International Journal of u- and e- Service, Science and Technology
Vol.7, No.3 (2014), pp.217-226
http://dx.doi.org/10.14257/ijunesst.2014.7.3.19

The Impact of Higher Level Thinking on Students' Achievement toward Project Management Course

Tomas U. Ganiron Jr

College of Architecture, Qassim University, Buraidah City
tomas@qec.edu.sa

Abstract

This quasi-experimental research design was conducted to determine the effectiveness of case-based teaching and problem based learning in higher order thinking skills such as comprehension, engineering problem solving, planning, organizing and decision making skills at the Qassim University. Two groups of forty (40) engineering students in Project Management course of comparable mental ability was used in this study. One group was exposed to higher level thinking exercises while the other was not. Results showed a significant difference in the mean gain scores of the group given higher level thinking in case-based teaching, and the group which was not. However, the same exercises showed no significant difference on students' problem based learning in Project Management course.

Keywords: *Case based teaching, higher level thinking, problem based learning, students achievement, teaching strategies*

1. Introduction

Recently, many universities and colleges in ASEAN countries have moved toward the use of innovative teaching techniques to improve student learning. One of the most commonly used techniques has been active learning, which has been defined as anything that involves students in doing things and thinking about the things they are doing.

Professors and teachers need to be increasingly knowledgeable of methodologies that assist them with the challenging prospects of individualizing instruction [1]. Teachers need to understand how various learning processes integrate to form workable instructional strategies that lead to the formation of usable knowledgeable structures. Moreover, teachers need to redesign lessons so that they'll encourage more critical thinking on the part of the students. They have to figure out how to teach in ways that don't just impart knowledge, but instead helps students to construct their own interpretation.

Professors and teachers naturally are concerned about student learning. They especially are concerned about student learning that is measured by legislatively-mandated (standardized) assessments that affect the public's image of what they do, and the reputation of their universities and colleges. As a result they tend to avoid instructional practices that are not familiar or may be perceived as not achieving the desired outcomes, i.e., higher scores on standardized tests [2]. In an age, however, when it is imperative that people be good thinkers, administrators, the media, legislators, parents, need to encourage teachers to feel comfortable experimenting with practices that challenge students to think at higher levels.

ISSN: 2005-4246 IJUNESST

Studies showed that case-based teaching and problem -based learning is more effective in increasing students' academic achievement, as well as allowing them to work in groups and construct their knowledge through social negotiation compared to traditional teaching methods [3]. Problem based learning is highly appropriate for realizing the aims of Accreditation Board for Engineering and Technology (ABET). Problem based learning and case-based teaching might be an effective way of promoting engineering learning, which is highly related to real life and requires students to possess high level of critical thinking skills [4]. In fact, many engineering educators investigated the effects of case-based teaching and problem -based learning in engineering education.

Records of Qassim University for the School Year 2008-2009 show that the performance of the level ten (10) engineering students in GE 402-Project Management course in the final examination was quite low [5, 6]. This prompted the researcher to take steps that would help improve the performance of the students in this course.

The purpose of the present study is to investigate the effectiveness of case-based teaching and problem -based learning in 10th level engineering students higher order thinking skills such as comprehension, engineering problem solving, planning, organizing and decision making skills.

The study hypothesized a higher achievement in Project management course among engineering students exposed to higher level thinking case-based teaching and problem -based learning than those who were not. A significant difference between these two groups of engineering students was also predicted in the attitude towards project management course which those exposed to higher level thinking case-based teaching and problem -based learning showing more positive values.

2. Related Literature

Teachers interested in involving their students more fully in classroom discussion have found that case studies can provide a rich basis for developing students' problem solving and decision making skills. While the curricula at architecture, civil engineering and mechanical engineering have for many years been based on the analysis of real world cases, professors in a variety of disciplines have been finding that an occasional case study can help them assess students' ability to synthesize, evaluate, and apply information and concepts learned in lectures and texts. Cases can help us organize and bring to life abstract and disparate concepts by forcing students to make difficult decisions about complex human dilemmas.

2.1. Case Studies

The term 'case study' covers a wide range of problems posed for analysis, but most types include several key elements. Most cases are either based on real events, or are a construction of events which could reasonably take place. They tell a story, one involving issues or conflicts which need to be resolved—though most case studies do not have one obvious or clear solution [7,8]. The information contained in a case study might be complex (including charts, graphs, and relevant historical background materials) or simple—a human story that illustrates a difficult situation requiring a decision.

Traditional case studies in fields such as architecture, civil engineering and mechanical engineering can contain design codes, architecture projects, engineering applications and structural stability for actions to be taken. But case studies are

increasingly being written from a more personal perspective, involving real characters in actual situations. Indeed, a survey of faculty and students at Harvard Business school found that what engages students most in a case is that it tell a story: "a good case presents an interest provoking issue and promotes empathy with the central characters" [9]. It delineates their individual perspectives and personal circumstances well enough to enable students to understand the characters' experience of the issue. The importance of the compelling issue and the empathetic character reflects the fact that cases typically focus on the intersection between organizational or situational dynamics and individual perception, judgment, and action.

For example, a writing instructor wanting to teach students about the proper use of sources and plagiarism decided that rather than simply discuss these topics, a set of examples placing the student in the grader's position would be a much more effective learning experience [10]. Students were given several papers, and several articles used to write those papers, and then were asked to determine whether plagiarism had occurred and how they would respond to the students if they were the instructor. A biology professor teaching a course in parasitology had students construct their own cases; after having worked through several chapters on parasites and their effects on humans, students developed cases of individuals suffering a variety of symptoms—cases which were then used as the basis for class discussion [11]. The class had to evaluate the cases' presentation of symptoms, pathology, and epidemiology, and then arrive at a diagnosis. In both instances, students were required to make decisions about how they would respond to complex situations involving difficult choices.

2.1.1. The Goals of Case Studies: As with other teaching methods, the effective use of case studies requires instructors to determine the specific goals they hope to accomplish. In general terms, cases can assess the application of concepts to complex real world situations, including building analytic skills that distinguish high priority from low priority elements. Working in groups on cases also helps students develop interpersonal skills and the capacity to work in a team—goals that some instructors rate highly and evaluate [12]. Cases also help students make connections between what they might otherwise consider to be separate disciplines—for example, they see the need to draw upon principles in economics, environmental studies, and ethics to solve a problem in urban planning, or the need to use historical, philosophical, and sociological materials to make a decision about carrying out an anthropological project [13].

2.1.2. Writing or Finding Case Studies: While creating an effective case study can be time consuming, basing cases on actual events or experiences can help limit the initial investment of time. As civil engineer or architecture, there are complex issues in the research or teaching that can often naturally lead to a story others will profit from. Turning experiences into cases can be as simple as outlining the major components of a problem to be solved, or can require gathering materials that are necessary background to the circumstances students will find themselves in as decision makers [14]. Most case writers advise experimenting, and sharing cases with colleagues for comments and suggestions. Often, cases need revision after you've taught them once or twice and discovered their strengths and weaknesses. Because the case study method is now being used in many disciplines, relying on published cases can save preparation time.

2.1.3. Teaching with a case: Case studies usually generate animated class discussion, especially if students feel that the case will serve as a basis for wide-ranging

exploration [15]. A good classroom atmosphere will help generate and sustain students' participation, and this atmosphere can be quickly created by setting some ground rules for participation. Instructors can emphasize that the analysis will be a group project, and that no one will be criticized for raising naive questions or uncertainties. The group must recognize the significance of cooperation in working toward the goal of making sense of the problem, and that everyone is required to actively work together on the analysis. According to [16], his analysis of case discussion, student involvement develops on at least three distinct levels. At the first level, students explore a problem by sorting out relevant facts, developing logical conclusions, and presenting them to fellow students and the instructor. The students discuss someone else's problem; their role is that of the commentator-observer in a traditional academic sense [17]. On the second level, students can be assigned roles in the case, and take on perspectives that require them to argue for specific actions from a character's point of view, given their interests and knowledge. Finally, on the third level, students will take the initiative to become fully involved, so that topics are no longer treated as abstract ideas, but become central to the student's sense of self—of what they would choose to do in a specific real world situation. Given the complexity of many cases, it's useful to begin class discussion with questions that require students to review and organize information on the first level: what are the relevant facts and how do they translate into major themes or issues. Once students have agreed on the most significant information in the case, you can begin to pose more challenging questions.

2.1.4. Keeping the Discussion Alive: Once the basic information in a case has been reviewed, discussion can center on objectives and solutions. Good discussion can be generated by the kinds of questions that you ask to make sure that all the angles of the case are carefully considered. Open-ended questions are especially useful, because they demonstrate that you don't have a predetermined conclusion that you're aiming for. It's also important to ask exploratory and relational questions—questions that probe into the reasoning behind conclusions, since some students may want to jump quickly to a solution without carefully examining the evidence or their assumptions [18]. As students identify key concerns, these can be listed on the board for future reference—along with a separate list of possible actions. As a facilitator, you can organize the discussion by seeing if the class is satisfied that each of these action recommendations is discussed fully before moving on to the next. As in all discussion leading, it's important to listen carefully to students' responses, paraphrase when necessary, and give students sufficient time to reflect on questions or issues that are raised [19]. Of course, leading discussion on a case can be difficult at times. Students uncomfortable with ambiguity and interested solely in having the instructor offer up appropriate facts and truths may be unwilling to participate. Some students may also fear suggesting inadequate solutions, and so wait until someone else figures out 'the right' response. And even if the discussion is lively, the open ended nature of a case can sometimes lead the discussion on tangents that are inappropriate. But by preparing students well for what is expected of them, and then by preparing yourself with good questions, these difficulties can be minimized or eliminated [20].

2.2. Problem Based Learning

Problem based learning as a process that make people face with ill-defined problems which reflect real-life problems [21]. Problem-based learning engages problem solvers actively by giving them responsibility of their own learning and consequently it

develops problem solving skills as well as basic skills [22, 23]. Problem based learning motivates students to define the problem, search for the concepts and cooperative learning. It improves communication skills, and supports a powerful classroom learning process which uses real-life problems [20]. Problem-based learning requires people work with a group or a team, copes with different situations, improves self- learning and self- evaluation skills and motivates people to practice these skills [19].

[21], identifies the steps which are required for implementing the problem-based learning as following: a) clarifying concepts b) defining the problem and listing the concepts which need to be learned c) brainstorming d) systematic classification d) formulating the learning objectives e) lectures and self- study f) clearing up and, g) reporting

3. Research Methodology

The study was designed according to the pretest-posttest with control group model, which is one of the true experimental models. The study was conducted with level ten (10) engineering students. Two sections with forty (40) students, each comparable in terms of IQ, comprised the experimental and the control groups. These engineering students were picked by the researcher from their sections through random selection. Case-based teaching and problem-based learning was implemented in one class by the researcher and the traditional methods were implemented in another section. An achievement test prepared in accordance with objectives of the topic entitled "Project Management Processes" in the instructional unit "Styles and Strategies in Managing Projects" in the general engineering course was used as testing tools. These testing tools were administered to the experimental and control groups as pretest and posttest. The data obtained after an application that lasted 4 weeks were analyzed. For analyzing the data, t-test has been used.

3.1. Sample

The sample of this study consisted of two separate level ten (10) engineering students from Bachelor of Civil Engineering, Bachelor of Electrical Engineering and Bachelor of Mechanical Engineering in Qassim University in city of Buraidah which is located in Kingdom of Saudi Arabia. The two classes had similar socioeconomic backgrounds, similar curriculum implemented and same topics covered in both classes. Both experimental group and control group consisted of 40 students.

3.2. Variables

Independent variable is the instructional methods. Experimental group utilized case-based teaching and problem-based learning and control group utilized traditional instruction. Dependent variable is the higher order thinking skills.

3.3. Instruments

In order to collect data for the dependent variable which was investigated in the study, an achievement test was developed, pilot tested and administered. The objectives of the lessons related to the topics in "Project Management Processes" which was covered in the "Styles and Strategies in Managing Projects" unit were determined. The objectives or each lesson in the topic "Project Management Processes" were identified at a table to ensure content validity of the achievement test items. In accord with this table, 45 questions were prepared to test the higher order thinking skills of the students.

The questions were investigated by science teachers and experts in the area of assessment and evaluation and some revisions were made based on their suggestions.

45-item pilot test was administered to one hundred and twenty seven level ten (10) engineering students. Based on the data, reliability constant (KR-20) of the test and discrimination indices of the each item were computed. The items which have item discrimination index under 0.30 were eliminated from the test. Based on the analyses, final test was consisted of 30 items and the reliability constant was found to be 0.74. The test was consisted of items which were accessing comprehension (10), problem based learning (10), and case management skills (10).

4. Results and Discussion

The statistical techniques used to analyze the data were means, Standard deviations and t-test. The data were analyzed by using statistical software SPSS. The data indicate a significantly higher achievement gain score in the experimental group than the control group. Using a one-tailed t-test at the 0.05 level of significance the difference in the mean gain scores of the two groups is significant as gleaned from Table 1.

Table 1. Comparison of Experimental and Control Groups for Difference in Comprehension Level

Groups	N	Mean Score			Difference between gain scores	t-test	Probability
		Pretest	Posttest	Gain			
Experimental	40	0.20	10.00	9.75	8.7	9.88	$p \leq 0.05$
Control	40	5.35	6.40	1.00			

As shown in Table 2, with regard to problem based learning, no significant difference was found in the students' problem based skills towards Project Management course between those exposed to higher level thinking exercises and those who were not.

The non-significant difference in problem based learning change may due to the fact that the students already had initially positive problem based learning towards Project Management course. Having been taught by the same teacher from the start of the school year, it could be that the two groups after the four (4) month experimental treatment no longer showed a significant change in their problem solving skills.

Furthermore, integrating problem based learning in case management process skills present in both groups emphasizes the relevant and usefulness of Project Management course to real life situations and thus may have narrowed down problem based learning differences between the two groups to non-significant levels.

Table 2. Comparison of Experimental and Control Groups for Difference in Problem Based Learning

Groups	N	Mean Score			Difference between gain scores	t-test	Probability
		Pretest	Posttest	Gain			
Experimental	40	3.65	9.30	5.60	0.30	0.11	$p \geq 0.05$
Control	40	4.40	9.75	5.30			

Table 3 shows pre-test scores of students on case management skills. Case Management process skill scores for traditional instruction group is 2.5 and for problem based instruction group it is 1.13. The t-test result shows a significant difference at 0.05 levels. Control group students' case management process skills were found to be more improved compared to experimental group students.

Moreover, the posttest shows that the mean score on the case management process skills is 4.43 for control group and 8.19 for experimental groups. The t-test result indicates that the difference is significant at 0.05 levels. The result suggest that problem based learning is more effective than the traditional instruction in improving case management skills.

Table 3. Comparison of Experimental and Control Groups for Difference in Case Management Skills

Groups	N	Mean Score			Difference between gain scores	t-test	Probability
		Pretest	Posttest	Gain			
Experimental	40	1.13	8.19	7.00	5.10	-9.10	$p \geq 0.05$
Control	40	2.50	4.43	1.90			

5. Conclusion

Exposure to higher level thinking exercises in case based teaching resulted in greater gains and improvement in the achievement test scores of Project Management course.

Problem-based learning applications resulted in improvements in all level of learning outcomes namely comprehension, problem solving skills and case management skills. In control group, classifications, definitions and rules directly given to the students and their getting used to traditional instruction could be the reason of the increase in their scores.

However, the increase in experimental group's score is higher than the control group's score. Experimental group students learn the lesson by scenarios, made connections with the real life problems, used inquiry and investigative activities, and tried to acquire the objectives of the lesson by using higher order thinking skills.

As a result these activities their skills in comprehension, case management skills and problem solving skills have increased more than the traditional group students. During the experimental application, problem based learning group students stated the problems with their own words which made them aware of the lesson objectives.

This indicates that teaching of thinking skills in subject matter teaching leads to improved students' thinking and more meaningful context learning.

Applying opportunities for brainstorming sessions and demonstrating higher order thinking skills more likely improve the cognitive structure as well as the academic performance and the students

References

[1] T. W. Banta, K.E. Black and K.A. Kline, "PBL 2000 Plenary Address Offers Evidence for Against Problem-Based Learning", PBL Insight, **(2000)**, vol. 3, no. 3, pp. 1-11.

[2] C.Y. Chang, "Comparing the Impacts of a Problem-Based Computer-Assisted Instruction and the Direct-Interactive Teaching Method on Student Science Achievement", Journal of Science Education and Technology, vol. 10, no. 2, **(2001)**, pp. 147-153.

[3] T. U. Ganiron Jr, "Application of Accelerated Learning in Teaching Environmental Control System in Qassim University", International Journal of Education and Learning, vol.2, no.2, **(2013)** September, pp.27-38.
[4] B. Duch, S.E. Groh, and D.E. Allen, "The Power of Problem Based Learning", A Practical for Teaching Undergraduate Courses in Any Discipline, Sterling, VA: Stylus Publications, **(2001)**.
[5] M.A.Copland, "Problem Based Learning and Prospective Principals" Problem Framing Ability, Educational Administration Quarterly, vol. 36, no. 4, **(2000)**, pp. 585-607.
[6] T. U. Ganiron Jr, "Accelerated Learning Techniques: Teaching Critical Thinking in Qassim University, Journal of Proceedings of the 41st Annual Conference of the European Society for Engineering Education, **(2013)** September 16-20; Leuven, Belgium.
[7] T. U. Ganiron Jr, "The Effect of Study Group Activity Guide in Expository Reading and Writing Course at the College of Architecture in Qassim University", International Journal of Education and Learning, vol. 3, no. 1, **(2014)** March, pp.23-34.
[8] N. L. Greenwald, "Learning from Problems", The Science Teacher, vol. 67, no. 4, **(2000)**, pp. 28-32.
[9] T. U. Ganiron Jr, "Cultural Learning Environment and Perception of Structural Engineering Classes in Qassim University", World Scientific and Engineering Academy and Society Transactions on Advances in Engineering Education Journal, vol. 9, no. 3, **(2012)** December, pp. 84-93.
[10] T. Harland, Zoology Student, "Experiences Collaborative Enquiry in Problem Based Learning", Teaching in Higher Education, vol. 7, no. 1, **(2001)**, pp. 3-15.
[11] T. U. Ganiron Jr, "Designing and Developing Web Enhanced Project Management Course for Engineering Graduating Students", Journal of Proceedings of the International Forum on Engineering Education, United Arab Emirates, **(2010)** November.
[12] T. U. Ganiron Jr, "Student Competencies in Structural Engineering: Modeling Cultural Environment in Qassim University", Journal of Proceedings of the 40th Annual Conference of the European Society for Engineering Education, **(2012)** September 23-26; Thessaloniki, Greece.
[13] E. Lehtinen, "Developing Models for Distributed Problem-Based Learning: Theoretical and Methodological Reflection", Distance Education, vol. 23, no. 1, **(2002)**, pp.109-117.
[14] D. T. Martinez, T.Ucol-Ganiron Jr and C. S. Lacsamana, "Development of Hardware Interfacing System for Visual C++", International Journal of Advances in Applied Sciences, vol. 2, no. 4, **(2013)** December, pp. 1001-1005.
[15] T. U. Ganiron Jr, "Web-Enhanced Project Management Course", International Journal of u- and e- Service, Science and Technology, vol. 6, no. 1, **(2013)** February, pp.49-59.
[16] J.T. McDonald, "Using Problem Based Learning in Science Methods Course", Annual Meeting of the Association for the Education of Teachers in Science, **(2002)** January; Charlotte.
[17] C. S. Lacsamana, T. U. Ganiron Jr and H. S. Taylor, "Developing Low Cost Laboratory Apparatus for Hardware Interfacing System", International Journal of u- and e- Service, Science and Technology, vol.7, no.2, (**2014**) April, pp. 113-126.
[18] J.T. McDonald, "Using Problem Based Learning in Science Methods Course", Annual Meeting of the Association for the Education of Teachers in Science, (**2002**) January 10-13; Charlotte, NC
[19] I. W. Anderson and D. R. Krathwohl, "A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives, **(2001).**
[20] I Beatty and W. Gerace, "Technology-Enhanced Formative Assessment: A Research Based Pedagogy for Teaching Science with Classroom Response Technology", Journal of Science Education and Technology, vol.18, no. 2, **(2009).**
[21] T. U. Ganiron Jr and D. Tesoro, "Investigation of the Predictors of Civil Engineer Career Success, Proceedings of the 41st Annual Conference of the European Society for Engineering Education, **(2013)** Sept 16-20; Leuven, Belgium.
[22] J. M. Braxton and W. A. Jones, "The Role of Active Learning in College Persistence", New Directions for Teaching and Learning, vol. 115, **(2008),** pp.71–83.
[23] C. Fies and J. Marshall, "The C3 Framework: Evaluating Classroom Response System Interactions in University Classrooms", Journal of Science Education and Technology, vol. 17. no.5, **(2008)**, pp. 483-499.

Author

Dr. Tomas U. Ganiron Jr, this author obtained his Doctor of Philosophy in Construction Management at Adamson University (Philippines) in 2006, and subsequently earned his Master of Civil Engineering major in Highway and Transportation Engineering at Dela Salle University-Manila (Philippines) in 1997 and received Bachelor of Science in Civil Engineering major in Structural Engineering at University of the East (Philippines) in 1990. He is a registered Civil Engineer in the Philippines and Professional Engineer in New Zealand. His main areas of research interest are engineering education, construction engineering, construction management, project management and recycled waste materials.