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Project-Based Learning with Gallery Walk: The Association with the Learning Motivation and Achievement

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Abstract: With the rapid and constant changes in computer and information technology, the content and learning methods in Computer Science related courses need to be continuously adapted and consistently aligned with the latest developments in the field. This paper proposes a learning approach called the Gallery-walk integrated Project-Based Learning (G-PBL) which can develop students' lifelong learning skills that are extremely crucial for Computer Science students. The G-PBL was designed by incorporating the advantages of Project-Based Learning (PBL) and gallery walk learning strategy. In contrast to traditional PBL where students may present their project work to instructors only, students have to present their project work to their classmates as part of the G-PBL approach. All students are required to evaluate their peers' project work and then give feedback and suggestions. For the research experiments, the G-PBL was implemented as an instructional approach in two Computer Science related courses. This study focuses on exploring the differences in knowledge gain, learning motivation, and perceived usefulness when learning by using the teacher-centered and G-PBL approach. Moreover, the impact of gender differences on learning outcomes is also investigated. The results reveal that using the G-PBL approach helps students to gain more knowledge significantly, for both male and female students. In terms of motivation, female students are more favorable toward the G-PBL approach. On the contrary, male students prefer learning via a teacher-centered approach. Regarding the perceived usefulness, female students strongly view the G-PBL as a highly effective learning approach, whereas male students are more prone to concur that the teacher-centered approach is a more effective learning method.

Index Terms: Project-based learning, gallery walk, learning motivation, perceived usefulness, learning achievement, lifelong learning.

1. Introduction

Classroom teaching and learning methods have been designed and developed over time to meet the changing in students' learning behaviors and to achieve the course learning outcomes. One of the teaching challenges in Computer Science related courses is that the course content is constantly updated and changed according to the evolving trends in computer and information technology. Therefore, lifelong learning skills are highly crucial for Computer Science students in order to prepare for the changes that will occur in the future [1, 2].

Learning in general was given by the instructors in a face-to-face classroom. Several learning and teaching approaches were used to ensure the quality of learning. For instance, the traditional teacher-based learning approach is among the most frequently teaching methods used in the classroom. It refers to the learning activities that students need to attend the physical classroom and listen to the lecture [3]. Another approach that received much attention from

educators is learning by doing. It is a learning technique that encourages students to do things on their own through learning activities in a real environment for practicing critical thinking and professional skills [4-6]. By applying this technique, learners gain more motivation and engaged in their learning. In addition, the instructors reduce their role in educating the learners directly but, on the other hand, increase more learning activities that make learners more enthusiastic to learn. Project-Based Learning (PBL) is an instructional approach that encourages learners to collaborate with their team members and learn by doing project work until they get answers to their questions or concerns [3, 7]. Moreover, PBL encourages learners to connect their previous experiences with what they are learning and integrate their knowledge with real practice. Furthermore, PBL also helps learners to solve problems appropriately and think critically. Several research reports the positive affects of using PBL to support learning [8-11]. Another teaching and learning approach that can be used to encourage students is a gallery walk approach. The gallery walk approach is an active learning strategy that encourages learners to exchange information, ideas, or experiences related to their works with their peers and, consequently, receive feedback and suggestions from their peers in order to improve their works as well as fulfill their knowledge and understanding [12, 13]. Moreover, the gallery walk technique supports students to practice assessing their peers' works and comparing them with their own works as well as developing teamwork and communication skills, including speaking, listening, reading, and writing. Even though research reports the positive impact of the gallery walk, not much research explores the integration of gallery walk in the PBL activities, especially, for Computer Science education. This research aims to bridge this gap by integrating the gallery walk to enhance an instructional approach for Computer Science practice-oriented courses. The examination on the results of implementing the approach in terms of knowledge gain, learning motivation, and perceived usefulness as compared to the teacher-centered learning approach aims to investigate its effectiveness.

In this paper, the Gallery-walk integrated Project-Based Learning (G-PBL) was proposed. The G-PBL combines the advantages of project-based learning and the gallery- walk approach. Unlike traditional PBL which students may present the project work to the only instructors only, the G-PBL approach requires students to exhibit the project work to their peers as well. All students are required to assess all their peers' work as well as provide feedback and suggestions. The experiments was carried out during the academic year 2022. The G-PBL instructional approach was implemented in the Human-Computer Interaction (HCI) and Mobile Application Development course which offered for the Bachelor of Science Program in Information and Communication Technology for Management (ICTM). This research is based on a quasi-experimental based design by using a one-group pre-test and post-test experiment to observe the the differences in knowledge gained. In addition, the differences in learning motivation and perceived usefulness between the teacher-centered learning approach and G-PBL are investigated. Furthermore, the impact of gender differences on learning outcomes of the teacher-centered learning approach and G-PBL are also studied.

The rest of this article is organized as follows: In Section 2, we present a thorough description of the learning approaches related to this research as well as their specific problems and research issues through a review of the relevant literature. Section 3 describes the target group of experiments, the experimental procedures, the research instruments, and the data analysis methods. The results of the experiments are provided in Section 4 followed by a discussion of the results given in Section 5. Finally, the conclusion and recommendations are presented in Section 6.

2. Literature Review

2.1 Learning Motivation

Teaching and learning in the 21st century are challenging. This is because new information is rapidly updated and new innovations are constantly being invented [2]. According to the World Intellectual Property Organization (WIPO) report, every 23 seconds new invention was registered to apply for Intellectual Property in 2022 [14]. This reflects how fast technology is being developed. To cope with the rapid advancement of technology, students need to be equipped with several skill sets to be able to obtain up-to-date abilities and knowledge. This is also the goal of being lifelong learners. Lifelong learning refers to the continuous pursuit of knowledge, skills, and personal development throughout one's life. The learners are required to constantly monitor, maintain regulation, and direct their own learning.

In Computer Science related fields, lifelong learning skills are highly important for personal growth and development. The surge of technology results in changes in working and daily activities. Those who work in the field of Computer Science need to frequently be updated and adapted to these changes [2]. Hence, equipping the skills to ensure the ability to face these changes when entering the employment sector is one of the important goals of the higher education sector. Among the important sets of skills and competencies that have been highlighted as important skills are planning and decision-making, rational and critical analysis skills, and professional skills. Hence, research studies in Computer Science education are looking forward to the pedagogy and approach that could enhance the development of such skills.

Motivation has long been recognized as the important factor that drives one's success in learning. Based on the Self-Regulated Learning (SRL) theory [15], motivation is considered as the internal cognitive condition that influences the learning process. That is, motivations influence the students' choices of learning tactics and strategies as well as, consequently, influence how they proceed with learning. Motivation has been found as one of the factors that can be predictive of learning performance and achievement. Learning motivation can be described as the desire or willingness that drives the student to engage in learning activities to acquire knowledge and/or master the skills. Educational

psychology research categorized motivation into two board types [16] including:

- **Extrinsic motivation:** refers to the motivation that is driven by external incentives such as rewards, recognition, or the avoidance of punishment rather than internal factors. Extrinsic motivation has been reported to enhance performance in specific tasks. However, its effectiveness in promoting optimal performance and fostering high-quality learning outcomes is not guaranteed. Research indicates that an excessive emphasis on external rewards can have a narrowing effect on individuals' attention and motivation. Consequently, their inclination to take risks, explore alternative approaches, and engage in profound levels of critical thinking and understanding may be reduced.
- **Intrinsic motivation:** refers to the motivation that is driven by internal desires or personal goals such as interests, passions, curiosity, perceived benefits, perceived relevance of the learning topic, self-efficacy, social influences, the learning environment, or a sense of personal accomplishment. That is, students participate and engage in learning activities because they find it naturally enjoyable, challenging, or meaningful. This form of motivation fosters deep engagement [17, 18], sustained effort, and a strong desire to learn and explore. Intrinsic motivation is also an important factor in several educational theories such as goal orientation, self-determination theory, and others. These theories are characterized by the characteristics of students who are driven by a goal of mastery, the desire for personal growth, and the pursuit of excellence. Students with strong achievement motivation often set challenging goals, invest their efforts to acquire knowledge and skills, and exhibit persistence and perseverance in the face of difficulties.

Both extrinsic and intrinsic motivation can work together and coexist in the learning situation. Several research studies reported that learning motivation is associated with academic performance [8, 19, 20]. That is, highly motivated students tend to have better learning performance as compared to those who exhibit lower scores. As highlighted, intrinsic motivation promotes long-term effectiveness which is necessary for the development of lifelong learning.

Intrinsic motivation differs among individuals and in different learning settings. Particularly, intrinsic motivation is influenced by personal interests, goals, past experiences, and the perceived value of the learning outcomes. It is also influenced by individual differences such as gender, social and economic status, etc. For instance, Carrier et al. [18] reported that motivation is also associated with gender differences. That is, female students are often reported as highly motivated students [18]. Similarly, Tanaka [8] and Yashima et al. [21]also found that female students have a stronger intrinsic motivation as compared to male students. They explained that this is contributed by the nature of females who are more socialized and prefer communication and social activities. Also, the learning environment, instructional cues, and task definition contribute to the student's level of motivation. By creating a supportive and engaging learning environment, providing meaningful and challenging tasks, and allowing for autonomy and choice, motivation to learn can be enhanced. Considering these characteristics and benefits of intrinsic motivation, research has long investigated motivation in several learning settings such as in the teacher-centered learning and students-centered learning settings.

2.2 Teacher-Centered Approach

Teacher-centered approach refers to the traditional teaching method which emphasizes the role of teachers. Even though contemporary research often reported that the teacher-centered approach is a less effective teaching method as compared to the student-centered approach. This approach is often viewed as passive learning where teachers will be lecturing at the front of the classroom while students are considered as the receiver of the information [3]. Regardless of the less effective concern of such a method, this method is highly practiced by most institutions with a combination of other teaching and learning approaches. The teacher-centered approach is suitable for learning about the theoretical part when students have less knowledge of the learning topic, and they need extensive guidelines on the subject.

Contemporary research in education argues that the student-centered approach is more effective as compared to the teacher-centered approach [4]. In the student-centered approach, teachers' roles were shifted to the role of trainers or coaches. Students play the most important role in their learning. They are the actuators of the knowledge acquisition process under the guidance of the teachers. This approach has been reported to contribute to active learning, motivation, and learning achievement. Several teaching and learning methods were developed to allow the practice of student-centered approaches such as problem-based learning, and project-based learning.

2.3 Project-Based Learning Approach and Gallery Walk

Project-based learning (PBL) is a learning pedagogy that is centered around the students. Students are the main actuators of this learning approach. They need to tackle real-world problems by using inquiry-based learning [9]. PBL involves several steps including preparation, task identification, design, development, presentation, and evaluation [22].

PBL has been proven to be one of the effective student-centered approaches. That is, by using PBL students were more engaged in learning, they developed necessary skills needed such as communication, teamwork, collaboration, and technical skills [7, 8, 10, 11, 23, 24]. For instance, Chiang & Lee[9] conducted a quasi-experiment to study the vocational students' motivation and problem-solving skills when learning via PBL and traditional teacher-centered learning approaches. They found that students had a higher level of motivation, and problem-solving skills when learning by using PBL. PBL is often practiced by the higher education institution, especially for the final year students.

Particularly, Computer Science program in the higher education institutions is often designed to have a final-year project where students need to conduct their own project. Not only for the final year, but Computer Science students also usually participated in the mini project in the practical subject as well. For instance, Ocak and Uluyol [20] implemented the PBL in a Computer Hardware course. They conducted a single measurement of a single case study during the 14 week course. They collected the data regarding the students' motivation by adopting a matured motivational survey (i.e., the Internal Motivation Measurement Survey) and open-ended questions. They found that PBL positively impacts engagement and motivation. They posited that the social environment facilitates and increases the students' intrinsic motivation.

Traditional PBL has shown itself to be an effective learning approach. However, students often lack the ability to peer evaluate their work. For instance, Bjork et al. [25] stated that students tend to make faulty judgments about their learning. To improve the student's ability to evaluate the work. In a traditional PBL, evaluation was done by the instructor or lecturer of the subject. Hence, students are less fortunate to develop critical evaluation and rational analysis skills. Rationale analysis would help to improve self-efficacy which is one of the important cognitive conditions in the SRL process. To close this gap, this study implements project-based learning by integrating the gallery walk to allow students to peer evaluate and practice critical and rationale analysis skills.

Gallery walk is a learning activity that symbolizes walking in an art exhibition [13]. That is, students need to walk through their peers' products. To ensure that they were not just simply walking, students were asked to answer certain questions. In this study, during the presentation and evaluation stage in the PBL, students will be presenting their final products to teachers and their peers. Their peers will be asked to critically evaluate the products based on a set of rules to guide them. By using such a method, it is hypothetical to assume that students would learn better and develop a necessary skill. Yet not much research has implemented the gallery walk together with the PBL, especially, in terms of learning motivation which is an important factor in prolonging the development of lifelong learning skills. Hence the following research questions were formulated to measure the effectiveness of such a method, including:

RQ1: Does Gallery-walk integrated Project-Based Learning (G-PBL) contribute to knowledge gain?

RQ2: Are there any differences in learning motivation when learning using a teacher-centered approach and Gallery-walk integrated Project-Based Learning (G-PBL)?

RQ3: Are there any differences in perceived usefulness when learning using a teacher-centered approach and Gallery-walk integrated Project-Based Learning (G-PBL)?

3. Method

This study utilizes a quantitative research method to analyze and assess the differences in knowledge gain, learning motivation, and perceived usefulness between the teacher-centered and G-PBL approach as well as examine the impact of gender differences on learning outcomes. The study was carried out by using the quasi-experimental design using a one-group pre-test and post-test experiment to observe the differences in knowledge gained. Data collection is carried out through research questionnaires. The detailed research methodology for each part will be further explained in the following subheadings.

3.1 Target groups

This classroom research focuses on two subjects that are designed to incorporate the G-PBL as an instructional approach. These two subjects include Human-Computer Interaction and Mobile Application Development. Both subjects are designed for third-year students who enroll in the Bachelor of Science Program in Information and Communication Technology for Management (ICTM) at a university in Southern Thailand. The population in this research consists of third-year students who enroll in either Mobile Application Development or Human-Computer Interaction subject as well as those who enroll in both subjects. In the academic year of 2022, there were 21 and 26 third-year students who registered for Mobile Application Development and Human-Computer Interaction subject, respectively. Besides, 21 third-year students were enrolled in both subjects. However, 3 students did not complete all of the questionnaires. Hence, only 23 third-year students are identified as the target group of this research in which there are 12 male and 11 female students. The identified number of target groups is sufficient for the experimental design. As mentioned by Cohen [26] on page 102, when conducting experimental research, the number of participants should not be less than 15 samples to ensure the quality of work.

3.2 Quasi-experimental based research

This research is based on a quasi-experimental design by using a one-group pre-test and post-test experiment.

$$O_1 \quad X \quad O_2$$

Whereas

O_1 denotes the application of pre-test to observe the knowledge gained when applying the teacher-centered learning approach.

X denotes the experiment of using the gallery walk learning strategy to enhance the students' project-based learning experiences.

O_2 denotes the application of post-test to observe the knowledge gained after the gallery walk learning approach has been integrated with project-based learning (i.e., G-PBL). Furthermore, other types of surveys will also be deployed to capture the differences in learning motivation and perceived usefulness when learning using a teacher-centered learning approach and G-PBL

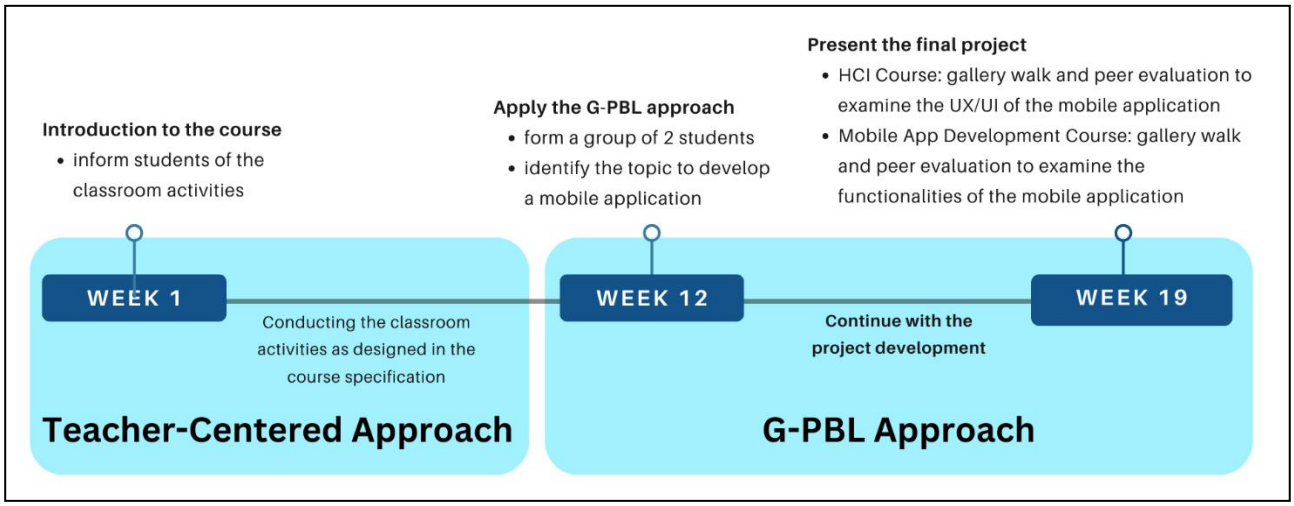

Fig. 1.Timeline of the classroom activities

The timeline of the classroom activities is presented in Fig.1. The procedure for conducting the experiments can be briefly explained as follows. First, the students will be informed of the classroom activities by stating that the data collected while students participate in the learning activities will be used to enhance their learning and, moreover, by answering the questionnaire deployed during the pre-test and post-test (O_1 and O_2), the scores will not be used to determine their final grade. The pre-test was conducted in the 11^{th} week and the post-test was given in the 19^{th} week.

During the 12^{th} week (out of 16 weeks of learning for each semester and additional 2 weeks of examination), students will form groups of 2 members and then, present their project proposal. Consequently, students will need to design and develop a fully-functioned mobile application according to their project proposal. The mobile application development period will last till the 18^{th} week and the project presentation will be held during the 19^{th} week.

Fig.2 illustrates the processes taken to conduct the G-PBL in the two courses. In general, the G-PBL approach consists of six steps, including,

- **Preparation:** in this step, students will be asked to form a group of two members at their own preference. Then both of them will be asked to present the idea of the topic that they wish to develop the mobile application.
- **Task identification:** students will be asked to plan, identify the relevant tasks that they need to carry out in order to develop the mobile application of their choice.
- **Design:** students design the prototype, functions, modules, components, and interfaces of the mobile application.
- **Development:** students develop the mobile application, in this step students need to do coding and programming to ensure the functionalities of the application.
- **Presentation:** students present the final developed mobile application. The gallery walk learning strategy will be implemented in this step. Unlike traditional PBL, which students may present the developed mobile application to the instructors only, the G-PBL approach requires students to present the final developed application to their peers as well. All students are required to attend the presentations of their peers' projects and evaluate them.
- **Evaluation:** The instructors will create the rubric to evaluate the project. Students will also be provided with the same rubric to evaluate their peers' projects. They will be informed prior to the evaluation session that the evaluation from peers will not be used to determine their final grade to prevent the bias that might occur.

After the presentation and evaluation process, students will be asked to fill in the post-test questionnaire to gather information regarding their knowledge gain, learning motivation, and perceived usefulness.

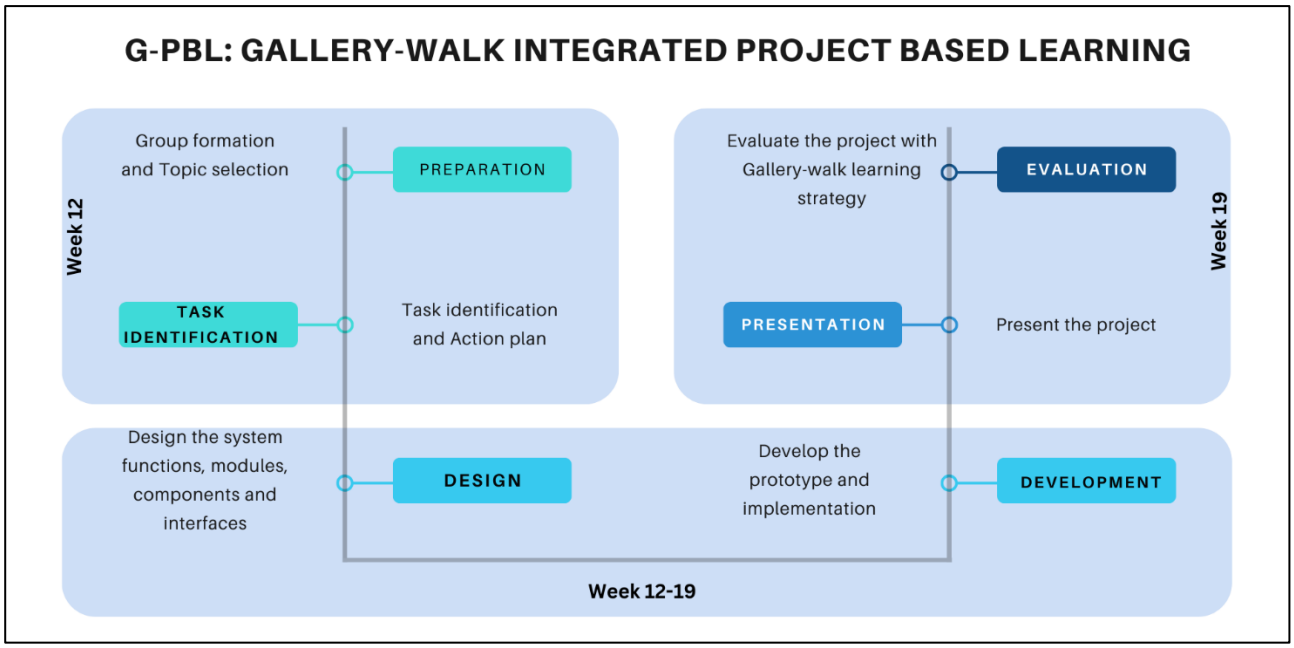

Fig. 2. The timeline of G-PBL approach designed for the two courses.

3.3 Data analysis method

The questionnaire deployed to capture the differences in learning motivation and perceived usefulness between the teacher-centered learning approach and G-PBL applies the Likert 7-point scale or all scale items, ranging from 1 meaning "strongly disagree" to 7 meaning "strongly agree" [27]. The question items in the questionnaire were assessed by three relevant experts [28] in the field of Computer Science education and learning assessment. The Likert scale of 1 to 5 categories is used to evaluate the research instrument. The category options include a scale of 1 for "Very Inappropriate", 2 for "Inappropriate", 3 for "Neutral", 4 for "Appropriate" and 5 for "Very Appropriate". To ensure the reliability and accuracy of the finding, the construct validity was carried out. Construct validity refers to how well the measurement accurately reflects the investigated concept. Several methods can be used to measure the construct validity including content validity. Content validity is the degree to which a measure such as items in the questionnaire covers all of the relevant content related to the factors being evaluated. That is, Aiken's validity index (V) [29, 30] was used to determine the level of content validity in the questionnaire based on the evaluation of expert reviews. As shown in Table 1, the question items with V value below 0.4 are declared invalid. In case the V value is between 0.4 and 0.8, they are expressed as moderate validity. The questionnaire is determined as having high validity if the value of V is greater than 0.8 [31]. Table 2 exhibits the results of the questionnaire validity assessment using Aiken's validity index. There are 12 question items evaluated as being very valid, however, only 1 question item has moderate validity, resulting in the questionnaire being acceptable.

Table 1. Interpretation of Aiken's validity index (V) [29]

Aiken's Validity Index (V)	Interpretation
$0 \leq V \leq 0.4$	Invalid
$0.4 < V \leq 0.8$	Moderate Validity
$0.8 < V \leq 1$	Very valid

To answer the research questions, descriptive statistics such as mean, standard deviation, median, and t-test are used to examine the overall score for both pre-test and post-test domain knowledge. That is, the descriptive statistics presented in the form of boxplots were used to visualize the results to represent the mean, SD, and overall performance across the tests and genders. T-test was then applied to examine the significant differences between the tests and genders. By using such a method, the first research question can be answered. To answer the second and third research questions, the bar plot together with the standard error was plotted. The graphs were plots to examine the differences between those who learned using the teacher-centered and those who learned by using the G-PBL. Additionally, the gender differences were also explored by using the bar plot.

Table 2. Results of questionnaire validity assessment

Domain	Factors	Question Items	$\bar{x}$	SD	Aiken Index (V)	Interpretation of Aiken Index
Learning Motivation	Challenge	Learning by using the G-PBL approach gives you the challenge to succeed in your studies.	5.00	0.00	1.00	Very Valid
	Difficulty	Learning by using the G-PBL approach increases the difficulty of the learning process.	3.33	1.53	0.58	Moderate Validity
	Interest	Learning by using the G-PBL approach is an interesting method for teaching and learning.	5.00	0.00	1.00	Very Valid
	Enthusiasm	Learning by using the G-PBL approach makes you enthusiastic to study.	5.00	0.00	1.00	Very Valid
	Enjoyment	Learning by using the G-PBL approach makes your learning more enjoyable.	5.00	0.00	1.00	Very Valid
	Attention	Learning by using the G-PBL approach helps you concentrate on tasks assigned by the instructor.	4.67	0.58	0.92	Very Valid
	Commitment	Learning by using the G-PBL approach gives you the commitment to learning in order to improve the academic performance and achievement.	4.33	0.58	0.83	Very Valid
Perceived Usefulness	Understanding	Learning by using the G-PBL approach helps you better understand the content of subject.	5.00	0.00	1.00	Very Valid
	Knowledge acquisition	Learning by using the G-PBL approach encourages learners to develop new knowledge.	5.00	0.00	1.00	Very Valid
	Planning and decision making	Learning by using the G-PBL approach encourages learners to develop the planning and decision-making skills.	5.00	0.00	1.00	Very Valid
	Analysis	Learning by using the G-PBL approach encourages learners to develop the skill of rational analysis.	5.00	0.00	1.00	Very Valid
	Self-efficacy	Learning by using the G-PBL approach encourages learners to be courageous in thinking and making decisions.	4.67	0.58	0.92	Very Valid
	Profession skills	Learning by using the G-PBL approach helps you develop essential skills in your profession.	5.00	0.00	1.00	Very Valid

4. Results

4.1. RQ1: Does Gallery-walk integrated Project-Based Learning (G-PBL) contribute to knowledge gain?

There are 21 third-year students who are registered for Mobile Application Development subject and 26 students registered for Human-Computer Interaction subject. However, 21 students registered for both subjects. Since 3 students did not answer all the questionnaires, hence, they were excluded from this study. As a result, only 23 students were included in this study, in which 11 students were female and 12 students were male.

Based on the pre-test that was used to capture the students' prior domain knowledge before exposing to the learning topics, the mean score for pre-test was 10.76 out of 20 (SD = 2.919), median (Q1, and Q3) was 10.5 (8.5, 12.5).

After learning by using G-PBL approach, there was an improvement in the students' performance. That is, the mean score increased to 12.87 (SD = 2.555). The median score was 13.5 (12, 15) as presented in Fig.3.

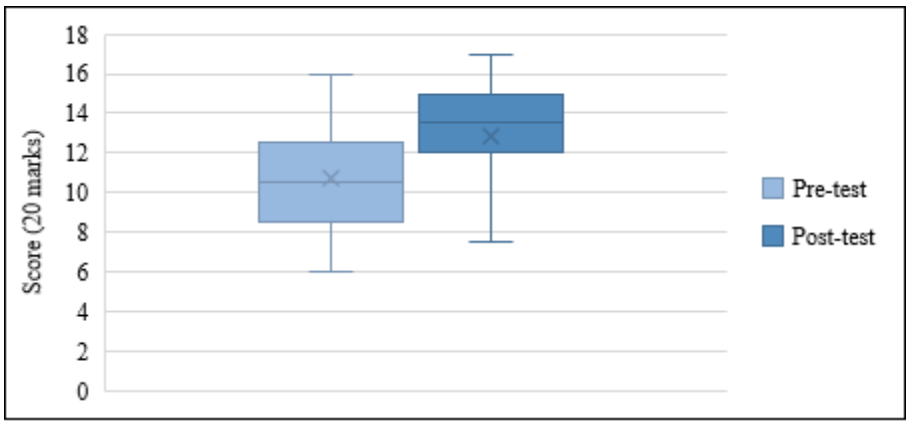

Fig. 3. Boxplot of Pre-test and Post-test of above and below average groups

The t-test was then used to examine if the pre-test and post-test scores were significant difference. The result showed that there was a significant difference between the two tests at the standard p-value < 0.05 (p-value was 0.00004629).

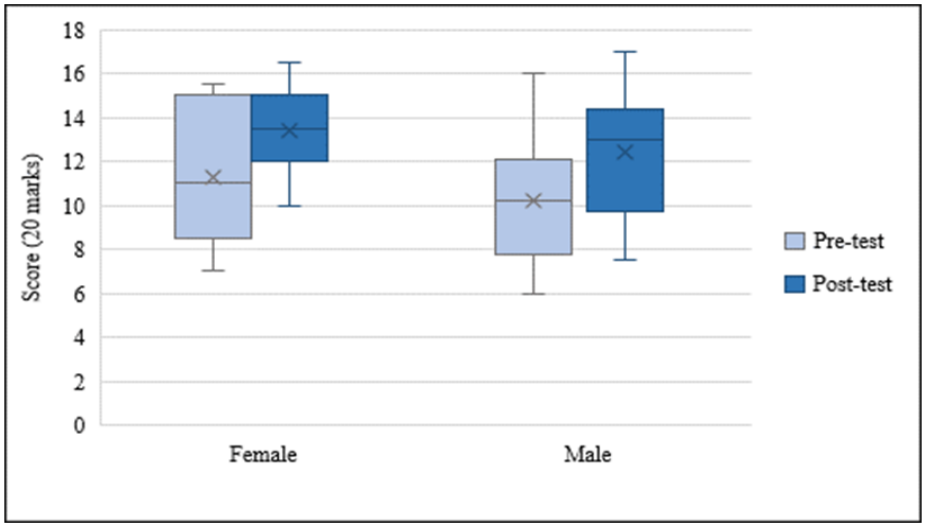

Fig. 4. Pre-test and Post-test scores for both male and female students

When comparing between male and female students, the results showed that female students scored higher as compared to male students both in terms of pre-test and post-test (see Fig.4). That is, females earned 11.318 marks on average (SD = 2.847) for pre-test and scored 13.36364 (SD = 2.057) for the post-test. Male students scored on average 10.25 (SD = 2.890) for their pre-test and obtained about 12.417 (SD = 2.864) on average for post-test. The result showed that there was a significant difference between the pre-test and post-test score at the standard p-value < 0.05 for both males and female students. That is, the p-value for the t-test was 0.0003 for male students and a p-value of 0.0141 for female students.

4.2. RQ2: Are there any differences in learning motivation when learning using a teacher-centered approach and Gallery-walk integrated Project-Based Learning (G-PBL)?

To answer this research question, a set of questionnaires was used. In general, students viewed G-PBL as a pedagogy that is more challenging, more difficult, and more interesting approach as compared to the traditional teacher-centered approach as presented in Fig.5. Students agreed that they were more eager and enjoyed learning by using the G-PBL. However, when inquired about the aspects of attention and commitment, students revealed that they slightly paid more attention and more commitment when learning by using the traditional teacher-centered approach.

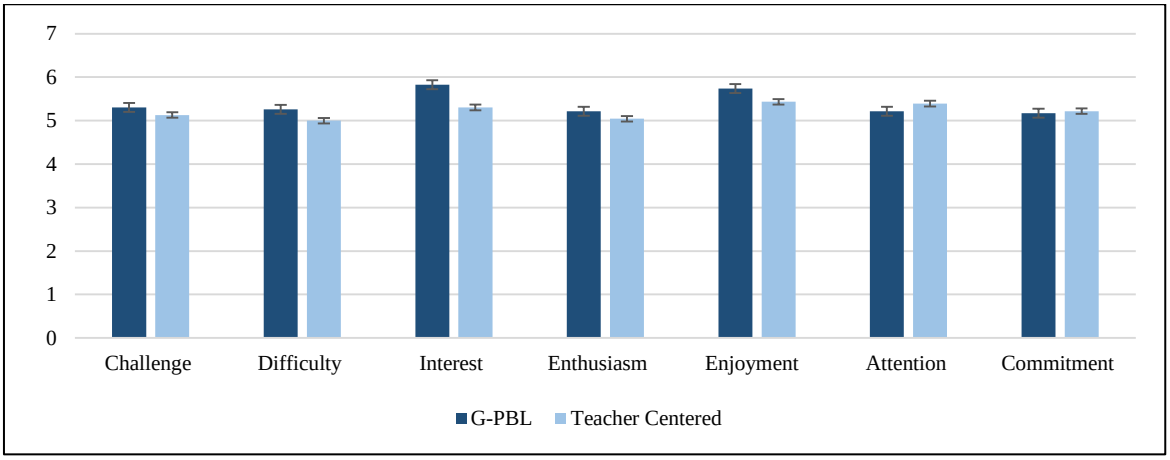

Fig. 5. Students' rates of their learning motivation when using G-PBL and teacher-centered approach

Exploring in terms of gender differences, the results showed that females scored higher in terms of motivation. That is, female students tend to view the G-PBL as a challenge and difficult teaching and learning pedagogy. Yet, they strongly agreed that G-PBL is an interesting teaching and learning approach. They found that using such pedagogy was enjoyable and they paid more attention and were more committed to learning when learning through the G-PBL as compared to the teacher-centered approach. In contrast, male students preferred learning via a teacher-centered approach. As presented in Fig.6, male students rated the teacher-centered approach as more challenging. They were more enthusiastic about learning as compared to the use of G-PBL. They also put in higher effort, more committed to

learning when learning via a teacher-centered approach as compared to the use of G-PBL.

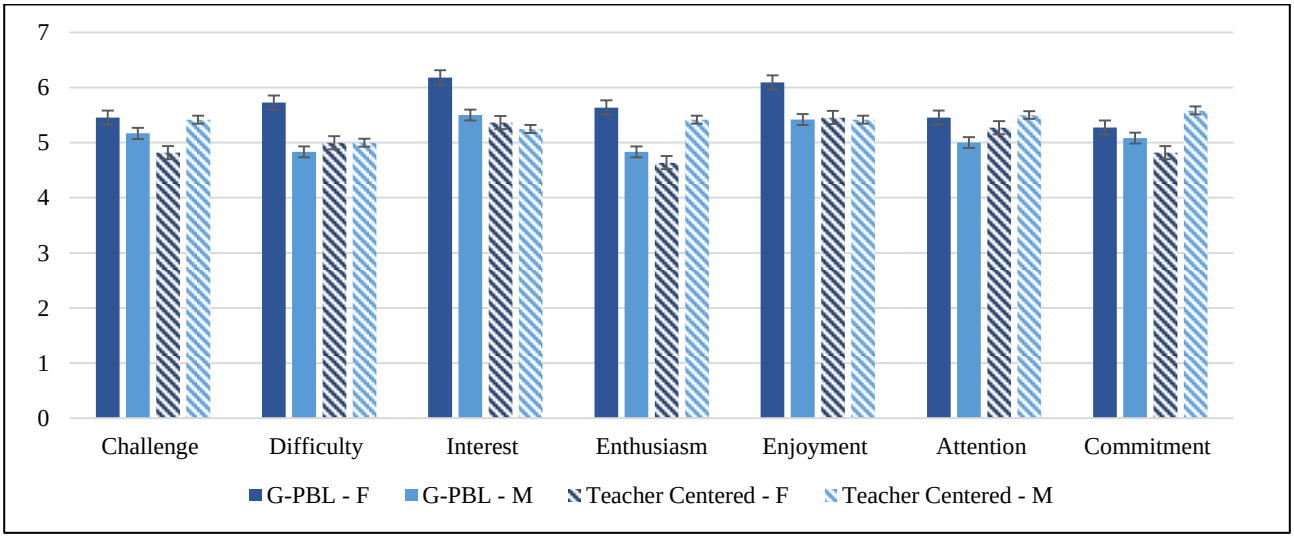

Fig. 6. Students' learning motivation based on the comparison between genders and teaching approaches

4.3. RQ3: Are there any differences in perceived usefulness when learning using a teacher-centered approach and Gallery-walk integrated Project-Based Learning (G-PBL)?

When exploring how students perceived the potential usefulness of using the G-PBL and traditional teacher-centered approach, students generally perceived G-PBL as a highly beneficial learning approach. That is, students agreed that G-PBL helps them to understand the learning content and assists in knowledge acquisition. The scores of these two items for G-PBL were slightly higher as compared to the teacher-centered learning approach. Students also rated higher in terms of the benefits of G-PBL in helping them to develop planning and decision-making, rationale analytics, self-efficacy, and professional skills as compared to the teacher-centered approach as presented in Fig.7.

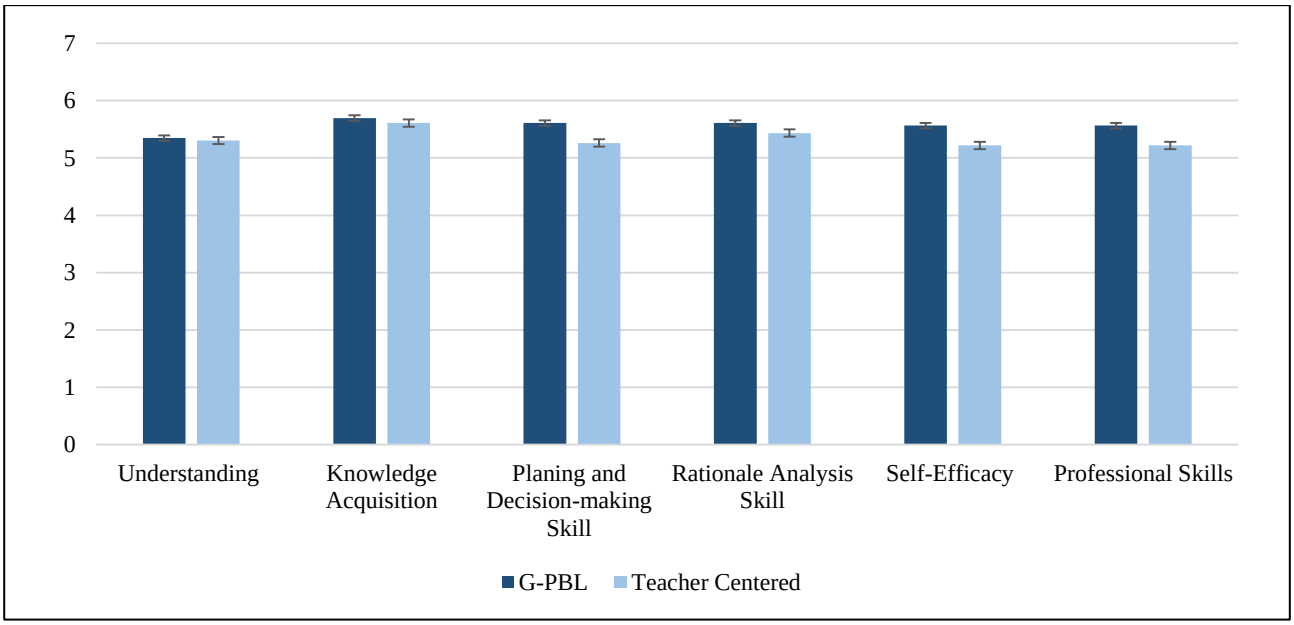

Fig. 7. Perceived usefulness of using G-PBL and teacher-centered approach

Similar to the findings in RQ2, female students strongly viewed the G-PBL as a highly effective learning approach as shown in Fig.8. They viewed that both G-PBL and the teacher-centered approach have the potential to help them understand the learning content. However, they scored higher when asking if G-PBL helps them in the process of knowledge acquisition as compared to the teacher-centered approach. In terms of skills development including, planning and decision making, rationale analytics, self-efficacy, and professional skill set, female students agreed that the G-PBL would be more highly beneficial as compared to the teacher-centered approach and male students.

In contrast to the female students, male students were more likely to agree that the teacher-centered learning approach would be more effective in helping them to understand and acquire knowledge. In general, they view that the

teacher-centered approach was equally beneficial to the G-PBL in terms of the development of the skills.

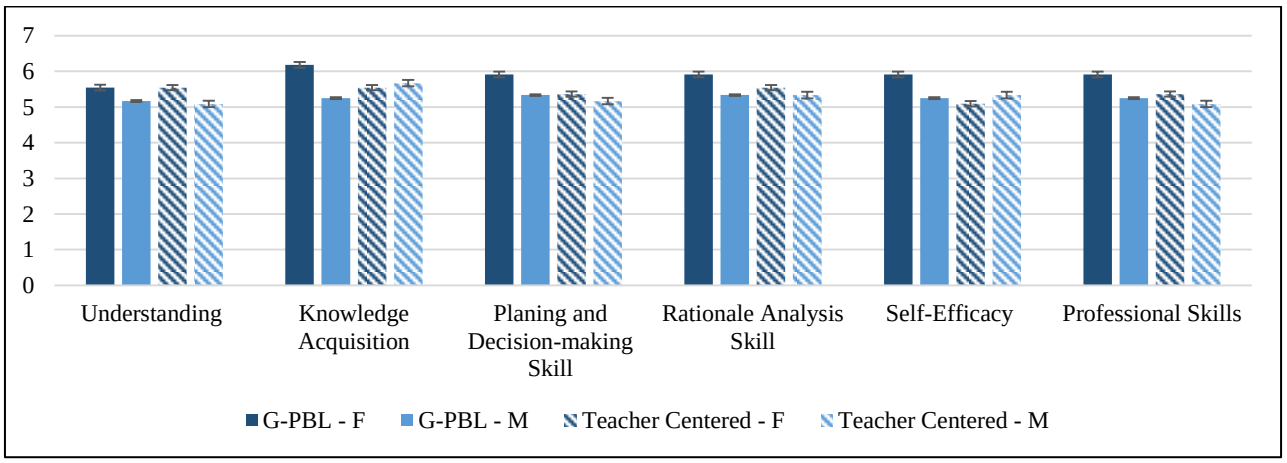

Fig. 8. Perceived usefulness of using G-PBL and teacher-centered approach when comparing between female and male students

5. Discussion

PBL is an active teaching approach. It is often used in Computer Science education, especially during the final year when students are expected to apply all knowledge and skills they have acquired and applied to develop their own projects. This is one of the common learning outcomes of Computer Science courses. In this study, the gallery walk was integrated into the PBL process which aims to help students develop evaluation and critical thinking skills during the third-year mini-project on two Computer Science related subjects. Based on the results from the implementation of G-PBL, the students' knowledge increased significantly. That is, the statistical analysis of the pre-test and post-test showed significant differences. This is aligned with the work of Ralph [32] and Chiang and Lee [9] who reported that PBL helps students to gain knowledge. The comparison between the pre-test and post-test was generally used to gather prior knowledge before exposure to the learning materials and learning process. The post-test was used to measure how much knowledge was gained after the learning process. The significant differences between the pre-test and post-test scores suggested that students gained knowledge when learning via the use of G-PBL. In terms of gender differences, significant differences in terms of pre-test and post-test scores were observed for both genders.

Besides knowledge acquisition, the questionnaire was also used to capture the students' motivation when learning via G-PBL. The results presented earlier showed that students reported slightly higher scores in terms of motivation when comparing the G-PBL and traditional teacher-centered method. This is aligned with the study of Chiang and Lee [9] which examined the differences in terms of motivation when learning by using PBL and traditional methods. They found that students were more motivated when learning via PBL as compared with the traditional method. In this study, intrinsic motivation was explored. Intrinsic motivation is influenced by various factors, such as personal interests, goals, self-efficacy, beliefs, past experiences, perceived relevance, and perceived importance of learning tasks or outcomes. Research reported that motivated students are more likely to commit to learning, pay attention, and deploy a great effort to engage in learning activities. Other constructs that drive to increase the student's motivation are interest, fun, and enjoyment of the learning activities. When individuals find a learning activity interesting, enjoyable, or personally meaningful, their intrinsic motivation is naturally intensified. Personal interests and enthusiasm play a significant role in sustaining intrinsic motivation. Also, the perceived difficulty and challenge of the learning activities are among the factors that contribute to learning motivation. The questionnaire results showed that G-PBL yields to the introduction of the desired motivational senses such as interest, challenge, difficulty, enjoyment, and enthusiasm. However, when explored in terms of the differences between genders, it showed that most of the female students rated G-PBL as a highly motivated approach, but male students rated it otherwise. This showed that most of the male students preferred learning with the teachers-centered approach whereas female students preferred the G-PBL. This is aligned with several research studies, for instance, Tanaka [8, 21] found that females had a higher level of motivation compared with male students. As highlighted by research in the psychology field, a female has a higher tendency to be more attentive and responsive to social interaction, hence, learning approaches that emphasize social presence, group working, and sharing are favored by female students [8, 33].

Besides knowledge acquisition, the questionnaire was also used to capture the usefulness and motivation of using G-PBL, the students perceived that G-PBL contributes to the development of planning and decision-making skills, rational analysis, and professional skills.PBL is also used to help students in skills development. Comparing between traditional teacher-centered method and PBL, the students reported that PBL helps to develop the skills [9]. In the same vein, the G-PBL was applied, it is expected to observe the same findings in skills development. In general, students perceive the G-PBL as a useful approach to developing skills. Similar to motivation, female students rated higher in terms of the perceived usefulness of the G-PBL in skills development. Based on these observations, it can be argued

that female students preferred G-PBL. They were much more aware of the usefulness of such learning method as compared to male students. Male students prefer a teacher-centered approach. This might be due to the nature of the gender. Psychology research reported that male students tend to be less socially oriented as compared to female students [19]. Also, several research studies posited that females are more likely to be attentive to communication[8, 21] . The application of G-PBL requires students to socially communicate by frequently working as a team, presenting the results, and providing feedback to their peers. Therefore, the emphasis on such communication-based activities might be one of the reasons for female's higher preference for this teaching and learning approach as compared to male students.

Even though the findings derived from this study are promising and extend the body of knowledge regarding the application of Gallery-walk to PBL, however, further studies are needed in order to explore the G-PBL in other subjects in the field of Computer Science education. Besides that, this research relies on quantitative data. Research was conducted following standard procedures and ethical considerations to minimize the possible issues that could affect the reliability and accuracy of the result.

6. Conclusion

This study presents the exploration of the use of G-PBL in two classrooms of a Computer Science related program (i.e. Mobile Application Development and Human-Computer Interaction subject). The results revealed that G-PBL statistically improved students' prior knowledge significantly. Hence, it is one of the effective teaching approaches that can be used in the classroom. In terms of motivation, overall students viewed the G-PBL as a highly motivated learning approach as compared to the teacher-centered approach. When comparing male and female students, it showed that females showed stronger intrinsic motivation (i.e., internal motivation) as compared to males. This is aligned with the psychology research explaining the nature of females as having a higher tendency toward communication and socially oriented activities as compared to males. Hence, the activities that require communication and social interaction such as peer evaluation and feedback in the process of G-PBL are much preferred by female students. However, it is important to note that this research only explores a certain timeline of learning during the academic year of 2022.

This research contributes a new piece of knowledge to the Computer Science education field by exploring how the gallery walk can be integrated into the PBL. In terms of implication for practice in higher education, this research study demonstrates that G-PBL can be used as a pedagogical to motivate students. The steps in implementing the G-PBL were explained clearly in the methods section which included six main steps. The timeline presented in the methods section can be used as a guideline for course design. However, additional research studies are needed in order to verify if the proposed method can be generalized for other Computer Science education. Even though such methods are preferable to female students it contribution to male students was not much different. The positive effect of such a method has been recognized by both genders. In terms of the contribution to the research and theoretical perspective, this research strengthens the findings of several scholars such as Chiang and Lee [9], and Ralph [24]who revealed the positive effect of using a PBL pedagogy. Not only does the PBL contribute to the gain of knowledge but it also motivates learners, particularly, it increases intrinsic motivation.

While research study provides valuable insights, it's essential to remember that learning motivation differs among individuals and in different learning settings. While some individuals may be naturally driven by intrinsic motivation, others may find external incentives or rewards more influential in certain circumstances. Furthermore, motivation can change over time. Hence, it is important to note that students may have changed their motivation when participating in other classes and learning activities. Also, motivation is influenced by personal interests, goals, past experiences, and the perceived value of the learning outcomes.

This research provides an initial discovery on the integration of gallery walk in project-based learning activities. Future work should also focus on the exploration of gallery walk and its influence on the evaluation process. It is expected that offering the students the opportunity to walk through their peers' products and offering them the chance to practice critical evaluation would increase their analytical skills which is one of the fundamentals for Computer Science courses.

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