The influence of multimedia supported courseware with collaborative learning in algebraic fractions and problem solving skills among Pre-University students

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***Abstract* — A strong understanding in elementary mathematics played an important factor in progressing to higher semesters in the learning life of a university engineering student. This paper tries to describe the contribution of an interactive multimedia courseware CD with Collaborative Learning (CDiCL) principles in the learning of algebraic fractions among pre-engineering students in a polytechnic, Malaysia. The research method used was quasi-experimental plus participant observation. 4 different groups of students (n=137) were used. Control group, Collaborative Learning only group, CD only group and CDiCL group. Pre and Post Test were used to collect primer data. Quantitative data analysis showed that CDiCL group scored the highest while CL group scored the least. This paper will only focus on the influence of using CDiCL towards this learning through the analysis of the interview protocol and the error exhibited in the answer scripts of an important test within the syllabus of the polytechnic education. Semi-structured interviews and transcription were used to triangulate the quantitative findings from the above Pre and Post Test results.**

***Index Terms*— CDiCL, Collaborative Learning, Hermann Whole Brain Model, semi-structured interviews.**

I. INTRODUCTION

Semi skilled technical professionals such as technical and engineering assistants have to be profess 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, 2006) who are future semi technical professionals is quite worrying. New approach in teaching method need to be identified to ensure these students had obtained understanding of mathematics. Some educators suggest technology to supplement learning while others promote a collaborative effort in learning mathematics [2,3,4,5]. The outcomes of these studies have been mixed depending on the levels of students and context of learning. For example [2,6,7] discovered significant differences in classroom instruction by the technology used and [3] assessed student's satisfaction in learning, and staff time. This project therefore, sought to determine the effect of technology (CD-ROM interactive algebra) integrating collaborative learning to learn algebraic fractions in a polytechnic, KBP, MoHE, Malaysia.

One aspect of mathematics that is of particular concern is algebraic fractions as this is the gate to calculus [6]. There is a strong link between the understanding of basic fractions and algebraic concepts [5]. Research by [8] analyzed computational estimation skills on fractions among college students. Overall they concluded there is some misunderstanding of the basic concepts in both fractions and algebra. Current teaching methods in polytechnics have not been that successful where remediation has been dominating the prescription of fractions and algebra performance in mathematics in general.

II. OBJECTIVES

The purpose of the study is to analyze (a) the interactions between lecturers, students and peers using a CDiCL algebra, (b) the outcomes resulting from CDiCL with collaborative learnings set-up, and (c) the elements affecting levels of interaction between members in collaborative learning groups.

A. Variables

The independent variables are the method of learning CDiCL, CD and CL and traditional teaching, while the dependent variables are the gain score after the post test, level of perceptions of member effectiveness, participation and fully preparedness among group members. Confounding variables are teacher qualities, lecture notes, and classroom time of interaction.

III. LITERATURE REVIEW

In math education, students are mostly been spoon fed by teachers who comfortably teach by telling i.e., traditional teaching [14,15]. Telling methods in mathematics teaching created two things i.e., confidence in handling mathematical content, and ready-made prescriptions for what they must do with that content to affect student learning. Few methods of teaching math

with computers lack those two important supports [16]. Mathematics experience produces many cases of anxiety among teachers and students. Thus teachers teach according to their confidence and power. By these, teachers can design things that the students wanted to throw at them. However teaching mathematics with computers produced many episodes of anxiety and lack of confidence when experimenting things in the computer laboratory [16].

According to [14,15] the students learn to collaborate with their peers to learn. Dialogue in groups is used to link math symbols and formal language used by students doing problem solving [17]. Learning collaboratively produced two outcomes – accountability and commitment [18]. But, staff has to be good in the subject content thus promoting self confidence among the students [19,20,21]. Factors such as motivation that influence effectiveness, preparedness and commitment levels among group members are also multi-related and needs teacher's control [22,23].

Computer Based Learning CBL through drilling and practice in mathematics packages helps students to acquire more skills and understanding. However, CBL catered for individualized learning [24]. Most schools are not equipped to this mode. Thus there could be a merging point between the strengths of group learning and CBL.

In education, a cognitive theory by [25] wrote: the human left brain specialized on facts while the right brain dwells better on visual images. [26] adapted Hermann model for mathematics work and concepts. Human's retention rate derived from different teaching and learning methods as retention rate by discussion group 50%, practice by doing 75%, audio-visual 20% and teaching others 80% need exploiting[4]. However, to design computer software with multimedia technology is a challenge when [27] argued two important points. First, the principles in instructional design, dual coding theories and generative theory of multimedia learning [28,29] had to be adhered so that learning happens in CBL. Second, most instructional designers talked about human memory overloading [30]. But in the computer laboratories one screen per idea may not be the most effective method for group work when different ability learners are paired. However the students have to cope with this different perspectives [32] to survive in pre-university education. This work using CDiCL elements is proposed to address the above issues.

A. Assumptions and Limitations

All engineering polytechnic students are academically equivalent as processed by TED, MoHE. Academic program runs on 15 week semester. This project took strictly the KBP time-table set-up.

B. Method

Population – polytechnics engineering students in 20 polytechnics in Malaysia.

Sample – Kota Bharu Polytechnic KBP's four intact classes of certificate engineering students. They were the representative samples for the whole populations of polytechnic engineering students in Malaysia. 137 students took part.

C. Research Tools

The instrument is a CD-interactive written in English. A pilot test was administered on the usability which gave 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% depict acceptable and strong level [32]. Content validity was processed by a subject matter expert in KBP, graduate math teachers from a Kelantan secondary school, two maths IT lecturers in UTHM and 23 math lecturers in KBP participating in a teaching method course. The English difficulty level from the CD was tried to 10 secondary school students in SM Meranti and cross-examined by a senior English language lecturer from KBP.

Collaborative Learning (CL) has 30 questions. Four questions were used per week focusing on solving word algebraic problem. This engaged group discussion.

Courseware development – The CD was developed using the ADDIE instructional model. Its content was limited to Pre-Algebra, Factorization and Simplification only. This was determined from SPM (GCSE equivalence) item analysis. There are three modules in the CD called Revision, Test and Links. Exercises were provided at the end of each topic in the Revision module. The CD Test module contained three levels. The students will need the required password in order to take the first test. The next tests demanded the student to score at least 50% in order to proceed. The Links provided as an enrichment strategy. The layout, content and interface design of this CD was developed based on the Hermann Whole Brain Theory model. The CD design also incorporates the education philosophy called psychomotor, cognitive and affective.

Lecture notes B1001 module taken from TED (MoHE). The content of these lecture notes were piloted to 50 DIT Diploma Students 2005/2006 UTHM. The notes were given out to all 4 classes.

Peer Evaluation Form. Each member graded on the scale of 0 to 10 in terms of group interaction The forms were adapted from Murdoch University.

Pre Test and Post Test. There were 10 questions in each test. It covered factorization, simplification, equations, number computations, and fractions. The questions in Pre and Post Tests were checked by KBP math lecturers and 40 marked scripts were cross-checked by two independent lecturers from UTHM to ensure consistency with the marking scheme.

Peer Evaluation form, Audio-video recording and semi-structured interviews were done to triangulate the results from the quantitative analysis results done by SPSS version 12.0.

IV. RESEARCH PROCEDURE

The study uses a quasi-experimental design approach with pre and post test using equivalent groups. Participant observation was also used to extract important

points related to the objectives. 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: students were given no CD-interactive and no CL. Control Group Treatment 2: students were given CL only. Treatment 3: students were given CD only. Treatment 4: students were given both CD-interactive and CL. Common to all groups are a hard copy of lecture notes and Dictionary CDiCL. Duration of treatment was 8 weeks. Each week the treatment was administered in the first period of a B1003 Computer Application subject. Peer Feedback forms, interviews and video recording done to triangulate findings. Internet service was available.

Figure 1. Research Procedure In CDiCL Project

V. RESULTS

This project has three objectives. First examining the influence of interactions between three main components that contribute to learning algebra called lecturers, students and peers in using a CDiCL. Second analyzing the outcomes resulting from the use of the CD, and Third studying the working habits when group work was operational.

A. Quantitative Results

[9] showed by Mean Plots (mean gain), One Way ANOVA test and Post Hoc Analysis that Group 4 performed the best and Group 2 performed the least.

Peer Evaluation Forms asked opinions on the four methods but few students failed to respond. The opinions covered: a) how effective was your group, b) how many members participated in your work group and c) how many participants were really prepared. A correlation values was generated using SPSS and it was concluded there are strong correlation between the above three points measured.

B. Interview Transcripts

Besides analyzing by SPSS package [9], this project called a few series of interviews between the main author and KBP mathematics lecturers, the main author and the students. The transcripts are shown in Figure 2:

Question 1: Express the following into a much simpler form a) $\frac{2}{3}+\frac{a}{2}$ b) $\frac{1}{2q}-\frac{q-3}{4q^2}$ *Question 2: Factorize* q^6-1 R: researcher S1: student 1 S2: student 2
Pre Use of CD
Answers: Question 1.a) $\frac{2}{3}+\frac{a}{2}=\frac{4+3a}{6}=\frac{7a}{6}$; Question 1.b) $\frac{1}{2q}-\frac{q-3}{4q^2}=\frac{4q^2-2q(q-3)}{4q^2}=\frac{2q-q-3}{4q^2}$ Question 2. q ..1
After using CDiCL
Answers: Question1.a) $\frac{2}{3}+\frac{a}{2}=\frac{4+3a}{6}$ Question 1.b) $\frac{1}{2q}-\frac{(q-3)}{4q^2}=\frac{2q-q+3}{4q^2}$ Question 2. $q^6-1=(q^2-1^2)^3$
R: You did well with the denominators? And .. you saw ..how ..-$(q-3)=-q+3$. Why like that?
S1: It is easy to ..multiply negative sign with '*q*' in the bracket … then the ended part ..in the bracket ..multiply by negative too. S2: I put … '-*q*' then concentrate with '-' times '-' and .. we know..becomes '+' ..then put 3. I think so (laugh).
R: You did well in this factorize difference of two squares. Putting q^2 outside. Why like that?
S1: I saw the CD .. 2 different colors used.. red squared and orange squared….(laugh) R: Oh! I see.. so why stop at that level…? S1: But power 2 …then power 3 becomes 6.. (laugh) S2: Yes… it must do something with that diagram red color you squared and ..another color ..you squared.. yes power 2 by 3 … gives me 6.

Figure 2. Transcripts of researcher with 2 selected students in Group 4 (translation)

VI. DISCUSSION

The findings are consistent with [7,17]. It accepted that technology improves learning by taking groups to function actively in the classroom. They saw the importance of treating *like* and *unlike* terms carefully in expressing the final answers. Fig. 2 proved some form of understanding in algebraic fractions was slowly developing by the use of CDiCL method. Participant observation methodology found that the teacher's voice played an important key when highlighting important issues in teaching [18] of algebraic fractions. A strong teacher's voice and his physical presence affected discipline among the students to focus in learning algebra. This conformed to [5] that teacher's voice played an important role in constructing understanding in fractions concepts. If the construction of probing important questions in problem solving was not properly guided in group learning then many students would treat numbers, fractions and algebra as separate identities [6]. Some group work failed to produce important impact might be due to the lack of motivation, interest and commitments level among group members in solving word problems. Students who perceived their group is effective feel that their group member are more prepared and participated actively [9].

VII. CONCLUSION

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 short transcript of this mathematics project in KBP there is some significant influence between group interactions and the courseware in building the understanding of algebraic fraction. This multimedia

courseware by adapting Hermann Whole Brain model plus effective interactions between lecturers, students and peers had motivated students to learn in this project. Mere discussion as found in Group 2 did not contribute enough to learning if the members had limited ability. In Group 4 by taking CDiCL they performed the best than the other three groups in KBP. Future research could expand on the issues of what kind of basic algebraic fractions that could work more deeply among the users of CDiCL.

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