Original Article

Effects of Peer Teaching Method in Software Testing Course in Comparison with Traditional Teaching Method

Girma Neshir Alemneh

Addis Ababa Science and Technology University, Ethiopia

Email: - girma.neshir@aastu.edu.et

Abstract

This action research project incorporated peer teaching model for creating active learning environment for teaching the course "Software Verification, Validation and Testing". Topics covered in the course comprised overview of software testing, software quality, types of software testing, test case design techniques, test documentations, software test frameworks; model based testing, software verification and validation. The aim of the research was to explore to what extent the peer teaching would increase students' learning motivation, engagement, develop critical thinking skills, and their performance. The research was conducted for one semester and data were generated using questionnaire, test scores, and students' activities record as instruments. The test score data is collected from 10 students taking the course. The data were analyzed using both qualitative (textual data obtained from open ended response) and quantitative (numerical data from questionnaires, and test scores) methods. The result showed that peer teaching approach has positive effect in the attitudes of students towards software testing course compared to lecture mode instruction.

Keywords: - Action Research, Software Verification, Validation, Peer Teaching

1 Introduction

Action research is an approach to educational research that is commonly used by educational practitioners, and professionals to examine, and ultimately improve their pedagogy and practice (Clark, Porath, Thiele & Jobe, 2020). They carried out action research to provide knowledge related to teaching, learning and assessment of students' affective, cognitive needs and cultural and socio economic factors of the schools and other factors related to improving schools.

Stakeholders in education sector make decisions affecting quality of education for their students and intervene based on the knowledge obtained with the research results.

An action research is situation and context based, collaborative and participatory, iterative and ongoing undertaken by individuals with a common purpose. It may have four stages/cycles: (a) propose a change, (b) engage in action, (c) observe results and (d) reflect on action. These research cycles have also many other models with consideration of other basic supplementary processes. The models are describing the same process of action research with different characterization. In such a perspective, the teacher is the researcher and students are target population from which data are collected and the teacher identifies, analyzes data, reflect on action and plan for the next time intervention. The overall purpose of this study was to examine the effects of peer teaching method on students' attitude towards software testing course and their performance in software testing.

2 Related works

This section presents a brief review of key related research papers on investigation of peer teaching as active learning techniques on various disciplines such as computer science, mathematics, biology, geology, education, English and physics. In the end of this section, research questions which are going to be addressed are stated in order to investigate effect of peer teaching to conduct software testing, verification and validation course for post graduate program in the department of software engineering.

Yıldız & Gündüz (2020) investigated the effects of peer teaching method in programming teaching on secondary school students' attitudes towards software courses and their perception of programming self-efficiency comparing to traditional teaching methods are examined. Both quantitative and qualitative research approaches have been used. With quantitative research, pre-test post-test control group and semi-experimental research model have been utilized on the other hand a qualitative research is used to deeply describe the different thoughts and opinions of students about peer teaching method in a more detailed way. Semi-structured interview was conducted with 12 volunteered students from experimental groups. The research findings has shown that peer teaching method increases students' perception and programming skills compared with traditional teaching method. Students participated in peer teaching method said that peer

teaching method helped to improve their communication skill and suggested the method to be applied in the other course as well.

The peer teaching method is one of the active learning models that allow the student to understand the concepts of software testing and students can able to answer comprehensive questions and helps to retain concepts to apply it in capstone projects and further discuss it with peers. In this method, a significant contribution is made to the success of the student who gets help from the peer.

Peer teaching is proven active learning model which is tested in different ways on different disciplines and there are studies examined the effect of the peer teaching in computer courses teaching on the students' performances and attitudes in the literature. To name a few, microteaching physics and mathematics in high school (Sanaeifar *et al*, 2020), effects of peer teaching pre-services physics (Shen, 2010), investigated combined microteaching and simulation for initial teacher educators (Ledger & Fischetti, 2019), peer-designed active learning modules as a strategy to improve confidence and comprehension within introductory computer science (Packard *et al*., 2020), investigation of effects of peer tutoring on the academic achievement of students in the subject of biology at secondary level (Ullah, Tabassum & Kaleem, 2018), studying a peer-teaching model using geospatial open source tools to address community health issues (Jones, Darsow & Jones, 2020), investigating effect of peer teaching on academic achievement of the undergraduate students (Abdelkarim1 & Abuiyada, 2016).

3 Research method

In order to answer aforementioned research questions, the research method followed, teaching design, research design how to collect data and the type of data are discussed in the following section. Mixed research approach that is combination of quantitative and qualitative research methods is used in order to answer the above-mentioned research questions.

A mixed research approach was employed in order to get a comprehensive and complete picture of the solutions to the research questions. Indeed, this research design will collect both qualitative and quantitative data. Those data were analyzed separately and finally the findings were interpreted together. In quantitative part, pretest, and post test scores of participants/learners were collected.

85

3.1 Teaching Design

Software Verification, Validation and Testing (SVVT) course has four course learning outcomes (CLO). These include restated the as upon successfully completing this course, a student should be able to CLO1: Identify different testing techniques and design test plans, develop test suites, and evaluate test suite coverage, CLO2: Produce quality software in line with software requirements, standards and guidelines, CLO3: Use testing frameworks and testing tools, and CLO4: Apply the concepts and theory related to software verification and validation. To achieve these CLOs, the course content is divided into seven chapters. And SVVT course description comprises of discussion of basic concepts of software testing and error handling and debugging mechanisms. It focuses on applying techniques to design test cases, test plan and implement for ensuring software quality. SVVT course consists of basic and advanced software testing principles: white box testing based on code analysis, black box testing, inspection and reviews, and other advanced testing issues like software testing frameworks, model based testing. The teaching SVVT course has been designed at three stages of the course. These include the pre-class, in-class and post class. The activities in these stages are described below.

Pre-class: The course has seven units. The first three units are offered using traditional lecture method by the teacher. In the remaining part of the course, each student (10 Post graduate students = 4FTP + 6Regular) has been assigned a topic and all the lecture slides have been given for guiding them to prepare their own lecture slide that is to be presented for 10 minutes.

In-class: The assigned student has been instructed to take responsibility for teaching the topic. For each peer teaching session, 10 minutes is allocated depending on the coverage and depth of the assigned topic. The teacher facilitates the peer teaching presentation session, and the rest of the session's time is used for question and answering, followed by comments on the session and closes with highlighting key points of the session. Continuous assessments including final exam are delivered to students taking the course.

Post-class: At the end of the course class, questionnaires have been administered to be filled by students. Almost all the questions in the questionnaire are open ended questions and students are asked to give feedback on the course using Google form. This is to collect qualitative data about

86

the effect of peer teaching in their motivation and attitude on the learning of software testing course in comparison with traditional teaching methods. Using open-ended questionnaire, among 10 students, only 7 students give their feedback on the course. On the other hand, as part of quantitative part, students' test scores on the course assessment were used. In line with this, before intervention and the other after intervention assessment scores were used to compare effect of peer teaching on the performance of students.

3.2 Research Design

Students in regular M.Sc. in Software Engineering program (who were registered for the course Software Verification, Validation and Testing in 2022/23) are considered. The quantitative data were analyzed using statistical techniques (i.e. t-test). In this research, the independent variable comprises of the peer teaching presentation whereas the dependent variable is their attitude, engagement and performance on the course.

Data collection: In the study, open ended questionnaires were developed by the researcher for collecting qualitative feedback on software verification, validation and testing course from learners.

Results: After the collected data (both qualitative and quantitative) were obtained, findings of the statistical analysis on the quantitative data were used as the solution of the sub-problems of the research and their interpretation were presented. Besides, the interpretations of the results gained from the analysis of the qualitative data were used to address the research problem/questions with in depth.

Analysis: The collected data was analyzed depending on the type of data. Quantitative data such as the students' scores in the course were analyzed using statistical methods whereas the qualitative data obtained from questionnaire was analyzed using content analysis. Statistical analysis helps to answer whether there is significant performance gain of students comparing two assessments administered before and after peer teaching is introduced. With both quantitative and qualitative analysis, finding were interpreted and have more credible answers to the research questions stated earlier.

4 Results and Discussion

According to the analysis of the collected data, the answers to the aforementioned research questions can be briefly answered as follows.

RQ1. *What is the effect of the peer teaching model in software testing teaching on the attitudes of students towards Software course compared to the traditional teaching method?*

According to the qualitative analysis of learners' responses to questionnaires, six of the seven students argued that peer teaching approach has positive effect in the attitudes of students towards software testing course comparing to lecture mode instruction. Sample textual responses from Google form of one of the learner is depicted in text below.

> "*The positive effects included that we were required to deep search the topics we were assigned therefore we had a better understanding of the topics. Another positive effect is that we had the opportunity to practice our presentation skills. We were also able to see our classmates present and this allowed us to learn from our peers. I wasn't affected on a negative note when it came to this change in the learning process.*"

Another respondent also stated in his response that:

> "*Positive: we searched more on the subject and practiced how to deliver or teach other, Negative: May be some students fear to communicate (deliver) their knowledge*"

Peer teaching software verification, validation and testing showed positive effect in the process of learning and the negative side of peer teaching is time consuming to prepare presentation slides and some students are shy to communicate inform of students.

RQ2. *What is the effect of peer teaching method on software testing students' performance compared with traditional teaching methods in software testing teaching?*

Though the background of learners might have disparities to some extent (regular and FTP), the test scores of the learners in the second assessments after peer teaching had introduced showed higher performance as compared to the performances of the learners in the assessment on lecture method. In other words, the intervention of peer teaching method showed encouraging effect in students' performance as compared to lecture mode instruction of software testing course. The statistical test comparison of students' performance between two scores with independent sample

88

t - test indicated difference in probability distribution ($0.0481 < p\text{-value} \leq 0.05$) on the assessments scores (before and after scores) with the assumption that the two assessment scores were independent samples. Therefore, we do not reject the null hypothesis of equal population means. If the p-value is smaller than our threshold, then we have evidence against the null hypothesis of equal population means. By default, the p-value was determined by comparing the t-statistic of the observed data against a theoretical t-distribution. This implies the performance of the students after peer teaching is introduced is significantly greater than performance before peer teaching (i.e. lecture mode).

In addition, one of the questions in the questionnaire was asking respondents rate level of acquiring each course learning outcomes with 5 scales (poor, fair, satisfactory, very good, and excellent). Accordingly, their responses were from very good to excellent on attaining the four course learning outcomes (see Figure 1). However, two respondents rated the second course learning outcome as satisfactory. The reason could be due to shortage of time to practice for their capstone project and limiting them to create quality software; they did not attain it to the expectation of the course.

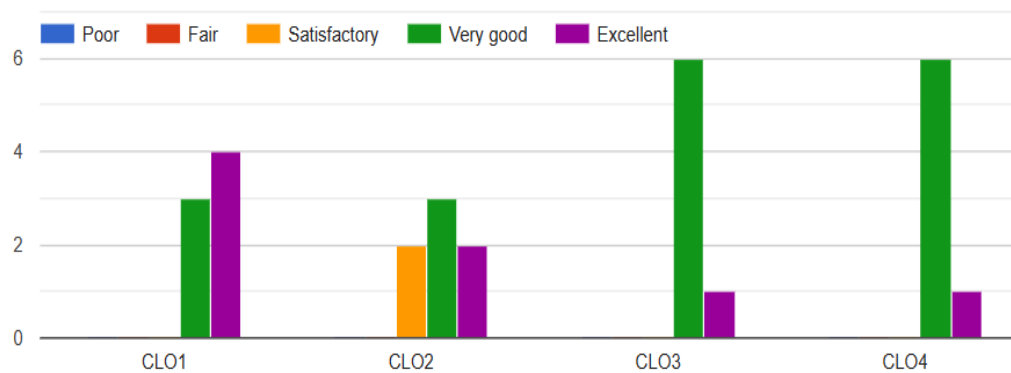To what degree you achieved course learning outcomes mentioned above?

Figure 1: students' response of their ratings on course learning outcome attainment

RQ3. *What are the student views of the peer teaching method applied in software testing teaching?*

Based on most of the responses of learners, peer teaching improved their engagement, and their intercommunication skills compared to lecture mode instruction of software testing course. As

short coming, some of students stated that it consumes their time in preparation of their peer teaching presentation. For example, one of the responses confirmed this argument.

> "*We were assigned to present with a fellow classmate therefore we had to communicate and collaborate. Therefore, we were able to improve both our communication skills and relationships.*"

Apart from students' performance improvement on the course, students' communication skills and relationships with their peers has shown improvement once peer teaching is used in place of lecture instruction. There is also a question in the questionnaire asking respondents to give their view whether to apply peer teaching in another software engineering course. Most of the respondents suggested peer teaching to apply in all other related software engineering courses. In arguing this statement, one of the responses is shown below:

> "*I think peer teaching can be an optimum method to not only learn software engineering but also any type of engineering course.*"

Within the scope of the research, when the students were asked whether they wanted a peer teaching method to be applied by other teachers in different courses, all of 7 students except 1 student are agreed to peer teaching to be applicable all other software engineering course.

5 Conclusion

Based on the findings, peer teaching method for teaching software verification, validation and testing course has a positive effect on students' attitude and performance compared to traditional teaching mode. The opinions in favor of the conclusion that the peer teaching method in software testing teaching improves the attitude and performance of software verification, validation, and testing are frequently observed when the results from the questionnaires and test scores are examined.

Declaration of Conflict of interest

The author declare no conflict of interest.

References

Abdelkarim1, R. & Abuiyada, R. (2016). *The Effect of Peer Teaching on Mathematics Academic Achievement of the Undergraduate Students in Oman*, International Education Studies, 9(5),124-132.

Bell, N. D. (2007). Microteaching: What is it that is going on here? Linguistics and Education 18, P. 24–40.

Cheng, P. & Chen, L. (2017). *Peer learning efficacy analysis on undergraduate software design course*, Comput Appl Eng Educ. 2017, 1–12.

Clark, J. S., Porath, S., Thiele, J. & Jobe, M. (2020). "Action Research" *NPP eBooks*. 34.

Gopal, B. & Cooper, S. (2021). *Peer Instruction in Software Testing and Continuous Integration*, SIGCSE '21: Proceedings of the 52nd ACM Technical Symposium on Computer Science Education, P. 548–554.

Jones, D., Darsow, E., & Jones, D. F. (2020). *Preliminary Testing of a Peer-Teaching Model Using Geospatial Open Source Tools to Address Community Health Issues, Testing of Peer-Teaching Model*, Journal of STEM Outreach, 3(1), 1-7.

Ledger, S., & Fischetti, J. (2020). Micro-teaching 2.0: Technology as the classroom. *Australasian Journal of Educational Technology*, *36*(1), 37–54.

Lim, L. L. (2014). *A Case Study on Peer-Teaching*. Open Journal of Social Sciences, 2, P.35-40 http://dx.doi.org/10.4236/jss.2014.28006.

Odom, S., Glenn, B., Sanner, S. & Cannella, K. (2009). *Group Peer Review as an Active Learning Strategy in a Research Course*, International Journal of Teaching and Learning in Higher Education, 21(1), 108-117.

Packard, B. W., Solyst, J., Pai, A. & Yu, L. (2020). Peer-Designed Active Learning Modules as a Strategy to Improve Confidence and Comprehension within Introductory Computer Science, Journal of College Science Teaching, 49(5), 76-83.

Sanaeifar, S. H. et al (2020). *Optimizing Students' Engagement through Implementing Peer-assessment Practice in Iranian Public High School: An Action Research*, Theory and Practice in Language Studies, 10(8), 940-946.

Shen, A. I. (2010). *Effects of Peer Teaching and Microteaching on Teaching Skills of Pre-Service Physics Teachers,* Education and Science, 35(155), 78-88.

Smith, J., Tessler, J., Kramer, E. & Lin, C. (2012). *Using Peer Review to Teach Software Testing*, ICER'12, Auckland, New Zealand.

Santos, P. & Travassos G. (2009). *Action Research Use in Software Engineering: an Initial Survey*, Third International Symposium on Empirical Software Engineering and Measurement. P. 414-417.

Topping, K. (1998). *Peer Assessment Between Students in Colleges and Universities, Review of Educational Research,* 68(3), 249-276.

Ullah, I., Tabassum, R. & Kaleem, M. (2018). *Effects of Peer Tutoring on the Academic Achievement of Students in the Subject of Biology at Secondary Level*, MDPI Education Sciences. *8*(3), 112.

Yıldız, T. & Gündüz, S. (2020). *The Effect of Peer Instruction Method in Programming Education to Student's Attitudes towards Course and Programming Self-Efficacy,* International Journal of Education, 8(4), 50–56.