IS THERE ENOUGH IMPACT OF INTERACTION OF LECTURERS, STUDENTS AND PEERS USING CD-INTERACTIVE ALGEBRA COURSEWARE AND COLLABORATIVE LEARNING – IN A POLYTECHNIC, MALAYSIA?

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ABSTRACTS

Currently the teaching and learning of mathematics engineering in polytechnics, Malaysia (MoHEM) produces problems in 3 main areas. They are the subject itself, time constraints and fresh engineering graduates teaching this critical subject. This paper proposes a new method called CD-interactive with Collaborative Learning (CDiCL) which merge the strength of multimedia CD and collaborative learning to be taught in a computer laboratory. Pre Test, Post Test and Control method are used to collect primer data among 4 groups of certificate engineering first semester students in 2 engineering departments in a polytechnic, Malaysia. Besides, a series of interviews and video recordings support the findings that CDiCL has helped the understanding towards mathematics algebra among the users. SPSS and ATLAS/ti are used to justify this claim.

Keywords: CD-interactive, Collaborative Learning, SPSS and ATLAS/ti.

INTRODUCTION

Semi skilled technical professionals such as technical and engineering assistants have to be good at mathematics as mathematics often form the basis of analytical-mathematical problem solving tool in their line of work [1]. Poor achievements in mathematics in polytechnic engineering students (Interview Director Curriculum, DTE, MoHE, 2003) who are future semi technical professionals in engineering is certainly something to be concerned about. New approach and teaching method need to be identified to ensure these students acquire adequate grasp and understanding of mathematics. Some educators suggest the use of technology to supplement learning support while others promote a more collaborative effort in learning mathematics [2,3,4,5]. The outcomes of these studies have been mixed and varied depending on the specific groups and context of learning. For example [2] discovered significant differences in classroom instruction by the amount of technology used and [3] assessed student satisfaction, student learning, and faculty and staff time. This project therefore, sought to determine the effect of technology (CD-ROM interactive algebra) integrated collaborative approach on the learning of mathematics in a polytechnic, MoHE, Malaysia.

One aspect of mathematics that is of particular concern is algebra as skills in algebra problem solving is the gate to many higher level mathematical skills especially calculus [6]. Current teaching methods in polytechnics have not been that successful where remediation has been dominating the solution to poor performance in mathematics in general. Therefore, understanding how algebra can be learnt more efficiently will be beneficial to students and teachers equally especially in this era where many schools and polytechnics (MoHE) have internet facilities including Kota Bharu Polytechnic – KBP .

OBJECTIVES

The purpose of this study is to: (a) investigate the interactions between three important components that contribute to learning i.e., lecturers, students and peers using a courseware cd-interactive algebra, (b) analyze the outcomes resulting from learning elementary algebra using a courseware cd-interactive with collaborative learning set-up.

HYPOTHESIS

The null hypothesis (H_o) there is no impact of interactions of lecturers, students and peers in using CD-interactive algebra and collaborative learning and the alternative hypothesis (H_1) there is an impact of the interactions of lecturers, students and peers by CDiCL model.

VARIABLES

The independent variables are the method of learning CDiCL, CD and CL and traditional teaching, while the dependent variables are the score marks at the end of post test. Early indication of success in CDiCL is the high attendance of students coming to the computer lab using the cd-interactive courseware. Confounding variables are teacher qualities, lecture notes, and classroom's time of interaction. A variable map is constructed to control Hawthorn effect.

LITERATURE REVIEW

In the world of math education, students are mostly been spoon fed by teachers who comfortably teach by telling i.e., traditional teaching[7]. Schifter and Fosnot wrote telling methods in mathematics teaching created 2 things:(1) confidence in handling mathematical content that they have studied extensively and providing strong vivid methods , (2) prescriptions for what they must do with that content to affect student learning. Other methods of teaching math like maths with computers could not afford those two important supports. Maths experience produces many cases of high anxiety among teachers and students [8, 9, 10]. Strong innovation in teaching was not done globally since it looks that little rewards is given to teachers who dedicated doing researched on how to teach effectively compared to teachers that publish research papers in the universities and higher learning [11].

Thus teachers teach according to how they were taught. They feel they are in control with the knowledge. At this state of confidence, teachers can design things that the students wanted to throw at them. With math in computers they are put in a new territory

and they felt handicapped from the 2 supports propagated by [7]. They despised experimenting things first with a body of math content(sets of rules, procedures, answers and problems) in the computer laboratory which they had already mastered in the comfort zone. However, computers provides a means of communication between people [11,12,13].

According to [14,15] the students learn to collaborate and cooperate with their peers in order to learn something together. The schools purchased special desks to facilitate student-peer learning. If they can cooperate well they can learn better [16,17]. Learning collaboratively and cooperatively produced 2 important outcomes – accountability and commitment[18]. But, staff has to promote self confidence in students so that they are equipped to deal with confusion and conflict. One way is staff has to be good in her subject content [19,20].

Computer Based Learning CBL gives benefits to teachers and students. Drilling and practice in mathematics packages helps students to acquire more skills and understanding. However, CBL is good for individualized learning and practice [21,22]. Presently, schools are not equipped to this type of individual learning [23]. Thus there could be a meeting point between what schools learning in groups are equipped with and the strength of CBL could offer in KBP.

In education, a cognitive theory by Hermann Brain Model [24] wrote the left brain specialized on facts while the right brain dwells better on visual images. [25] adapted Hermann model for mathematics graphical exploration work and concepts. [4,16] talked about human's retention rate derived from different teaching and learning methods such as retention rate by reading is 10%, audio-visual 20%, discussion group 50%, practice by doing 75% and teaching others 80%. However, to design computer software with multimedia technology is a challenge when [26] argued 2 perspective from designers and users point of view. First, the principles in instructional design, dual coding theories and generative theory of multimedia learning [27,28,29,30] had to be adhered so that productive learning happens in CBL. Second, most instructional designers propagates one screen, limited lines per idea to avoid problems with human memory overloading [30]. But in practice in the computer laboratories one screen per idea is not the most effective method for group work when faster learner are paired with slow learners. Thus this project, a 4 quadrant-screen model with collaborative elements is proposed.

Assumptions and Limitations:
All certificate engineering students are academically equivalent thus variances are equal. Academic program is run on 15 week semester. Academic program runs from February 2006 – June 2006. KBP computer labs opened from 0800 am – 0415pm five day week only.

Method:
Population – polytechnics engineering students in 19 polytechnics in Malaysia.
Sample – four intact classes of students (SKA1C, SKA1B, SKM1A, SPT1A). They are the representative samples for the whole populations of polytechnic engineering students in Malaysia. They comprised of 137 students only.

Research Tools:
The instrument is a CD-interactive written in English. A pilot test was administered on the usability which gave a outcome reliability test – measuring tool in usability on the following categories: a) learning ability 87%; b) effectiveness 76%; c) screen arrangement 76%; d) graphics 77%; e) user satisfaction – 79%; f) overall performance 88%. A more than 70% performance depict acceptable and strong level (Sung, 1999). Content validity was processed by a subject matter expert in KBP who has 20 years of teaching maths experience and holding masters engineering degree , 2 graduate maths teacher from SM Meranti, Pasir Mas Kelantan, 2 maths IT lecturers in FTMM, KUiTTHO and 23 maths lecturers in KBP participating in an effective math teaching method course using this CD. The English difficulty level from the cd was tried to 10 secondary school students SM Meranti, Pasir Mas and examined by Senior English Language lecturer, KBP.

Collaborative Learning (CL) has 30 questions. 4 questions per week given from a CL book taken from Durell(1959) Volume I and II. These are problem solving type and worded problem. This is to engage group discussion and construction of higher problem solving techniques. The questions were given in 2 versions English and Malaysian language.

Courseware development – The cd is developed using the ADDIE instructional model. The content of the cd is limited to Pre-Algebra, Factorization and Simplification only. These contents are determined based on item analysis from SPM 2002-04. There are 3 modules in the CD called Revision, Test and Links. Exercises are provided at the end of each topic in the Revision module. The Test module contains 3 levels. The students will need the required password in order to take the first test. The second, third test demands the student to score 50% and above in the previous tests in order to proceed. The Links module provides an internet link as an enrichment strategy. The layout, content and interface design of this cd is developed based on the Hermann Brain Theory model. The cd design also incorporates the education philosophy called psychomotor, cognitive and affective. The CD is in English due to the pressure from the Malaysian government.

Lecture notes are built from the researcher's learning and teaching experience of teaching math in secondary schools, polytechnic and KUiTTHO, while references are made from KBSM text books, B1001 module from TED (MoHE) and Durell(1959). The content of these lecture notes was also piloted to 50 DIT Diploma Students 2005/2006 intake KUiTTHO. The lecture notes are given out to all 4 classes participating in this project.

The researcher used these notes to teach algebra in B1001 math classrooms for 3 weeks himself.

Peer Evaluation form. Each member is graded on the scale of 0 to 10 in terms of 5 characteristics of group interaction The forms were adapted from Murdoch University, Australia.

Pre Test and Post Test, there are only 10 questions in each test. The questions covered factorization, simplification, solving equations, number computations, and fractions. The questions in Pre and Post Tests are cross-checked by math department, KBP math lecturers in the first 2 meetings between the researcher and staff before the project proceeded. Audio- video recording was taken. Interviews are held after office hour in F-Block, KBP.

SPSS Version 12.0 was used to analyze pre and post test scores and ATLAS/ti Version 4 was used to analyze visual qualitative data.

RESEARCH PROCEDURE

Uses a quasi-experimental design approach with pre and post test , control using equivalent groups. Basic design of study is shown in Figure 1.

Group 1: Pre Test → treatment 1 → Post Test
Group 2: Pre Test → treatment 2 → Post Test
Group 3: Pre Test → treatment 3 → Post Test
Group 4: Pre Test → treatment 4 → post test
Treatment 1 is students are given no CD-interactive and no CL. Control Group.
Treatment 2 is students are given CL only.
Treatment 3 is students are given CD only.
Treatment 4 is students are given both CD-interactive and CL.
Common to all groups are a hard copy of lecture notes and Dictionary CDiCL.
Duration of treatment is 8 weeks. Each week the treatment is administered in the first hour of a subject coded B1003 Computer Application. Pre Test was administered in the first week. Post Test was given at the end April 2006. 2 weeks is used for training the students using the CD. Interviews and video recording was done to triangulate findings.

Figure 1: Research procedure in CDiCL project.

RESULTS

This project has 4 objectives. First, to examine the impact of interactions between 3 main components that contribute to learning algebra called lecturers, students and peers in using a CDiCL. Second, to analyze the outcomes resulting from learning elementary algebra using the CD. Third, study the working habits when group work is functioning among students in groups of 5's ; finally checking scaffolding effects by CDiCL.

One Way ANOVA was chosen to test whether the means between the 4 groups significantly differ or not. Assumption made prior to this analysis was the groups' variances are equivalent. Table 1 shows the results.

Table 1 Descriptive data

Group #		Mean	Standard Deviation
1 SPT1A	Pre	5.581	4.45
n = 31	Post	9.482	6.352
2 SKM1A	Pre	6.81	5.63
n =36	Post	8.43	6.4776
3 SKA1B	Pre	8.064	4.8493
n = 39	Post	14.09	5.67
4 SKA1C	Pre	6.00	5.56
n = 31	Post	10.84	8.49

Table 2 Mean Plots

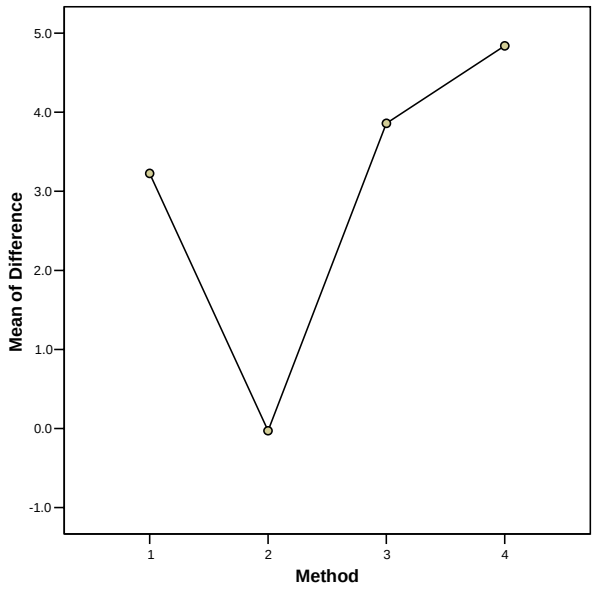

Table 2 shows Group 4 (CdiCL) has the highest mean of difference and Group 2 (CL only) has the lowest.

Table 3 ANOVA Gain Scores

Difference

	N	Mean	Std. Deviation	Std. Error
1	31	3.226	4.1208	.7401
2	36	-.028	5.9844	.9974
3	39	3.859	7.4991	1.2008
4	31	4.839	5.3578	.9623
Total	137	2.916	6.1985	.5296

From the One Way ANOVA data , standard deviation and standard errors are lowest for Group 1(Control), highest for Group 3 (CD only), while Group 2 (CL only) and Group 4 (CD + CL) have quite similar standard deviations and standard errors.

Table 4: Levene Statistic (Test of Homogeneity of Variances)

Difference

Levene Statistic	Df1	df2	Sig.
3.597	3	133	.015

- Sig is less than 0.05

The Levene statistic rejects the null hypothesis that the group variances are equal. This is shown in Table 4. While Table 5 shows ANOVA difference of mean scores between the 4 groups.

Table 5: ANOVA Difference

Difference

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	464.2	3	154.77	4.3	.006
Within Groups	4761.1	133	35.8		
Total	5225.3	136			

The significance value of F test is 0.006, thus we reject the null hypothesis that the improvement score are equal across groups and accept the alternative hypothesis that the improvement scores are differenct across the 4 groups.

Table 6: Post Hoc Multiple Comparisons

Dependent Variable: Difference
LSD

(I) Method	(J) Method	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	3.2536(*)	1.4660	.028	.354	6.153
	3	-.6332	1.4397	.661	-3.481	2.214
	4	-1.6129	1.5197	.290	-4.619	1.393
2	1	-3.2536(*)	1.4660	.028	-6.153	-.354
	3	-3.8868(*)	1.3828	.006	-6.622	-1.152
	4	-4.8665(*)	1.4660	.001	-7.766	-1.967
3	1	.6332	1.4397	.661	-2.214	3.481
	2	3.8868(*)	1.3828	.006	1.152	6.622
	4	-.9797	1.4397	.497	-3.827	1.868
4	1	1.6129	1.5197	.290	-1.393	4.619
	2	4.8665(*)	1.4660	.001	1.967	7.766
	3	.9797	1.4397	.497	-1.868	3.827

* The mean difference is significant at the .05 level.

Table 6 shows that the mean difference is significant at 0.05 level thus there are issues between group 1 and group 2, group 2 with group 3 and 4, group 3 with group 2; and group 4 with group 2 that has to be analyzed.

Table 7 shows the analysis done by ATLAS/ti software that processed codes for categories and subcategories of student teacher interactions using the CD. It shows episodes of discussion and clarification on important algebraic concepts between student-peers-lecturers derived from interviews with the researcher.

Table 7: Categories and sub-categories derived from interviews – lecturers.

	PRIMARY DOCS				
CODES	1	2	3	4	Totals
VA	28	32	20	7	87

VA1	38	44	29	9	120
VA2	6	7	1	0	14
VA3	3	0	7	1	11
VA4	1	5	8	2	16
VA5	0	1	4	1	6
VB	3	0	0	0	3
VB1	0	1	1	0	2
VC	1	1	3	7	12
VC1	1	1	2	3	7
VCD	15	8	5	5	33
VCD1	16	6	6	14	42
VCD2	10	1	0	2	13
VCD3	4	8	4	3	19
VI	0	3	2	0	5
VI1	0	6	1	0	7
VP	1	0	0	0	1
VP1	1	0	0	0	1
Totals	128	124	93	54	399

OBSERVATIONS

There are few things noted: a) CDiCL group – focus time spent is much longer i.e., within 20 – 30 minutes time span generated by 2 components called cd animations and group discussions by lecturers, students and peers. The dictionary CDiCL was rarely consulted b) CD only – focus time is low because quality discussion depends on types of friends he/she is having and the dictionary CDiCL was rarely consulted; c) CL – focus time discussing on algebra varies depending on team strength. Mostly the girls in the CL gave lower peer evaluation to each other than boys. d) Control group SPT1A – mid noon class showed the state of rush when lunch break is on every body's mind. From interviews and ATLAS/ti lecturers demand proper training in using technology in math teaching. Four lecturers who took part in this project are not math major in their universities in which 2 of them are non-engineering graduates and thus having very limited teaching experience less than 2 years. However students interviewed were comfortable using the 4 quadrant screen model in this CDiCL project. They got the word 'focus' as the main point behind learning while using CDiCL.

DISCUSSION

The findings are consistent with Morell (2001). It accepted that technology improves learning by taking proper important steps while encouraging collaborative work to function among groups in the classroom. But group 2 is inconsistent with Atkinson (1999), and Dillenbourg (1999). In collaborative work the skills in constructing questions is one of the key factors towards healthy group work that produce effective learning(Atkinson, 1999). In this project, the variances at the Pre Test was assumed to be equivalent but this is not so from the results. The one way ANOVA, the Levene Statistics and ANOVA difference table produced a significant value of F-test 0.006, thus we reject the null hypothesis that the improvement score are equal across groups. This explains that there is an impact by introducing CDiCL into group 4. Constructing a mean plot shows that Group 4 improves the most even though they come from the third class in civil engineering certificate program in KBP. Group 2 i.e. mechanical engineering certificate students hardly improved explained that students need more time in acquiring collaborative learning skills in order to produce enough impact in mathematics subject.

CONCLUSIONS

The study set out to identify whether there is an impact of interaction between 3 important components called lecturers, students, peers while using CDiCL courseware. From the project in KBP there is statistically significant impact between group interactions and the courseware as shown in Group 3 and Group 4. Multimedia courseware plus effective interactions between 3 components proved to motivate students to excel by using the first hour of B1003 set up i.e. computer laboratory as shown in this project. Greater heights in learning impact could be achieved if the participating teachers are trained in using technology to teach mathematics and this project is allowed to run throughout the semester. Multiple regression between dependent and independent variables regarding this project would be the next step in future work.

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REFERENCES

[1] Smith M. S, Scoll B.W., Link J. "Improving America's Schools: The role of incentives", US Department of Education. 1996

[2] Waycaster P."A study of success in developmental mathematics classes", Inquiry, Vol 6, No 1, Virginia Community College System.2001

[3] Clark, W.M. "Using Multimedia and Cooperative Learning In and out of Class", Worcester Polytechnic Institute, Worcester, MA. 1998

[4] Linda W.K. "*Jump Start – Authentic Problem Based Learning*.", Prentice Hall: Singapore. 2004

[5] Jorgenson F. "*The Students Voice.* In *The Aalborg PBL Model – Progress, Diversity and Challenges*". (eds) Anette Kolmos, Flemming K. Fink, Lone Krogh. Aalborg University Press. Aalborg: Denmark. 2004

[6] Barnett R.A., Ziegler M.R., Byleen K.E. "College Algebra with Trigonometry", 7th Edition New York: McGraw Hill Higher Education. 2001

[7] Schifter D., Fosnot C. T. "Reconstructing Mathematics Education: Stories of teachers meeting the challenge of reform", Teachers College Press, New York. 1993

[8] Prichard R. M. O. "Reconstructing Education", Berghahm Books, Oxford.1994

[9] Lewin J. "My Philosophy of Mathematics Education". Professor of Kennesaw State University, Mariette, Georgia. (accessed: 1/08/06http://science.kennesaw.edu/~jlewin/fb/teaching-philosophy.pdf)

[10] Marzita Puteh "Factors Associated with Mathematics Anxiety ", Universiti Perguruan Sultan Idris 2002

[11] Schuyten, G. , Goeminne, K., & Dekeyser, H. "Student preference for verbal, graphical and symbolic representation of information", In Proceedings of the 50th Session Tome LVI Book 4(p. 1997). Beijing: International Statistical Institute. 1995

[12] Norizah@Norazah Mohd Nordin. (2002). Pembangunan dan keberkesanan pakej multimedia berasaskan pendekatan hybrid dalam mata pelajaran matematik (matriks) Tingkatan Empat Sekolah Bestari PhD thesis , Universiti Kebangsaan Malaysia. 2002

[13] Wan Fatimah Wan Ahmad Pembangunan dan keberkesanan perisian multimedia dalam pendidikan matematik untuk visualisasi corak geometric (V-Maths) Unpublished PhD thesis UKM. Bangi. 2005

[14] Atkinson, S. "Key Factors Influencing Pupil Motivation in Design and Technology. ", Journal of Technology Education. 10(2) 1999

[15] Dillenbourg P. "What do you mean by collaborative learning?. In P. Dillenbourg (Ed) Collaborative –learning: cognitive and computational approaches. (pp 1-19). Oxford: Elsevier. 1999

[16] Tan Oon Seng, Parsons R.D., Hinson S.L. and Sardo-Brown D. (2003). "*Educational Psychology – A practitioner-researcher approach*.", An Asian Edition. Wadsworth: Belmont, CA. 2003

[17] Morell L., Buxeda R., Orenga M., Sanchez A." After so much effort: Is faculty using cooperative learning in the classroom?" Journal of Engineering Education pg 357 – 362. 2001

[18] Felder,R.M. "Effective Teaching: A workshop", Department of Chemical Engineering, North Corolina State University, Raleigh, NC. 1991

[19] Eisenhart M., & Borko H. "Designing Classroom Research – Themes, Issues, and Struggles", Allyn & Bacon, Massachusetts. 1993

[20] Savin-Baden, M. Facilitating Problem-Based Learning. Illuminating Perspectives. The Society for Research in Higher Education. Maidenhead: Open University Press. 2003

[21] Woodhouse D and McDougall A. *"Computers – Promise and challenge in education*.", Blackwell Scientific Publication, Australia. 1986

[22] Webb, N M "Task related verbal interaction and mathematical learning in small groups." Research in Mathematics Education. 22(5) pp 366-389. 1991

[23] Chen Ai Yen, Looi Chee Kit, Chen Der Thang, Hung Wei Loong. " Strategic Use of Computers for constructing effective studies: A Pilot Study.", Paper presented at the Joint Conference of the Educational Research Association, Singapore and the Australian Association of Educational Research. 25-29 November 1996. 1996

[24] Hermann, N. "The creative brain", (2nd Edition), USA: Quebecor Printing Book Group. 1995

[25] Steyn, T. "Workshop on the principles and practices of an an academic support programme for engineering students", Faculty of Engineering, UKM, 28-29 January 2004. 2004

[26] Atkinson, S. " An exploration of cognitive style and computer aided learning from the perspective of the user and designer", in I. Mottier & M.De Vries(Eds) PATT11: New Media in Technology Education pp.3-14 Holland: Eindhoven University of Technology. 2001

[27] Stemler, L.K. "Educational characteristics of multimedia: A literature review." Journal of Educational and Hypermedia, 6(3/4), 339-359. 1997

[28] Rosli Abdul Ghani. (2004). *Panduan Intensif Teori dan teknik asas Macromedia Flash MX 2004 Professional*, Venton Publishing: Selangor. 2004

[29] Baharuddin Aris, Rio Sumarni Shariffudin, Manimegalai Subramaniam. *Reka Bentuk Perisian Multimedia*. Penerbit UTM: Johor. 2002

[30] Sung Heum Lee "Usability testing for developing effective interactive multimedia software: Concepts, dimensions, and procedures.", Educational Technology & Society. **2**(2): 20-29. 1999

[31] Durell C.V. " General Mathematics for Malayan Schools " Vol 1,2. G. Bell & Sons, Ltd : London. 1959