

# Integrating Pedagogy and Instructional Design in the eLearning Approach for the Teaching of Mathematics

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## **Abstract**

*As eLearning is becoming more readily available and accessible in formal and informal contexts, more education institutions, including schools, are developing courses virtually. Educators are gradually incorporating elements of eLearning in the discussions on integrating pedagogy and instructional design. Such integration is increasingly important in mathematics as the subject involves thinking and creativity; readiness to face ambiguous problems and ability to refine them into a clearer conceptualization and ability to analyze problems using the heuristic approach. Realizing the importance of the integration, a study is being undertaken to develop a suitable instructional design model using the eLearning approach. The use of such approach would enhance literacy and motivate interest towards mathematics. The instructional design model incorporates the elements of Mathematical Approaches, Lesson Sequencing, Interactive Multimedia, Systematically Designed and Developed Teaching and Learning Modules and Submodules, and Holistic Development of Students.*

## **1 Introduction**

As the ICT is becoming a new trend in the communication of educational information, the most suitable choice of educational media used in the teaching and

learning process should be given the highest priority. One of the most interesting developments in the Information Age is the emergence of the Internet technology in education where the teaching and learning process play a major role. In such situation, students' roles will have to change: they will not only receive knowledge or truth but act as 'explorers and seekers' of knowledge or truth. This means that today, the education world is experiencing a change not just in terms of curriculum but also in terms of approaches to teaching and learning strategies. These changes in learning strategies from traditional to dynamic strategies based on the use of information technology create a learner centred learning environment. (Halimah Badioze Zaman et. al 1998). Research has shown that the potential of online learning has enabled institutions, including schools and educators to reach new learners at a distance, increases convenience, and expands educational opportunities (Hara & Kling 2001). The most important role of an instructor in an online environment is a high degree of interactivity and participation. This means designing and conducting learning activities that result in engagement with the subject matter and with fellow learners using proper pedagogical approaches are very important. Research has also proven that students generally face difficulties in understanding mathematical concepts, operations and

formulas because mathematics has always been taught in isolation to the lives of the students (Halimah Badioze Zaman et. al 1998). Mathematics is also a subject that involves thinking and creativity; readiness to face ambiguous problems and ability to refine them into a clearer conceptualization; and ability to analyze problems using the heuristic approach. This paper hopes to use the concept of eLearning by highlighting the instructional design model of the teaching of mathematics (Matrices) to enhance literacy and to motivate interest towards mathematics.

## 2 Literature Review on eLearning

The idea of using computer to assist training of people started long time ago like the use of Computer-assisted Training (CBT). Since the invention of Internet and various digital media, this idea of using these media for educational experience emerges as what we call eLearning today. According to Taylor (2002), educators have the perception that eLearning represents a challenging medium with the availability of multimedia enhancements, automated submission of assignments and the ability to change ideas virtually instantaneously. Taylor also added that in implementing eLearning, educators need to address a steep learning curve. They have to become knowledgeable about eLearning, tackle it, learn how to adapt subject areas to an online learning environment, and then make the commitment to keep up with the technological advancement.

McInnis (2002) argues that online learning environments increase the opportunities for educators to organize student groups, instruct students and support student learning and evaluate student performance. Furthermore, Vonderwell's (2003) studies on students' view on elearning found out that asynchronous environment allowed students to write carefully about their ideas, and this

environment force them to do reflection. According to Petrides' study (2002), students reported it was very flexible to work in collaborative groups in an online course without arranging everyone's schedule as one might do in the conventional face-to-face class. Students in Chizmar and Walbert's (1999) study indicated that the ability to freely pick and choose from one menu of diverse learning experiences enabled them to find the approaches that best fit the way they learn.

Based on the above findings, many factors have to be taken into consideration when designing the course materials, including pedagogical approaches to ensure the effectiveness in improving students' learning outcomes. According to Hara and Kling (2001), pedagogical strategies are very important to promote learners' online learning experience, as well as the overall perceptions of online learning. Realizing the importance of the design, a study is being undertaken to develop a suitable instructional design model using the eLearning approach. The use of such approach would enhance literacy and motivate interest towards mathematics. The instructional design model incorporates the elements of Mathematical Approaches, Lesson Sequencing, Interactive Multimedia, Systematically Designed and Developed Teaching and Learning Modules and Sub Modules, and Holistic Development of Students.

## 3 eLearning Model

Among many eLearning solutions, there are diverse definitions and services provided by the experts and vendors. According to Henry (2001), the key elements of 'total' eLearning solution comprises Content, Technology, Service and Strategy. One of the key success factors for an eLearning programme is the integration of these components. The model is shown in Figure 1. This paper is highlighting the

instructional design of the teaching of secondary school mathematics embedded in the Strategy component.

#### **4 Instructional Design of the Teaching of Mathematics Embedded in the eLearning Model**

The instructional design of the teaching of mathematics incorporates the elements on Mathematical Approaches, Hierarchy of Teaching, Interactive Multimedia, Systematically Designed and Developed Teaching and Learning Modules and Sub Modules, and Holistic Development of Students. The instructional design is indicated in Figure 2. As can be viewed, the online materials are developed based on the pedagogical, androgogical, and technological aspects of teaching and learning to ensure the effectiveness of the teaching and learning activities received by the students.

#### **5 Elements in the Instructional Design**

The instructional design of the teaching of mathematics embedded in the Strategy component of the eLearning Model is designed and developed with the integration of the following elements:

##### **5.1 Mathematical Approaches**

There are six teaching approaches embedded in the development of the instructional design as shown in Figure 2. The main teaching approach used is Expository Teaching. The instructional design also uses modeling approach to show how and why an expert does a task. The third teaching approach is coaching, which observes students as they work and correct their performance immediately as the students go through the sub modules provided. The next teaching approach used is articulation. Articulation will get the students to articulate their own knowledge and reasoning. In order to replay and abstract students' work and contrasting that

expert's performance, the reflecting approach is used. Finally, instructional design adopts the exploration approach to push students into the mode of trying to do the activities better on their own.

##### **5.2 Lesson Sequencing**

There are three aspects of lesson sequencing embedded in the development of the instructional design. The first aspect is scaffolding, which allows students to develop greater autonomy as they master subsets of the required skills. The next aspect of lesson sequencing is increasing complexity, as the students become more competent in a topic. The final aspect of the lesson sequencing is increasing diversity, which will enable the students to learn when and where the skills they learned are relevant and useful.

##### **5.3 Teaching Modules**

Figure 3 shows the details of the modules built in the mathematics course materials based on the foundational aspects of students learning process: Cikgu or Teacher Module; Ulangkaji or Revision Module; Latihan Komprehensif or Comprehensive Exercise Module and Pengukuhan Bestari or Smart Reinforcement Module.

The Cikgu/Teacher Module attempts to give introduction to each subtopic by presenting advance organizers (Woolfolk 1998), such as video clips and related activities prior to the actual lessons. In the module, as shown in Figure 4, a video clip of a scenario about the trading process in a Pasar Tani (a Malaysian well-known weekly wet market run by local farmers) was used. The scenario is a potential fit between the students' schemas and the material to be learned. The module is considered very important because it involves explanation of the mathematical concepts, the operation involved, the steps and examples of how to understand the concept and solve the

problem in a more detailed manner. The Cikgu/Teacher Module involves steps and examples of how to understand certain concept and to solve problems in the required manner. The module consists of four sub modules namely: Penerangan or Explanation, Contoh or Example, Latihan or Exercise and Ujian Topik or Topical Test. Penerangan sub module includes the expository learning approach (Ausubel 1977) to introduce a topic that is to be taught with the aim to attract interest of the student. Contoh sub module includes steps and examples on how to solve problems related to the topic discussed. Latihan sub module involves monitoring students' performance based on the exercises set by the system. In this sub module, the questions are randomized and the given is specific. Ujian Topik sub module has the objective of testing students on the understanding of the specific topic in the system.

The Ulangkaji or Revision Module (Figure 5) has the same objective as the Cikgu Module but is designed specially for the slow learners who cannot follow the Cikgu Module. The module involves steps and examples of how to understand certain concept and to solve problems in more detailed manner meant for slow learners. The Ulangkaji Module has one extra sub module, Contoh Terbimbing or Guided Example sub module. This sub module uses more interactivity element of multimedia, so that the slow learner can interact more with the system. Students can work on the module for as long as they wish without feeling of embarrassment from others, before they continue on to a new topic in the Cikgu Module.

The Latihan Komprehensif or Comprehensive Exercise Module (Figure 6) is built in the system with the aim of testing students on the understanding of the overall topics taught in the system (summative evaluation). The modules includes two

sections, which are objective tests and subjective or structural test.

The Pengukuhan Bestari or the Smart Reinforcement Module enables fast learners who are good in certain topic to be given a more enriching and challenging test to motivate them further. The module consists of objective questions.

#### **5.4 Holistic Development of Students**

The mathematics teaching and learning process involved in the specially designed eLearning environment is based on the multimedia technology, which integrates the multimedia elements such as texts, sounds, voices, animations, video and audio. Thus, the technology has the capability to touch various modalities of the students' interest to learning and to motivate students' interest in the learning process. The process of delivering mathematical concepts, generalization and application, which are presented in all the modules is able develop the aspects of cognitive, affective and psychomotor in the following manner. The multimedia elements used in the modules have the capability to generate the students' thinking process on the mathematical concept that they are learning. The thinking process would indirectly help in the development of the cognitive aspect of the students. The development of the affective aspect, which involves emotional respond is embedded mostly in Cikgu and Latihan Komprehensif modules. In Cikgu, the affective aspect, is embedded in the advance organizer in the form of video clips. The first video clip presented, which involves a scenario in a Pasar Tani, shows the farmers selling their own products from their farms. It is hoped that the multi racial Malaysians who do their marketing in the Pasar Tani can instill a feeling of pride and gratitude to be Malaysians among the students.

## 6 Conclusions

This paper has tried to highlight briefly the instructional design embedded in the eLearning approach (Strategy component of the eLearning Model) of the teaching of secondary school mathematics. The approach has taken into account the pedagogical aspects of delivery that enhance effective and meaningful learning activities. A case study on the effectiveness test has been done in a smart school by using quasi-experimental method based on the ethnographic approach (Norazah & Halimah

2004). Results have shown that the instructional design has successfully enhanced the learning of mathematics (Matrices) and motivated the students to learn mathematics. With the ICT being a new emerging trend in the teaching and learning mathematics, future research should focus on what constitutes effective web-based teaching and learning of mathematics and the monitoring process of acquiring skills in mathematics using web-based for the secondary school.

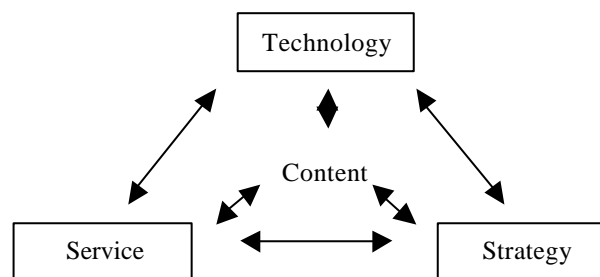


Figure 1 The eLearning Model

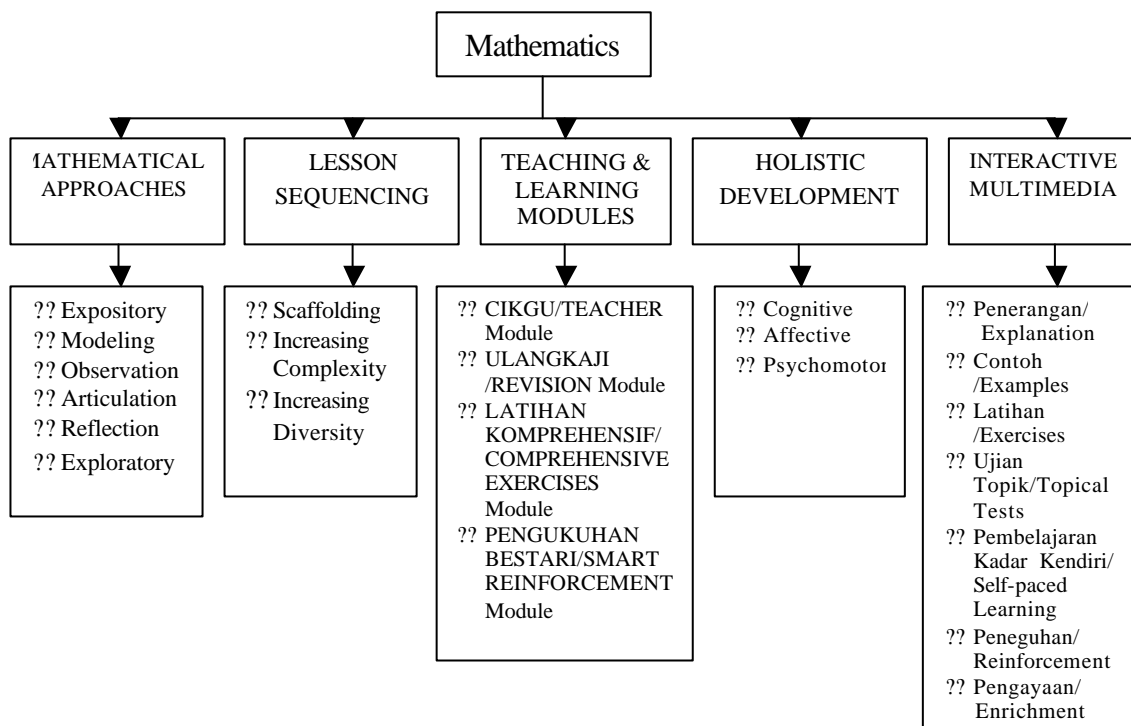


Figure 2 The Instructional Design of the Teaching of Mathematics

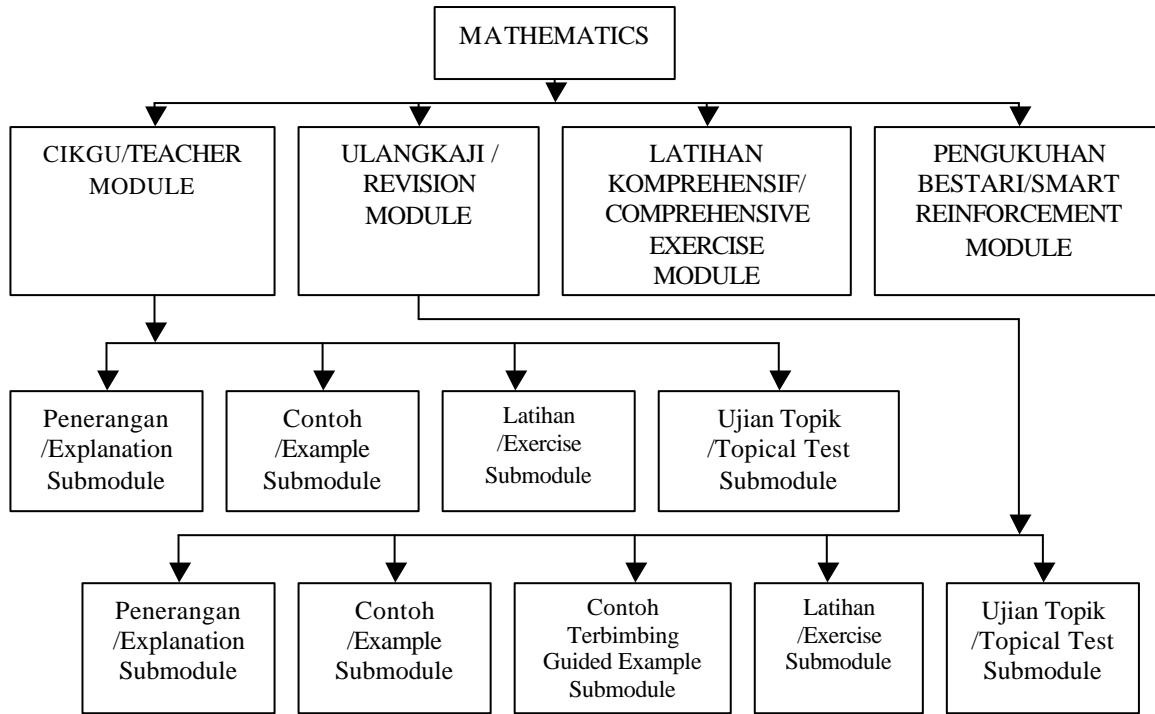


Figure 3 Modules and sub modules in the mathematics course materials



Figure 4 Video Clip used in the Cikgu/Teacher Module

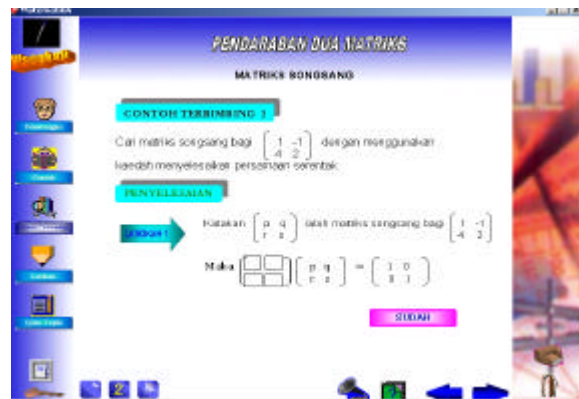


Figure 5 Ulangkai/Revision Module



Figure 6 Latihan Komprehensif/ Comprehensive Exercise Module

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