5I’s Learning Path with Cultural Approach Embedded to CAI on Student’s Conceptual Understanding

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Received September 04, 2020; Revised October 06, 2020; Accepted October 15, 2020

Abstract This study aimed to determine the effectiveness of 5I’s Learning Path with Cultural Approach embedded in Computer-Aided Instructional (CAI) Material to the conceptual understanding among 1st year Bachelor of Science in Hospitality Management students, who are officially enrolled during 1st Semester, School Year 2019-2020 taking Mathematics in the Modern World at Sultan Kudarat State University - Tacurong City Campus. Two sections of 31, students each class were used as participants of the study and randomly selected as control and experimental groups which employed a quasi-experimental research design. The level of conceptual understanding of the students was measured using their scores in taking the Conceptual Understanding Test (CUT). Mean, standard deviation, and the analysis of covariance (ANCOVA) were used to analyze the data collected. Results revealed that 5I’s Learning Path with Cultural Approach embedded in CAI helped develop the students’ conceptual understanding.

Keywords: 5I’s learning path, cultural approach, CAI, conceptual understanding

Cite This Article: Allan Jay S. Cajandig, and Laila S. Lomibao, “5I’s Learning Path with Cultural Approach Embedded to CAI on Student’s Conceptual Understanding.” American Journal of Educational Research, vol. 8, no. 10 (2020): 772-778. doi: 10.12691/education-8-10-6.

1. Introduction

To seek innovations that leverage on teaching approaches and technologies to better engage the new generation of learners is one of the most important issues facing among educators nowadays. For instance, in mathematics education, how mathematics is taught, learned, and assessed with appropriate integration of technology which impacts mathematics curriculum. However, despite of the growing popularity and availability on educational technology, there is sometimes scarcity on facilities and technical assistance as well as teachers’ readiness to implement technology integration in the classroom setting. In addition, pedagogical aspects are seemed to be challenging for mathematics education because most initiatives tend to focus on technological aspects instead of pedagogical and instructional issues [1].

In Singapore, mathematics teachers primarily adopted Information and Communication Technology (ICT) to improve passive behaviors towards reading and listening, and to encourage active behaviors such as creating [2]. However, technology alone shall not be regarded as a substitute for all pedagogies. For academic progress, it is not an automatic result of adding computer solely to learning but with collaboration of learning principles and pedagogies as technology-based are designed and implemented [3].

Meanwhile, mathematics educators are facing challenges with problems on students’ diversity [4] such as language diversity [5] and multicultural classroom [6]. To address this, teachers need to be conscious on socio-cultural background of their students [7]. As such, Amit and Quoder [8], stressed out that mathematics was developed simultaneously by different cultures across the world. Recent researches increasingly concede that mathematics is indeed a cultural product, and hence, the role of culture with all its complexities and contestations is an important aspect of mathematics education. In this context, while technology has become a central element, it should not lose sight the key role of cultural aspects. All these aspects require significant reflection on education and technology in providing easy access to high quality learning opportunities for all.

Considering these aforementioned views, this study aimed to explore the application of 5I’s (impress, identify, inspire, inspect, and invoke) with cultural approach embedded to an educational software as a computer-aided instructional material that invades teaching and learning mathematics in a unique integration of classical and contemporary features by valuing own characteristics of culture and mathematics.

1.1. Theory of Effective Computer-Based Instruction

The present study is anchored to the theory of effective Computer-Based Instruction (CBI) by Lowe and Holton [9]. The theory comprises of three units reversely presented as output, process and input. In the output unit of the
theory, learning outcome is identified. The learning outcome describes what the learner can do after learning is completed. The process unit of the theory influences the learning outcomes which includes the instructional strategy design classified into three categories; organizational strategy, delivery strategy and management strategy. Lastly, input unit of the theory where learners are encouraged to take responsibility of cognition and contextualized process in constructing learning outcomes. Hence, in this study, process unit refers to the organizational strategy which is the sequencing of information based on the 5I’s Learning Path identified as impress, identify, inspire, inspect, and invoke.

Impress is to provide materials that catch student’s attention and problem-based situations as the focus of the lesson. This is to acquire vivid impression of admiration and stimulate initial analysis of the featured lesson among learners which anchored to the problem-posing approach. The study also uses connection theory which includes the motivational materials to stimulate interest and different problem-based situations related to a certain topic with cultural representations that will challenge the students to find solutions in the given problem.

Identify is to determine expected learning outcomes and prior knowledge. This section is anchored to the sense-making approach of Dervin [10] with emphasis on conceptualizations of users from the noun-based knowledge framework to verb-based-framework. Knowledge is re-conceptualized from noun to verb. In this section, the system includes distinguishing the necessary skills and desired objectives/goals expected to the students. It is about figuring out what students need to create and what limitations or restrictions they face through identifying prior knowledge in the provision of solutions to the posed problems.

Inspire is to guide and give idea about what to do or create. This section is anchored to the Control Theory of Frank [11] illustrating concepts and forming a basis for tutorial in mathematics in a concise self-study guide complementing the classic text by emphasizing the simple conceptual unity of the subject. The designed software provides material that illustrates detailed examples and graphics so that users learned the lesson naturally until the reader has a view of the whole concept. User with concise and easy-to-grasp input will stimulate students’ broad understanding of the concept.

Inspect is to examine critically in order to see and learn more solving problems correctly. This section is anchored to the Constructivist Theory of Bruner [12] as an active process where learners construct new ideas or concept based upon current knowledge relying on cognitive structure. This cognitive structure provides meaning and organization to experiences and allows students to go beyond what information given. In this section, the “AHA Moment” phenomenon allows students to find structured pattern within known information. This is all about searching for clear strategies to solve problems and acquire higher level of abstraction based on the given input.

Invoke is an application of effectiveness and feasibility of the new idea. This section uses new ideas in the form of formative assessment. Formative assessment is not necessarily associated with learning theories. However, current conceptualization of formative assessment is rooted in socio-cultural constructivist view of learning [13].

1.2. Contextualized Teaching

Contextualization is a drive making students more engage in learning where students relate on the situations pertaining in the lesson [14]. It creates meaningful and relevant lesson to the students’ daily living by relating familiar context to mathematical content being taught. Concepts are presented in the context of their use and of what the students already know and problems are contextualized and presented in real-life situations and experiences that are familiar to the students [15].

This study is also congruent to socio-cultural learning theory of constructivism which emphasized the cultural and social context influencing learning. He emphasized the critical importance of interaction with people in the cognitive development and suggested that cultures are actually formed through the use of tools and symbols. In the underlying theories on contextualized teaching, [16] identified the Connection Theory which is all about learning the content and the connection to the context in which the content will be used. Initially, learners must be aware of the content depending on their prior acquisition of knowledge to give new meaning to what they are learning. Hence, this study proposed a program which integrates the culture in the community such as arts, customs, social institutions, achievements and other manifestations.

2. Methods

The study used the pretest-posttest quasi-experimental design to determine the effects of 5I’s Learning Path with Cultural Approach embedded in a CAI material to student’s conceptual understanding. This involves the experimental group and control group which was carefully selected through randomization process. The experimental group was exposed to treatment which utilized 5I’s Learning Path with Cultural Approach embedded in a CAI material while the control group was exposed to Contextualized Approach with blended instruction.

To measure the conceptual understanding of the students, Conceptual Understanding Test (CUT) was administered. As for the design of CUT, the researcher patterned the construction from the previous researches Andamon and Tan [17]; Zeeuw, Craig and You [18]; and Bisson, Gilmore, Inglis and Jones [19]. The 8-item researcher-made instrument was validated with k-alpha = 0.6354. Also, the instrument undergone in a form of try-out test and yielded the coefficient of the reliability of alpha = 0.754 which means a higher level of reliability. There were three (3) Mathematics experts particularly specialized on Mathematics in the Modern World course including the researcher checked the answers of the participants. The following rating scale was used in evaluating the conceptual understanding patterned from the work of Bartell, Webel, Bowen and Dyson [20]: 4-Very Good Evidence, 3-Good Evidence, 2-Some Evidence and 1-No Evidence.
The participants of the study were the two intact classes of 1st year Bachelor of Science in Hospitality Management taking a course of Mathematics in a modern World in the 1st semester, School Year 2019-2020 at Sultan Kudarat State University - Tacurong City Campus.

The researcher took the delivery and technical aspects of the lesson. For experimental group, the teacher-researcher facilitated the routine of the laboratory management, such as arrangement of the facilities and installing the equipment and securing materials. Further, the teacher-researcher is responsible to guide the participants in dealing with the system throughout the lesson. The entire lesson was delivered pursuant to the planned schedule of the lesson. The student initially logged-in in the system then instruction guide appeared prior to the lesson. The participants explored the system per lesson using the 5I's learning path. Each path corresponds to different features. First, Impress, the motivational video appears with the problem of the day in. Second, Identify, it directs the participants to review or drill in a form of multiple choice test and short answer test. Here students can receive immediate feedback after they encode their answers. After which is the Inspire. The participant exposed to different learning resources such as audio-visual presentation, video lesson and pdf files with illustrations as concept tutorial, supplementary and enhancement activity of the given topic. It was followed the Inspect. The participant directed to revise the answer in the given problem of the day. Also, the participants identified the skills acquired while answering the given problem and then identified the acquired learning outcomes. Finally, Invoke learning path, where application activities to participants and self-reflection of the lesson learned.

For control group, teacher-researcher facilitated the lesson based on the prepared lesson guide using contextual approach with blended instruction. The classes used varied technology-based instruction such as power point presentation and other audio-visual materials to deliver the lesson. Also, 5I’s learning path was also used for possible enhancement in delivering the lesson. In the beginning, the teacher-researcher presented an audio-visual presentation as motivation featuring different contexts related to the lesson then it follows the posing of the problem of the day. The initial part is referred to as Impress in the 5I’s learning path. Then, Identify is when the teacher-researcher instructed the participants to identify the learning outcome as the possible goal to be achieved in the lesson. After identifying, the teacher gave review or drill like multiple choice test and short answer test to activate prior knowledge and then the teacher-researcher asked the necessary skills needed while answering the review or drill. After which, the participants answered initially the given problem of the day. The next part is Inspire. The teacher-researcher provided concept tutorial through power point presentation of the topic with supplementary video lesson. In the Inspect learning path, the teacher-researcher instructed the participants to revise their given solution in the given problem of the day. Also, the participants identified the skills acquired while answering the given problem and then identified the learning outcomes they acquired. Then, it follows the Invoke learning path. This is the last part where teacher-researcher gave application activities to participants and self-reflection of the lesson learned.

To describe the students’ conceptual understanding, mean and standard deviation of the pretest and posttest scores were computed. To determine the influence of the two methods of teaching in the mathematical creativity, one-way Analysis of Covariance (ANCOVA) was used, with the pretest as covariate.

3. Results and Findings

Table 1 shows the performance of students’ conceptual understanding during pretest and posttest both under the Control and Experimental Groups.

### Table 1. Mean and Standard Deviation of Conceptual Understanding

|                  | Control Group | Experiment Group |
|------------------|---------------|------------------|
|                  | Pre-test      | Posttest         | Pre-test | Posttest |
| Mean             | 10.74         | 18.95            | 9.78     | 21.56    |
| SD               | 3.65          | 4.82             | 2.99     | 3.05     |

Legend:
- **Score**: 0 - 15 = Failed, 16 - 19 = Passing, 20 - 23 = Average, 24 - 26 = Very Good, 27 - 29 = Excellent
- **Rating**: 0 - 15 = Failed, 16 - 19 = Passing, 20 - 23 = Average, 24 - 26 = Very Good, 27 - 29 = Excellent
- **Description**: 0 - 15 = Failed, 16 - 19 = Passing, 20 - 23 = Average, 24 - 26 = Very Good, 27 - 29 = Excellent

As reflected in the Table 1, majority of the participants get the mean scores of 10.74 and 9.78 under control and experimental groups respectively indicating that participants from both groups were failing. This means that students have less prior understanding about the concepts of the subject. However, the topics were already discussed during their senior high school Mathematics. Hence, it was surprising that there is low conceptual understanding in mathematics among the first year college students including the BS Hospitality Management in the beginning of the lesson. This shows further that conceptual understanding of the participants in the lesson is not evidently observed. Further, it can be observed that participants under control group have a standard deviation of 3.65 while students under experimental group recorded 2.99. The slight difference of the standard deviation value indicates that the scores in the control group is nearly similar compared to experimental group. This means that participants in both groups are homogeneous in terms of their conceptual understanding in the lesson prior to teaching the course. Below are the sample students’ responses on Conceptual Understanding Tests from the experimental group and control group during pre-test.

Figure 1 and Figure 2 shows the content analysis of students’ responses on item 5 and 6 both under control and experimental groups. This item was designed to assess the understanding of the concept through constructing and interpreting graphical display. Figure 1 shows answer of student under control group with misconception on the given item as well as on Figure 2, student’s answer elicits wrong response. Most students did not recognize that the
given data were bivariate. The most common error made by the students was to construct a graphical display that is designed to univariate data such as histograms and line graph. This is a manifestation that although students had a prior knowledge on the graphical presentation of the data however, they lack knowledge as to the purpose or when to use a certain graphical display which further, resulted to wrong interpretations of the data given. Moreover, most of students misconceptions observed in the student’s response to item 6 common error on this part were to think that a cause-and-effect relationship can be inferred from a strong relationship without taking study design into consideration. Most of the students indicated that it is reasonable to draw conclusion based from the data of this study but gave an incorrect reason. This implies further that students acquire little knowledge on interpreting relationship and draw conclusion based from the given data of the study.

Figure 1. Student’s Response on Item 5 & 6 during Pretest under Control Group

Figure 2. Student’s Response on Item 5 & 6 during Pretest under Experimental Group
Table 1 further shows the performance of students in terms of conceptual understanding during posttest both under the control with mean score of 18.95 interpreted as “Passing” and students under experimental group have a mean score of 21.56 interpreted as “Average”.

It implies that performance of participants in both groups increase particularly in their conceptual understanding after management of the lesson. However, participants under experimental group performed a better increase from failing to average level of conceptual understanding compared to control group which is from failing to passing level. The result implies that using 5I’s learning path with cultural approach integrated in CAI may increase the students’ conceptual understanding.

Further, the standard deviation score of experimental group is slightly higher compared to control group which are scattered compared to the scores of participants under control group. This means that the effect of the treatments varied depending on how the participants engaged and their level of ability to learn. This means further that some students managed to increase their performance as high as possible while others also managed to increase their performance but better than pretest.

Figure 3 and Figure 4 shows the content analysis of student’s response on item 1 both under control and experimental group. This item is designed to assess the understanding through describing steps of performing sampling method. Figure 3 shows answer of student under control group with a little understanding on the concept assessed by this question and received a score of 3 while Figure 4 shows answer of student under experimental group with better understanding on the concept and received a score of 4. This is an indication that both students under control and experimental groups can describe the steps of performing sampling method. This implies further that after the treatments students understand better through describing steps or procedures.

To determine if there is a significant difference on the effects of the treatments both in control and experimental groups, further analysis is done using analysis of covariance (ANCOVA) as shown in Table 2.

| Source     | SS     | Df | MS   | F    | P-value |
|------------|--------|----|------|------|---------|
| Group      | 184.653| 1  | 184.653 | 26.146 | .000    |
| Error      | 416.686| 59 | 7.062 |      |         |
| Corrected Total | 601.339| 60 |       |      |         |

Table 2. One-Way ANCOVA Summary on Conceptual Understanding

1. Suppose you want to determine the average grade of 530 students enrolled in Mathematics in the Modern World course in the University. Determine your sample using an appropriate method. Describe your steps in performing sampling method.

A method used to perform is Systematic Sampling Method. Here’s how:

- Step 1: I will give number to every student who are enrolled.
- Step 2: Sample size must be 530.
- Step 3: Identify the 5th student from the assigned number 1 up to 530 students and complete the 530 (sample) selected students as sample.
As shown in the Table 2, the analysis yielded a computed probability value of .000 which is less than 0.05 level of significance. Hence, there is sufficient evidence to reject the null hypothesis. It can be inferred therefore that there is significant difference in level of conceptual understanding of participants under the control and experimental groups. The findings revealed that the result in the experimental group is remarkably higher than control group in favor of the group who had the cultural approach integrated in CAI. This finding suggests that the use of the cultural approach integrating CAI in teaching mathematics apparently promotes better learning among students. Though, the other approach demonstrated a considerable gain yet it appeared that the latter resulted to higher and subsequently tested as remarkably more effective. It is interesting to note that in this innovation, the 5I’s learning path particularly in impress where students are exposed to culturally-related context with problem solving that may challenge them to solve using their prior knowledge. It is in the impress learning path where a pre-assessment is given to the students to activate their prior knowledge and identify the necessary skills needed to solve the given problem. Student then, answer the given problem based on their own procedures relying on their prior knowledge. It is about figuring out what students need to create and what limitations or restrictions they face through identifying prior knowledge in the provision of solutions to the posed problems. As expected, students did not have concrete answer. The inspire learning path provides audio-visual lesson, illustrative examples and exercises for students’ exploration of the given lesson which emphasizes the simple conceptualizing of the illustrated tutorial of the topic to attain concise self-study guide among students. User with concise and easy-to-grasp input will stimulate students’ broad understanding of the concept [21]. Moreover, inspect learning path allows students to examine critically in order to see the cognitive structure and go beyond in the given information. Students revised their initial strategies and solutions in the posed problem. The acquired strategies and higher level of abstraction applies for effectiveness and feasibility of the new ideas which can be done in the invoke learning path. This view is similar to formative assessment of Trumbull and Lash [22] which uses new ideas for application.

4. Conclusions and Recommendations

Based on the findings of the study, 5I’s learning path positively influenced the students’ conceptual understanding more effectively if with Cultural Approach embedded in CAI. Moreover, instructional designers particularly teachers may design activities in mathematics classes with integration of culture and local context such that students’conceptual understanding in mathematics is developed. In addition, school administrators may initiate wide dissemination such as seminar-workshop on 5I’s learning path as an approach in the teaching and learning mathematics subjects. Further, similar studies may also be conducted to a wider scope using different population in different institutions for refinement of the method. Corollary to this, another study that could effectively foster develop students’ critical thinking and problems solving skills in mathematics.

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