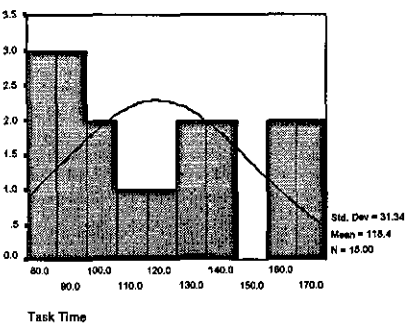


Figure G3d

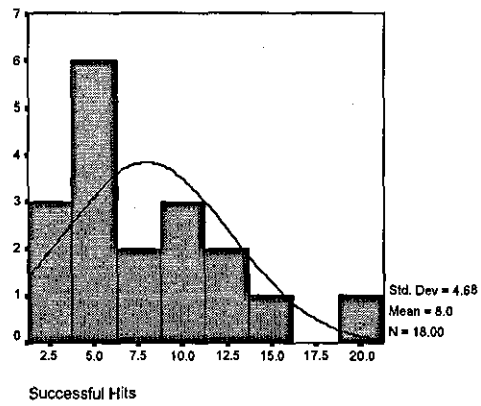


Figure G3h

Figure G4d

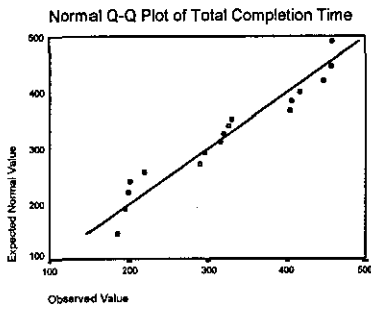


Figure G4a

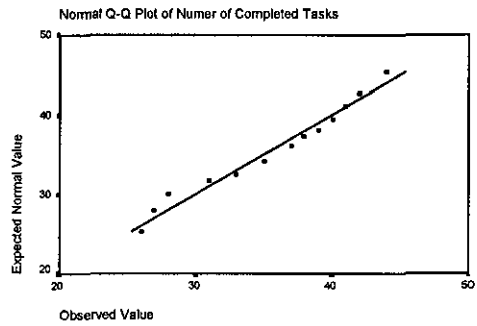


Figure G4e

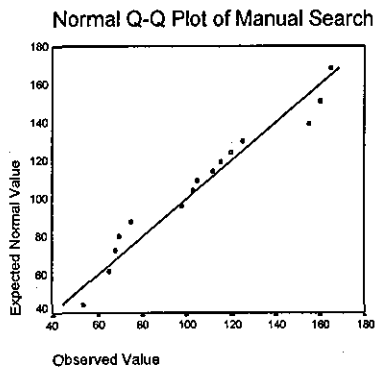


Figure G4b

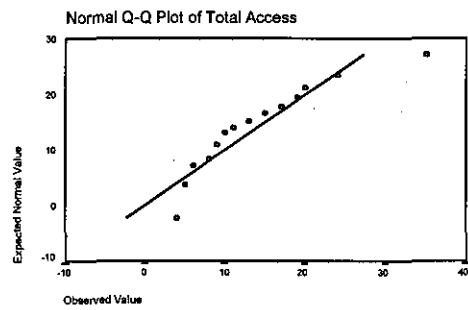


Figure G4f

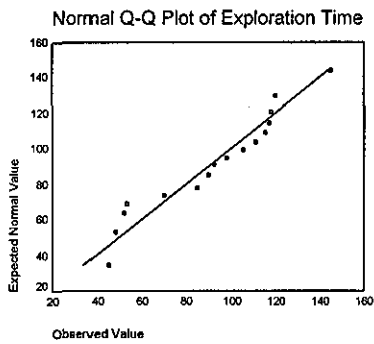


Figure G4c

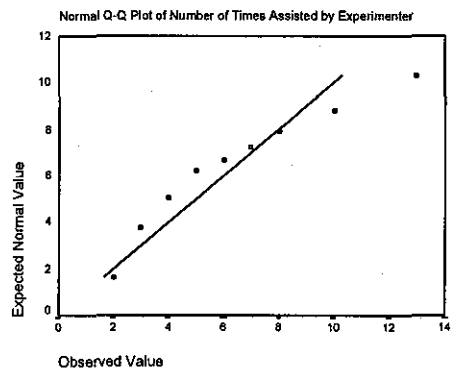


Figure G4g

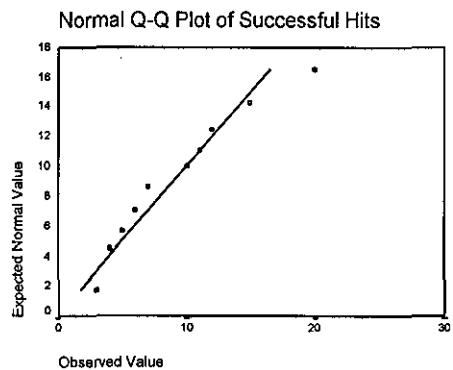
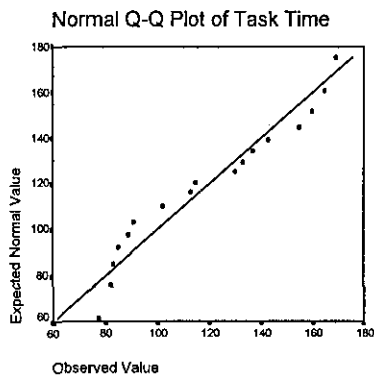


Figure G4h

G.3 Statistical Significance test for Chapter VIII.

Test for homogeneity of Variances

Table G5 shows the results of Levene's Test. From the table, we can see that the Levene's statistics based on all the variables is sufficiently large ($>>0.05$). This means that we do not have enough evidence to suspect that the variances are unequal.

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Total Completion Time	1.535	2	19	.241
Help Search Time	2.908	2	19	.079
Exploration Time	.797	2	19	.465
Total Task Time	1.780	2	19	.196
Total Completed tasks	.748	2	19	.487
Total Access Number of Times Assisted By Experimenter	2.500	2	19	.109
	2.686	2	19	.094

Table G5: Levene's Test for Homogeneity of Variances

Test for Normality

Table G6 gives a summary of the results of some of these tests. From the table, it will be seen that all the tests (Least Significant Difference (LSD), Bonferroni and Dunnett) indicate that the data did not come from normal distribution.

However, the histogram shown in Figure G5 for each of the variables show a normal distribution. Based on this, we can assume that the data is from a reasonably normal distribution.

Similarly, the normal probability plot graphs shown in Figure G6, a straight line through the plots indicates that the data is from a normal distribution. Hence this further confirms our assumption that the data comes from a reasonably normal distribution.

Multiple Comparisons

LSD

Dependent Variable	(I) User Level	(J) User Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Taks	Expert	Intermediate	7.67*	1.139	.000	5.09	10.24
		Novice	16.00*	1.315	.000	13.03	18.97
	Intermediate	Expert	-7.67*	1.139	.000	-10.24	-5.09
		Novice	8.33*	1.139	.000	5.76	10.91
	Novice	Expert	-16.00*	1.315	.000	-18.97	-13.03
		Intermediate	-8.33*	1.139	.000	-10.91	-5.76
Exploration Time	Expert	Intermediate	-30.17*	8.497	.006	-49.39	-10.95
		Novice	-33.33*	9.811	.008	-55.53	-11.14
	Intermediate	Expert	30.17*	8.497	.006	10.95	49.39
		Novice	-3.17	8.497	.718	-22.39	16.05
	Novice	Expert	33.33*	9.811	.008	11.14	55.53
		Intermediate	3.17	8.497	.718	-16.05	22.39
Integrated Base Search Time	Expert	Intermediate	-29.17*	9.823	.016	-51.39	-6.95
		Novice	-66.00*	11.343	.000	-91.66	-40.34
	Intermediate	Expert	29.17*	9.823	.016	6.95	51.39
		Novice	-36.83*	9.823	.005	-59.05	-14.61
	Novice	Expert	66.00*	11.343	.000	40.34	91.66
		Intermediate	36.83*	9.823	.005	14.61	59.05
Number of Times Assisted	Expert	Intermediate	-3.33*	1.036	.011	-5.68	-.99
		Novice	-6.67*	1.197	.000	-9.37	-3.96
	Intermediate	Expert	3.33*	1.036	.011	.99	5.68
		Novice	-3.33*	1.036	.011	-5.68	-.99
	Novice	Expert	6.67*	1.197	.000	3.96	9.37
		Intermediate	3.33*	1.036	.011	.99	5.68
Successful Hits	Expert	Intermediate	-10.67*	1.743	.000	-14.61	-6.72
		Novice	-16.67*	2.012	.000	-21.22	-12.11
	Intermediate	Expert	10.67*	1.743	.000	6.72	14.61
		Novice	-6.00*	1.743	.007	-9.94	-2.06
	Novice	Expert	16.67*	2.012	.000	12.11	21.22
		Intermediate	6.00*	1.743	.007	2.06	9.94
Total Access	Expert	Intermediate	-14.17*	1.658	.000	-17.92	-10.42
		Novice	-20.67*	1.915	.000	-25.00	-16.33
	Intermediate	Expert	14.17*	1.658	.000	10.42	17.92
		Novice	-6.50*	1.658	.004	-10.25	-2.75
	Novice	Expert	20.67*	1.915	.000	16.33	25.00
		Intermediate	6.50*	1.658	.004	2.75	10.25
Total Task Completion Time	Expert	Intermediate	-13.33	7.391	.105	-30.05	3.39
		Novice	-45.00*	8.535	.001	-64.31	-25.69
	Intermediate	Expert	13.33	7.391	.105	-3.39	30.05
		Novice	-31.67*	7.391	.002	-48.39	-14.95
	Novice	Expert	45.00*	8.535	.001	25.69	64.31
		Intermediate	31.67*	7.391	.002	14.95	48.39
Total Completion Time	Expert	Intermediate	-71.00*	17.677	.003	-110.99	-31.01
		Novice	-144.33*	20.412	.000	-190.51	-98.16
	Intermediate	Expert	71.00*	17.677	.003	31.01	110.99
		Novice	-73.33*	17.677	.002	-113.32	-33.34
	Novice	Expert	144.33*	20.412	.000	98.16	190.51
		Intermediate	73.33*	17.677	.002	33.34	113.32

*. The mean difference is significant at the .05 level.

Table G6a: The LSD Test for Normality of Variances

Multiple Comparisons

Bonferroni

Dependent Variable	(I) User Level	(J) User Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Taks	Expert	Intermediate	7.67*	1.139	.000	4.33	11.01
		Novice	16.00*	1.315	.000	12.14	19.86
	Intermediate	Expert	-7.67*	1.139	.000	-11.01	-4.33
		Novice	8.33*	1.139	.000	4.99	11.67
	Novice	Expert	-16.00*	1.315	.000	-19.86	-12.14
		Intermediate	-8.33*	1.139	.000	-11.67	-4.99
Exploration Time	Expert	Intermediate	-30.17*	8.497	.019	-55.09	-5.24
		Novice	-33.33*	9.811	.024	-62.11	-4.55
	Intermediate	Expert	30.17*	8.497	.019	5.24	55.09
		Novice	-3.17	8.497	1.000	-28.09	21.76
	Novice	Expert	33.33*	9.811	.024	4.55	62.11
		Intermediate	3.17	8.497	1.000	-21.76	28.09
Integrated Base Search Time	Expert	Intermediate	-29.17*	9.823	.047	-57.98	-.35
		Novice	-66.00*	11.343	.001	-99.27	-32.73
	Intermediate	Expert	29.17*	9.823	.047	.35	57.98
		Novice	-36.83*	9.823	.014	-65.65	-8.02
	Novice	Expert	66.00*	11.343	.001	32.73	99.27
		Intermediate	36.83*	9.823	.014	8.02	65.65
Number of Times Assisted	Expert	Intermediate	-3.33*	1.036	.032	-6.37	-.29
		Novice	-6.67*	1.197	.001	-10.18	-3.16
	Intermediate	Expert	3.33*	1.036	.032	.29	6.37
		Novice	-3.33*	1.036	.032	-6.37	-.29
	Novice	Expert	6.67*	1.197	.001	3.16	10.18
		Intermediate	3.33*	1.036	.032	.29	6.37
Successful Hits	Expert	Intermediate	-10.67*	1.743	.001	-15.78	-5.55
		Novice	-16.67*	2.012	.000	-22.57	-10.76
	Intermediate	Expert	10.67*	1.743	.001	5.55	15.78
		Novice	-6.00*	1.743	.022	-11.11	-.89
	Novice	Expert	16.67*	2.012	.000	10.76	22.57
		Intermediate	6.00*	1.743	.022	.89	11.11
Total Access	Expert	Intermediate	-14.17*	1.658	.000	-19.03	-9.30
		Novice	-20.67*	1.915	.000	-26.28	-15.05
	Intermediate	Expert	14.17*	1.658	.000	9.30	19.03
		Novice	-6.50*	1.658	.011	-11.36	-1.64
	Novice	Expert	20.67*	1.915	.000	15.05	26.28
		Intermediate	6.50*	1.658	.011	1.64	11.36
Total Task Completion Time	Expert	Intermediate	-13.33	7.391	.314	-35.01	8.35
		Novice	-45.00*	8.535	.002	-70.03	-19.97
	Intermediate	Expert	13.33	7.391	.314	-8.35	35.01
		Novice	-31.67*	7.391	.006	-53.35	-9.99
	Novice	Expert	45.00*	8.535	.002	19.97	70.03
		Intermediate	31.67*	7.391	.006	9.99	53.35
Total Completion Time	Expert	Intermediate	-71.00*	17.677	.009	-122.85	-19.15
		Novice	-144.33*	20.412	.000	-204.21	-84.46
	Intermediate	Expert	71.00*	17.677	.009	19.15	122.85
		Novice	-73.33*	17.677	.007	-125.19	-21.48
	Novice	Expert	144.33*	20.412	.000	84.46	204.21
		Intermediate	73.33*	17.677	.007	21.48	125.19

*. The mean difference is significant at the .05 level.

Table G6b: The Bonferroni Test for Normality of Variances

Multiple Comparisons

Dunnnett (2-sided)^a

Dependent Variable	(I) User Level	(J) User Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Expert	Novice	16.00*	1.315	.000	12.58	19.42
	Intermediate	Novice	8.33*	1.139	.000	5.38	11.29
Exploration Time	Expert	Novice	-33.33*	9.811	.014	-58.82	-7.85
	Intermediate	Novice	-3.17	8.497	.900	-25.24	18.90
Integrated Base Search Time	Expert	Novice	-66.00*	11.343	.000	-95.46	-36.54
	Intermediate	Novice	-36.83*	9.823	.008	-62.35	-11.32
Number of Times Assisted	Expert	Novice	-6.67*	1.197	.001	-9.78	-3.56
	Intermediate	Novice	-3.33*	1.036	.019	-6.03	-.64
Successful Hits	Expert	Novice	-16.67*	2.012	.000	-21.89	-11.44
	Intermediate	Novice	-6.00*	1.743	.013	-10.53	-1.47
Total Access	Expert	Novice	-20.67*	1.915	.000	-25.64	-15.69
	Intermediate	Novice	-6.50*	1.658	.006	-10.81	-2.19
Total Task Completion Time	Expert	Novice	-45.00*	8.535	.001	-67.17	-22.83
	Intermediate	Novice	-31.67*	7.391	.004	-50.87	-12.47
Total Completion Time	Expert	Novice	-144.33*	20.412	.000	-197.36	-91.31
	Intermediate	Novice	-73.33*	17.677	.005	-119.25	-27.41

*. The mean difference is significant at the .05 level.

a. Dunnnett t-tests treat one group as a control, and compare all other groups against it.

Table G6c: The Dunnnett Test for Normality of Variances

Figure G5: Histogram of Variables

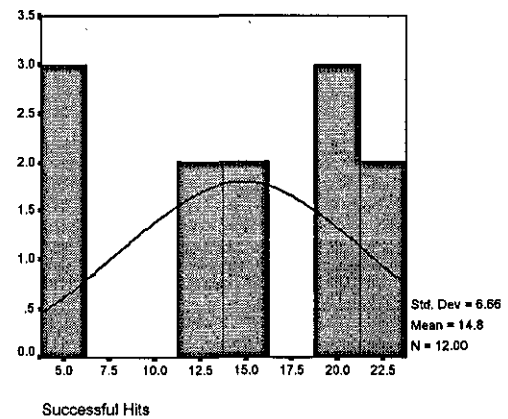
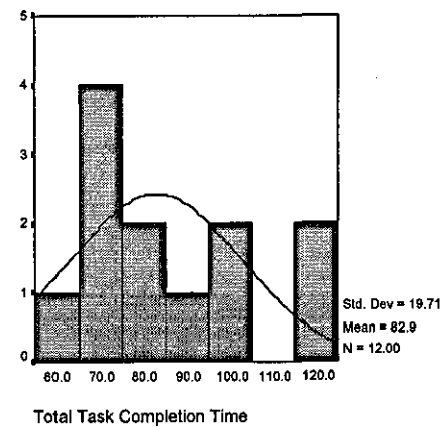
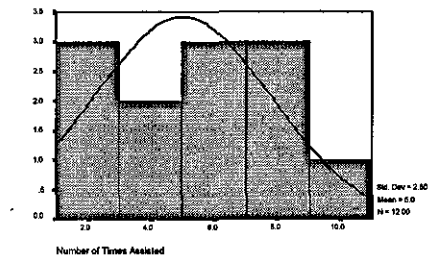
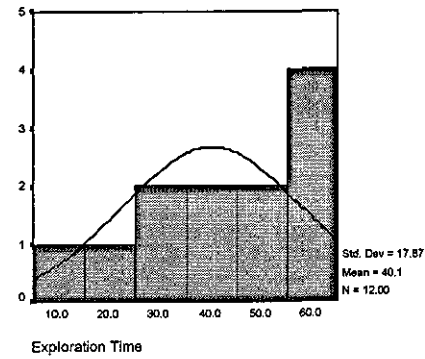
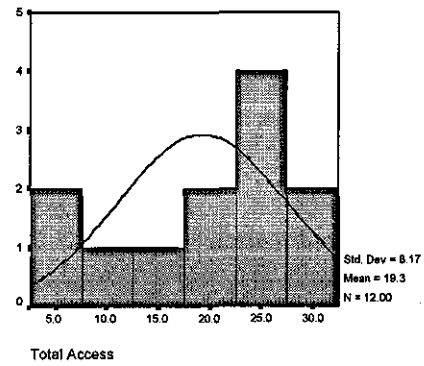
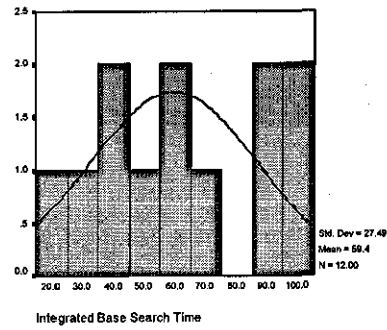
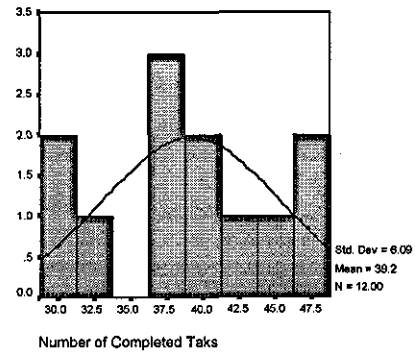
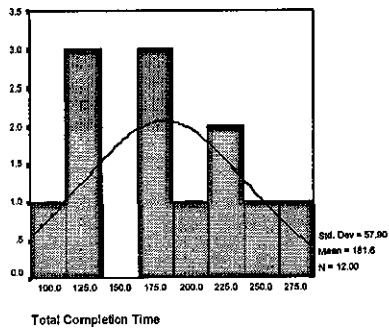
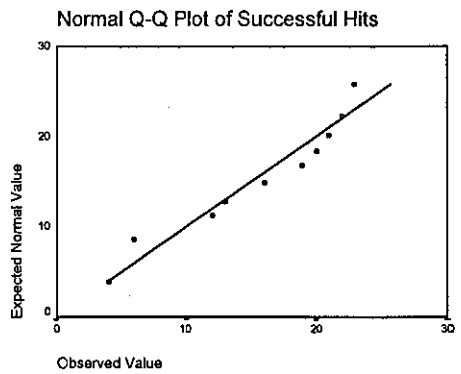
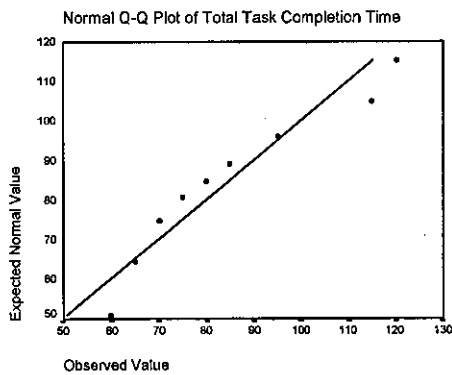
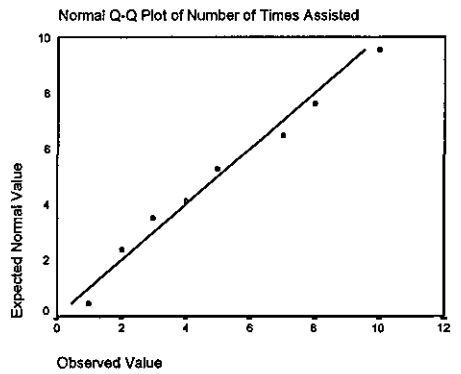
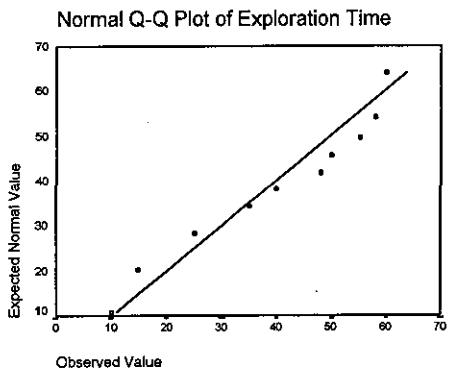
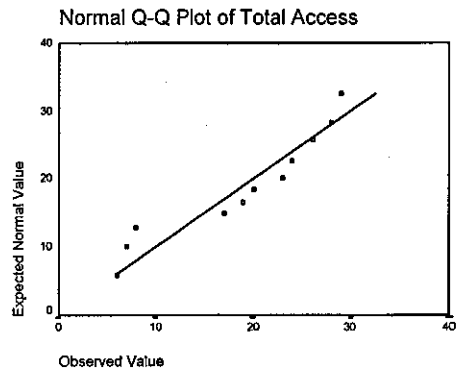
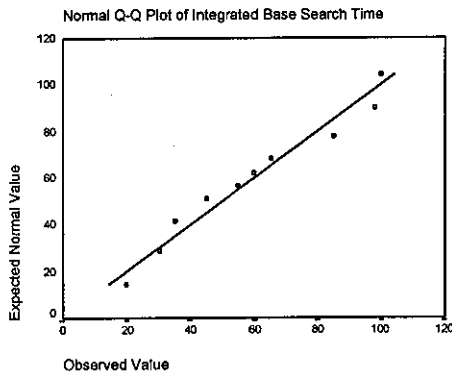
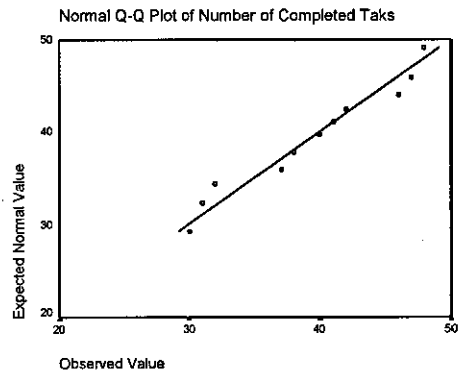
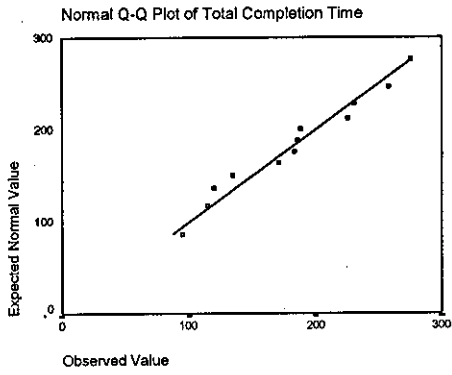


Figure G6: Normal Probability Plot



G.3 Statistical Significance test for Chapter IX.

Expert Users across applications

Test for homogeneity of Variances

Table G7 shows the results of Levene test. From the table, we can see that the Levene's statistics based on all the variables is sufficiently large ($\gg 0.05$). This means that we do not have enough evidence to suspect that the variances are unequal.

Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Number of Completed Tasks	1.143	2	10	.357
Exploration Time	1.764	2	10	.221
'Help' Search Time	.002	2	10	.998
Number of Times Assisted	2.130	2	10	.170
Partially Successful Hits	2.698	2	10	.116
Successful Hits	1.430	2	10	.284
Total Access Actual Task Time	.980	2	10	.409
.311		2	10	.740
Total Completion Time	.137	2	10	.874
Unsuccessful Hits	6.447	2	10	.016

Table G7: Levene's Test for Homogeneity of Variances

Test for Normality

Table G8 gives a summary of the results of some of these tests. From the table, it will be seen that all the tests (Least Significant Difference (LSD), Bonferroni and Dunnett) indicate that the data did not come from normal distribution.

However, the histogram shown in Figure G7 for each of the variables show a normal distribution. Based on this, we can assume that the data is from a reasonably normal distribution.

Similarly, the normal probability plot graphs shown in Figure G8, a straight line through the plots indicates that the data is from a normal distribution. Hence this further confirms our assumption that the data comes from a reasonably normal distribution.

Multiple Comparisons

LSD

Dependent Variable	(I) Means of Assistance	(J) Means of Assistance	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	User Manual	-5.60*	1.095	.000	-8.04	-3.16
		Integrated Base	-11.40*	1.265	.000	-14.22	-8.58
	User Manual	Online Help	5.60*	1.095	.000	3.16	8.04
		Integrated Base	-5.80*	1.265	.001	-8.62	-2.98
	Integrated Base	Online Help	11.40*	1.265	.000	8.58	14.22
		User Manual	5.80*	1.265	.001	2.98	8.62
Exploration Time	Online Help	User Manual	-26.20*	4.193	.000	-35.54	-16.86
		Integrated Base	6.33	4.841	.220	-4.45	17.12
	User Manual	Online Help	26.20*	4.193	.000	16.86	35.54
		Integrated Base	32.53*	4.841	.000	21.75	43.32
	Integrated Base	Online Help	-6.33	4.841	.220	-17.12	4.45
		User Manual	-32.53*	4.841	.000	-43.32	-21.75
Help Search Time	Online Help	User Manual	-32.80*	4.903	.000	-43.73	-21.87
		Integrated Base	5.27	5.662	.374	-7.35	17.88
	User Manual	Online Help	32.80*	4.903	.000	21.87	43.73
		Integrated Base	38.07*	5.662	.000	25.45	50.68
	Integrated Base	Online Help	-5.27	5.662	.374	-17.88	7.35
		User Manual	-38.07*	5.662	.000	-50.68	-25.45
Actual Task Time	Online Help	User Manual	-16.60*	3.915	.002	-25.32	-7.88
		Integrated Base	2.00	4.521	.668	-8.07	12.07
	User Manual	Online Help	16.60*	3.915	.002	7.88	25.32
		Integrated Base	18.60*	4.521	.002	8.53	28.67
	Integrated Base	Online Help	-2.00	4.521	.668	-12.07	8.07
		User Manual	-18.60*	4.521	.002	-28.67	-8.53
Total Completion Time	Online Help	User Manual	-75.60*	7.782	.000	-92.94	-58.26
		Integrated Base	13.60	8.986	.161	-6.42	33.62
	User Manual	Online Help	75.60*	7.782	.000	58.26	92.94
		Integrated Base	89.20*	8.986	.000	69.18	109.22
	Integrated Base	Online Help	-13.60	8.986	.161	-33.62	6.42
		User Manual	-89.20*	8.986	.000	-109.22	-69.18
Unsuccessful Hits	Online Help	User Manual	.80*	.283	.018	.17	1.43
		Integrated Base	2.20*	.327	.000	1.47	2.93
	User Manual	Online Help	-.80*	.283	.018	-1.43	-.17
		Integrated Base	1.40*	.327	.002	.67	2.13
	Integrated Base	Online Help	-2.20*	.327	.000	-2.93	-1.47
		User Manual	-1.40*	.327	.002	-2.13	-.67

*. The mean difference is significant at the .05 level.

Table G8a: Least Significance Test for Normality of Data

Appendix G.22

Multiple Comparisons

Bonferroni

Dependent Variable	(I) Means of Assistance	(J) Means of Assistance	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	User Manual	-5.60*	1.095	.001	-8.74	-2.46
		Integrated Base	-11.40*	1.265	.000	-15.03	-7.77
	User Manual	Online Help	5.60*	1.095	.001	2.46	8.74
		Integrated Base	-5.80*	1.265	.003	-9.43	-2.17
	Integrated Base	Online Help	11.40*	1.265	.000	7.77	15.03
		User Manual	5.80*	1.265	.003	2.17	9.43
Exploration Time	Online Help	User Manual	-26.20*	4.193	.000	-38.23	-14.17
		Integrated Base	6.33	4.841	.660	-7.56	20.23
	User Manual	Online Help	26.20*	4.193	.000	14.17	38.23
		Integrated Base	32.53*	4.841	.000	18.64	46.43
	Integrated Base	Online Help	-6.33	4.841	.660	-20.23	7.56
		User Manual	-32.53*	4.841	.000	-46.43	-18.64
'Help' Search Time	Online Help	User Manual	-32.80*	4.903	.000	-46.87	-18.73
		Integrated Base	5.27	5.662	1.000	-10.98	21.52
	User Manual	Online Help	32.80*	4.903	.000	18.73	46.87
		Integrated Base	36.07*	5.662	.000	21.82	54.32
	Integrated Base	Online Help	-5.27	5.662	1.000	-21.52	10.98
		User Manual	-36.07*	5.662	.000	-54.32	-21.82
Actual Task Time	Online Help	User Manual	-16.60*	3.915	.005	-27.84	-5.36
		Integrated Base	2.00	4.521	1.000	-10.97	14.97
	User Manual	Online Help	16.60*	3.915	.005	5.36	27.84
		Integrated Base	18.60*	4.521	.006	5.63	31.57
	Integrated Base	Online Help	-2.00	4.521	1.000	-14.97	10.97
		User Manual	-18.60*	4.521	.006	-31.57	-5.63
Total Completion Time	Online Help	User Manual	-75.60*	7.782	.000	-97.93	-53.27
		Integrated Base	13.60	8.986	.483	-12.19	39.39
	User Manual	Online Help	75.60*	7.782	.000	53.27	97.93
		Integrated Base	89.20*	8.986	.000	63.41	114.99
	Integrated Base	Online Help	-13.60	8.986	.483	-39.39	12.19
		User Manual	-89.20*	8.986	.000	-114.99	-63.41
Unsuccessful Hits	Online Help	User Manual	.80	.283	.054	-1.18E-02	1.61
		Integrated Base	2.20*	.327	.000	1.26	3.14
	User Manual	Online Help	-.80	.283	.054	-1.61	1.18E-02
		Integrated Base	1.40*	.327	.005	.46	2.34
	Integrated Base	Online Help	-2.20*	.327	.000	-3.14	-1.26
		User Manual	-1.40*	.327	.005	-2.34	-.46

*. The mean difference is significant at the .05 level.

Table G8b: Bonferroni Test for Normality of Data

Multiple Comparisons

Dunnett (2-sided)^a

Dependent Variable	(I) Means of Assistance	(J) Means of Assistance	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	Integrated Base	-11.40*	1.265	.000	-14.61	-8.19
	User Manual	Integrated Base	-5.80*	1.265	.002	-9.01	-2.59
Exploration Time	Online Help	Integrated Base	6.33	4.841	.341	-5.97	18.64
	User Manual	Integrated Base	32.53*	4.841	.000	20.23	44.84
'Help' Search Time	Online Help	Integrated Base	5.27	5.662	.548	-9.12	19.65
	User Manual	Integrated Base	38.07*	5.662	.000	23.68	52.45
Acutal Task Time	Online Help	Integrated Base	2.00	4.521	.858	-9.49	13.49
	User Manual	Integrated Base	18.60*	4.521	.004	7.11	30.09
Total Completion Time	Online Help	Integrated Base	13.60	8.986	.256	-9.23	36.43
	User Manual	Integrated Base	89.20*	8.986	.000	66.37	112.03
Unsuccessful Hits	Online Help	Integrated Base	2.20*	.327	.000	1.37	3.03
	User Manual	Integrated Base	1.40*	.327	.003	.57	2.23

*. The mean difference is significant at the .05 level.

a. Dunnett t-tests treat one group as a control, and compare all other groups against it.

Table G8c: Dunnette's 2-sided Test for Normality of Data

Figure G7: Histogram

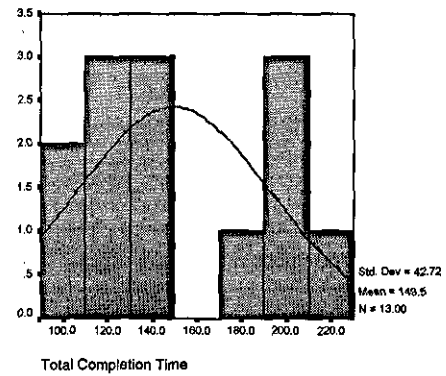
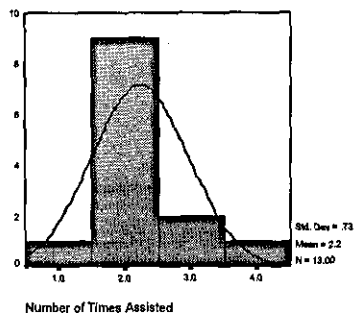
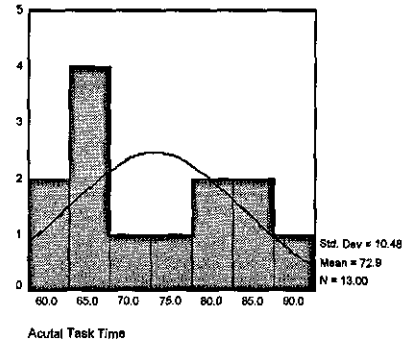
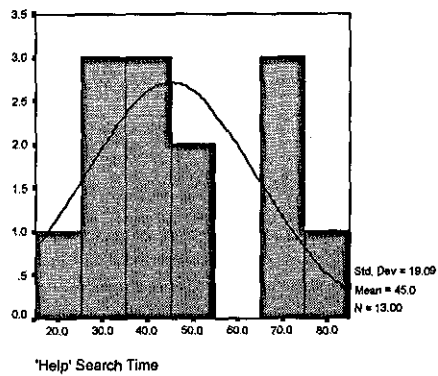
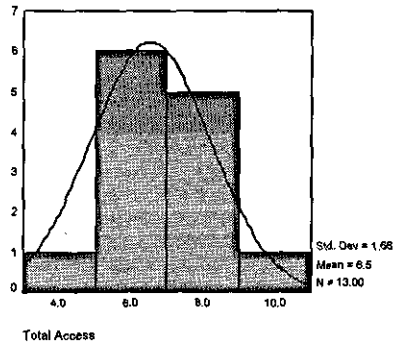
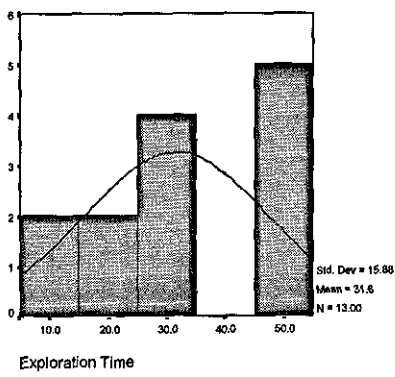
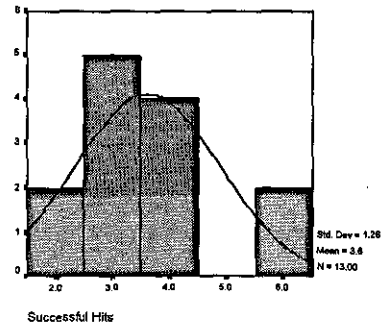
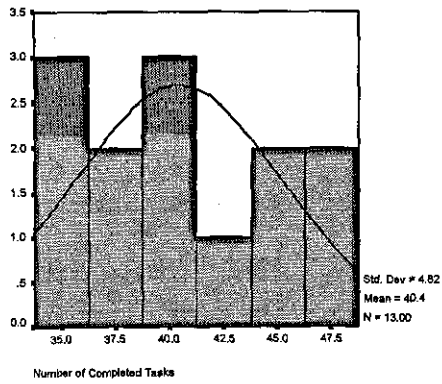
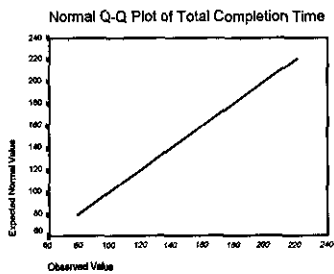
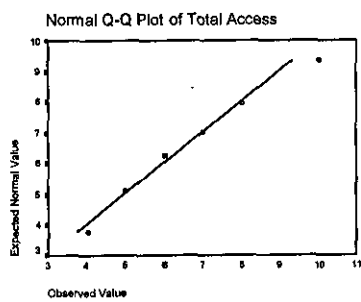
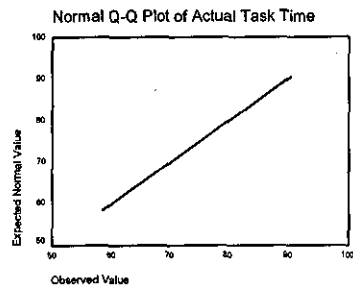
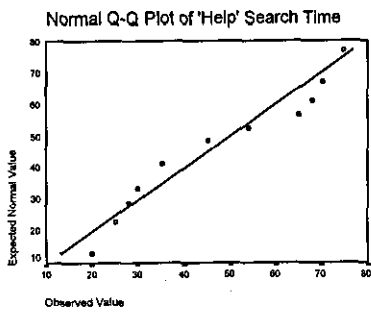
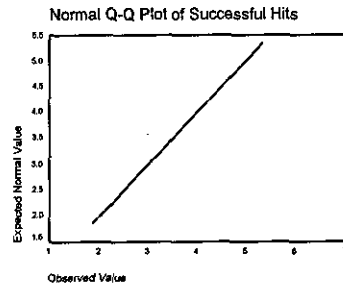
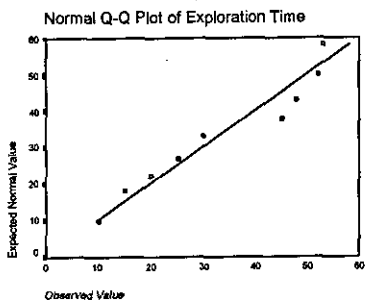
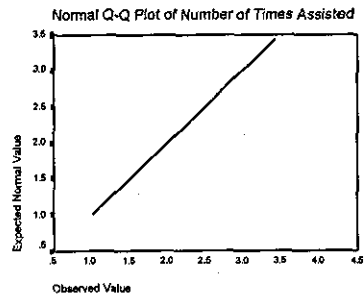
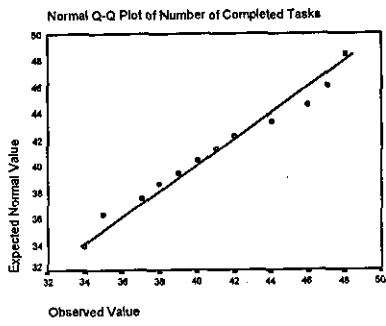
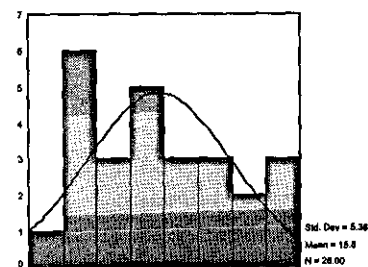
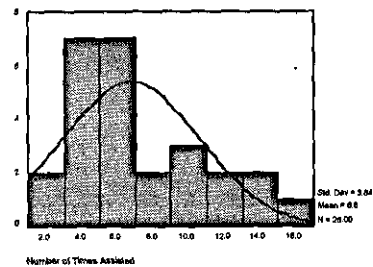
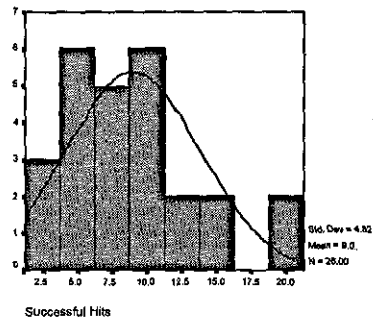
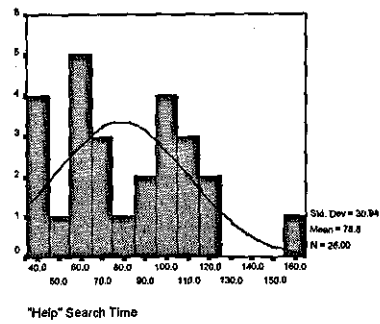
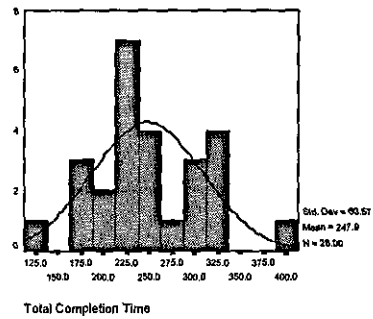
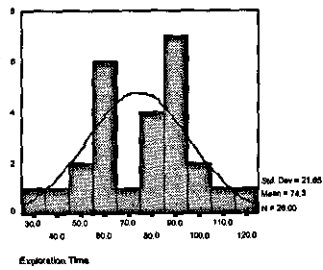
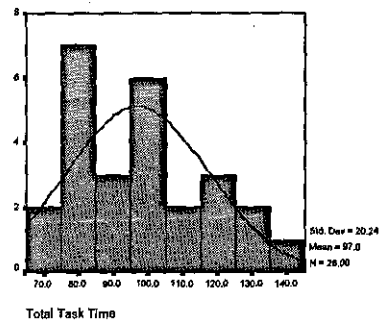
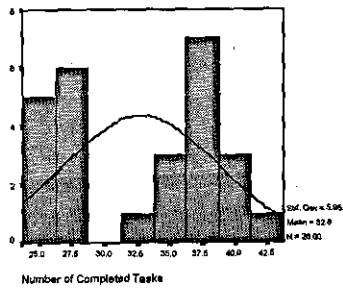


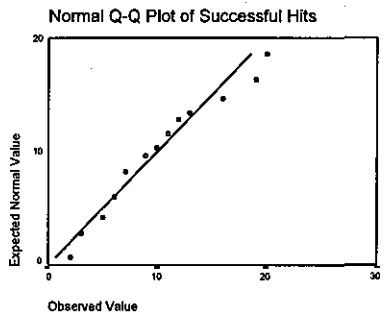
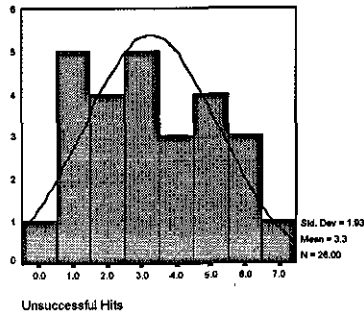
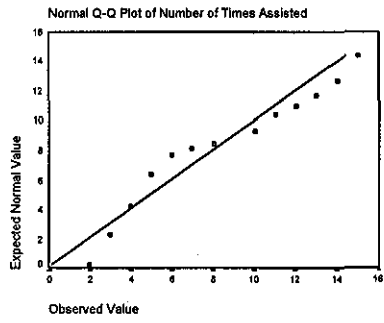
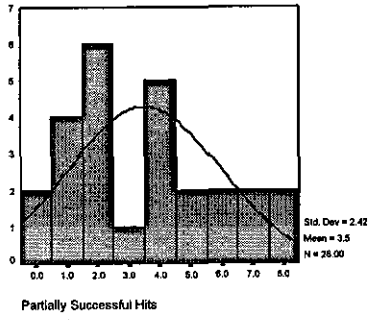
Figure G8: Normal Probability Plot



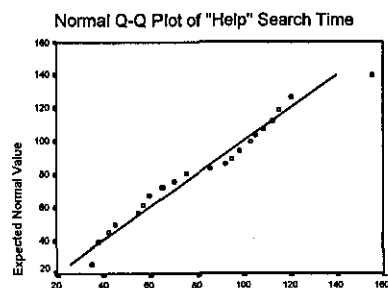
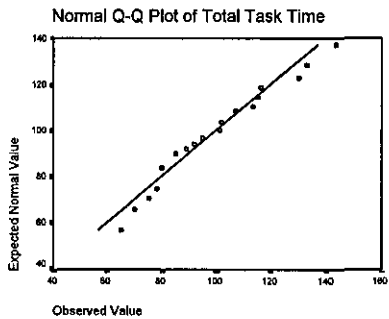
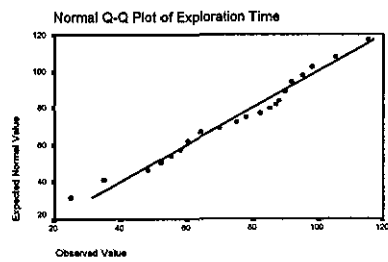
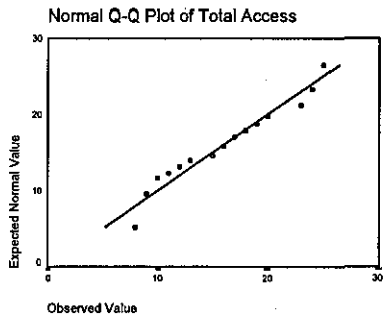
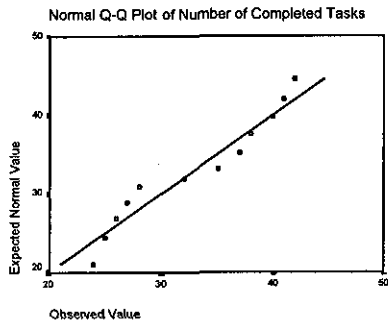
Intermediate Users Across Applications

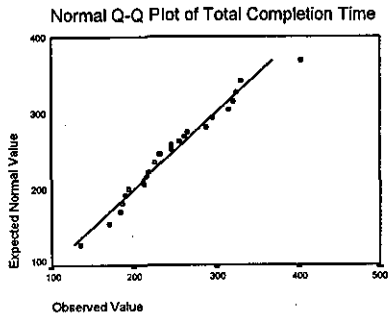
Histogram

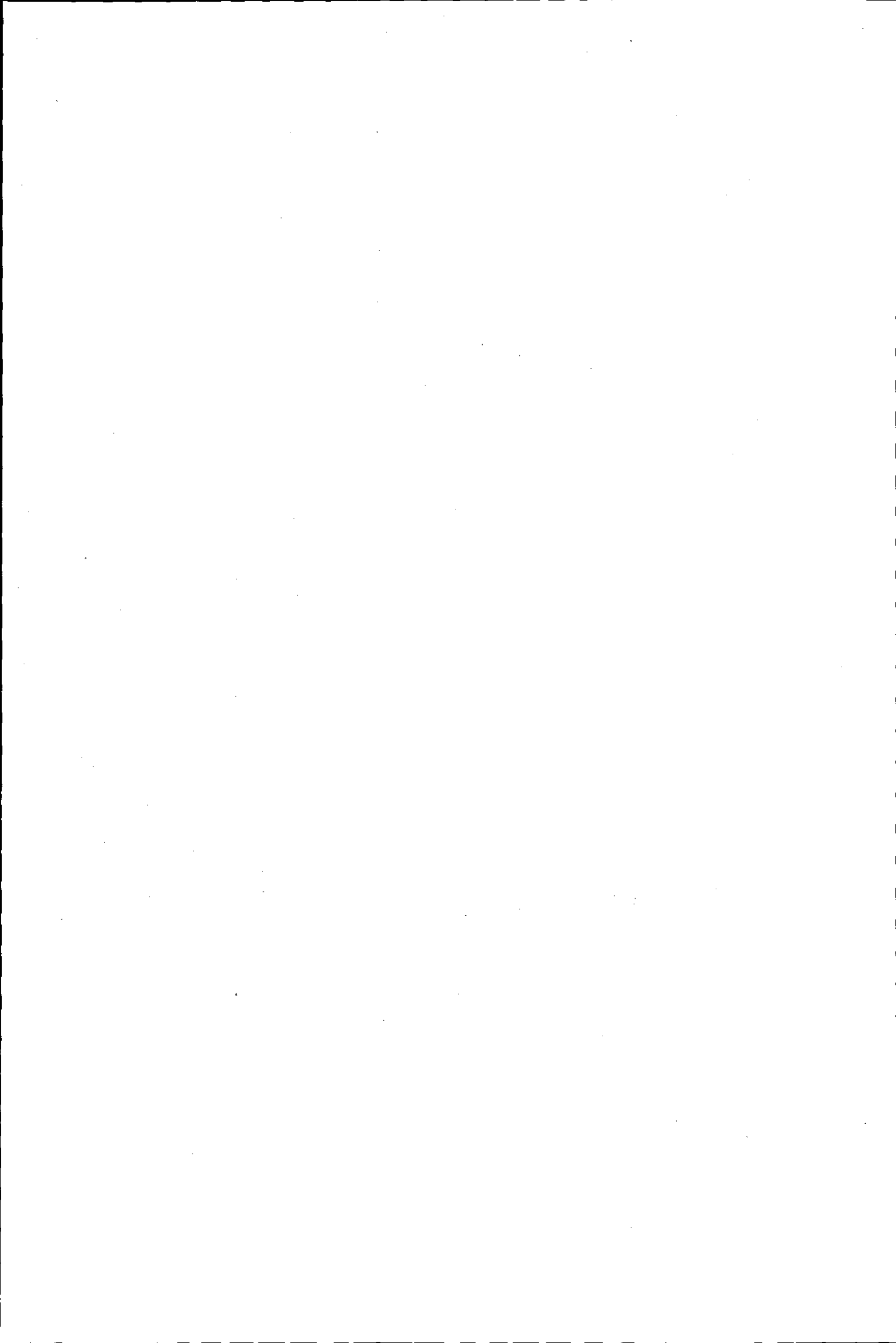




Normal Probability Plot







Multiple Comparisons Test: LSD

Multiple Comparisons

LSD

Dependent Variable	(I) Assistance Mechanism	(J) Assistance Mechanism	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	User Manual	-7.96*	1.498	.000	-11.06	-4.86
		Integrated Base	-11.67*	1.641	.000	-15.06	-8.27
	User Manual	Online Help	7.96*	1.498	.000	4.86	11.06
		Integrated Base	-3.71*	1.773	.048	-7.38	-4.07E-02
	Integrated Base	Online Help	11.67*	1.641	.000	8.27	15.06
		User Manual	3.71*	1.773	.048	4.07E-02	7.38
Exploration Time	Online Help	User Manual	-17.63*	6.270	.010	-30.60	-4.65
		Integrated Base	28.67*	6.869	.000	14.46	42.88
	User Manual	Online Help	17.63*	6.270	.010	4.65	30.60
		Integrated Base	46.29*	7.419	.000	30.94	61.64
	Integrated Base	Online Help	-28.67*	6.869	.000	-42.88	-14.46
		User Manual	-46.29*	7.419	.000	-61.64	-30.94
Help Search Time	Online Help	User Manual	-46.83*	9.455	.000	-66.39	-27.27
		Integrated Base	8.92	10.358	.398	-12.51	30.34
	User Manual	Online Help	46.83*	9.455	.000	27.27	66.39
		Integrated Base	55.75*	11.188	.000	32.61	78.89
	Integrated Base	Online Help	-8.92	10.358	.398	-30.34	12.51
		User Manual	-55.75*	11.188	.000	-78.89	-32.61
Successful Hits	Online Help	User Manual	-.58	1.333	.666	-3.34	2.17
		Integrated Base	-9.33*	1.460	.000	-12.35	-6.31
	User Manual	Online Help	.58	1.333	.666	-2.17	3.34
		Integrated Base	-8.75*	1.577	.000	-12.01	-5.49
	Integrated Base	Online Help	9.33*	1.460	.000	6.31	12.35
		User Manual	8.75*	1.577	.000	5.49	12.01
Total Task Time	Online Help	User Manual	-22.04*	6.850	.004	-36.21	-7.87
		Integrated Base	15.50	7.504	.050	-2.22E-02	31.02
	User Manual	Online Help	22.04*	6.850	.004	7.87	36.21
		Integrated Base	37.54*	8.105	.000	20.78	54.31
	Integrated Base	Online Help	-15.50	7.504	.050	-31.02	2.22E-02
		User Manual	-37.54*	8.105	.000	-54.31	-20.78
Total Completion Time	Online Help	User Manual	-88.96*	13.048	.000	-115.95	-61.97
		Integrated Base	51.42*	14.294	.002	21.85	80.99
	User Manual	Online Help	88.96*	13.048	.000	61.97	115.95
		Integrated Base	140.38*	15.439	.000	108.44	172.31
	Integrated Base	Online Help	-51.42*	14.294	.002	-80.99	-21.85
		User Manual	-140.38*	15.439	.000	-172.31	-108.44
Unsuccessful Hits	Online Help	User Manual	2.92*	.540	.000	1.80	4.03
		Integrated Base	3.25*	.592	.000	2.03	4.47
	User Manual	Online Help	-2.92*	.540	.000	-4.03	-1.80
		Integrated Base	.33	.640	.607	-.99	1.66
	Integrated Base	Online Help	-3.25*	.592	.000	-4.47	-2.03
		User Manual	-.33	.640	.607	-1.66	.99

*. The mean difference is significant at the .05 level.

The Bonferroni Test

Multiple Comparisons

Bonferroni

Dependent Variable	(I) Assistance Mechanism	(J) Assistance Mechanism	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	User Manual	-7.96*	1.498	.000	-11.83	-4.09
		Integrated Base	-11.67*	1.641	.000	-15.90	-7.43
	User Manual	Online Help	7.96*	1.498	.000	4.09	11.83
		Integrated Base	-3.71	1.773	.143	-8.29	.87
	Integrated Base	Online Help	11.67*	1.641	.000	7.43	15.90
		User Manual	3.71	1.773	.143	-.87	8.29
Exploration Time	Online Help	User Manual	-17.63*	6.270	.030	-33.82	-1.43
		Integrated Base	28.67*	6.869	.001	10.93	46.40
	User Manual	Online Help	17.63*	6.270	.030	1.43	33.82
		Integrated Base	46.29*	7.419	.000	27.14	65.45
	Integrated Base	Online Help	-28.67*	6.869	.001	-46.40	-10.93
		User Manual	-46.29*	7.419	.000	-65.45	-27.14
"Help" Search Time	Online Help	User Manual	-46.83*	9.455	.000	-71.25	-22.42
		Integrated Base	8.92	10.358	1.000	-17.83	35.66
	User Manual	Online Help	46.83*	9.455	.000	22.42	71.25
		Integrated Base	55.75*	11.188	.000	26.86	84.64
	Integrated Base	Online Help	-8.92	10.358	1.000	-35.66	17.83
		User Manual	-55.75*	11.188	.000	-84.64	-26.86
Successful Hits	Online Help	User Manual	-.58	1.333	1.000	-4.03	2.86
		Integrated Base	-9.33*	1.460	.000	-13.10	-5.56
	User Manual	Online Help	.58	1.333	1.000	-2.86	4.03
		Integrated Base	-8.75*	1.577	.000	-12.82	-4.68
	Integrated Base	Online Help	9.33*	1.460	.000	5.56	13.10
		User Manual	8.75*	1.577	.000	4.68	12.82
Total Task Time	Online Help	User Manual	-22.04*	6.850	.011	-39.73	-4.36
		Integrated Base	15.50	7.504	.151	-3.87	34.87
	User Manual	Online Help	22.04*	6.850	.011	4.36	39.73
		Integrated Base	37.54*	8.105	.000	16.62	58.47
	Integrated Base	Online Help	-15.50	7.504	.151	-34.87	3.87
		User Manual	-37.54*	8.105	.000	-58.47	-16.62
Total Completion Time	Online Help	User Manual	-88.96*	13.048	.000	-122.65	-55.27
		Integrated Base	51.42*	14.294	.005	14.51	88.32
	User Manual	Online Help	88.96*	13.048	.000	55.27	122.65
		Integrated Base	140.38*	15.439	.000	100.51	180.24
	Integrated Base	Online Help	-51.42*	14.294	.005	-88.32	-14.51
		User Manual	-140.38*	15.439	.000	-180.24	-100.51
Unsuccessful Hits	Online Help	User Manual	2.92*	.540	.000	1.52	4.31
		Integrated Base	3.25*	.592	.000	1.72	4.78
	User Manual	Online Help	-2.92*	.540	.000	-4.31	-1.52
		Integrated Base	.33	.640	1.000	-1.32	1.98
	Integrated Base	Online Help	-3.25*	.592	.000	-4.78	-1.72
		User Manual	-.33	.640	1.000	-1.98	1.32

*. The mean difference is significant at the .05 level.

The Dunnett Test

Multiple Comparisons

Dunnett (2-sided)^a

Dependent Variable	(I) Assistance Mechanism	(J) Assistance Mechanism	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	Integrated Base	-11.67*	1.641	.000	-15.50	-7.83
	User Manual	Integrated Base	-3.71	1.773	.082	-7.85	.43
Exploration Time	Online Help	Integrated Base	28.67*	6.869	.001	12.62	44.71
	User Manual	Integrated Base	46.29*	7.419	.000	28.96	63.62
"Help" Search Time	Online Help	Integrated Base	8.92	10.358	.584	-15.28	33.11
	User Manual	Integrated Base	55.75*	11.188	.000	29.62	81.88
Successful Hits	Online Help	Integrated Base	-9.33*	1.460	.000	-12.74	-5.92
	User Manual	Integrated Base	-8.75*	1.577	.000	-12.43	-5.07
Total Task Time	Online Help	Integrated Base	15.50	7.504	.086	-2.03	33.03
	User Manual	Integrated Base	37.54*	8.105	.000	18.61	56.47
Total Completion Time	Online Help	Integrated Base	51.42*	14.294	.003	18.03	84.81
	User Manual	Integrated Base	140.38*	15.439	.000	104.31	176.44
Unsuccessful Hits	Online Help	Integrated Base	3.25*	.592	.000	1.87	4.63
	User Manual	Integrated Base	.33	.640	.810	-1.16	1.83

*. The mean difference is significant at the .05 level.

a. Dunnett t-tests treat one group as a control, and compare all other groups against it.

ANOVA Test Run

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Number of Completed Tasks	Between Groups	636.163	2	318.082	29.514	.000
	Within Groups	247.875	23	10.777		
	Total	884.038	25			
Exploration Time	Between Groups	7378.830	2	3689.415	19.549	.000
	Within Groups	4340.708	23	188.726		
	Total	11719.54	25			
"Help" Search Time	Between Groups	14056.70	2	7028.349	16.378	.000
	Within Groups	9869.917	23	429.127		
	Total	23926.62	25			
Successful Hits	Between Groups	383.833	2	191.917	22.502	.000
	Within Groups	196.167	23	8.529		
	Total	580.000	25			
Total Task Time	Between Groups	5061.087	2	2530.543	11.236	.000
	Within Groups	5179.875	23	225.212		
	Total	10240.96	25			
Total Completion Time	Between Groups	72919.05	2	36459.53	44.612	.000
	Within Groups	18796.79	23	817.252		
	Total	91715.85	25			
Unsuccessful Hits	Between Groups	60.865	2	30.433	21.704	.000
	Within Groups	32.250	23	1.402		
	Total	93.115	25			

Kruskall-Wallis H Test

Ranks

	Assistance Mechanism	N	Mean Rank
Number of Completed Tasks	Online Help	12	7.13
	User Manual	8	16.44
	Integrated Base	6	22.33
	Total	26	
Exploration Time	Online Help	12	13.50
	User Manual	8	20.50
	Integrated Base	6	4.17
	Total	26	
"Help" Search Time	Online Help	12	10.54
	User Manual	8	22.00
	Integrated Base	6	8.08
	Total	26	
Number of Times Assisted	Online Help	12	19.83
	User Manual	8	5.88
	Integrated Base	6	11.00
	Total	26	
Partially Successful Hits	Online Help	12	18.71
	User Manual	8	5.00
	Integrated Base	6	14.42
	Total	26	
Successful Hits	Online Help	12	10.29
	User Manual	8	10.81
	Integrated Base	6	23.50
	Total	26	
Total Access	Online Help	12	14.88
	User Manual	8	5.69
	Integrated Base	6	21.17
	Total	26	
Total Task Time	Online Help	12	12.75
	User Manual	8	20.19
	Integrated Base	6	6.08
	Total	26	
Total Completion Time	Online Help	12	12.08
	User Manual	8	22.50
	Integrated Base	6	4.33
	Total	26	
Unsuccessful Hits	Online Help	12	19.96
	User Manual	8	8.50
	Integrated Base	6	7.25
	Total	26	

Test Statistics^{a,b}

	Number of Completed Tasks	Exploration Time	"Help" Search Time	Number of Times Assisted	Partially Successful Hits	Successful Hits	Total Access	Total Task Time	Total Completion Time	Unsuccessful Hits
Chi-Square	17.695	15.684	14.710	17.178	15.912	13.531	14.890	11.980	20.141	16.361
df	2	2	2	2	2	2	2	2	2	2
Asymp. Sig.	.000	.000	.001	.000	.000	.001	.001	.003	.000	.000

a. Kruskal Wallis Test

b. Grouping Variable: Assistance Mechanism

Mann-Whitney U Test: Online Help Vs User Manual

Ranks

	Assistance Mechanism	N	Mean Rank	Sum of Ranks
Number of Completed Tasks	Online Help	12	7.08	85.00
	User Manual	8	15.63	125.00
	Total	20		
Exploration Time	Online Help	12	7.83	94.00
	User Manual	8	14.50	116.00
	Total	20		
"Help" Search Time	Online Help	12	6.83	82.00
	User Manual	8	16.00	128.00
	Total	20		
Number of Times Assisted	Online Help	12	14.42	173.00
	User Manual	8	4.63	37.00
	Total	20		
Partially Successful Hits	Online Help	12	14.33	172.00
	User Manual	8	4.75	38.00
	Total	20		
Successful Hits	Online Help	12	10.29	123.50
	User Manual	8	10.81	86.50
	Total	20		
Total Access	Online Help	12	13.71	164.50
	User Manual	8	5.69	45.50
	Total	20		
Total Task Time	Online Help	12	7.96	95.50
	User Manual	8	14.31	114.50
	Total	20		
Total Completion Time	Online Help	12	6.50	78.00
	User Manual	8	16.50	132.00
	Total	20		
Unsuccessful Hits	Online Help	12	14.17	170.00
	User Manual	8	5.00	40.00
	Total	20		

Test Statistics^a

	Number of Completed Tasks	Exploration Time	"Help" Search Time	Number of Times Assisted	Partially Successful Hits	Successful Hits	Total Access	Total Task Time	Total Completion Time	Unsuccessful Hits
Mann-Whitney U	7.000	18.000	4.000	1.000	2.000	45.500	9.500	17.500	.000	4.000
Wilcoxon W	85.000	94.000	82.000	37.000	38.000	123.500	45.500	95.500	78.000	40.000
Z	-3.185	-2.474	-3.397	-3.652	-3.583	-.196	-2.996	-2.367	-3.706	-3.434
Asymp. Sig. (2-tailed)	.001	.013	.001	.000	.000	.845	.003	.018	.000	.001
Exact Sig. [2*(1-tailed Sig.)]	.001 ^a	.012 ^b	.000 ^b	.000 ^b	.000 ^b	.851 ^a	.002 ^b	.016 ^b	.000 ^b	.000 ^b

a. Not corrected for ties.

b. Grouping Variable: Assistance Mechanism

Online Help Vs Integrated Base

Ranks

	Assistance Mechanism	N	Mean Rank	Sum of Ranks
Number of Completed Tasks	Online Help	12	6.54	78.50
	Integrated Base	6	15.42	92.50
	Total	18		
Exploration Time	Online Help	12	12.17	146.00
	Integrated Base	6	4.17	25.00
	Total	18		
"Help" Search Time	Online Help	12	10.21	122.50
	Integrated Base	6	8.08	48.50
	Total	18		
Number of Times Assisted	Online Help	12	11.92	143.00
	Integrated Base	6	4.67	28.00
	Total	18		
Partially Successful Hits	Online Help	12	10.88	130.50
	Integrated Base	6	6.75	40.50
	Total	18		
Successful Hits	Online Help	12	6.50	78.00
	Integrated Base	6	15.50	93.00
	Total	18		
Total Access	Online Help	12	7.67	92.00
	Integrated Base	6	13.17	79.00
	Total	18		
Total Task Time	Online Help	12	11.29	135.50
	Integrated Base	6	5.92	35.50
	Total	18		
Total Completion Time	Online Help	12	12.08	145.00
	Integrated Base	6	4.33	26.00
	Total	18		
Unsuccessful Hits	Online Help	12	12.29	147.50
	Integrated Base	6	3.92	23.50
	Total	18		

Test Statistics^a

	Number of Completed Tasks	Exploration Time	"Help" Search Time	Number of Times Assisted	Partially Successful Hits	Successful Hits	Total Access	Total Task Time	Total Completion Time	Unsuccessful Hits
Mann-Whitney U	.500	4.000	27.500	7.000	19.500	.000	14.000	14.500	5.000	2.500
Wilcoxon W	78.500	25.000	48.500	28.000	40.500	78.000	92.000	35.500	26.000	23.500
Z	-3.340	-3.005	-.798	-2.750	-1.573	-3.384	-2.077	-2.036	-2.909	-3.172
Asymp. Sig. (2-tailed)	.001	.003	.425	.006	.116	.001	.038	.042	.004	.002
Exact Sig. [2*(1-tailed Sig.)]	.000 ^b	.001 ^b	.437 ^b	.005 ^b	.125 ^b	.000 ^b	.041 ^b	.041 ^b	.002 ^b	.000 ^b

a. Not corrected for ties.

b. Grouping Variable: Assistance Mechanism

User Manual Vs Integrated Base

Ranks

	Assistance Mechanism	N	Mean Rank	Sum of Ranks
Number of Completed Tasks	User Manual	8	5.31	42.50
	Integrated Base	6	10.42	62.50
	Total	14		
Exploration Time	User Manual	8	10.50	84.00
	Integrated Base	6	3.50	21.00
	Total	14		
"Help" Search Time	User Manual	8	10.50	84.00
	Integrated Base	6	3.50	21.00
	Total	14		
Number of Times Assisted	User Manual	8	5.75	46.00
	Integrated Base	6	9.83	59.00
	Total	14		
Partially Successful Hits	User Manual	8	4.75	38.00
	Integrated Base	6	11.17	67.00
	Total	14		
Successful Hits	User Manual	8	4.50	36.00
	Integrated Base	6	11.50	69.00
	Total	14		
Total Access	User Manual	8	4.50	36.00
	Integrated Base	6	11.50	69.00
	Total	14		
Total Task Time	User Manual	8	10.38	83.00
	Integrated Base	6	3.67	22.00
	Total	14		
Total Completion Time	User Manual	8	10.50	84.00
	Integrated Base	6	3.50	21.00
	Total	14		
Unsuccessful Hits	User Manual	8	8.00	64.00
	Integrated Base	6	6.83	41.00
	Total	14		

Test Statistics^a

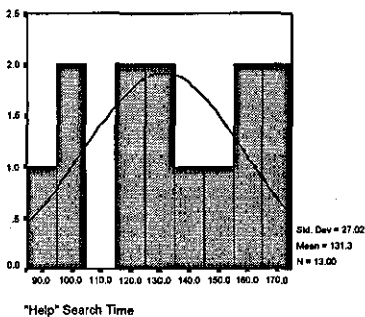
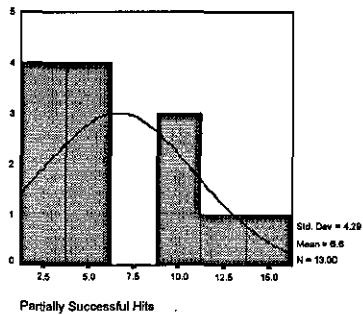
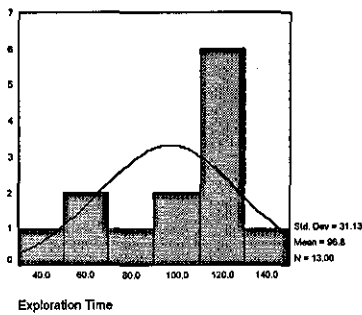
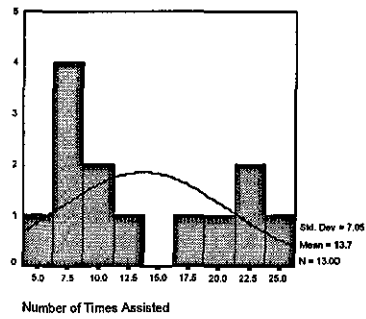
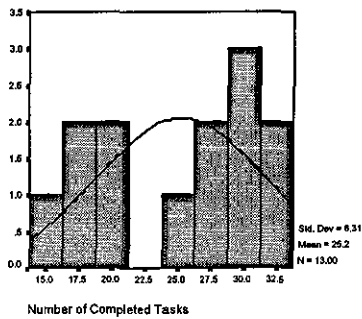
	Number of Completed Tasks	Exploration Time	"Help" Search Time	Number of Times Assisted	Partially Successful Hits	Successful Hits	Total Access	Total Task Time	Total Completion Time	Unsuccessful Hits
Mann-Whitney U	6.500	.000	.000	10.000	2.000	.000	.000	1.000	.000	20.000
Wilcoxon W	42.500	21.000	21.000	46.000	38.000	36.000	36.000	22.000	21.000	41.000
Z	-2.292	-3.102	-3.102	-1.875	-2.922	-3.119	-3.116	-2.973	-3.102	-.543
Asymp. Sig. (2-tailed)	.022	.002	.002	.061	.003	.002	.002	.003	.002	.567
Exact Sig. [2*(1-tailed Sig.)]	.020 ^b	.001 ^b	.001 ^b	.081 ^b	.003 ^b	.001 ^b	.001 ^b	.001 ^b	.001 ^b	.662 ^b

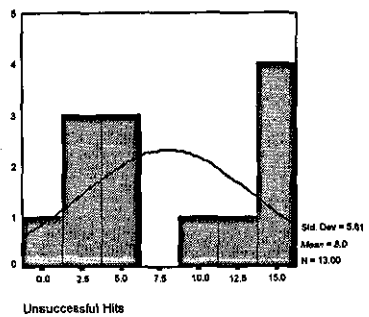
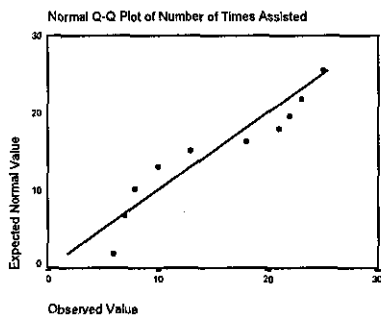
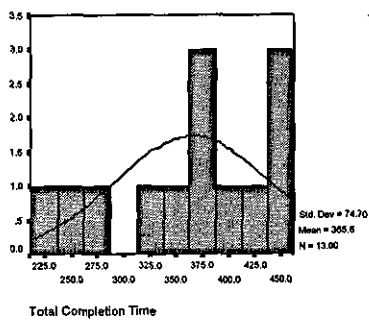
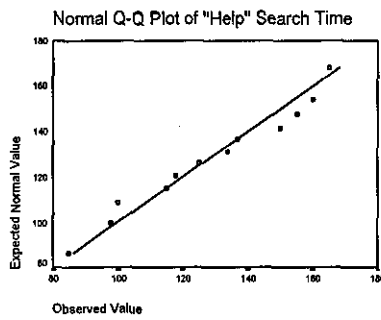
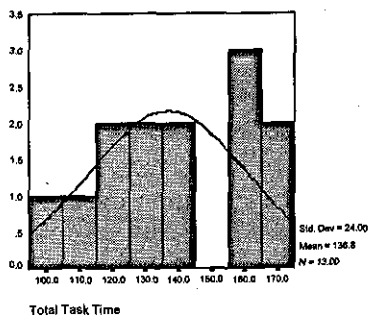
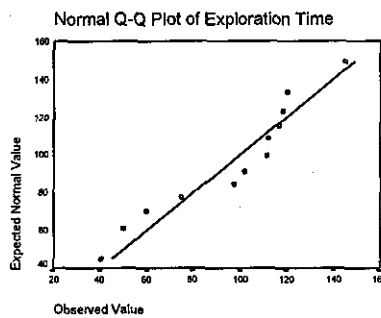
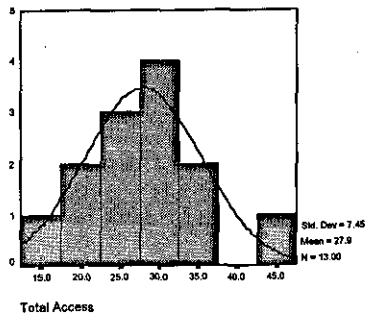
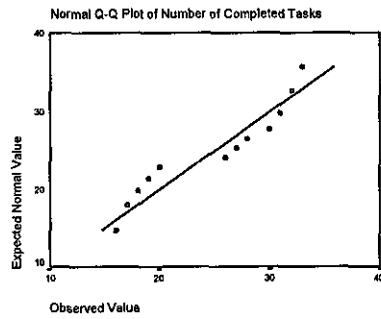
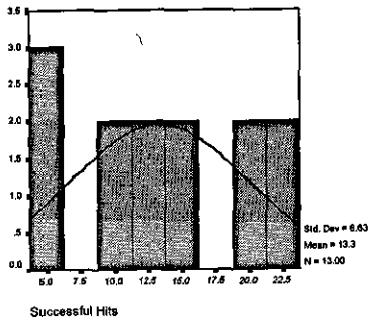
a. Not corrected for ties.

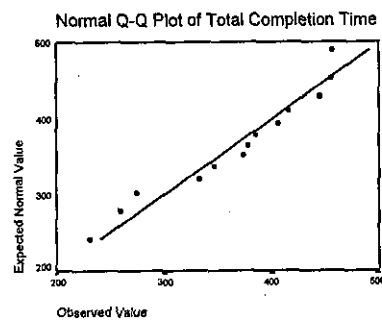
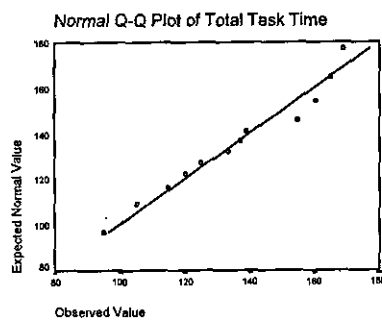
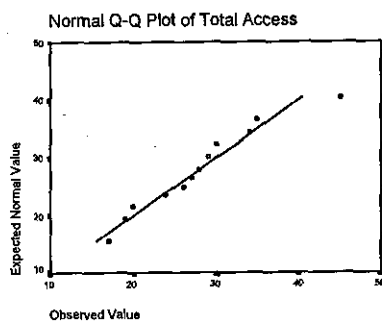
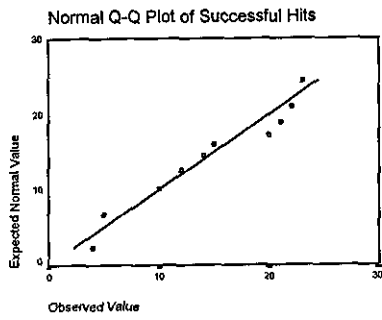
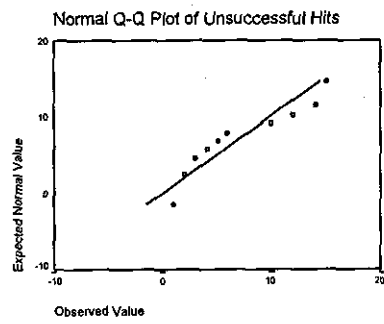
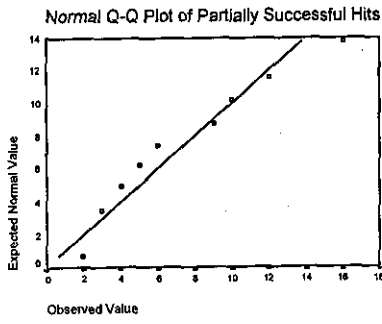
b. Grouping Variable: Assistance Mechanism

Novice Users across applications:

Probability Plots







Multiple Comparisons Test: LSD

Multiple Comparisons

LSD

Dependent Variable	(I) Assistance Mechanism	(J) Assistance Mechanism	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	User Manual	-11.00*	1.356	.000	-14.02	-7.98
		Integrated Base	-13.00*	1.566	.000	-16.49	-9.51
	User Manual	Online Help	11.00*	1.356	.000	7.98	14.02
		Integrated Base	-2.00	1.566	.230	-5.49	1.49
	Integrated Base	Online Help	13.00*	1.566	.000	9.51	16.49
		User Manual	2.00	1.566	.230	-1.49	5.49
Exploration Time	Online Help	User Manual	-22.80*	8.476	.023	-41.69	-3.91
		Integrated Base	49.40*	9.787	.001	27.59	71.21
	User Manual	Online Help	22.80*	8.476	.023	3.91	41.69
		Integrated Base	72.20*	9.787	.000	50.39	94.01
	Integrated Base	Online Help	-49.40*	9.787	.001	-71.21	-27.59
		User Manual	-72.20*	9.787	.000	-94.01	-50.39
Help Search Time	Online Help	User Manual	-23.20*	9.129	.029	-43.54	-2.86
		Integrated Base	36.47*	10.541	.006	12.98	59.95
	User Manual	Online Help	23.20*	9.129	.029	2.86	43.54
		Integrated Base	59.67*	10.541	.000	36.18	83.15
	Integrated Base	Online Help	-36.47*	10.541	.006	-59.95	-12.98
		User Manual	-59.67*	10.541	.000	-83.15	-36.18
Partially Successful Hits	Online Help	User Manual	7.60*	1.414	.000	4.45	10.75
		Integrated Base	7.20*	1.633	.001	3.56	10.84
	User Manual	Online Help	-7.60*	1.414	.000	-10.75	-4.45
		Integrated Base	-4.0	1.633	.811	-4.04	3.24
	Integrated Base	Online Help	-7.20*	1.633	.001	-10.84	-3.56
		User Manual	.40	1.633	.811	-3.24	4.04
Successful Hits	Online Help	User Manual	-6.20*	2.332	.024	-11.40	-1.00
		Integrated Base	-14.40*	2.693	.000	-20.40	-8.40
	User Manual	Online Help	6.20*	2.332	.024	1.00	11.40
		Integrated Base	-8.20*	2.693	.012	-14.20	-2.20
	Integrated Base	Online Help	14.40*	2.693	.000	8.40	20.40
		User Manual	8.20*	2.693	.012	2.20	14.20
Total Access	Online Help	User Manual	10.00*	4.082	.034	.90	19.10
		Integrated Base	5.33	4.714	.284	-5.17	15.84
	User Manual	Online Help	-10.00*	4.082	.034	-19.10	-9.0
		Integrated Base	-4.67	4.714	.348	-15.17	5.84
	Integrated Base	Online Help	-5.33	4.714	.284	-15.84	5.17
		User Manual	4.67	4.714	.348	-5.84	15.17
Total Task Time	Online Help	User Manual	-24.80*	10.163	.035	-47.44	-2.16
		Integrated Base	22.40	11.735	.085	-3.75	48.55
	User Manual	Online Help	24.80*	10.163	.035	2.16	47.44
		Integrated Base	47.20*	11.735	.002	21.05	73.35
	Integrated Base	Online Help	-22.40	11.735	.085	-48.55	3.75
		User Manual	-47.20*	11.735	.002	-73.35	-21.05
Total Completion Time	Online Help	User Manual	-72.80*	14.709	.001	-105.57	-40.03
		Integrated Base	108.27*	16.985	.000	70.42	146.11
	User Manual	Online Help	72.80*	14.709	.001	40.03	105.57
		Integrated Base	181.07*	16.985	.000	143.22	218.91
	Integrated Base	Online Help	-108.27*	16.985	.000	-146.11	-70.42
		User Manual	-181.07*	16.985	.000	-218.91	-143.22

*. The mean difference is significant at the .05 level.

Bonferroni

Multiple Comparisons

Bonferroni							
Dependent Variable	(I) Assistance Mechanism	(J) Assistance Mechanism	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	User Manual	-11.00*	1.356	.000	-14.89	-7.11
		Integrated Base	-13.00*	1.566	.000	-17.50	-8.50
	User Manual	Online Help	11.00*	1.356	.000	7.11	14.89
		Integrated Base	-2.00	1.566	.691	-6.50	2.50
Exploration Time	Online Help	User Manual	-22.80	8.476	.068	-47.13	1.53
		Integrated Base	49.40*	9.787	.002	21.31	77.49
	User Manual	Online Help	22.80	8.476	.068	-1.53	47.13
		Integrated Base	72.20*	9.787	.000	44.11	100.29
Help Search Time	Online Help	User Manual	-23.20	9.129	.088	-49.40	3.00
		Integrated Base	36.47*	10.541	.018	6.21	66.72
	User Manual	Online Help	23.20	9.129	.088	-3.00	49.40
		Integrated Base	59.67*	10.541	.001	29.41	89.92
Partially Successful Hits	Online Help	User Manual	7.60*	1.414	.001	3.54	11.66
		Integrated Base	7.20*	1.633	.004	2.51	11.89
	User Manual	Online Help	-7.60*	1.414	.001	-11.66	-3.54
		Integrated Base	-.40	1.633	1.000	-5.09	4.29
Successful Hits	Online Help	User Manual	-6.20	2.332	.072	-12.89	.49
		Integrated Base	-14.40*	2.693	.001	-22.13	-6.67
	User Manual	Online Help	6.20	2.332	.072	-.49	12.89
		Integrated Base	-8.20*	2.693	.037	-15.93	-4.47
Total Access	Online Help	User Manual	10.00	4.082	.103	-1.72	21.72
		Integrated Base	5.33	4.714	.853	-8.20	18.86
	User Manual	Online Help	-10.00	4.082	.103	-21.72	1.72
		Integrated Base	-4.67	4.714	1.000	-18.20	8.86
Total Task Time	Online Help	User Manual	-24.60	10.163	.104	-53.97	4.37
		Integrated Base	22.40	11.735	.256	-11.28	56.08
	User Manual	Online Help	24.60	10.163	.104	-4.37	53.97
		Integrated Base	47.20*	11.735	.007	13.52	80.88
Total Completion Time	Online Help	User Manual	-72.80*	14.709	.002	-115.02	-30.58
		Integrated Base	108.27*	16.985	.000	59.52	157.01
	User Manual	Online Help	72.80*	14.709	.002	30.58	115.02
		Integrated Base	181.07*	16.985	.000	132.32	229.81
Total Completion Time	Online Help	User Manual	-108.27*	16.985	.000	-157.01	-59.52
		Integrated Base	-181.07*	16.985	.000	-229.81	-132.32

*. The mean difference is significant at the .05 level.

Dunnett

Multiple Comparisons

Dunnett (2-sided)^a

Dependent Variable	(I) Assistance Mechanism	(J) Assistance Mechanism	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of Completed Tasks	Online Help	Integrated Base	-13.00*	1.566	.000	-16.98	-9.02
	User Manual	Integrated Base	-2.00	1.566	.356	-5.98	1.98
Exploration Time	Online Help	Integrated Base	49.40*	9.787	.001	24.53	74.27
	User Manual	Integrated Base	72.20*	9.787	.000	47.33	97.07
"Help" Search Time	Online Help	Integrated Base	36.47*	10.541	.011	9.68	63.25
	User Manual	Integrated Base	59.67*	10.541	.000	32.88	86.45
Partially Successful Hits	Online Help	Integrated Base	7.20*	1.633	.002	3.05	11.35
	User Manual	Integrated Base	-.40	1.633	.953	-4.55	3.75
Successful Hits	Online Help	Integrated Base	-14.40*	2.693	.001	-21.24	-7.56
	User Manual	Integrated Base	-8.20*	2.693	.022	-15.04	-1.36
Total Access	Online Help	Integrated Base	5.33	4.714	.430	-6.65	17.31
	User Manual	Integrated Base	-4.67	4.714	.512	-16.65	7.31
Total Task Time	Online Help	Integrated Base	22.40	11.735	.140	-7.42	52.22
	User Manual	Integrated Base	47.20*	11.735	.004	17.38	77.02
Total Completion Time	Online Help	Integrated Base	108.27*	16.985	.000	65.10	151.43
	User Manual	Integrated Base	181.07*	16.985	.000	137.90	224.23

*. The mean difference is significant at the .05 level.

a. Dunnett t-tests treat one group as a control, and compare all other groups against it.

ANOVA Test Run

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Number of Completed Tasks	Between Groups	432.308	2	216.154	46.990	.000
	Within Groups	46.000	10	4.600		
	Total	478.308	12			
Exploration Time	Between Groups	9830.308	2	4915.154	27.367	.000
	Within Groups	1796.000	10	179.600		
	Total	11626.31	12			
"Help" Search Time	Between Groups	6677.303	2	3338.651	16.025	.001
	Within Groups	2083.467	10	208.347		
	Total	8760.769	12			
Partially Successful Hits	Between Groups	171.077	2	85.538	17.108	.001
	Within Groups	50.000	10	5.000		
	Total	221.077	12			
Successful Hits	Between Groups	390.769	2	195.385	14.367	.001
	Within Groups	136.000	10	13.600		
	Total	526.769	12			
Total Access	Between Groups	250.256	2	125.128	3.003	.095
	Within Groups	416.667	10	41.667		
	Total	666.923	12			
Total Task Time	Between Groups	4332.308	2	2166.154	8.389	.007
	Within Groups	2582.000	10	258.200		
	Total	6914.308	12			
Total Completion Time	Between Groups	61546.01	2	30773.01	56.892	.000
	Within Groups	5409.067	10	540.907		
	Total	66955.08	12			

Kruskal-Wallis H Test

Ranks

	Assistance Mechanism	N	Mean Rank
Number of Completed Tasks	Online Help	5	3.00
	User Manual	5	8.90
	Integrated Base	3	10.50
	Total	13	
Exploration Time	Online Help	5	6.30
	User Manual	5	10.70
	Integrated Base	3	2.00
	Total	13	
"Help" Search Time	Online Help	5	6.60
	User Manual	5	10.40
	Integrated Base	3	2.00
	Total	13	
Number of Times Assisted	Online Help	5	11.00
	User Manual	5	4.50
	Integrated Base	3	4.50
	Total	13	
Partially Successful Hits	Online Help	5	11.00
	User Manual	5	4.20
	Integrated Base	3	5.00
	Total	13	
Successful Hits	Online Help	5	3.70
	User Manual	5	7.30
	Integrated Base	3	12.00
	Total	13	
Total Access	Online Help	5	9.70
	User Manual	5	4.40
	Integrated Base	3	6.83
	Total	13	
Total Task Time	Online Help	5	6.30
	User Manual	5	10.30
	Integrated Base	3	2.67
	Total	13	
Total Completion Time	Online Help	5	6.00
	User Manual	5	11.00
	Integrated Base	3	2.00
	Total	13	
Unsuccessful Hits	Online Help	5	11.00
	User Manual	5	6.00
	Integrated Base	3	2.00
	Total	13	

Test Statistics^{a,b}

	Number of Completed Tasks	Exploration Time	"Help" Search Time	Number of Times Assisted	Partially Successful Hits	Successful Hits	Total Access	Total Task Time	Total Completion Time	Unsuccessful Hits
Chi-Square	8.912	9.646	8.833	8.643	8.747	8.636	4.650	7.487	10.549	10.696
df	2	2	2	2	2	2	2	2	2	2
Asymp. Sig.	.012	.008	.012	.013	.013	.013	.098	.024	.005	.005

a. Kruskal Wallis Test

b. Grouping Variable: Assistance Mechanism

Mann-Whitney U Test: Online Help Vs User Manual

Ranks

	Assistance Mechanism	N	Mean Rank	Sum of Ranks
Number of Completed Tasks	Online Help	5	3.00	15.00
	User Manual	5	8.00	40.00
	Total	10		
Exploration Time	Online Help	5	3.30	16.50
	User Manual	5	7.70	38.50
	Total	10		
"Help" Search Time	Online Help	5	3.60	18.00
	User Manual	5	7.40	37.00
	Total	10		
Number of Times Assisted	Online Help	5	8.00	40.00
	User Manual	5	3.00	15.00
	Total	10		
Partially Successful Hits	Online Help	5	8.00	40.00
	User Manual	5	3.00	15.00
	Total	10		
Successful Hits	Online Help	5	3.70	18.50
	User Manual	5	7.30	36.50
	Total	10		
Total Access	Online Help	5	7.20	36.00
	User Manual	5	3.80	19.00
	Total	10		
Total Task Time	Online Help	5	3.70	18.50
	User Manual	5	7.30	36.50
	Total	10		
Total Completion Time	Online Help	5	3.00	15.00
	User Manual	5	8.00	40.00
	Total	10		
Unsuccessful Hits	Online Help	5	8.00	40.00
	User Manual	5	3.00	15.00
	Total	10		

Test Statistics^a

	Number of Completed Tasks	Exploration Time	"Help" Search Time	Number of Times Assisted	Partially Successful Hits	Successful Hits	Total Access	Total Task Time	Total Completion Time	Unsuccessful Hits
Mann-Whitney U	.000	1.500	3.000	.000	.000	3.500	4.000	3.500	.000	.000
Wilcoxon W	15.000	16.500	18.000	15.000	15.000	18.500	19.000	18.500	15.000	15.000
Z	-2.611	-2.305	-1.991	-2.611	-2.627	-1.897	-1.776	-1.886	-2.611	-2.643
Asymp. Sig. (2-tailed)	.009	.021	.047	.009	.009	.058	.076	.059	.009	.008
Exact Sig. (2*(1-tailed Sig.))	.008 ^b	.016 ^b	.056 ^b	.008 ^b	.008 ^b	.056 ^b	.095 ^b	.056 ^b	.008 ^b	.008 ^b

a. Not corrected for ties.

b. Grouping Variable: Assistance Mechanism

Online Help Vs Integrated Base

Ranks

	Assistance Mechanism	N	Mean Rank	Sum of Ranks
Number of Completed Tasks	Online Help	5	3.00	15.00
	Integrated Base	3	7.00	21.00
	Total	8		
Exploration Time	Online Help	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
"Help" Search Time	Online Help	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
Number of Times Assisted	Online Help	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
Partially Successful Hits	Online Help	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
Successful Hits	Online Help	5	3.00	15.00
	Integrated Base	3	7.00	21.00
	Total	8		
Total Access	Online Help	5	5.50	27.50
	Integrated Base	3	2.83	8.50
	Total	8		
Total Task Time	Online Help	5	5.60	28.00
	Integrated Base	3	2.67	8.00
	Total	8		
Total Completion Time	Online Help	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
Unsuccessful Hits	Online Help	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		

Test Statistics^a

	Number of Completed Tasks	Exploration Time	"Help" Search Time	Number of Times Assisted	Partially Successful Hits	Successful Hits	Total Access	Total Task Time	Total Completion Time	Unsuccessful Hits
Mann-Whitney U	.000	.000	.000	.000	.000	.000	2.500	2.000	.000	.000
Wilcoxon W	15.000	6.000	6.000	6.000	6.000	15.000	8.500	8.000	6.000	6.000
Z	-2.236	-2.236	-2.236	-2.236	-2.249	-2.249	-1.500	-1.640	-2.236	-2.306
Asymp. Sig. (2-tailed)	.025	.025	.025	.025	.024	.024	.134	.101	.025	.021
Exact Sig. [2*(1-tailed Sig.)]	.036 ^a	.036 ^a	.036 ^a	.036 ^a	.036 ^a	.036 ^a	.143 ^a	.143 ^a	.036 ^a	.036 ^a

a. Not corrected for ties.

b. Grouping Variable: Assistance Mechanism

User Manual Vs Integrated Base

Ranks

	Assistance Mechanism	N	Mean Rank	Sum of Ranks
Number of Completed Tasks	User Manual	5	3.90	19.50
	Integrated Base	3	5.50	16.50
	Total	8		
Exploration Time	User Manual	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
"Help" Search Time	User Manual	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
Number of Times Assisted	User Manual	5	4.50	22.50
	Integrated Base	3	4.50	13.50
	Total	8		
Partially Successful Hits	User Manual	5	4.20	21.00
	Integrated Base	3	5.00	15.00
	Total	8		
Successful Hits	User Manual	5	3.00	15.00
	Integrated Base	3	7.00	21.00
	Total	8		
Total Access	User Manual	5	3.60	18.00
	Integrated Base	3	6.00	18.00
	Total	8		
Total Task Time	User Manual	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
Total Completion Time	User Manual	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		
Unsuccessful Hits	User Manual	5	6.00	30.00
	Integrated Base	3	2.00	6.00
	Total	8		

Test Statistics^a

	Number of Completed Tasks	Exploration Time	"Help" Search Time	Number of Times Assisted	Partially Successful Hits	Successful Hits	Total Access	Total Task Time	Total Completion Time	Unsuccessful Hits
Mann-Whitney U	4.500	.000	.000	7.500	6.000	.000	3.000	.000	.000	.000
Wilcoxon W	19.500	6.000	6.000	13.500	21.000	15.000	18.000	6.000	6.000	6.000
Z	-.900	-2.236	-2.249	.000	-.455	-2.249	-1.342	-2.236	-2.236	-2.249
Asymp. Sig. (2-tailed)	.368	.025	.024	1.000	.649	.024	.180	.025	.025	.024
Exact Sig. [2* (1-tailed Sig.)]	.393 ^a	.036 ^a	.036 ^a	1.000 ^a	.786 ^a	.036 ^a	.250 ^a	.036 ^a	.036 ^a	.036 ^a

a. Not corrected for ties.

b. Grouping Variable: Assistance Mechanism