Journal of Theoretical and Applied Information Technology
15th March 2025. Vol.103. No.5

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

IMPROVING STUDENT ENGAGEMENT IN LEARNING REQUIREMENT ENGINEERING SUBJECT USING PAIR LEARNING

NURAZLINA MD SANUSI[1], ABDUL KARIM MOHAMAD[2]

[1]Senior Lecturer, UNIVERSITI TEKNIKAL MALAYSIA MELAKA, Department of Diploma, Malaysia

[2]Senior Lecturer. UNIVERSITI TEKNIKAL MALAYSIA MELAKA, Department of Software Engineering, Malaysia

E-mail: [1]nurazlina@utem.edu.my, [2]karim@utem.edu.my

ABSTRACT

Requirement engineering is one of the disciplines in software engineering areas that play an important role in determining successful software development. Many researchers have highlighted the importance of requirement engineering aspects in software engineering. They pointed out that one of the difficulties of teaching requirement subjects is the preparation in the classroom to teach requirement engineering subject and make students engage. Learning requirement subject can be difficult for some students in the classroom. In this paper, we presented a new engagement framework using pair work learning in the classroom. We adapted pair work and explored this approach in teaching and learning requirement engineering subject. With the assistance of the learning management system (Moodle platform – in our university, we called ULearn), the activities and assessments designed in pair, we lead the students to linkage with engagement and lead them to learn.

Keywords: *Software Engineering, Student Engagement, Pair Learning, Requirement Engineering, Requirement Engineering Education.*

1. INTRODUCTION

Teaching and learning requirement engineering (RE) in the classroom is challenging to lecturer/educator. They must find new ways to set student's perspective into software development according to student's understanding. In learning RE process, students need to learn and understand all the tasks of a software engineer to complete the requirement engineering process. Students are not only taught how to specify functional requirements and non-functional requirements, but they must also know how to elicit, negotiate, validate and verify requirements [1]. This is also agreed by Umar and Lano (2024) where they stated the importance of using natural language to elicit requirements from the stakeholders [2].

Difficulties of teaching RE have become one of the essential factors for improving student learning in requirement engineering education (REE) [3]. Most previous studies stated that failures and deficiencies of software system are caused by the lack of appropriate skills and knowledge on the RE activities taught in the classroom and left to the software industry to train their staff to be efficient software engineers [4].

Many RE courses in the Computer Science programs at universities are instructed as a part of software engineering programs. Students are taught lecture style in the classroom and are not given real life problems as examples [1]. Students found it is hard to understand the elicitation techniques taught in the classroom because lack of access to real life projects, do not allow them to communicate with stakeholders is one of the biggest problems in learning RE process. The biggest challenge of teaching RE subject is lecturers/educators must be technical competencies and critical thinking to connect technical skills with knowledge to stimulate end-user driven experience to students in the classroom [5].

Research in pair learning mainly in practical hands-on subjects such as programming [6]. In 2011, Albakry and Kamalrudin investigated the use of pair learning in requirement engineering activities and reported there were no significant results between pair and solo in their case study [7]. One possible reason is due to software engineers lack of appropriate skills and knowledge of RE

activities to engineer the requirements [3]. In addition, Rupakheti et al (2018) seen Computer Science students are being more trained to 'hard skills' – that involved with learning coding, testing and algorithmic thinking rather than 'soft skills' that valued the same in any engineering ability. From their findings, they concluded that one teaching approach may work for one but may not work for others. The more recent attention of literature on REE approaches includes current practices trends toward the authentic and industry-realistic experiences to improve students' understanding of RE subjects [1].

Thus, the work on how to engage students and lead them to better learning the RE subject is still infancy and needs more practical applicability in requirement engineering education. To date, little research has been carried out to investigate to what extent the uses of REE teaching approaches contribute to improving student engagement and leading them in learning.

This paper reports on a study that adapted a pair learning approach in engagement theory to help in teaching and learning requirement engineering subject and lead on student engagement in learning. The remainder of this paper is organized as follows: Section 1 is the introduction section; The pair learning approach is presented in Section 2. The theoretical framework of the research is presented in Section 3. Followed by the research methodology in Section 4. The implementation of the method is presented in Section 5. The results are presented in Section 6. Later, we presented evidence of engagement in Section 7 and lastly, we presented the discussions and conclusions in Section 8.

2. PAIR LEARNING APPROACH

The pair approach has been one of pedagogical tools in technology-based learning for Computer Science courses particularly in programming subjects at universities and higher learning institutions. There are numerous studies on pair learning approach in programming. According to Bryant et al. (2008), their definition of pair programming is when two people play two roles of programmer, driver' and 'navigator' writing the code on the same computer to solve problems [8].

Learning requirement engineering subjects in the classroom can be difficult as new needs and problems always imposed on the user's perspective as software projects progress. This has been reported by Janisar et al (2024) in their work examined the existing methods and obstacles in security software requirements elicitation. Students must experience the requirements elicitation to understand the security requirements problems [9]. Catania et al (2022) points out that think pair share could improve student engagement regarding the topics studied [10]. They have indicated that the use of collaborative learning was effective and appreciated more by students. Prior studies have also pointed out that factors beyond the group work are becoming key factors in the domain of student engagement in requirement engineering education. For example, in 2014, Kamalrudin et al, investigated the application of pair work to capture and analyze multi-lingual requirements [11]. This approach is intended to assist practitioners in developing correct and consistent requirements as well as developing teamwork skills. It was found that pair work improves accuracy and hence helps users perform better in developing high quality requirements models in REE.

There are many researchers that are concerned about pair work in education, but they have not yet done the research in the requirement engineering (RE) education for the pairing approach. Motivated by this, we adapted the pair work to our work and developed a new engagement framework in REE.

3. THEORETICAL FRAMEWORK

Pair learning can be one of the potentially approach in pedagogical transformation of theoretical subjects in software engineering areas. To improve students learning engagement and motivation, we believe that pair learning can help getting students to participate in requirement engineering activities. In student engagement theory [12] learning in an technology environment, they promote the student activities comprises of :

i. Relate – learning activities to be occurred in group.
ii. Create – learning activities are to be created as project-based.
iii. Donate – learning that are authentic and has outside customer that focus to work -related acitvities

Therefore, to capture the full complexity of student engagement in REE and attend to the pair work approach pursued in this work the findings are explored through the lenses of both pair learning and engagement theory., Figure 1.0 presents the following simplified framework emerged (solid arrows denote the relationships explicitly addressed in this research while dotted arrows denote additional relationships suggested by the theories considered).

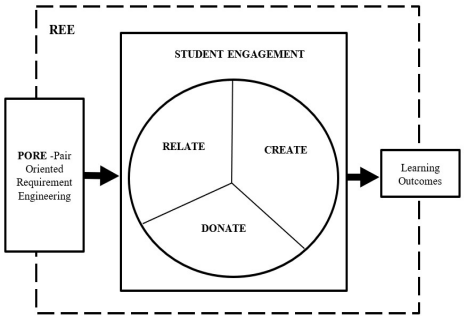

Figure 1: Proposed integrated framework for student engagement in REE

The proposed theoretical framework (Figure 1.0) reveals some fundamental principles and assumptions. Firstly, as the above diagrammatic model illustrates, the theory that can help to better explain student engagement in REE is one that acknowledges the RELATE, CREATE, and DONATE facets of engagement rather than one which emphasizes a single RE tasks (in the classroom and online), in the ways they reason or reflect about their level of engagement, as well as in what they feel when they are engaged.

4. RESEARCH METHOD

We adopted the approach of positivist paradigm to conduct our study. We employed a mixed method which entailed a concurrent collection and analysis of qualitative and quantitative data [13]. Concurrent with Kearsley's and Shneiderman's theory, the uses of pair learning approach with learning management system (in this case, we use Moodle platform - ULearn) encouraged students collaboration of the study. We developed a new approach called Pair Oriented Requirement Engineering (PORE) an extension of pair learning which also considers student's learning progressive behaviours when planning the teaching activities.

At the beginning of the semester, we distributed our questionnaires titled 'Survey on Pair-Oriented Requirement Engineering Approach to Studying BITPXXXX' – where XXXX is the code name of subject taught. We received our ethical approval prior to conducting this study and mentioned students are entirely voluntary and no pressure on them nor grades benefits on their participation.

The survey had a demographic section and divided into four (4) sections. Each section of the survey are given in different time frames, for example section 1 related to self motivation are given at the beginning of the semester. The reason is we want to monitor student's progress and aligned our teaching and learning activities accordingly.

Section 1 is related to self-motivation. The aim of the section 1 survey is to gain some ideas on what factors made student to engage and motivate to come to class of the subject taught. The examples of questions in this section such as I would engage and come to class when; 1) the lecturer taught the subject sessions in an organized way with a learning management system. (example-give announcements, send early notifications etc); 2) the lecturer explained clearly the subject topics of teaching as stated in the teaching plan and its requirements in the classroom. 3) the lecturer discusses or work through course material using pair learning system in the class on how to answer the assignment questions, etc. The students must answer the survey using Likert scale with five (5) has the highest level of agreement. The result of the survey for this section will later share in ULearn and we discuss the best approach agreed upon negotiation amongst students.

In Section 2 of the survey, we obtained further information on student's learning preferences in the classroom. Questions such as: I would engage and motivate to learn in class when: 1) there is a pair work involved in the classroom rather than working solo doing the assignments given. 2) the lecturer uses his/her knowledge in real industry to relate with the current issues with the topics of subject taught. 3) the course materials related to requirement elicitation can be easily understood. 3) the course materials related to requirement modelling and analysis can be easily understood. 4) the course materials related to requirement modelling and analysis can be easily understood. 5) the course materials related to requirement validation and verification can be easily understood. 6) the course materials related to requirement management be easily understood. The result survey of section 2 is important to us as we need these feedbacks to shape up our teaching and learning activities in the classroom uses PORE.

To gain further feedback on the PORE applications in course settings, we set survey questions in section 3. In section 3, the examples of questions such as I would engage and motivate to learn when: 1) the lecturer allows students to work in SOLO in learning requirement elicitation topics. 2) the lecturer allows students to work in PAIR/GROUP in learning requirement elicitation topics. With these results, we set up students in learning activities according to their preferences for course settings.

The last section in the survey is section 4. In this section, we aim to obtain students' feedback whether uses PORE could lead to their engagement in learning the subject taught. The examples questions such as I would engage and motivate to learn when: 1) the uses cases assignment given can be done in SOLO. 2) the uses cases assignment given can be done in PAIR. These results help us to design requirements activities as assessment tasks according to student learning preferences. Each assessment task is designed to suit the requirements activities of the subject taught. Markings guidelines are explained explicitly during the laboratory session.

For this survey, the questionnaires have been validated by two academic experts and one industry expert. The constructs used in this questionnaires have been well identified in the literature review of this study.

5. IMPLEMENTING THE METHOD

In our university, we applied our method PORE - to subjects related to requirement engineering areas since 2022. This paper reported the application of PORE to BITP 2223- Software Requirement and Design subject. This subject is offered in second semester to all second year students. In recent semester, there were 32 students enrolled this subject. This subject introduces the object oriented approach using Unified Modelling Language (UML) to apply Object Oriented Analysis and Design (OOAD) to develop software project. Teaching consisted of 70% for course works and 30% of final examination

The learning activities that we designed includes students are required to capture requirements in use cases, perform analysis modelling to produce interaction diagrams, static and dynamics and identifies design elements in software projects. The students are also taught to identify the requirements, know the sources of requirement, major activities in requirement, identify classes via use case analysis, managing requirement, defining relationships and outlining attributes and methods.

In design phase, the student are taught to design software architecture, high level and detail design which will be realized through refined class diagram, component diagram and deployment diagram.

6. RESULTS

The profile of students registered BITP 2223- Software Requirement and Design subject during the second semester of session 2023/2024 is shown in Figure 1, which highlights that majority of the students were female (62%) and male (28%).

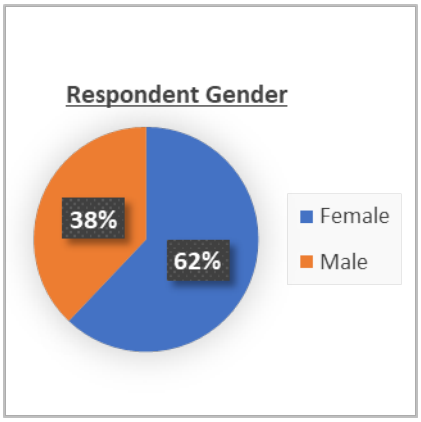

Figure 1. Respondent Gender (n=32)

The results for questionnaires are presented in Table 1 - 5.

Table 1: Summary of students' responses to questions related to self-motivation

Section 1 (Question 1-8) I would engage and motivate myself to come to class when:	**Responses (%) n=32**
the lecturer taught the subject sessions in an organized way with learning management system. (example- give announcements, send early notifications etc)	56
the lecturer explained clearly the subject topics of teaching as stated in the teaching plan and its requirements in the classroom.	62
the lecturer discusses or work through course material using pair learning system in the class on how to answer the assignment questions.	75
the lecturer uses learning support tools (clickers, interactive web, video games, you tube etc) to connect learning requirement subject with real life problems or issues.	61
the lecturer taught the requirement subject topics that are relevant with the real-life problems.	94
the lecture can involve all students to be participated in all learning activities done using learning management system in the	58

classroom.	
the lecturer tried to better understand my point of views as a student by imagining how an issue can be solved from my perspective.	80
the subject topics of teaching do a lot of practical hands on with the help of learning management system rather than learning theoretical facts.	82
requirement modelling and analysis can be easily understood with pair work.	
the course materials related to requirement validation and verification can be easily understood with pair work.	82
the course materials related to requirement management be easily understood with pair work.	80

We analyzed the results (Table 1) and designed our teaching activities and deliveries according to students' responses. For example, 94% of students wanted the lecturer to teach requirement subject related to real life problems or issues. Students also want to do a lot of practical work (82%) rather than learning from the slide's presentation. They also want lecturers to understand from their point of view (80%) when solving problems and guide them on how to improve. To tackle this, we threw the idea on improvised university library management system. We came up with feasibility studies where we asked students to list reasons for whether we improve the system. Surprisingly, all sorts of ideas have been listed and all agreed to use it as our case study for the semester. They were happy and felt motivated when lecturers counted their opinions.

In Table 2, we analyzed students' responses on learning preferences in the classroom. We realized that most students enrolled in the subject taught preferred to work in pair rather than solo. They responded (above 80%) that working with pair helped them better understanding of the learning activities done in the classroom or lab/tutorial.

Table 2: Summary of students' responses to questions related to learning preferences in the classroom

Section 2 (Question 1-6) I would engage and motivate myself to learn the subject:	**Responses (%) n=32**
there is a pair work involved in the classroom rather than working solo doing the assignments given.	80
the lecturer uses his/her knowledge in real industry to relate with the current issues with the topics of subject taught.	58
the course materials related to requirement elicitation can be easily understood with pair work.	80
the use cases diagram related to	81

In terms of course settings, we would like to obtain whether PORE is best to be set up via online mode or with traditional classroom set up. From the results shown in Table 3, we found that above 80% of students responded that they were engaged and motivated to come to class when they learn the subject taught in the traditional classroom.

Table 3: Summary of students' responses to questions related to course settings

Section 3 (Question 1-8) I would engage and motivate myself to come to class when:	**Responses (%) n=32**
the lecturer allows students to work in PAIR/GROUP via online mode for requirement elicitation topic.	56
the lecturer allows students to work in PAIR/GROUP in learning requirement elicitation topic in the classroom.	80
the lecturer allows students to work in PAIR/GROUP via online mode for requirement modelling practice.	58
the lecturer allows students to work in PAIR/GROUP SOLO in learning requirement modelling practice in the classroom.	94
the lecturer allows students to work in PAIR/GROUP via online mode requirement validation and verification topics.	61
the lecturer allows students to work in PAIR/GROUP learning requirement validation and verification topics in the classroom.	82
the lecturer allows students to work in PAIR/GROUP via online mode learning requirement management topic.	56
the lecturer allows students to work in PAIR/GROUP learning requirement management topic in	82

the classroom.	

For the assessment designed, the information is provided from the questionnaire's results as shown in Table 4. The analysis showed that more than 80% of students responded that they were motivated to do the required assessment tasks in pairs.

Table 4: Summary of students' responses to questions related to requirement activities

Section 4 (Question 1-8) I would engage and motivate myself to come to class when:	**Responses (%) n=32**
the drawing of diagrams such as use cases in requirement elicitation activities can be done in SOLO.	61
the drawing of diagrams such as use cases in requirement elicitation activities can be done in pair/group.	88
the analysis and refine activities related to requirement modelling can be done in SOLO.	62
the analysis and refine activities related to requirement modelling can be done in pair/group.	88
the reviews and inspection activities related to requirement validation and verification can be done in SOLO.	56
the reviews and inspection activities related to requirement validation and verification can be done in pair/group.	94
the documentation, analysing, prioritizing activities related to requirement management can be done in SOLO.	62
the documentation, analysing, prioritizing activities related to requirement management can be done in pair/group.	88

7. EVIDENCE OF ENGAGEMENT

To prove the concept of pair work can lead to engagement in learning, we conducted an interview when the semester ended. Out of 32 respondents, we managed to interview 20 of them. The percentage of the respondents that we managed to interview is 62.5%. All the interviews were combined, coded and classified using NVIVO. Different responses were coded and transcribed including the following for learning in pairs that promotes:

1) Motivation in learning.
2) Peer learning.
3) Collaborative learning.
4) Better communications skills.
5) Better understanding of subject taught.

The summary of engagement factors in pair learning is shown in Figure 2.

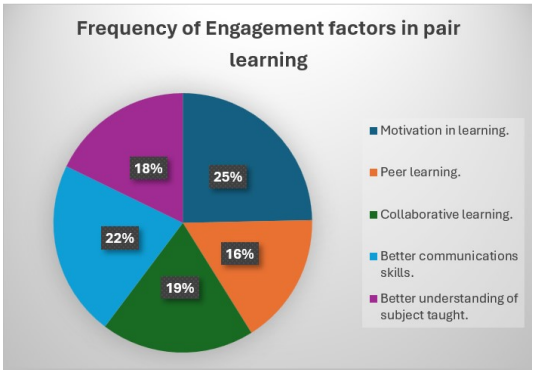

Figure 2. Summary of engagement factors

Our findings also indicated that interaction with lecturers also plays a significant role in student engagement. Students are motivated and appreciated when their lecturer respects their point of views during the requirement activities. They were seen actively engaged in the classroom.

Lastly, our findings suggested that pair work is more efficient if we acknowledge the RELATE, CREATE, and DONATE activities in the REE.

8. DISCUSSIONS

The results of this study showed that the pair approach did engage and motivate students to come and learn the requirement subject. Though the number of samples is small, we discovered engagement factors that could be used as variables in future research.

For example, 25% of respondents during interviews stated that they were motivated to come to class and joined the activities set up during the lesson. Surprisingly, 22% of students claimed they were not shy and felt confident when they presented their work in front of the classroom as they knew it was duo work. Students also claimed (19%) that they were engaged whilst doing the practical work in the classroom. This is aligned with collaborative learning [14]. Whereas 18% claimed that they have a better understanding of the subject taught because they like to do activities

together with their friends. They can easily ask other opinions and get understanding from their classmates' point of view. Thus, we are in the opinion of with the right teaching approach and good design of learning activities in the classroom, could engage students and lead them to better learning the subject taught.

In general, our work concludes that by using pair work in engagement framework, our work overcomes the issue of survey data to measure student engagement, and extend our understanding of how to produce specific RE activities related to real-life problems and the need for more collaborative communications amongst students and lecturers.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Universiti Teknikal Malaysia Melaka (UTeM) and Faculty of Information and Communication Technology (FTMK) for its support and all those who participate in the study and helped to facilitate the research process.

REFERENCES:

[1] Daun M, Grubb AM, Stenkova V, Tenbergen B., "A systematic literature review of requirements engineering education", *Requirements Engineering*, Vol.28, No 2, 2023, pp 45-75.

[2] Umar MA, Lano K, "Advances in automated support for requirements engineering: a systematic literature review", *Requirements Engineering*, Vol.3, 2024, pp 1-31.

[3] Rupakheti CR, Hays M, Mohan S, Chenoweth S, Stouder A, "On a pursuit for perfecting an undergraduate requirement engineering course", *Journal of Systems and Software*, Vol. 144, 2018, pp. 366-381.

[4] Tenbergen B, Daun M, "Calibrated Peer Reviews in Requirements Engineering Instruction: Application and Experiences", *InHICSS*, 2022, pp. 1-10).

[5] Ouhbi S, Pombo N, "Software engineering education: Challenges and perspectives", *IEEE Global Engineering Education Conference (EDUCON)*, 2020, pp. 202-209.

[6] Sanusi NM, Ibrahim A, Kamalrudin M, "Common Practices of Teaching and Learning in Requirement Engineering subject", *Journal of Theoretical and Applied Information Technology*. Vol. 18, No 101, 2023.

[7] Albakry, K. and Kamalrudin, M., "Pair analysis of requirements in software engineering education", In *2011 Malaysian Conference in Software Engineering*, 2011, pp. 43-47.

[8] Bryant, Sallyann, Pablo Romero, and Benedict du Boulay. "Pair programming and the mysterious role of the navigator." *International Journal of Human-Computer Studies*, Vol. 66, No.7, 2008, pp. 519-529.

[9] Janisar, Aftab Alam, et al., "Software Development Teams Knowledge and Awareness of Security Requirement Engineering and Security Requirement Elicitation and Analysis.", *Procedia Computer Science*, Vol. 234, 2024, pp.1348-1355.

[10] Catania, B., Guerrini, G. and Traversaro, D., "Collaborative Learning in an Introductory Database Course: A Study with Think-Pair-Share and Team Peer Review", In *1st International Workshop on Data Systems Education,* 2022, pp. 60-66.

[11] Kamalrudin, Massila, Safiah Sidek, Norsaremah Salleh, John Hosking, and John Grundy, "A pair-oriented requirements engineering approach for analysing multi-lingual requirements." In *Requirements Engineering: First Asia Pacific Requirements Engineering Symposium, APRES 2014, Auckland, New Zealand, Proceedings*, 2014, pp. 150-164.

[12] Kearsley G, Shneiderman B, "Engagement theory: A framework for technology-based teaching and learning", *Educational technology*, Vol. 38, No. 5, 1998, pp. 20-23.

[13] Hirose M, Creswell JW, "Applying core quality criteria of mixed methods research to an empirical study", *Journal of Mixed Methods Research*, Vol. 17, No. 1, 2023, pp. 12-28.

[14] Okolie UC, Mlanga S, Oyerinde DO, Olaniyi NO, Chucks ME, "Collaborative learning and student engagement in practical skills acquisition", *Innovations in Education and Teaching International*, Vol. 59, No. 6, 2022, pp. 669-78.