Loughborough University

This item was submitted to Loughborough's Research Repository by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Architecture of mobile formative assessment system (m-FAS) for enhancing students learning

PLEASE CITE THE PUBLISHED VERSION

PUBLISHER

© International Institute of Informatics and Systemics (IIIS)

VERSION

AM (Accepted Manuscript)

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Abdulwahed, Mahmoud, Zoltan K. Nagy, and Richard E. Blanchard. 2009. “Architecture of Mobile Formative Assessment System (m-fas) for Enhancing Students Learning”. figshare. https://hdl.handle.net/2134/5205.

Loughborough University

This item was submitted to Loughborough's Institutional Repository (https://dspace.lboro.ac.uk/) by the author and is made available under the following Creative Commons Licence conditions.

creative commons

COMMONS DEED

Attribution-NonCommercial-NoDerivs 2.5

You are free:

- to copy, distribute, display, and perform the work

Under the following conditions:

Attribution. You must attribute the work in the manner specified by the author or licensor.

Noncommercial. You may not use this work for commercial purposes.

No Derivative Works. You may not alter, transform, or build upon this work.

- For any reuse or distribution, you must make clear to others the license terms of this work.
- Any of these conditions can be waived if you get permission from the copyright holder.

Your fair use and other rights are in no way affected by the above.

This is a human-readable summary of the Legal Code (the full license).

Disclaimer

For the full text of this licence, please go to:
http://creativecommons.org/licenses/by-nc-nd/2.5/

Architecture of Mobile Formative Assessment System (m-FAS) for Enhancing Students Learning

Mahmoud Abdulwahed
Engineering Center of Excellence in Teaching and Learning, Loughborough University
Loughborough, LE11 3TU, UK

Zoltan K Nagy
Chemical Engineering Department, Loughborough University
Loughborough, LE11 3TU, UK

Richard Blanchard
Electrical Engineering Department, Loughborough University
Loughborough, LE11 3TU, UK

ABSTRACT

The m-FAS is a methodology of embedding automatic feedback concept of automatic control system theory into the pedagogical process for enhancing learning process by quick delivery of formative assessment for large number of students. Feedback is the core concept of system theory, it has enormous benefits in engineering design, it is inherited practice in natural systems, and it has been shown in the pedagogical research that feedback proved positive impact on students learning. Formative assessment is one practice of feedback, pedagogical research has recently emphasized on its role and the importance of delivery it quickly to the students, however this becomes real challenge when targeting large numbers classes. The time delay in Formative Assessment (FA) delivery can be greatly reduced utilizing short SMS messages sent to the students mobile numbers during the learning process and by developing an automated mechanism of implementing (FA)messages for large number of students. In this papers, we propose systematic architecture of general framework that can be used for generating formative assessment data and delivering it by SMS messages.

Keywords: Feedback, System Theory, Formative Assessment, Mobile Learning.

1. INTRODUCTION

In its national student survey in 2005 and 2006, the Higher Education Funding Council for England (HEFCE) has found that UK students are least satisfied with feedback and assessment. In particular the students think that they do not receive enough formative feedback**.** Indeed, a growing body of pedagogical research indicates that giving feedback is the most effective method we can do to foster and maintain student learning. It also suggest that late feedback is not useful and emphasizes on the importance of delivering it within 24 hours [1].

Feedback is the most important principle in Systems and Control Theory. In technical system, it is well established that feedback is mainly leading to improve the system's robustness, disturbance rejection, stability criteria, and reference goals tracking [2]. Hence, control engineers aim always at closing the loop in their engineering designs. In analogous way, formative assessment is a pedagogical approach for feeding the students back useful information to bridge the gap in their learning process [3].

In other words, formative assessment is transforming the teaching and learning from open loop to closed loop structure by providing the students with some feedback about their performance. This sort of methodology has received attention recently and proved positive impact on students learning and retention [1] and [4]. Many case studies and advices of delivering formative assessment can be found in [3].

However, formative assessment becomes real challenge when it approaches generating and delivering feedback for large classes. To overcome this challenge, we propose developing the m-FAS as a novel pedagogical instrument.

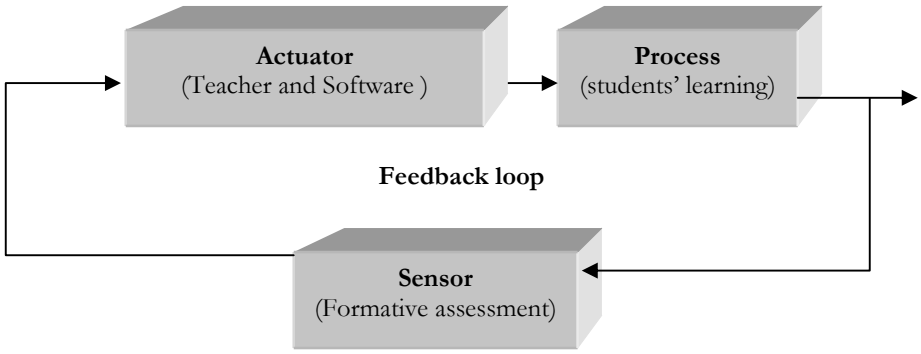

FIGURE 1.
SIMPLIFIED CLOSED LOOP STRUCTURE OF M-FAS.

The main objective of the m-Formative Assessment System (m-FAS) is to enhance the students' learning process and to provide a solution to the problem of delivering fast formative feedback for large classes. It can function as monitoring and fault diagnosis unit for early diagnosing of students draw in the learning process.

In m-FAS, students will be receiving immediate formative feedback with useful information about their participation activities in the classroom, general advices, alarm messages, recommendations, etc. It is also planned to develop delivering formative unit to the student's parents to regularly inform them about their children learning, in our opinion, this can foster additional external feedback and monitoring loop done by parents based on the received messages from m-FAS. These information will be delivered through SMS (Short Messages Service) messages to the students or the parents mobile numbers.

2. ARCHITECTURE OF THE M-FAS

Despite its effectiveness and the fact that it has found its innovative usage in some social sciences fields such as economy, systems theory is seldom taken into consideration in pedagogical research and design (Rompelman et al, 2006). One of the m-FAS novelties is that its design is directly derived from a systems theory point of view, we draw our design on two main concepts in system theory: 1- feedback 2-monitoring and fault diagnosis.

The main components of the m-FAS are:

- Process (Students' learning).
- Actuator (Teacher).
- Feedback generator (Formative feedback generator).

Simplified closed loop structure of m-FAS in Figure 1.

To cope with the problem of providing fast feedback for large classes, an automated blocks for m-FAS can be developed and joined with currently available technology for automatic answering of multiple choice questions during the lecture using electrical voting system (e-Voting) such as the one provided by 'Interwrite Learning' or 'Turning Point' learning technologies companies [5] and [6]. The methodology of the m-FAS process is illustrated in the following subsection.

Methodology:

The m-FAS is processing data gathering and delivery according to the following algorithm:

1. The teacher will design special multiple choice questions emphasizing on key points of the lecture.(5-6 questions in average for each one hour lecture).
2. Questions will show up frequently during the lecture (identification process) for students to answer.
3. Students will answer the questions using the remote voting system.
4. The answers will be collected and stored automatically.
5. Formative information will be extracted from the stored data.
6. Formative assessment SMSs will be created.
7. Formative feedback will be sent to the students mobile numbers using SMS messaging system.

Stages 2, 3, and 4 will be automated by using the electrical voting hardware and software systems [5] or [6]. While stages 5, 6, 7 can be automated by developing a messaging system to be coupled with the electronic voting software.

Using the multiple choice question is analogue to pumping energy into a system for identification purpose

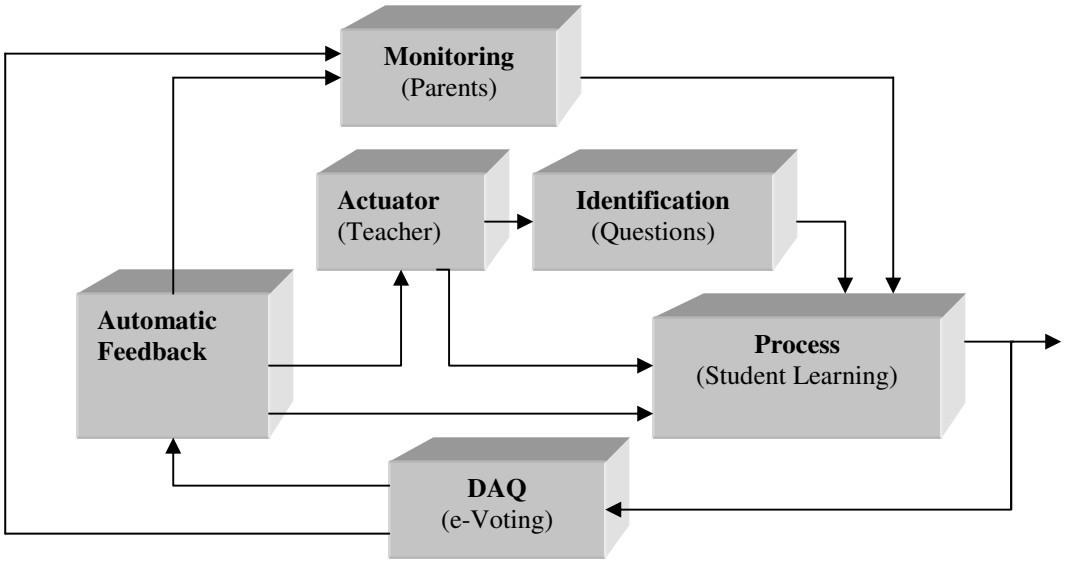

FIGURE 2
SYSTEMATIC CONCEPTUAL MODEL OF THE M-FAS METHODOLOGY.

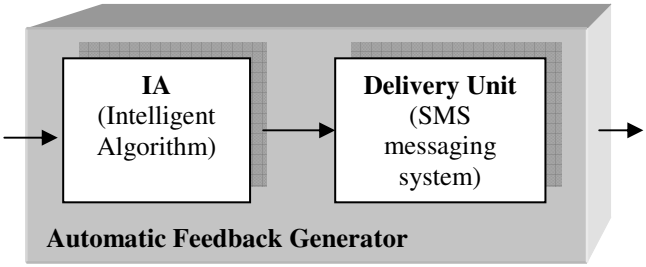

FIGURE 3
STRUCTURE OF THE AUTOMATIC FEEDBACK GENERATOR.

in control engineering language, extended systematic conceptual model of m-FAS is show in Figure 2.

There are three main closed loops in this model:

- **Loop 1:** Process - DAQ (Data Acquisition) - Automatic Feedback.
- **Loop 2:** Process – DAQ - Automatic Feedback - Actuator.
- **Loop 3:** Process – DAQ - Automatic Feedback - Monitoring.

Loop 1 is the core of m-FAS, it works automatically on delivering feedback to the students, which can dramatically reduce the effort spent by the teacher in order to do this personally for each student. The main block in this loop is the Automatic Feedback block which is composed of two main components: Intelligent Algorithm and Delivery Unit.

The intelligent algorithm (IA) will process the data received by the DAQ and try to infer significant conclusions which will be transferred to the delivery unit. The latter will send these conclusions to the students and other parties (teacher and/or parents) in form of SMS messages. The IA may be implemented using fuzzy logic, statistical inference techniques, or both.

Figure 3 shows block diagram of the automatic feedback generator system.

3. PRELIMINARY EVALUATION OF STUDENTS ATTITUDE TOWARDS THE M-FAS

To measure the students attitude towards the m-FAS, we have conducted small action research by delivering a questionnaire to the MSc students of the Batch Processing module, which was taught between 23-27, April, 2007 in the Chemical Engineering Department at Loughborough university.

The e-Voting system was used during the module lectures, the questions were designed to assess students attitude towards embedding the e-Voting system and the SMS messages in the module, they were:

- Q1- How did you find the idea of using the e-Voting system in the lectures?
- Q2- What do you think about the idea of receiving SMS with your average score?
- Q3- What do you think about the idea of receiving SMS with corrections to your wrong answers?
- Q4- What do you think about the idea of receiving SMS with short advices for recovering

the weak areas of your performance during the lecture?

- Q5- What do you think about the idea of receiving SMS comparing your performance with the average class score ?
- Q6- What do you think about the idea of receiving SMS comparing your performance with the highest score?
- Q7- In general, do you like the idea of receiving the SMSs ?
- Q8- Did asking the multiple choice questions help in keeping your attention to the lecture?
- Q9- What additional formative SMS messages would you like to receive?

About 90% of the students liked the idea of receiving formative SMSs (Q7), while 78% thought that using the e-Voting system in the lecture was very good idea. In both questions, negative attitude has not been reported. The other responses regarding the sort of formative assessment the students desire varied mainly between 'Very Good' and 'Good'.

TABLE 1
STATISTICS OF THE COLLECTED DATA

	Very Good	Good	Useless
Question 1	77.80 %	22.20 %	00.00 %
Question 2	66.70 %	33.30 %	00.00 %
Question 3	55.60 %	33.30 %	11.10 %
Question 4	55.60 %	44.40 %	00.00 %
Question 5	44.40 %	55.60 %	00.00 %
Question 6	44.40 %	55.60 %	00.00 %
Question 7	88.90 %	11.10 %	00.00 %

There has been 14 student registered with the module, 9 of them responded and filled up the questionnaire after the module end, the sample number of the surveyed students is small, however, the statistic provided rather good indication on the students positive attitude towards the m-FAS. It also reflects their desire of receiving more formative assessment and feedback.

The application of the e-Voting system has another advantage than the intended one of automatic collection of answers. It can aid in keeping students attention during the lecture.

The research on attention pattern is not recent, it has been found that students attention declines steadily during the lecture with multi factorial dependant rate [7]. This may be the main reason that the lecture information is not received effectively by the students, sever drop in attention after 10-18 minutes from lecture starting has been reported [7].

One core of this problem is to prompt students to think on factual questions repeatedly during the lecture [8]. This can be greatly facilitated by using the electrical voting system. Recent empirical research found positive impact of using the voting cards on students learning process [9].

In Q8 there has been three choices to answer:

- Yes.
- To some extent.
- Not at all.

The question aimed to measure the attention retention during the lecture when the voting cards are used. All students responded with 'Yes'.

The e-Voting system provides the possibility for all students to participate in a similarly active way during the lecture, which is has proved to be very efficient in the case of shyer students (which is often the case of international students) or students e.g. with speech disorder.

The m-FAS delivered messages can be extended in many ways. In the open ended question Q9, many students reported that they would like to receive info about latest module updates, news, schedule, alarms in case of emergency, and some educational content.

4. CONCLUSION

The architecture discussed in this paper provides general framework for developing automatic formative assessment delivery system, it can be multifunctional and used for another purposes such as monitoring and alarming. Based on our measurement, we expect that students would have positive attitude towards embedding the m-FAS into their learning process. We think that m-FAS can notably enhance this process, future empirical research should be taken to verify our hypothesis.

5. REFERENCES

[1] Race P, "Making Learning Happen", Sage (Paul Chapman) Publications 2005.

[2] Goodwin GC, Graebe SF, "Control System Design" , Prentice Hall 2001.

[3] Juwah C, Macfarlane-Dick D, Matthew B, Nicol D, Ross D, and Smith B, "Enhancing student learning through effective formative feedback", The Higher Education Academy Generic Centre - June 2004.

[4] Black P , "Assessment and feedback in science education", Studies in Educational Evaluation, 1995.

[5] Interwrite, http://www.interwritelearning.com, Retrieved on 19.05.2008

[6] Turningpoint, http://www.turningtechnologies.co.uk, Retrieved on 19.05.2008.

[7] Johnstone AH, Percival F, "Attention Breaks in Lectures"., Education in Chemistry, 13, 2, 49-50, Mar 1976.

[8] Middendorf J, Kalish A , "The change-up in lectures", The National Teaching and Learning Forum, 1996

[9] Kennedy GE, Cutts QI, "The Association between Students' Use of an Electronic Voting System and their Learning Outcomes", Journal of Computer Assisted Learning, v21 n4 p260-268 Aug 2005