

Mathematics in Online-Learning: The difference in its approach compared to face to face teaching

Rajasegeran Ramasamy
Wawasan Open University, Penang, Malaysia
rajasegeranr@wou.edu.my

Mathematics is known as a difficult course by students especially working adults. The performance of WUC 114/05 University Mathematics A, a compulsory course for all the students of the School of Science and Technology in Wawasan Open University is average, around 50 % for the past 4 presentations. The course material is on par with the content of Mathematics courses in face to face teaching in local universities in Malaysia. The course material is written similar to a text book approach. The question rose that lead to this research paper is does the approach or pedagogy of mathematics courses in online-learning should be different from face to face learning. This paper explores the degree of difference in the approach of course material in an online-learning environment. A thorough study investigating the approach of teaching mathematics in online-learning and face to face teaching mode from various angles, including the introduction and the development of the skills to the ways of explaining examples and providing relevant examples to make them meaningful. This paper also discovers the online-learning material design should move pedagogically to cater online-learning students.

Keywords: Pedagogy, Online-Learning, Wawasan Open University

Introduction

Online learning is a catching trend in universities throughout Malaysia. Online learning or Web-based learning refers to the learning by means of Web or the internet [6].

Even conventional universities in Malaysia such as Multimedia University, Universiti Tunku Abdul Rahman, Universiti Putra Malaysia and many more have started their online learning system to support their face to face lectures. However, this research paper will focus on the delivery of online teaching in distant education and open education. There are only three universities in Malaysia operating on a single mode (open distant learning); Wawasan Open University, Asia E-University and Open University of Malaysia.

This research is concerned with the material presented in the online learning compared to the face to face teaching in mathematics courses. In this study the focus will be mainly on the teaching materials as printed material in face to face learning as print is used far more than any other medium in online learning compared to other modes such as videos [8]. As Mathematics itself is considered a difficult course especially for adult learners, what considerations are taken while developing mathematics courses? The online learning material supposed to be more interesting, motivating, user friendly and suitable for individualized learning [9]. One of the major characteristic of online learning is the needs to shift the control of learning from the teacher to the student.

Does the material prepared in the online learning similar to the face to face teaching or should they be different to cater for these distant education students?

Background of the study

In Wawasan Open University, all the students of the School of Science and Technology are required to pass the university compulsory papers which include WUC 114/05 University Mathematics A. The performance in this course for the last four presentation beginning from January 2007 is far from satisfactory as the passing rate are lingering around 50% to 60%. The following table shows the performance of this course for all the presentations to date.

Figure 1: Performance of students in WUC 114/05 University Mathematics A

Semester	Passing rate	Completion rate
January 2007	56 %	34 %
January 2008	50 %	38 %
July 2008	57 %	45 %
January 2009	59 %	40 %

This leads to the question, aren't these students capable in following university level courses? Anyhow, the performance of the same batch of students in other courses show these students are capable in following undergraduate courses. An in-depth study was conducted to find the root of this problem. The course material was revisited including the materials available online in *Wawasanlearn*, the Learning Management System of the university.

As of January 2004, the Open University of Hong Kong was presenting 137 'online' courses. A number of these online courses consist simply of pdf versions of printed course materials supplemented by extra features such as WebCT 'news' and assignment information. [7]

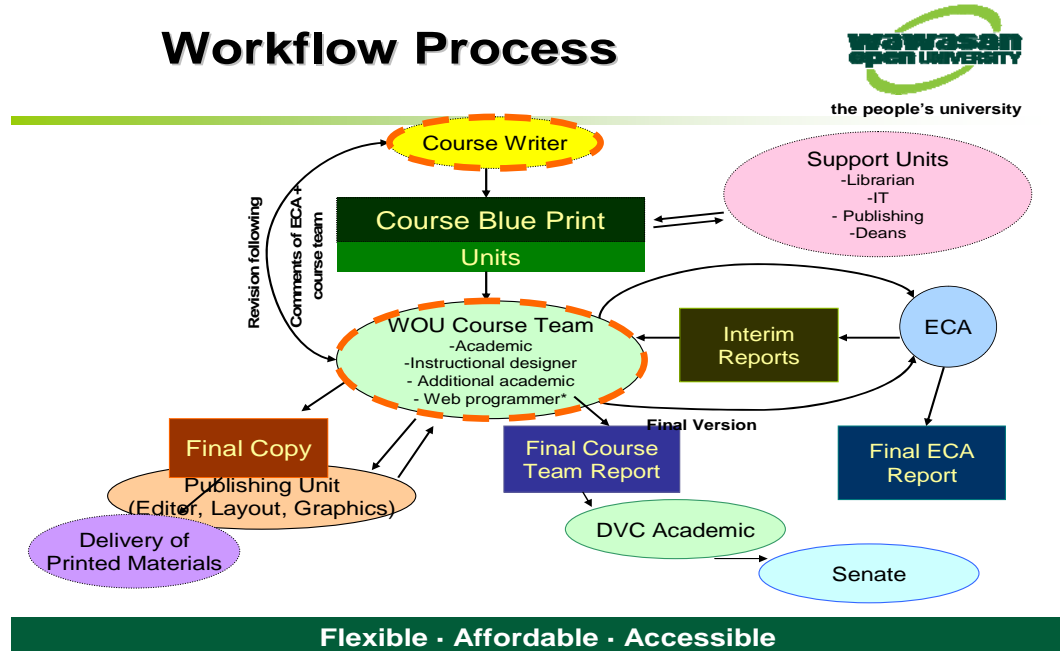
This entire situation led to this research paper to determine if there are needs for different considerations in addressing the mathematical course materials in online learning compared to the face to face learning?

Observations

Course Material

The online course material of WUC114/05 University Mathematics A is the electronic version of the printed course material. The printed course material went through a few series of quality assurance conducted internally and also by the external course assessor.

Figure 2: Quality Assurance process in Wawasan Open University



The report from the internal course team and the ECA are favorable of the course material. As the result, we can conclude the course material met the requirement as an undergraduate course.

The course material was compared to the material (face to face learning) from several public universities. The results of item by item comparison shows the quality and the approach of presentation are quite similar. A comparison on the course material was done with similar courses in other open universities in Malaysia shows similar results.

Anyhow, the researcher would like to emphasize that the institutional requirement to pass a course in Wawasan Open University is that students need to pass both assignments (TMA) and examination component as part of its quality control measures.

The following table shows the comparison between the course material of WUC 114/05 University Mathematics A and similar courses in other universities which is conducted on a face to face mode.

Figure 3: Comparison between similar course materials to WUC 114/05 University Mathematics A

	WUC114/05 University Mathematics A	Mathematics I Public University A	Engineering Mathematics I Private University	Calculus I Public University B	Mathematics ODL University	Mathematics I Distant Learning Programme Public University C
Content (Match)		80 %	90 %	80 %	75 %	80 %
Explanation on Theorems	Yes	Yes	Partial	Yes	Yes	Yes
Detail explanation on examples	Partial	Partial	Partial	Partial	Partial	Partial
Numbers of examples relatives to WUC 114/05	-	Less	Less	More	Less	Equal
Numbers of activities relatives to WUC 114/05	-	Less	Less	Less	Equal	Less
Summary	Yes	Yes	Yes	Yes	Yes	Yes
Solution	Provided (not full)	Provided (not full)	Partially Provided (not full)	Provided (not full)	Provided (not full)	Provided (not full)

Online Activities

The online course material of WUC 114/05 University Mathematics A is supplemented by a few online interactive exercises and quizzes. The number of participants in these activities on average is 60% of the student population. These activities are seen as a substitute to activities in the printed version as not much teaching was provided apart from the final solution. As pedagogical aspects are concerned, there is not much difference that can be observed compared to the printed course material.

Powerpoint Presentation

The PowerPoint presentation prepared by the course writer, course coordinators and tutors was analyzed. The slides contain summarized version of the printed course material, the gist of every section and examples for various problems.

PowerPoint slides that are being used for teaching similar courses in a few local universities which practice face to face learning mode are compared to the one used in Wawasan Open University. A few PowerPoint presentations on similar courses used in foreign universities which were available in the web were compared too.

The results show that the content, approach and the details on the examples does not differ much from the one used in the WUC 114/05 University Mathematics A. The approach taken in all these presentations is similar as they contain a shorter and brief version of printed course material.

Prior Knowledge

The Wawasan Open University students come from different backgrounds; demography, profession, age and etc. The prior knowledge in mathematics differs from one student to another. A quick look at the students' profile revealed that most of the students had taken

SPM Mathematics Paper (equivalent to 'O' Level). Some of the students even took SPM Additional Mathematics Paper. This prior knowledge is questionable since most of the students took this paper more than 5 years ago. The understanding of this fundamental mathematical concept is susceptible. Unlike the students in face to face learning, the majority of the students undergo similar content of pre-university mathematics at a similar time. The course material in online mathematics courses should address this vast prior knowledge of mathematics in these students.

Finding

The observation on the online course material and PowerPoint presentations show that the course material of WUC114/05 University Mathematics A has equivalent, if not of better, quality with other similar course materials from face to face learning in established universities in the country. The approach taken by the universities in designing the course material are similar.

Conclusion and Suggestion

The comfort of having a lecturer or teacher explaining each step in mathematical theorems and solving mathematical problems are seriously felt by the online learners in this course. The opportunity in injecting questions to clear any doubt in the middle of teaching are greatly being missed by the online learning students. In mathematical courses these elements play a very important role to ensure students understand the flow of concepts as any unclear concept or theorem or steps can jeopardize the understanding of the total idea.

The solution to derive Eigenvalues and corresponding Eigenvectors was taken as a sample case. The observation shows no explanation were given between the steps as the author assume these skills such as factorizing polynomials, multiplying matrices or finding determinant of a matrix and etc are fundamental skills that any undergraduate student has acquired. In face to face teaching, students can pose questions on these skills and the lecturer/teacher has the advantage of explaining them in detail. In online learning, students need to refer to previous units/chapters or even other courses to get an explanation. This situation can lead to students having problems in understanding the concepts. As a result, students might have an impression that the whole idea of Eigenvalues is a difficult concept without realizing where the problem lies.

The paper suggests since the online learning material has access to the technologies and means to address these problems compared to the printed version, the pedagogical aspect of the course material presented in online learning should move away from the traditional ways of teaching mathematics.

The usage of hyperlink should be incorporated in the online course material. The hyperlink should link to the teaching of the sub-skills being used in the main examples or theorems. An interactive exercise should also be incorporated in the hyperlink to ensure students grasp the skills before returning to the main concept. However these hyperlinks should not link to external resource as the approach might not be similar where the emphasis might not be right.

The examples or theorem should be introduced step by step with the click of the mouse. Students need to absorb each individual step before being introduced to another one. One

must understand that online learning supposed to be motivating. In mathematics, the ability to understand or solve simple problems (line) can motivates a student to explore further. Some can claim that this idea is already being practiced especially in PowerPoint presentations. The question is in face to face learning/teaching the lecturer/teachers are there to elaborate and explain the steps. How many PowerPoint presentations take the effort to explain the steps explicitly? Of course the processes are tedious and time consuming but the effect it has on the students' understanding and performance will be great. These sub-skills serve as building blocks to the main skills. More elaborate examples should be available to students to enhance the understanding the main concept and also the sub-skills.

This research paper concludes that in online mathematical courses, technologies must be fully utilized to substitute the role of physical lecturers/teachers of the face to face learning environment. The right pedagogical aspect must be adopted to address the online learning students.

Reference

1. Abtar Kaur & Ansary Ahmad. (2006). *E-Learning Challenges as Perceived by Communities of Practice: Open University Malaysia's Experiences*. AAOU Journal Vol 2(1), 51-65.
2. Anil K. Dimitri & Amit Chaturvedi. (2006). *Hierarchy of E-Learning Delivery Mechanism: A Paradigm Shift*. AAOU Journal Vol 2(1), 66-75.
3. Bright, B.P.(1989). *Theory and Practice in the Study of Adult Education*. Routledge, New York.
4. Harvinder Kaur. (2008). *Issue of Learning-Teaching Technologies at OUM*. Indian Journal of Open Learning Vol 17(3), 201-213.
5. Mishra, S.(2008). *Developing E-learning Materials: Some Pedagogical Concerns*. Indian Journal of Open Learning Vol 17(2), 155-162.
6. Murphy, D., Carr, R., Taylor, J. & Wong, T.M. (2004). *Distant Education and Technology: Issue and Practice*. Open University of Hong Kong Press.
7. Murphy, D., Shin, N.& Weiyuan, Z. (2002). *Advancing Online Learning in Asia*. Open University of Hong Kong Press.
8. Rowntree, D. (1994). *Preparing Material for Open, Distant and Flexible Learning*. Kogan Page, London.
9. Thorpee, M. & Grugeon, D. (1987). *Open Learning for Adults*. Longman Open Learning.

APPENDIX A

Find the eigenvalues and the corresponding eigenvectors of the matrix $A = \begin{bmatrix} 3 & 2 \\ 3 & -2 \end{bmatrix}$.

Solution

Using the characteristic equation, we have

$$\det(A - \lambda I) = 0$$

$$\det \left(\begin{bmatrix} 3 & 2 \\ 3 & -2 \end{bmatrix} - \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} \right) = 0$$

$$\text{Thus, } \det \left(\begin{bmatrix} 3-\lambda & 2 \\ 3 & -2-\lambda \end{bmatrix} \right) = 0$$

$$\text{We obtain } \begin{vmatrix} 3-\lambda & 2 \\ 3 & -2-\lambda \end{vmatrix} = 0$$

$$\lambda^2 - \lambda - 12 = 0$$

$$(\lambda - 4)(\lambda + 3) = 0$$

Solving, we have $\lambda_1 = 4$ and $\lambda_2 = -3$.

To find the eigenvector corresponding to $\lambda_1 = 4$, we will solve for

$$(A - \lambda_1 I) \mathbf{x} = \mathbf{0}$$

We have,

$$A - \lambda_1 I = \begin{bmatrix} 3 & 2 \\ 3 & -2 \end{bmatrix} - 4 \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} -1 & 2 \\ 3 & -6 \end{bmatrix}$$

By solving the homogeneous equation $(A - \lambda_1 I) \mathbf{x} = \mathbf{0}$; we have

$$\begin{bmatrix} -1 & 2 & | & 0 \\ 3 & -6 & | & 0 \end{bmatrix} \rightarrow \begin{bmatrix} -1 & 2 & | & 0 \\ 0 & 0 & | & 0 \end{bmatrix}, \text{ we obtain the equation: } x_1 = 2x_2$$

Thus, $\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 2x_2 \\ x_2 \end{bmatrix}$ is an eigenvector; $x_2 \neq 0$;

Therefore, any nonzero multiple of $\begin{bmatrix} 2x_2 \\ x_2 \end{bmatrix}$ is an eigenvector corresponding to $\lambda_1 = 4$;

particularly, $\begin{bmatrix} 2 \\ 1 \end{bmatrix}$ is an eigenvector, and $\left\{ \begin{bmatrix} 2 \\ 1 \end{bmatrix} \right\}$ is a basis for eigenspace corresponding

to $\lambda_1 = 4$.

Similarly, for $\lambda_2 = -3$, we have

$$A - \lambda_2 I = \begin{bmatrix} 3 & 2 \\ 3 & -2 \end{bmatrix} - (-3) \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 6 & 2 \\ 3 & 1 \end{bmatrix}$$

Solving as before, the homogeneous equation $(A - \lambda_2 I)\mathbf{x} = \mathbf{0}$, we have

$$\left[\begin{array}{cc|c} 6 & 2 & 0 \\ 3 & 1 & 0 \end{array} \right] \rightarrow \left[\begin{array}{cc|c} 3 & 1 & 0 \\ 0 & 0 & 0 \end{array} \right], \text{ we obtain the equation } x_1 = -\frac{1}{3}x_2$$

Thus, $\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} -\frac{1}{3}x_2 \\ x_2 \end{bmatrix}$ is an eigenvector, $x_2 \neq 0$.

So, any nonzero multiple of $\begin{bmatrix} -\frac{1}{3}x_2 \\ x_2 \end{bmatrix}$, $x_2 \neq 0$ is an eigenvector corresponding to $\lambda_2 = -3$;

and in particular, $\begin{bmatrix} -1 \\ 3 \end{bmatrix}$ is a basis for the eigenspace corresponding to λ_2 .