An Encounter with iMath: A Mathematics Courseware

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Abstract

The study anchors on several theories including Mayer's Multimedia Learning Theory (2001) and Dewey's Learning-by-Doing Theory (Santrock, 2011). It aimed to pair multimedia learning and traditional teaching methods with the use of iMath, a Mathematics courseware. Additionally, the study also aimed to evaluate the effectiveness of the aforementioned learning tool through the administration of pretest and posttest to assess student performance.

To accomplish the quasi-experimental study, 18 Grade Four pupils from a small private school in Navotas were randomly grouped to form the experimental and control groups. The experimental group was taught with both traditional and electronic methods, while the control group only received traditional form of instruction. With regard to the pretest-posttest results, in spite of having insignificant difference between the performances of both groups, the researcher found out that the courseware users (experimental group) improved from pretest to posttest, but further testing is required to validate and generalize this in other samples.

It is recommended that a follow-up study be conducted after pupils have had a longer period of interaction with the courseware. Likewise, it is suggested that the courseware be used by high school students for evaluation of academic achievement. It is encouraged that future studies about e-learning utilize the courseware as a template for the development of technology-equipped teaching and learning strategies.

Background of the Study

A courseware is educational software designed to create an instructional environment for the purpose of facilitating learning. A student that uses this can learn various things about a particular subject; a teacher using exercises provided by the courseware can help students test their progress at the same time focus on those who are having difficulties in the subject.

There have already been many researches conducted about improvement in the students' learning performance when they are engaged in technology-rich environments and many concluded that technology can help elevate analytical skills of students and also motivate them to learn. A particular local study conducted that shows technology can indeed escalate learning is "Let's Think and Learn" by Jennifer Cheng and Olivia Ng in 1995 at Chiang Kai Shek College. Their study showed good results, citing their courseware not only helped children with their intellectual skills, but also showed children having no difficulty in using their electronic learning tool. Additionally, "Shapes, Colors, Numbers, and Alphabet for Beginners" was developed by Norma Coliamco, Jose Carlo Ong and Lolita Prowel of Chiang Kai Shek College in 1996. This study proved that electronic medium of learning indeed increases students' interest by citing their evaluation result of having children interestingly using their software.

The National Council of Teachers of Mathematics (NCTM) also voiced its support for multimedia learning environment in teaching Mathematics and its significance. (National Council of Teachers of Mathematics, 2000) Furthermore, Wertherimer expressed that there are a lot of ways to apply technology in the field of learning; some of these are to assist in the understanding of concepts and to inspire further curiosity and discovery. (1990) Likewise, Blamires, in 1999, stated that multimedia features can be combined to produce computer-aided instructions that are designed according to the capabilities and interests of the users. Subsequently, these computer-aided instructions can facilitate understanding and engagement in learning.

According to Duhrkoph (1989) and Petero (2008), computer-based instruction in Mathematics offers opportunity for students to reinforce their knowledge. This in turn implies that courseware, as agent of electronic learning, can help teachers, agents of traditional teaching method, in addressing students' learning habits and patterns in Mathematics. Although in 1998, the National Research Council stated that lecturing and listening, both important processes in traditional teaching methods are some of the weakest strategies in teaching Mathematics. With regard to this notion, Petero, in 2008, stated that academicians should find ways to integrate technology in teaching, in order to achieve optimal learning. Years before Petero conceived of his idea, Poncelet and Proctor, in 1994, expressed that computer-aided instructions be built on the past experiences and knowledge of the user. This in turn can be analogous to the classroom discussion right before students are asked to do exercises via the courseware, which can be related to Ausubel's Theory of Meaningful Learning (1963), wherein the learning focuses on the students' having an idea already of the topics to be discussed, thus delivering a meaningful learning experience.

In light of these, the researcher's focus is on the pupils' academic achievement after being exposed to the coexistence of traditional (i.e. chalkboard and lecture methods) and electronic means of teaching and learning. The latter is conducted with the use of iMath, a Mathematics courseware developed for this study that allows teachers to create lessons, design multiple choice tests, and track students' progress.

Theoretical Framework

Learning Mathematics does not only require the attention span of pupils in listening to class discussions, but also involves ample time for them to practice solving. At first, pupils pattern their methods and solutions to their teacher's. As they progress, they come to a discovery of their own Mathematically-valid techniques; hence, making Mathematics easier to learn and understand. The proponents emphasize the importance of the time dedicated to solving exercises; thus, this study centers around the argument of John Dewey that "Children learn best by doing". (Santrock, 2011) Learning-by-doing or learning-by-experience is a process wherein through direct experience and engagement in the execution of tasks, one learns and acquires the necessary skills related. It gradually boosts the learner's confidence, hence improving his skill on the way.

Learning is not complete without training and instruction, as Marc Rosenberg (2001) has said in his book, *E-Learning: Strategies for delivering knowledge in the digital age*, "Training is the way instruction is conveyed; it supports learning, which is our internal way of processing information into knowledge." For him, training is the basic approach in facilitating and improving performance; whereas instructions are specific processes that aid training. Both are integral in shaping one's learning to a specific direction. They can be used to help learners acquire new knowledge and skills. But since there exists different ways to learn and implement training with instruction, an effective learning strategy must be applied to support training. With regard to this study, both the teacher and courseware will support pupils in their Mathematical learning, in hopes this combination will rouse their interest to practice more.

In support to the use of the courseware as means of learning is the Multimedia Learning Theory by Richard Mayer (2001) and it is based on Allan Paivio's (1971) Dual-Coding Theory. Both theories claim that optimal learning is achieved if both visual and verbal materials are used and presented simultaneously. In Dual-Coding Theory, it is postulated that the human brain attends to visual and verbal information separately on different channels, thus creating representations for each. These representations are then used to organize and classify incoming information into knowledge that can be acted upon, stored, and retrieved for later use. But these channels have their own limitations (e.g. Humans are having difficulty assessing multiple visual and verbal cues at the same time) and might overwhelm the learner. But Paivio's psychological research has shown otherwise. Learners tend to better remember information that has been presented in a multimedia manner. In support of this claim is the Theory of Working Memory as proposed by Baddeley and Hitch (1974). They said that the visual and verbal channels of the brain work together in parallel, hence leading to the simultaneous processing of information received by our senses of sight and hearing. In order to prove this, Mayer conducted series of tests that involved learning with multimedia and it resulted in favorable findings: learners exposed to multimedia (verbal and visual) consistently performed better than those who had only received mono-media (visual only) instructions.

Last, the study is also anchored on Vygotsky's Social Constructivist Theory (Santrock, 2011). In delivering a combination of traditional and electronic way of teaching and learning, both the teacher and courseware act as the "More Knowledgeable Other" to the students, being the more-skilled entities supporting the pupil in his learning.

Research Objective

The study aims to assess the academic performance of pupils in Mathematics with teaching and learning delivered through the traditional method of teaching only, compared to pupils exposed to a combination of traditional and courseware means of instruction.

Scope and Limitations

In the search for a school that will allow the research to be conducted, a small private school in Navotas graciously permitted that the experiment be carried out. The participants of the study were the only 18 Grade Four pupils of the school, then randomly grouped by their Mathematics teacher into the experimental and control groups. The lesson covered and used for evaluation was Basic Concepts on Geometry. Moreover, the courseware was only accessible in their school's computer laboratory as it was not meant to be installed at home or ported to the Internet.

A particular threat to internal validity is the selection process of participants since the Grade Four Mathematics teacher did not have the opportunity to randomly choose the participants due to small class size (i.e. 18 students for the entire year level), hence opted to use IQ-matching to form the experimental and control groups, which compensated for the absence of random selection. On the other hand, threat to population validity might be present due to the small sample size and the results of the study might not be representative of the population. Moreover, the length of exposure time to the courseware is also a threat to external validity since a short encounter might not truly show the effect on achievement. The school only permitted the research to be conducted for a period of one week, covering only one topic. Hence, it is recommended that the study be conducted to other sample groups as well, and for a longer time of usage and interaction with the courseware.

Assumptions

In conducting this study, the researcher has the following assumptions:

1. Pupils and teachers should be computer literate;
2. Pupils must have achieved a certain degree of competence in Math; i.e. familiar with the basic arithmetic operations; hence, the choice of Grade Four pupils;
3. The school's computer laboratory should be networked in order for the teacher's main workstation to monitor the progress of each student.

Significance of the Study

Technology is growing rapidly and is becoming available anywhere, however many schools still use traditional methods in teaching Mathematics. Many schools have computers but are mostly used for presentations and used in teaching computer-related subjects. (Kleiman, 2004) Most Mathematics courseware are being sold and installed at home, or downloaded from the Internet, thus losing the personal touch of the teacher and of the traditional teaching strategies. With the study, combining a Mathematics courseware and traditional teaching methods, if this indeed improves the learning and achievement of pupils, not only will place technology at the center of the classroom, but will also become a viable teaching and learning strategy for teachers and pupils.

Many elementary pupils are "dependent learners" when it comes to studying Mathematics (Ching, 2003), hence adding to the difficulty of understanding the lessons. Since pupils are attracted to multimedia-heavy software, a courseware can help ease the learning curve for pupils. It can also pave the way for an independent learning process for the pupils, eventually gaining a sense of responsibility over learning. It will serve as a remedial course for the Mathematically-challenged, and as extra drill for advanced pupils.

As for the teachers, they lack the time to facilitate, as much as possible, a one-on-one discussion with pupils having difficulty or expressing disinterest in the subject matter. With a developed courseware used in their computer laboratory as a supplemental exercise, the teachers can have the necessary opportunity to guide and have a personal focus on the said pupils.

The academe can benefit if this study yields favorable results. It will not only improve pupils' understanding of Mathematics and increase teachers' competence, but also become effective implementers of technology in the classroom, thus earn a competitive edge over other educational institutions, and the confidence of parents and other societal stakeholders.

Research Methodology

1. Research Design
   The study is of quasi-experimental design wherein the samples were not randomly chosen, but instead, randomly grouped based on IQ-matching as conducted by the Mathematics instructor.

2. Data Gathering
   The study espouses the use of courseware and traditional teaching methods to deliver learning content and experiences. The study lasted for one week --- as the time allocated by the school for the study, and likewise, ample time to cover one lesson on Basic Concepts on Geometry. The two groups were taught by their teacher on the first day, with the pretest serving as a culminating classroom activity. In the succeeding meetings, the experimental group was given the opportunity to use the courseware to learn more about the basic concepts in Geometry after having their teacher discuss it in class. On the other hand, the control group was again only taught by their teacher. A posttest was administered to both groups on the last meeting for the week.

3. Data Analysis
   In evaluating the Mathematics performance of both groups, it was imperative to compare the pretest and posttest results of the experimental group, and the posttest results of both the control and experimental group. Thus, there are two null hypotheses for the study: (1) There is no difference in the pretest and posttest results of the experimental group; (2) There is no difference between the posttest results of the experimental and control groups. The results were first converted to a common base of 50, and were statistically treated using Student's t-test (at 0.05 level of significance) to determine if the null hypotheses should be rejected or not. If the null hypotheses are not rejected, then the researcher can conclude that

the courseware might have been helpful in aiding students get a good understanding of Mathematics, specifically on basic concepts of Geometry.

The flow of the study can be summarized with a conceptual paradigm, as shown in the Input, Process, and Output model below:

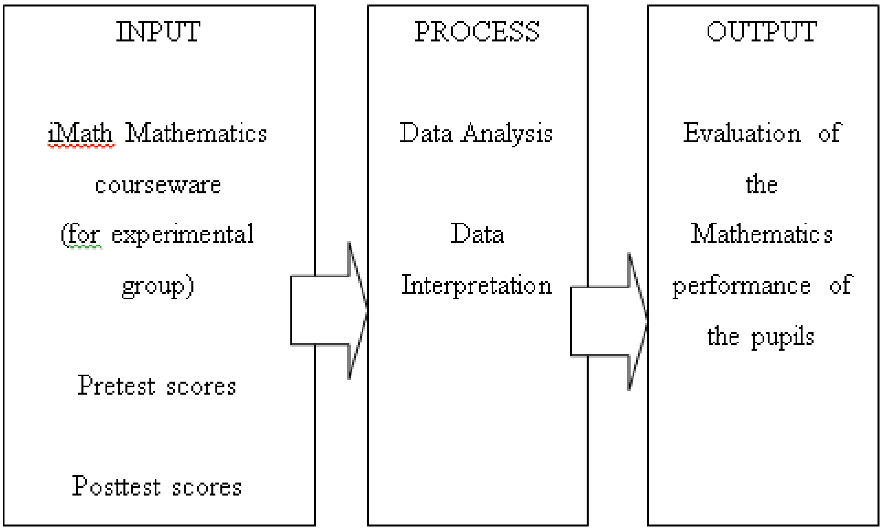

Figure 1. Paradigm of the Study (Showing the Inputs, Processes, Output)

Results

Table 1

Pretest and Posttest Result Comparison of Experimental Group (n=9)

Student No.	Pretest	Posttest
1	91.67	100
2	91.67	91.67
3	75	83.33
4	91.67	100
5	75	83.33
6	91.67	91.67
7	66.67	91.67
8	91.67	100
9	91.67	91.67
Mean	**85.1878**	**92.5933**
Variance	**100.3256**	**42.4506**
Standard Deviation	**10.0163**	**6.5154**
t-value	**1.8593**	
t-score at 0.05 significance	**2.1199 > 1.8593**	

For the experimental group, the Student's t-test reveals that at 0.05 level of significance and degrees of freedom of 8, there is no sufficient evidence to show that the means of the pretest and posttest are not significantly different for any sample size of 9 in the population, despite the increase in scores from pretest to posttest. Hence, we do not reject the null hypothesis, implying that the courseware may not have helped in improving pupils' performance.

Table 2
Posttest Result Comparison of Experimental and Control Group (n=9)

Student No.	Experimental	Control
1	100	100
2	91.67	66.67
3	83.33	83.33
4	100	100
5	83.33	100
6	91.67	83.33
7	91.67	100
8	100	100
9	91.67	100
Mean	**92.5933**	**92.5922**
Variance	**42.4506**	**146.5988**
Standard Deviation	**6.5154**	**12.1078**
t-value	**0.000242**	
t-score at 0.05 significance	**2.1199 > 0.000242**	

The Student's t-test shows that there is no significant difference between the posttest results of both groups, at 0.05 level of significance and degrees of freedom of 8. Hence, we do not reject the null hypothesis wherein both groups do have the same achievement, at least for the topic involved.

Conclusion

The posttest means of the two groups reveal that there is little to no difference between the test performances of being exposed to courseware and not. But, it cannot be thoroughly denied that the courseware was of help in some way for the experimental group to reach the same result to that of control group; this can be deduced from the fact that no one failed in the posttest in the experimental group and that it was either an increase or a maintenance of grade from pretest to posttest for them.

Moreover, another possible reason is that the pretest already provided a glimpse of possible question formats in the posttest; this may leave an impression that can help the pupils better prepare for the posttest based on their expectations. Nevertheless, the courseware may have helped in reinforcing prior knowledge of the pupils, as supported by Ausubel's Theory of Meaningful Learning (1963).

With the advent of technology reaching far and wide in our everyday lives, it will definitely be of importance to tackle its influence in shaping the realm of education, which includes the discipline of Mathematics. However, the presence of gadgets and devices alone does not necessarily reflect technology being alive inside the classroom (Kleiman, 2004); it should be exhaustively scrutinized and carefully implemented to better the teaching and learning experiences of both teachers and students. Such is the case of the courseware, a product of technology that can be harnessed and maximized to reinvent the delivery and overall impact of education.

Recommendations

Given the short period of time the experimental group got to use the courseware, it is recommended that a follow-up study be conducted after pupils have had a longer period of interaction with the courseware. Likewise, it is also suggested to append high school Mathematics topics into the courseware for high school students to use and have their performance be evaluated. It is encouraged that future studies about Mathematics (including other disciplines) and e-learning utilize the courseware as a template for the development of technology-equipped teaching and learning strategies. Furthermore, in light of several computer usage issues presented in the book Growing Up Wired: Raising Pinoy Kids in the Digital Age (Lee-Chua, Sison-Dionisio, et al, 2013), the researcher highly suggests conducting studies exploring the long term effects of courseware usage on health and academic performance, among others. Additionally, the ethical and health considerations in exposing children to early computer education and exposure can also be further studied and related to academic performance at large. Last, strategies on responsible integration of technology and traditional methods of teaching and learning is likewise a recommended topic of particular interest.

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