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In-Text Citation: (Kamarudin et al., 2022)
To Cite this Article: Kamarudin, S., Punzalan, C., Derahman, M. N., Mohd, S. M., Jan, N. M., Abdul Wahab, A. N. (2022). The Students' Self Perception on Learning C++ Programming via the Cryptography Project: A Case Study. *International Journal of Academic Research in Progressive Education and Development. 11(2),* 1534 - 1544.

The Students' Self Perception on Learning C++ Programming via the Cryptography Project: A Case Study

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Abstract

C++ programming course is among the most common programming subjects offered in tertiary education. Students' programming skills and other soft skills can be enhanced by adopting a project-based learning approach to the topic of Cryptography. Furthermore, students should be exposed to cryptography since security, confidentiality, and data privacy are key concerns in the communication world. Therefore, this study aims at identifying the students' self-perception of learning C++ programming through a project related to Cryptography. This project was assigned to the students who enrolled in the C++ programming course at Universiti Putra Malaysia in Semester 2, session 2020/2021. Finally, all students are capable of completing and demonstrating their projects. A survey questionnaire is delivered to indicate the students' perception of their programming skills, other soft-skill, and their knowledge of Cryptography. Since this course was conducted online, students were requested to list their challenges in completing this project. Through this approach, students positively perceive improving their programming skills and other soft skills and gaining knowledge about Cryptography. Overall, the selected theme related to the student's major field is recommended.

Keywords: Cryptography, C++ Programming, Perception, Project-based Learning, Undergraduate.

Introduction

Computer programming is regarded as a basic and important ability for any student pursuing a career in information technology in today's increasingly competitive world (Doddamani,

2018). In Malaysia, most students perceive programming as a challenging discipline (Salleh et al., 2009). Therefore, C++ Programming courses are still offered in higher education. C++ Programming has been listed as one of the top five programming languages next to Phyton, Java, Javascript, and C# in 2022 (Sandals & Mitchell, 2022). The first standard of the C++ programming language was in 1998 (C++98), and the current published standard is known as C++20 (Standard C++ Foundation, 2022). However, pre-university and university students find it challenging to understand programming (Shafie et al., 2020). Besides that, 21st-century learning is concerned with the concept of 4C (Creative, Critical, Collaborative, and Communication). Therefore, the assessment transformation from a paper-based examination into another assessment style mainly to assess the student's potential abilities and growth (Ravikumar, 2015; Rezqan, 2018), such as project-based learning (PBL). According to Shafie et al (2020), PBL is an instructional model that allows students to be actively involved in the project's development, which helps them learn more about the project's subject matter. Additionally, project-based learning is a broad approach to classroom teaching and learning that involves students researching authentic issues (Blumenfeld et al., 2011).

Meanwhile, the tremendous growth of the internet with the industrial revolution 4.0 (IR4.0) has raised significant concerns about security risks, particularly cyberattacks. Cryptography is considered the solution to computer network security issues. Cryptography requires a specific algorithm to protect data privacy and prevent unauthorized access (Atan & Kadir, 2020; Hamdan et al., 2022). The key concepts of Cryptography include the encryption and decryption process, and it is beneficial for protecting data and telecommunications. Additionally, Atan and Kadir (2020); Hamdan et al (2022) stated that early education should embrace the concept of cryptography. Participants in a study saw cryptography as vital and exciting but stressed the importance of a solid mathematics foundation, which may be reinforced by more rigorous undergraduate programming requirements (Griffiths, 2021). Furthermore, numerous ways have been developed in the literature to enhance cryptography teaching and learning in higher education, with an emphasis on increasing students' comprehension of cryptographic algorithms (Younis & Alghamdi, 2021). Due to this matter, university students, particularly those studying computer science and information technology, should be familiar with the fundamentals of cryptography. Due to its relevance, Cryptography was chosen as the PBL topic in this C++ programming course.

This study investigates the students' self-perceptions of learning C++ through PBL related to Cryptography. In addition, this study explores the students' perception of learning the basic concept of Cryptography. Since this study was conducted during the enforcement of the movement control order, this study also is expected to reveal the difficulties of conducting PBL online.

Methodology
This study is adopting the process of scholarship in teaching and learning research (Dickson & Treml, 2013; Kaco et al., 2021). Fig. 1 shows the methodology involved in this study involving four main phases: (1) preparation, (2) student planning and accomplishment, and (3) data collection and analysis (Fig. 1).
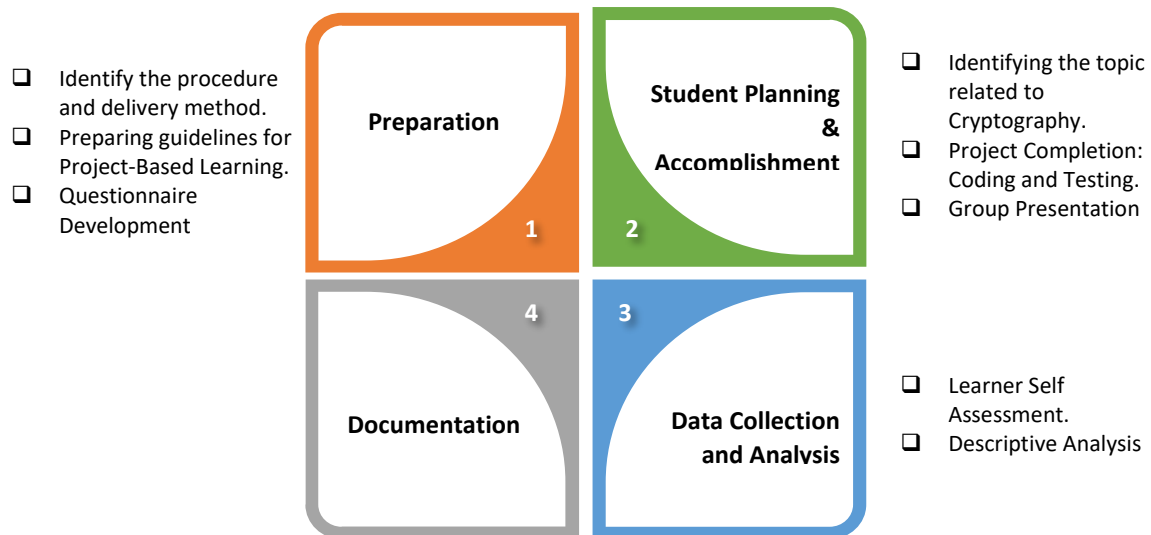
- Identify the procedure and delivery method.
- Preparing guidelines for Project-Based Learning.
- Questionnaire Development

Preparation 1

Student Planning & Accomplishment 2

- Identifying the topic related to Cryptography.
- Project Completion: Coding and Testing.
- Group Presentation

4 **Documentation**

3 **Data Collection and Analysis**

- Learner Self Assessment.
- Descriptive Analysis

Figure 1. The research methodology
The following describes the methodology of this study

Preparation
Three main activities are required, including identifying the procedure and delivery method, preparing the guideline for completing this project, and developing questionnaires. The first activity is preparation, which involves identifying the target respondents. The undergraduate students enrolled in C++ Programming Course in Semester 1 2020/2021 at Universiti Putra Malaysia have been selected as the target respondents. This course was held during the execution of Malaysia's Movement Control Order due to the Covid-19 outbreak. Hence it is conducted online.

For the second activity, the topic of Cryptography has been selected for this PBL. A guideline of the PBL has been prepared as the guidance for the students. Their proposed program should use the C++ programming syntax or elements needed to fulfill the criteria:
i.   using multiple files,
ii.   able to request input from users or files,
iii.   able to read and use the input,
iv.   able to display the results,
v.   using the suitable iteration or selection,
vi.   using the operator,
vii.   using function or namespace,
viii.   includes suitable libraries besides the iostream and
ix.   add another C++ programming syntax.

Finally, nine questions were developed to measure the respondent's perceptions of C++ programming and other soft skills. Four questions were developed, mainly focusing on the Cryptography. One question evaluated the learners' perception of this PBL approach.

Student Planning and Accomplishment
To complete this PBL, the students were divided into small groups. First, the students need to explore the basic concept of Cryptography for their understanding. Next, the students need

to identify the improvement that they might propose in their project. Then, they need to select a proper IDE such as Visual Studio Code, Dev C++, and Code Lite as their programming platform. Finally, they need to corporate with their groupmate since they are located in a different location.

Data Collection and Analysis
This study uses the purposive sampling method and where the respondents should be the students who enrolled in a C++ programming course. Therefore, Universiti Putra Malaysia undergraduate C++ Programming students in Semester 1 2020/2021 have been selected. This questionnaire is distributed online. The students were divided into small groups. Next, the students were assigned a problem where they were required to use a C++ programming language in expto explain Cryptography's concept data is collected after the presentation of the group presentation. The students were requested to complete the survey form through Google Forms. This study used descriptive statistical data analysis for reporting. The average of the total mean score is interpreted based on Table 1.

Table 1
The interpretation of the score means

Score Mean	Interpretation
1.00 – 2.33	Low
2.34 – 3.66	Medium
3.67 – 5.00	High

(Ahmad, 2002; Khalil, Othman, & Saidon, 2020; Shuhud et al., 2022)

Documentation
The results obtained from this study should be documented. The documentation is important to reveal the impact of a teaching and learning process and to provide ideas to other scholars (Dickson & Treml, 2013).

Results and Discussion
As a result, 21 students enrolled in the C++ programming course at Universiti Putra Malaysia in Semester 2, session 2020/2021. The findings of this study include the demographic information and students' self-perception of learning C++ through PBL. Therefore, the results and discussion are elaborated as follows:

Demographic Information of Respondents
The fundamental information collected as the respondents' background includes their age, gender, major, and semester in which they are attending. The analysis of respondents' demographics showed that there were 21 respondents, with 5 female respondents (24 percent) and the remaining 16 male respondents representing 76 percent of the total (Fig. 2). Besides that, the age distribution of the respondents is from only ranges from 17 to 25 years old. Fig. 3 shows that 10% (n=2) of respondents are at the age of 20 and below, and the majority of the respondents (90%, n=19) are in the range of 21-25 years old. Furthermore, this course has been offered as an elective subject for the computer science students at Universiti Putra Malaysia. Fig. 4 shows that the majority (95%, n=21) of students who enrolled in this course in that semester are majoring in networking. Meanwhile, only one student

majoring in software engineering enrolled in this course. Finally, Fig. 5 indicates that 95 percent (20) of respondents who registered in the course are in their second year, or the fourth semester of their undergraduate studies. The remaining one respondent (5%) was in the second semester of the first year.
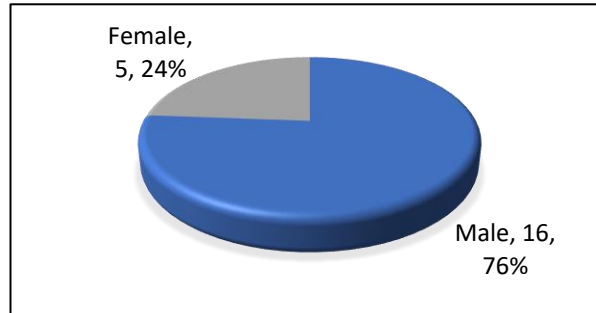

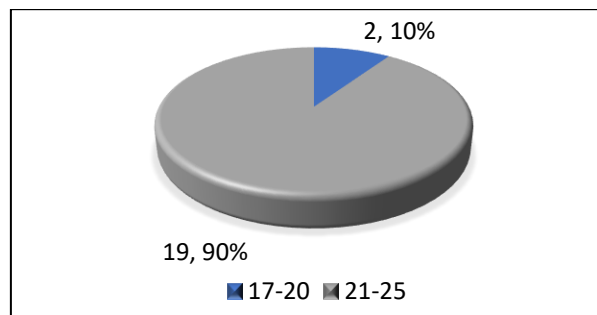Figure 2. The Percentage of Respondents based on Gender (n=21)

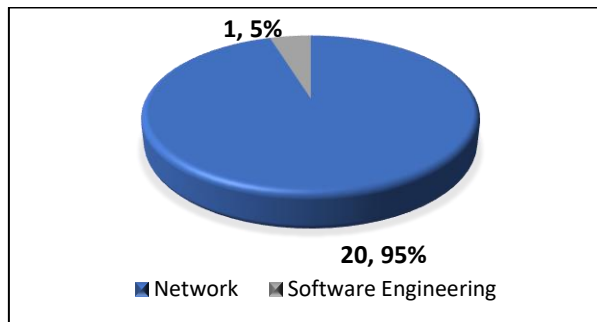Figure 3. The Range of Respondents Age (n=21)

Figure 4. The Percentage of Respondents based on Major in Computer Science (n=21)
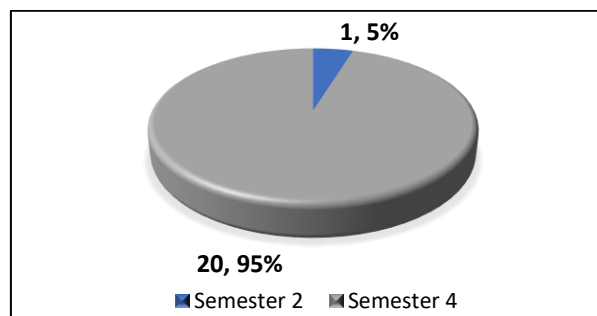

Figure 5. The Percentage of Respondents based on Semester (n=21)

Students' Self Perceptions of Learning C++ Programming Through PBL

Ten items are proposed to identify the learners' self-perception of using PBL to enhance their knowledge of C++ programming and other soft skills (Table 1). Question Q1 and Q2 are proposed to evaluate matters related to the preparation in completing this PBL. The guideline prepared by the instructor received a mean score of 4.76 (S.D. = 0.44). Therefore, as the instructor for this course, enhancement of the guideline is required if this same approach will be used in the coming semester. The learners are highly agreed (mean score = 4.95, S.D. = 0.22) that they used other online resources in helping them to complete this task. This indicates that the learners have lifelong learning skills in getting additional information. Q3 until Q4 assessed the impact of using PBL in learning C++ programming, with the mean score from 4.86 and 4.90. This finding shows that PBL is suitable to help learners understand C++ programming better. Next, Q7 has a mean score of 4.81 (S.D. = 0.40). This shows that the learner believes that they can communicate and explain to others. These results also show the capability of the learners in communicating with others. The teamwork skills and active participation received a similar mean score of 4.90 (S.D. = 0.30). This shows that students believe that they can participate and be active even though this PBL is conducted online. Finally, this approach is recommended for other future C++ programming classes.

Table 1
Students' Perception of C++ Programming through PBL

No.	Question	Mean	Std. Dev.
Q1.	I think the instructions and explanations of this project are easy to understand.	4.76	0.44
Q2.	I use another online source as a reference.	4.95	0.22
Q3.	I can reflect on what was learned (C++ Programming Language).	4.90	0.30
Q4.	This project has improved my skills in programming.	4.86	0.36
Q5.	I believe that my knowledge of this course has increased (C++ Programming Language).	4.86	0.36
Q6.	This project helped me to understand the topics better than by reading.	4.90	0.30
Q7.	I can explain the major concepts of this course (C++ Programming Language).	4.81	0.40
Q8.	I can work as a team, even though this project is conducted online.	4.90	0.30
Q9.	I am actively participating in completing this project.	4.90	0.30
	Overall	4.87	0.33
	Interpretation	High	

Table 2 displays a descriptive analysis of students' self-perception of understanding the concept of Cryptography. The overall mean score value for the student's self-perception was 4.75 (S.D. = 0.42), indicating a high mean interpretation. The majority of the students have the perception that knowledge about Cryptography with a mean score of 4.90 (S.D.=0.30). Further, Q12 and Q13 show that the students' self-perception of understandability and the enhanced Cryptography knowledge only scored 4.71 (S.D.=0.46) and 4.76 (S.D.=0.44),

respectively. The finding shows that students can explain the concepts of Cryptography with a mean score of 4.62 (S.D.=0.50). A result of selecting Cryptography as the theme for this PBL can also enhance students' knowledge of Cryptography.

Table 2
Mean Score of students' self-perceptions on the concepts of Cryptography.

No.	Question	Mean	Std. Dev.
Q10.	The knowledge about Cryptography is important.	4.90	0.30
Q11.	I am able to understand the concept of Cryptography.	4.71	0.46
Q12.	I believe that my knowledge about Cryptography has increased.	4.76	0.44
Q13.	I am able to explain the concepts of Cryptography to others.	4.62	0.50
	Overall	4.75	0.42
	Interpretation	High	

Issues in Implementing PBL in C++ Programming Course
The survey allows students to express their difficulties with the task. Students may have divergent views on this issue, and they can express more than one issues they experienced (Fig. 6). Nine of the students struggle with technology. This includes the compatibility of the C++ compiler (IDE) and C++ programming syntax. Besides that, they have experience related to internet access. While the course was being conducted, few students were located abroad. As a result, they must select an appropriate platform for conducting their group meeting. Five students raise concerns about a lack of references. Therefore, additional research should be performed to ascertain whether there are any concerns about the usage of C++ programming for cryptography. Two students mentioned that they are uninterested in the topic of Cryptography. Therefore, it is critical to convey the value of cryptography in today's digital environment to the students. Research studies discovered that attitudes (Dalgety et al., 2003), motivation (Covington, 2000), and a significant interest in the subject matter all have an impact on programming learning performance. Students who have a positive pre-course perception of the programming course and are driven by extrinsic motivation are more likely to achieve good grades and programming skills (Zainal et al., 2012). Finally, one student noted the group member's lack of dedication. As a result, peer assessment is highly suggested for assessing the group collaboration and increasing each student's willingness to participate actively in this PBL. It is recommended that the instructor emphasize the importance of each team member's contribution to the task's accomplishment.
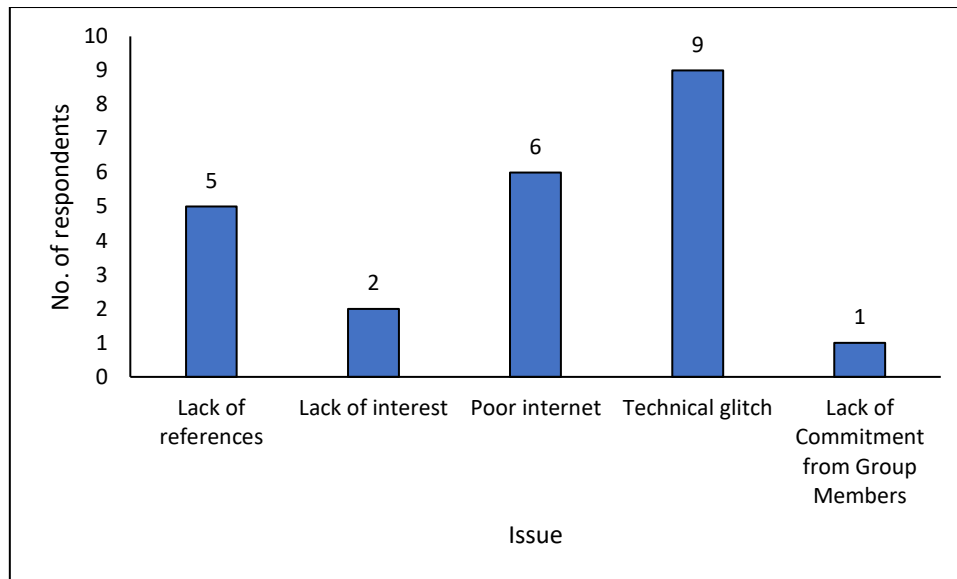
Figure 6. The issues of the PBL in the C++ Programming Course through online

Overall Students' Self Perception

Finally, one question addressed to identify if this approach of PBL with the selected theme related to Cryptography is recommended to be used for future classes (Question 14). The results reveal that the total mean score is 4.76 (S.D.=0.44). Therefore, this indicates that this approach has a high recommendation from the students. From the study of Panapt and Pandit (2019), both students and teachers benefit from the project-based learning approach implemented in cryptography class. Students improved their presentation abilities and teamwork through giving presentations in review sessions. Teachers learn how to analyze real-world problems according to course parameters when they use PBL at that time.

Conclusion and Recommendation

Overall, this study has shown that, even when conducted online, PBL can be carried out while giving C++ Programming Course priority and adding the subject of cryptography. Based on this study, students have a considerably better understanding of C++ programming and cryptography concepts. Students who took part in this study can also be referred to as lifelong learners because they were able to finish this task using the internet. Interestingly, although being delivered online, this technique has demonstrated its ability to foster teamwork among students by encouraging active engagement and effective communication. This research recommends that the PBL should be used consistently throughout the C++ Programming Course. Additionally, the topic of Cryptography should be considered for their PBL to bolster their knowledge of the Computer Science discipline. Despite hurdles, students performed this task successfully. Similar to the findings of Zouganeli, et al (2014), numerous students have viewed project-based learning's output as a form of reward for their hard work during the semester. They also like the PBL method and its effectiveness in enhancing their C++ and Cryptography knowledge, programming abilities, and other soft skills. Furthermore, the 4C (Creative, Critical, Collaborative, and Communication) is required for 21st-century technological skills. Therefore, it is highly recommended that the future assessment of this C++ programming course will highlight the element of creativity and communication skills. Course instructors should underscore the relevance of student motivation, success expectations, and teaching strategies that are aligned with the desired learning goal,

especially in employing the project-based learning (PBL) approach (Biggs & Tang, 2007). In the future, this approach can be experimented with a more significant number of participants and requires the commitment from other scholarship teaching and learning researchers. Finally, other Science and Computer topics should be used as PBL themes because this will help students improve their programming skills and their computer science knowledge as well.

Acknowledgement

Conflicts of Interests
Conflict of Interest The authors declare that they have no conflict of interests.

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