SQU E-learning in Large Multi-Section Mathematics Courses

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Abstract:

The Department of Mathematics and Statistics at Sultan Qaboos University adopts the system of uniform testing and grading for all its multi-section courses. Moodle is used as a Course Management System. Courses such as pre-calculus have as many as 20 to 25 sections of 40 to 45 students per section per semester. Handling all of these sections and students constitute a real challenge.

We will explore how we handled the situation. In particular we will shed light on the pros and cons of running a management system for such large population of students and instructors alike. Furthermore we will discuss the use of mathematical tools such as graphing devices, dynamic HTML and simple computer algebra system embedded in Moodle to enhance the understanding of mathematics and make it fun for students to learn and explore new concepts.

1. INTRODUCTION

It used to be that in classes where the number of students did exceed 20 most of learning experience took place inside the classroom. The instructor explained the principles gave some examples and then gave students the chance to solve some practice problems in-class. If those students had queries they were answered during the class.

Those days however are long gone as the class size got bigger and bigger. Now in class of 40 students and above the instructor cannot even ask his students do you have any questions. If only half the class has a single question then at least 20 minutes are spent answering them.

In these days instructors are relying on modern technology for compensate for the old one-to-one interaction between students and educators. Through Course Management Systems such as Moodle, Black Board and WeBCT educators now have means to make their students answer most of their queries through either educator-to-student interaction or student-to-student interaction.

As the time of the learning process inside the classroom is very limited educators are now providing their students with a 24/7 access to learning material via the Course Management System.

The best learning and exchange of ideas takes place in an environment where all three primary senses are used:

- Seeing
- Hearing
- Doing

Thus the Course Management System will not be efficient till it mimics at least an ideal classroom experience in addition to items that cannot be done inside the classroom due to time of other constraints.

The classroom experience typically provides seeing and hearing without much actual doing. Homework and individual study usually provide some doing and seeing – but no hearing and no interaction or feedback. Finally classroom examinations provide the doing, but by then – even with proper feedback, which is frequently absent - the period of actual learning is over.

A lot of is being done to integrate interactivity into the classroom experience. But this requires a reasonable class size, a dedicated teacher with appropriate training and the corresponding materials, equipment and/or technology. These requirement are scarce especially education institutions with limited budgets. It is these reasons that make interactivity usually limited to "experiments" or "team projects".

Interactive experiments work well in natural science classes and team projects work well in social science classes such as history and geography. Further, this type of interactivity usual clarifies physical happenings such as "No light, no plant growth." and not exposition or technique development. So it is indeed difficult to get an interactive experience in mathematics in the classroom.

Colleges and universities are reducing expenses by giving professors bigger teaching loads and large class sizes. They defend these actions by saying that technology and websites are compensating for the decrease in live teacher-student interaction. Most course websites contain merely some the course syllabus, some lecture notes, homework assignments and dates of examinations. The pressure on educators to use technology has pushed a lot to abuse the use of PowerPoint presentations to turn the classroom experience to a non-experience. So in short this kind of technology is working against the student.

Learning used to be carried out through gradual exposure and sequential understanding which comes when a teacher solves a problem at the board step-by-step while interacting with the students through eye-contact and good questions and adapting his explanation to the classroom situation.

Now learning is carried out in a darkened room and treated to a line-by-line exposure of pre-prepared lectures – almost in an atmosphere of a lecturer reading the textbook aloud. Further, if the student misunderstands or misses part of an explanation in the classroom the notes and website content will certainly prove inadequate. These practices lead us to ask the harsh question: where is active learning?

Our primary goal in this paper is to describe what we at Sultan Qaboos University are doing to handle the multi-section courses with large class size while developing educational content for mathematics in a blended eLearning environment that combines hearing, seeing and doing.

Such resources engage the user actively in the learning process, thus empowering pupils and students to be responsible for their own education. This move from passive observer to active learner is of vital importance both in terms of real understanding and as learning itself becomes a lifelong process [5], [6].

2. Key Components of Good Math eLearning Website

In order for any e-site to be effective it must contain a good:

- Easy Site Management
- Needed Educational content
- Graphical Resources
- Manageable Feedback system

There is no single way of achieving the above content. However, we will expose how we at Sultan Qaboos University tried to embed these components into our blended eLearning site.

2.1 Easy Site Management

For the most part the maintenance of course in the Course Management system has become the responsibility of the instructor of the course. It is then important to design the site such that the maintenance is not time consuming. Of course the design will facilitate that task.

Great care has to put into the design of site to make it easy to manage later on. The time well spent into the thinking of the design will pay its dividend during the maintenance of site. There is material that one uploads only once a semester and there is material that one has to update periodically such as announcements, quiz and test dates and so forth. It is always a good idea to

put the static data such as old exams and useful links below the dynamic data such announcements and solutions of tests and so forth. See the figure below for a simple sample Moodle site.
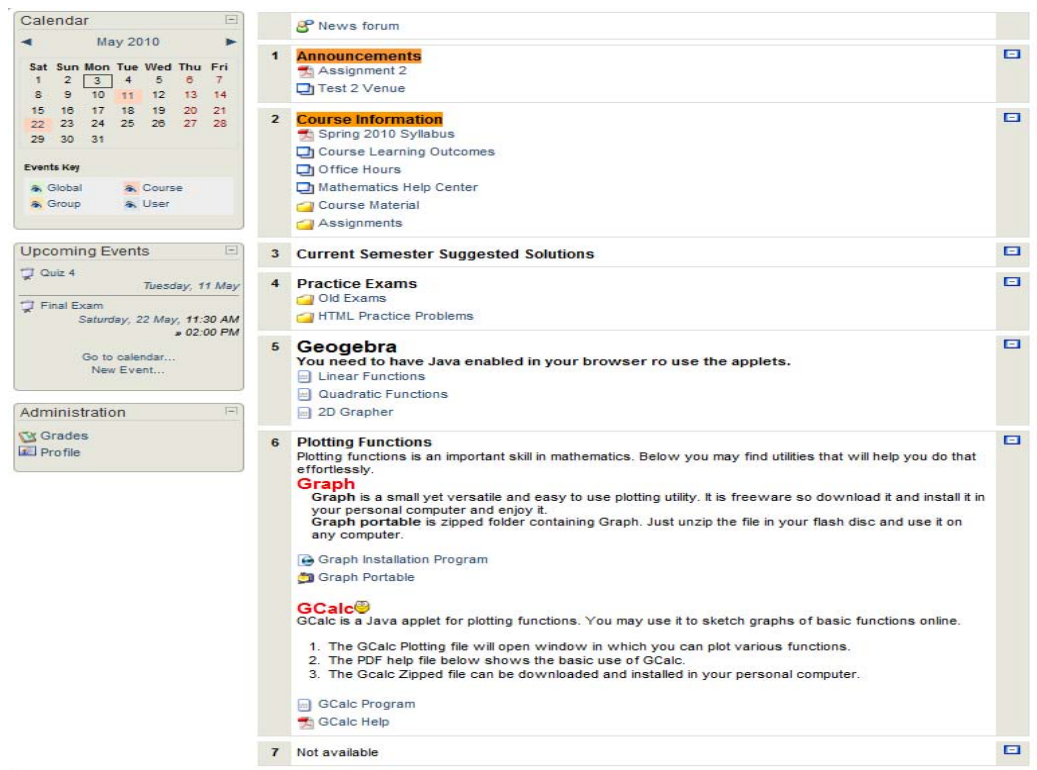

Figure 1: Sample Simple Moodle Site

One of the strength of Course Management System is the dissemination of information. With a few keyboards strokes you can tell all 900+ students and 20+ instructors of the course about any event. Furthermore, we save a lot of paper as we no longer have to print the 4 page syllabus of course. The calendar option is great tool to schedule all course events in timely fashion and have course users access them 24/7. Any changes can also be done with just few stoles and reflected immediately.

For the block "**Announcements**" all items could be entered at the beginning of semester. After which you show only what you want the students to see when you want them to see it. So the block from the administrator point of view would look like:
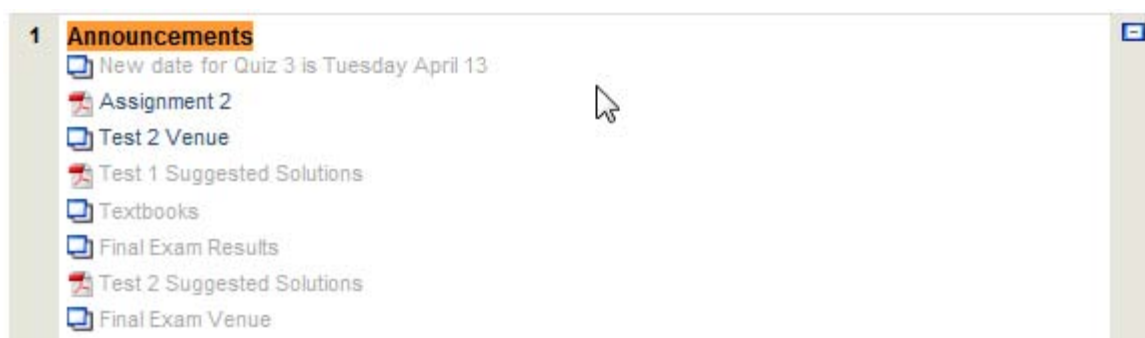
Figure 2: Administrator View

The dimmed items are items that students do not see. Students will see only the picture below.

Figure 3: Announcements Student View

We found from experience that student loved the resource about "**Practice Exams**" especially before specific tests and quizzes. Most students visited this resource to brush up and try to find out what to expect in their future examinations.

2.2 Needed Educational Content

No matter how well designed a site is, if it does not contain a good educational content that students need then they will not visit it. So educators have to put material needed by their students to understand the course material and help them in their quest to achieving good grades in the course.

One big problem that we face with our students is that they forget material they have learned either in previous classes of high school. A practice we tried that proved beneficial is to provide students with review of pre-requisite material in the course such as review of Basic Algebra and any items that are required to understand the present course at hand. At SQU most of our new students come from the public sector in which they studied mathematics in Arabic. We give our students translations of mathematical terminology so they may speed up the transition to college mathematics done in English.

Among the file we make available for students at the beginning of the semester are:

- Arabic-English Glossary: translation of mathematical terminology from Arabic to English.
- Formula Sheet: containing the usual formulas we find at the beginning and end of textbooks.

- Review of Basic Algebra: containing basic algebra such as numbers, basic operation, factoring and so forth.
- Review of Analytic Geometry: coordinates system, distance between points, line and circles.
- Basic Functions: containing a library of basic functions.
- Solutions of selected exercises from the textbook such as odd-numbered.

Course Material

NAME	SIZE	MODIFIED
Arabic-Eng_Glossary.pdf	1.4MB	28 September 2009, 09:54 AM
Basic_Functions.pdf	237.8KB	13 February 2010, 09:40 AM
Figures_and_Formulas.pdf	290KB	14 October 2009, 11:23 AM
Formula_Sheet.pdf	781.4KB	14 October 2009, 11:25 AM
Pages84-87.pdf	1.8MB	5 October 2009, 09:20 AM
Review_of_Algebra.pdf	421.9KB	14 October 2009, 11:22 AM
Review_of_Analalytic_Geometry.pdf	293.1KB	14 October 2009, 11:23 AM
SP10-M1101-Syllabus.pdf	57.9KB	8 February 2010, 09:49 AM
Solutions_Odd-Numbered.pdf	6.7MB	9 November 2009, 03:50 PM

Figure 4: Course Review Content

Not only these will help the students recall important facts required for the course, but it also relives the instructor from doing all of these in class. It is worth mentioning that students have to made aware of such resources as frequently as needed. In particular when instructors need students to review a certain topic, they make an announcement to students to review the topic and probably setup a link to the resource.

2.3 Graphical Resources

Some of the best ways to make students understand and appreciate mathematics is giving them the ability to explore mathematics and practice it on their own while learning. Our experience showed that Course Management System resources that allow students in an active learning environment had the greatest impact to improving understanding of the material. We mainly used visual learning combined with do it yourself learning to help students better understand mathematical concepts through plotting of functions. We use these plotting utilities not only to graph basic mathematical function but also to solve equations and inequalities. These resources made the link between the analytical, numerical and graphical solutions. We emphasize to students that even though they think that these concepts are different but in reality they are the same seen from different points of view.

We used GeoGebra's ability to export dynamic HTML files to make a set of basic functions. This allowed students the manipulations of various graphs and the exploration of the behavior of these functions while solving specific equation of inequalities.
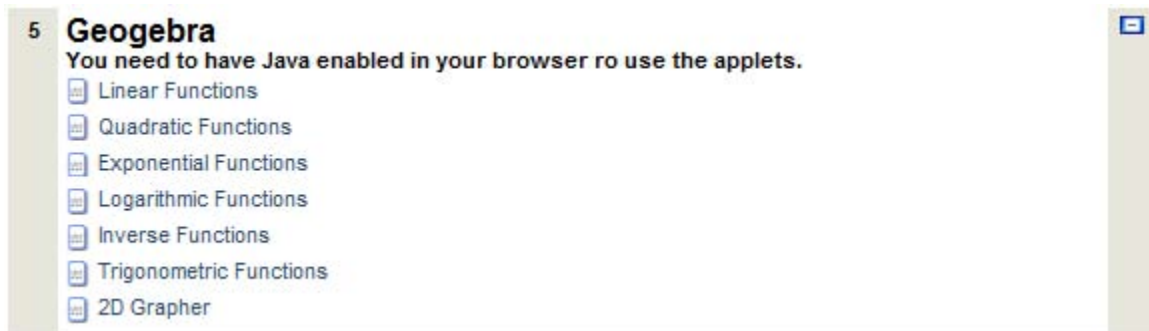

5 Geogebra
You need to have Java enabled in your browser ro use the applets.
- Linear Functions
- Quadratic Functions
- Exponential Functions
- Logarithmic Functions
- Inverse Functions
- Trigonometric Functions
- 2D Grapher

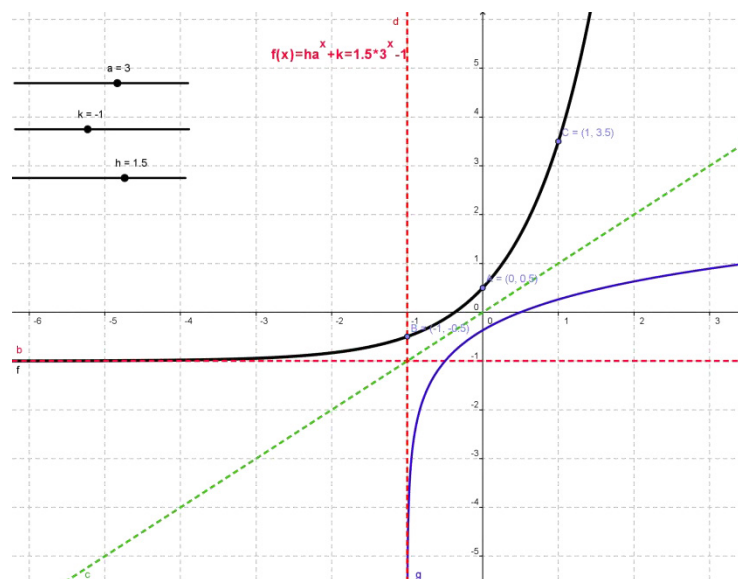Figure 5: GeoGebra Basic Dynamic Functions

Figure 6: Example of Dynamic Functions

2.4 Manageable Feedback System

Probably one of the most important features of a successful Course Management System is the forum discussion module. However, managing such forums for large number of students is very cumbersome and time consuming. That is why we opted not to use it in our course. We prefer getting students feedback through surveys rather than having all students write their feedbacks thru forums. In places where discussion forums are not commonly used the sensitive issue of proper behavior is always present.

As one of professor's said "Mathematics is not a spectator's sport. If you do not try it yourself you will not learn it". The key for learning mathematics is to practice mathematics. It is essential for students to do as many problems as possible to succeed in the course. Students should use

that practice as tool to understand the mathematics behind it. From the instructor's point of view the most useful feedback are those that come in the form of solutions of exams (current and old) and especially the HTML self testing practice problems. We set the HTML self test practice exercises to cover whole chapters of the course.

Name: _____

Feedback Example

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. The domain of the function $G(x) = \sqrt{x^2 - 9}$ is given by:
   A) $(-\infty, -3] \cup [3, \infty)$ B) $(-\infty, -3)$ C) $[-3, 3]$ D) $(-\infty, -3]$

2. If $f(x) = \begin{cases} 1 - x & \text{if } x \leq -1 \\ 2 - x^2 & \text{if } x > 1 \end{cases}$ then $(f \circ f)(-2)$
   A) 3   B) -7 C) -11 D) -2

3. Assume f is a one-to-one function. If $f(x) = 3 - 6x$, find $f^{-1}(33)$.
   A) 5   B) -5 C) 6   D) -3

4. Use the function $f(x) = x^2 + 1$ to evaluate $f(x + 5)$ and simplify.
   A) $f(x + 5) = x^2 + 10x + 26$ C) $f(x + 5) = x^2 - 10x + 26$
   B) $f(x + 5) = x^2 + 6$ D) $f(x + 5) = x^2 + 10x + 25$

5. The function $f(x)$ is reflected in the x-axis and then shifted up 5 units and the graph of $g(x) = 5 - x^2$ is obtained. What is $f(x)$?
   A) $f(x) = x^2 - 5$ B) $f(x) = x^2$ C) $f(x) = -x^2$ D) $f(x) = -x^2 + 5$

6. Find the minimum value of the function: $g(x) = 7x^2 - 28x$
   A) $f(2) = -28$ B) $f(-28) = -2$ C) $f(-28) = 2$ D) $f(2) = 28$

7. Use $f(x) = 2x - 8$ and $g(x) = 4 - x^2$ to evaluate $f(g(-1))$.
   A) -7 B) -28 C) -2 D) -96

Figure 7: Sample Self Testing HTML Problems

The trick of course is to make the students use these valuable resources. We achieve that by make some of the problems that re in the practice problems pool appear in either quizzes of tests. This strongly encourages students to do all of the assigned problems.

Our experience shoed that students use this resource only before the assessment is given. That is if students have a Test during a certain week they would do the practice problems just before the test. A practice that is not very good for long term sustained learning.

Feedback Example

Multiple Choice
Identify the choice that best completes the statement or answers the question.

❌ ____ 1. The domain of the function $G(x) = \sqrt{x^2 - 9}$ is given by:
      A) $(-\infty, -3] \cup [3, \infty)$ B) $(-\infty, -3)$ C) $[-3, 3]$ D) $(-\infty, -3]$

      ANSWER: A

$$D_f = \{x \in \mathbb{R}: \ x^2 - 9 \geq 0\} = \{x \in \mathbb{R}: \ (x-3)(x+3) \geq 0\}$$

Using the table of signes we get:

$$x \in (-\infty, -3] \cup [3, \infty)$$

      POINTS: 0 / 1
      FEEDBACK:
      REF:

❌ ____ 2. If $f(x) = \begin{cases} 1 - x & \text{if } x \leq -1 \\ 2 - x^2 & \text{if } x > 1 \end{cases}$ then $(f \circ f)(-2)$
      A) 3   B) −7   C) −11   D) −2

      ANSWER: B

$$\left(f \circ f\right)(-2) = f\left(f(-2)\right) = f(3) = -7$$

      POINTS: 0 / 1
      FEEDBACK:
      REF:

Figure 8: Feedback to Self Testing HTML Problems

3. Conclusions

Even though the main ways for learning have been the same for decades summarizes in Seeing, Hearing and Doing. However the tools used to achieving the learning are ever so changing with the changes in technologies. Educators have to keep up with changing trends of learning tools and methodologies.

A key component in today's learning process is a good Course Management System. However, managing such system for multi-section large courses could be a very difficult task. Careful considerations have to be taken into account during the design of the site to make it easy to maintain. This is ever so important since the task of maintenance has fallen into the duties of the instructor. One thing for certain building, maintaining, improving and expanding an effective eLearning course website is a continual process.

Mathematical and logical reasoning are very important in today's techno-global economy. Unfortunately mathematics results in international test are in a continuous decline. Using technology to provide students with and interactive learning environment that combines the Seeing, Hearing and Doing learning tools. In particular the Doing part should be enhanced with self-testing and feedback systems. For mathematics it is important to provide graphical and plotting tools that facilitate student's visualizations and enrich the "Seeing" part outside the classroom.

On top of a good educational content the site has to contain resources that students need to be successful in the course thus encouraging them to visit the site and benefit from what is has to offer.

4. References

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[3] Debevc, M., Kosec, P. (2006) Pedagogical and Didactical Aspects Of Transformation From Traditional Learning Content To Electronic Content.New Trends in Engineering Education, Ohrid 2006; Tempus SCM-C010A05 – Initiations of Blended Learning Systems.