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An Exploratory Study of University and High School Students' Educational Psychology Attitudes toward Game Programming Course Performance

Li-Hsun Peng[a], Ming-Han Bai[b*]

Abstract
Improving the information and communications technology (ICT) capabilities of computer science education contributes to sustainable development (ESD). Convenience sampling use to recruit third-year (12th grade) high school students and third-year university students to participate in this study. The participants enrolled in an 8-week computer programming course with a 100-minute lesson per week psychology through the Unity game development engine. At the end of the period, students filled in the motivated strategies for learning questionnaire (MSLQ) and the self-regulated learning questionnaire (SLRQ), and they took the computer programming aptitude test. Mann-Whitney U analyses use to compare learning performance, learning motivation, and self-regulated learning between different educational stages, age, and programming experience. The results showed no difference in learning performance between the two educational settings; however, high school students showed lower learning interests and learning goals than university students. A significant finding is that the academic stage, age, and programming experience did not affect learning performance. Nevertheless, learning motivation and self-regulated learning, high school students yielded lower outcomes than university students.
Keywords: Computer Science Education, Game Programming, Learning Performance, Educational and Psychological Attitudes

Introduction

In the 21st century, along with rapid changes in science and technology, sustainability issues concerning the environment, resources, and the economy have been continuously evaluated (Alcamo et al., 2012). These issues include reducing resources, improving reusability, and mastering information and communications technology (ICT). Knowledge and technology are important issues for future education and are also essential principles of sustainable and psychological development (Mora et al., 2018).

According to curriculum guidelines for 12-year basic-education in Taiwan, ICT has become one of the core courses in the junior and senior high school curriculum (Chang et al., 2018). Developing futuristic and developmental computer science courses is a big challenge. In current higher education, Unity has widely used in game development courses (Dickson, 2015; Hsu, 2017; Hsu & Lin, 2016; Ivanov, 2015; Pachoulakis & Pontikakis, 2015). Block-based programming coursework has been becoming mainstream in current K–12 computer science courses because it allows students to improve their computer science skills, creativity, abstract thinking, and problem-solving skills (Chou, 2018; Özden & Tezer, 2018; Panskyi et al., 2019). Introductory to text-based professional course content is essential for the current generation of high school computer science courses (Weintrop & Wilensky, 2019). Digital tools and games can help youth pay attention to and participate in public and environmental issues, thus empowering young people to help their communities in new ways (Gourmelon et al., 2011; Rexhepi et al., 2018).

The transition from high school to university is considered a big shock to students, especially in their educational and psychological attitudes (Appleby, 2006). Researchers have, therefore, explored the use of specific teaching methods or teaching modes at different stages of education

[a]Department of Creative Design, National Yunlin University of Science and Technology, Yunlin 64002, Taiwan
[b]Doctoral Program, Graduate School of Design, National Yunlin University of Science and Technology, Yunlin 64002, Taiwan
[*]Corresponding author: Ming-Han Bai
E-mail: minghan.bai@gmail.com

(Hortigüela Alcalá et al., 2019; Lawanto et al., 2013). Exploring differences in curriculum performance, learning motivation, and Psychological attitude between high school and college students helps determine the potential impact of new or improved curriculum designs on curriculum guidance (Tüysüz et al., 2010).

The present study intends to examine the different education stages of learning outcomes, following the findings to improve the computer programming courses to promote the overall ESD of computer science education. Figure 1 shows the conceptual framework used in this study.

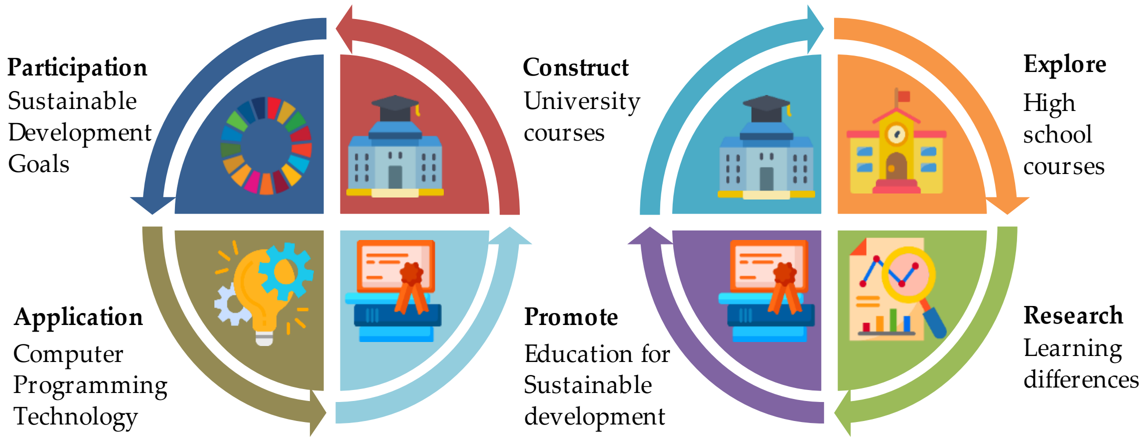


Figure 1. **Conceptual framework**

The following primary research questions formulated to guide this study:

1. Does learning performance differ between high school students and university students in computer programming courses involving Unity?
2. Do learning motivation and Psychological attitudes differ between high school students and university students in computer programming courses involving Unity?
3. Does self-regulated learning differ between high school students and university students in computer programming courses involving Unity?
4. Does the feedback differ between high school students and university students in computer programming courses involving Unity?

Literature Review

Computer Science Education

Computer science, education, and game programming concepts into computer science coursework could achieve through Scratch, Kodu, and Blockly block-based programming tools. This approach could motivate students to understand computer technology and promote elementary school students (approximately seven years old). In computer science courses, Game Maker can realize a fast and straightforward game programming environment. In short-term workshop courses, middle school students are quickly able to understand the concept of game programming. Such coursework could also inspire students' career interests in game development. However, this particular tool is still quite different from the specialized tools employed in the current game development workplace (Ernst & Clark, 2012; Guimaraes & Murray, 2008).

In recent years, the video game industry has been booming, so industrial and technological needs are continually changing. Therefore, game programming courses could help cultivate students' problem-solving abilities and develop professional skills oriented toward games and other industries (Kenwright, 2016). However, game development also requires technology and knowledge of different fields. Further, skill development takes a considerable amount of time. Although university students need to take many courses to prepare for employment, high school education in Taiwan currently does not offer game development curricula. As a result, most university students in Taiwan can learn how to develop games in two to three years (Mikami et al., 2010).

Currently, the most popular game development tools in the game industry are Unity and Unreal. Unity is widely used in game development by large studios, amateur developers, higher education institutions, and research institutions. Thus, Unity has become a crucial tool for game development (Anwyl-Irvine et al., 2018; Foxman, 2019; Nicoll & Keogh, 2019).

In higher education, game development and programming curricula have become relatively mature; therefore, higher education plays a vital role in ESD (Cebrián et al., 2020; Thomas, 2014; Wright Tarah, 2002). The challenge of transferring this curriculum and technology to K–12 education is essential for sustainable education development (Cortese, 2003). In summary, there are many game development departments and Unity game programming courses in higher education in Taiwan. Digital games are also widely used in general fields of teaching and research. However, there is still a lack of relevant high school education courses to help students understand and become involved in game programming. The present study aims to understand the learning impact of game programming courses on high school students in Taiwan through in-depth research.

Learning performance

Teachers are most concerned about whether they can promote effective learning. The scores of individual tests are the most commonly used and effective way to confirm students' proficiency. In addition to test scores, motivation is an essential factor for effective teaching (Slavin, 2000). Furthermore, self-regulated learning is significantly related to learning motivation, and psychological attitude can produce positive student learning outcomes (Wolters et al., 2005). Overall, learning performance in a course includes receiving a good score; instead, it can explain multiple variables.

Students' learning performance is not only expressed through improvements in course scores. Instead, it presents itself in different learning stages, reflecting the constant development of students' cognitive abilities, motivation, and strategy skills (McMillan & Hearn, 2008). However, when students face unfamiliar information, they present different reasons and self-confidence (Muhmmad et al., 2020).

Besides, age has also proven to be not directly related to programming performance but by professional knowledge (Kock et al., 2018).

In the education scene, they are evaluated through performance and compared with students' learning effects. The psychological state of students should be considered, such as learning motivation and self-regulated learning.

Learning Motivation and Psychological Attitude

Motivation is an intrinsic factor that can govern and maintain both goals and behavior. This factor can fill an individual with energy, inspire self-direction, and sustain behavior or maintenance activities with direction and strength (Slavin, 2000). Motivation also affects student achievement and learning effectiveness (Lai & Peng, 2020). Task value and self-efficacy are significantly related to course scores (Al-Harthy & Aldhafri, 2014; Chen, 2017; Oyuga et al., 2016).

Especially in computer science education, innovation ability emphasizes, and learning motivation positively correlates with students' degree of innovation (Law & Breznik, 2017; Law & Geng, 2019).

Self-regulated learning

Boekaerts (1997) believes that self-regulated learning includes two categories: cognitive self-regulation and motivational self-regulation. Students can achieve better performance upon learning through self-regulation skills (Alhadabi & Karpinski, 2020). Cognitive self-regulation and motivational self-regulation can subdivide into goals, mental strategies, and domain-specific knowledge. These subdivided into cognitive regulatory techniques, cognitive processes, content domain, motivational regulatory system, motivational approach, metacognitive knowledge, and motivational beliefs.

At teaching sites, students who lack prior knowledge also lack self-regulated learning. In such cases, teachers must provide active assistance and design the right media and teaching materials to serve as cognitive scaffolds for students (Yang et al., 2018). The concept of self-regulated learning helps understand students' learning performance and helps explore learning from a social cognitive perspective. Students use self-observation, self-judgment, and self-reflection to reflect on their unique environment and behavior. Therefore, the development and differences between individual students in the learning process do not only affect learning effectiveness (Handoko et al., 2019). Actively assigning appropriate teaching materials to teaching assistants can enhance students' learning unique; psychological attitude and self-regulated learning can also indirectly promote the sustainable and psychology development of education (Li et al., 2018; Svanström, 2008).

Research Method

Research Design

This study adopted action research based on mixing methods to explore whether different educational stages, ages, and programming experience affect the learning performance, learning motivation, psychological attitude, and self-regulated learning in computer programming courses through Unity, as shown in Figure 2.

This study used the same teachers and teaching materials to implement a nine-week programming course at a university and a high school to explore these research questions through questionnaire surveys and semi-structured interviews.

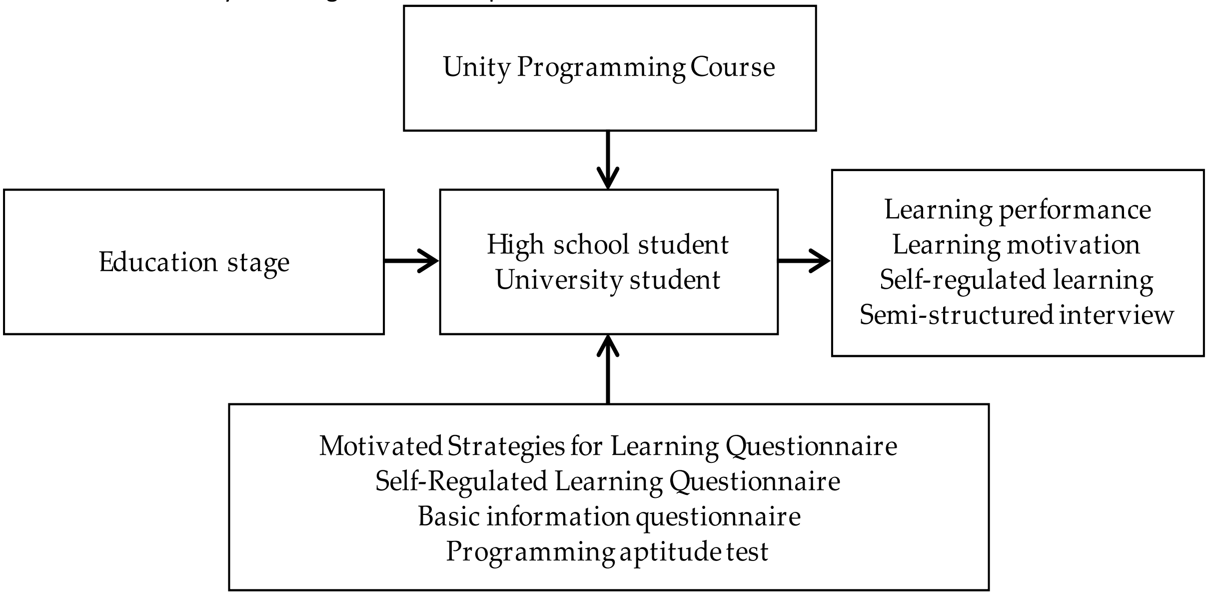


Figure 2. **Research framework**

The Participants

A total of 62 subjects participated in this study: 41 high school students and 21 university students. This research used convenience sampling technique to select high school students from one high school in two of the seven classes according to groups (science or liberal arts tracks) in a computer science core course, and university students from one university department of media design in an interactive media design elective course, both in southern Taiwan.

The high school group first recruited a total of 58 students. After removing invalid data (incomplete questionnaires), a total of 41 eligible participants enlisted to complete the study (13 males, 28 females; 27 science track, 14 liberal arts track). All high school students were high school third-year (12th grade) students (M = 17.49 ± .51 years), of which 29 high school students had programming experience.

Participants of the university students (one class) consisted of 21 (10 males, 11 females) university third-year students (M = 20.81 ± .81 years), of which five university students had programming experience.

Materials and Instruments

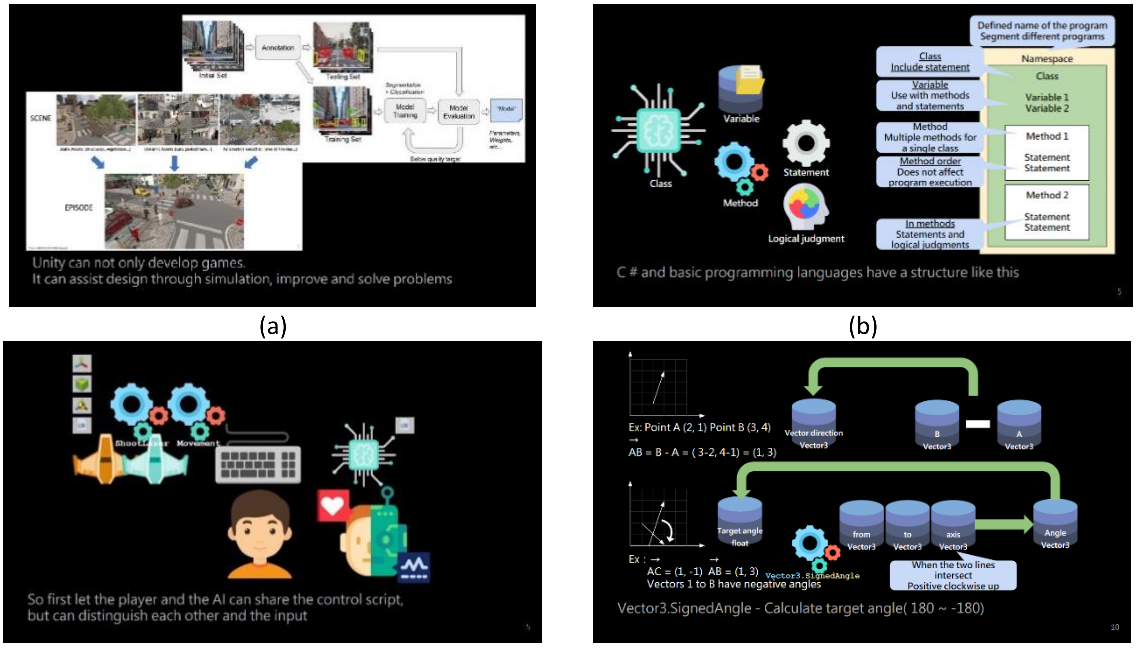
Teaching Materials

The teaching materials design for eight weeks, and the teaching materials set up based on the basic knowledge of C # and the essential operation of Unity. The weekly course outline show in Table 1.

Table 1. **Course Summary**

Week	Course Summary
1	Basic operations and basic concepts in C#
2	Components and physical controls
3	Input and logical operators
4	Prefabs, trigger zones, and object tags
5	Dynamically instantiate objects and arrays, loops
6	Scoring interface, design patterns, and special effects
7	Simple AI chase and attack
8	Touch control and building for Android

Teachers used slides to explain content to students, namely how to develop Unity games and perform practical exercises. The course materials slide and showcase appear in Figure 3 and Figure 4.



(a) (b) (c) (d)

Figure 3. **Course materials slide: (a) The application of Unity for driving simulation; (b) Programming language structure description; (c) Player and AI control description; (d) The game function as an example to explain vector angle calculation**

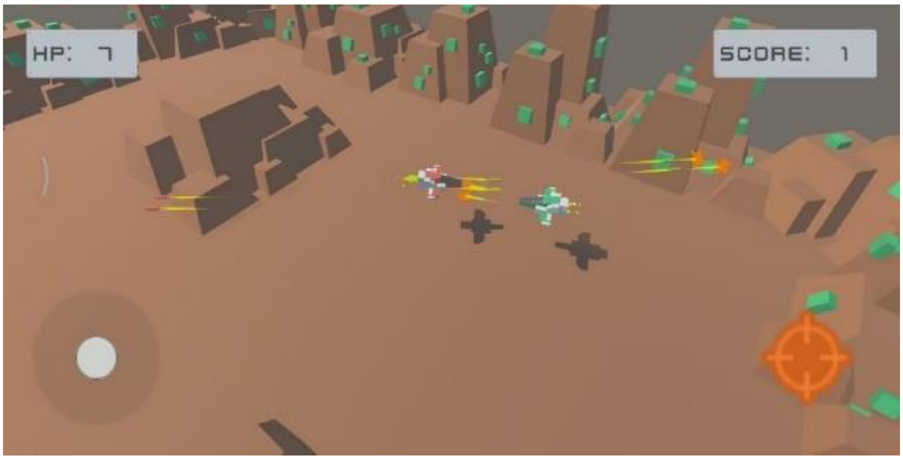


Figure 4. **Game programming showcase**

Motivated Strategies for Learning Questionnaire (MSLQ)

Understanding the students' learning motivations and psychological attitudes for the course uses MSLQ (R Pintrich et al., 1991).

The questionnaire will divide into two parts of the motivation scales and the learning strategies scales. There were 31 items in motivation scales to evaluate student beliefs about learning goals, courses, and tests. Learning strategies scales included 19 items for assessing students' cognitive, organizational, and critical thinking. Each question present in the form of a 5-Point Likert Scale. This study only measured the learning motivation and psychological attitudes part of the questionnaire.

The learning motivation and psychological attitudes part of the MSLQ included six dimensions: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. Reliability analysis performs on 31 items of the MSLQ. The analysis results showed that Cronbach's alphas internal consistency coefficient was .888, with acceptable reliability.

Self-Regulated Learning Questionnaire (SRLQ)

This study was completed and modified using the SRLQ (Barnard et al., 2009). The scale included 23 items, and each question present in the form of a 5-Point Likert Scale. This scale contained six dimensions: Goal Setting, Environment Structuring, Task Strategies, Time Management, Help Seeking, and Self-Evaluation. Reliability analysis conduct on 23 items of SRLQ. The analysis results showed that Cronbach's alphas internal consistency coefficient was .939, with acceptable reliability.

Basic information questionnaire & Computer programming aptitude test

The basic information questionnaire requires research participants to fill in gender, age, and programming experience (variables, if statements, arrays, loops, and inheritance).

The computer programming aptitude test was a researcher's self-made test. The tested criteria include the fundamental abilities and knowledge of computer programming languages. The test formulation is the multiple-choice questions that test the necessary expertise. This research utilized a questionnaire was to obtain quantitative data to evaluate the participants learning effectiveness.

Semi-structured interview for computer programming courses

Due to the research limitations, statistical analysis through semi-structured interviews allowed for more flexibility (Horton et al., 2004). At the end of the course, this study conducted semi-structured interviews on learning programming through Unity and the course's overall learning status through qualitative data. These interviews provide insights into the students' experience outside the questionnaire (Smith, 1995). Semi-structured interview questions items shown in Table 2.

Table 2. **Description of Semi-structured interview questions**

No.	Semi-Structured Interview Questions Items
1	Did you like learning computer programming using Unity? Why?
2	Apart from the arrangement, of course, contents, do you engage in studying computer programming actively?

Data Collection Procedure

Data collection took place between late October 2018 to early January 2019, and early September 2019 to early November 2019. The detailed data collection process of this study shown in

Table 3.

Each course's duration was eight weeks in total of 800 minutes; each week were two lessons lasting for 50 minutes. The source of data includes two classes in a high school and one class in a university. The same teacher conducts teaching and data collection.

Students must fill in a basic information questionnaire during the break time in the first-week course to understand the students' age and programming experience. The procedure took approximately five to ten minutes for each participant.

In the ninth week after the course, students need to conduct a computer programming aptitude test. The procedure took approximately thirty to fifty minutes for each participant. After the trial, fill in the MSLQ, SRLQ, and semi-structured interviews. The process took about twenty to forty minutes for each participant.

Table 3. **Data Collection Procedure of Study**

Week	Time Allocation	Procedure description
1	5-10 min	Basic information questionnaire
1-8	800 min	Computer programming courses
9	30-50 min	Computer programming aptitude test
9	20-40 min	MSLQ SLRQ Semi-structured interview

Data analysis

The Shapiro-Wilk runs tests to compare learning performance, learning motivation, psychological attitudes, and self-regulated learning for the two different educational stages. The test's normality results indicate that learning performance, learning motivation, psychological perspectives, and self-regulated learning between the two different educational sets were not normally distributed, showing p-values below 0.05. Based on the normality test, this study conducted nonparametric statistics, the Mann-Whitney U test, to verify the significant differences between the two different educational stages.

Although the participants' sample obtains through conventional sampling, the randomization test runs indicate that learning performance, learning motivation, psychological attitudes, and self-regulated learning between the two different educational stages had p-values above 0.05. Based on these results, observations obtained were randomized.

Results

Analysis of Learning performance

Mann-Whitney U test investigation was conducted on learning performance between the two different educational stages, as shown in Table 4.

The results indicate that the learning performance difference between the two different educational stages was not statistically significant (U = 346.5, z = -1.271, p = .204).

Table 4. **Mann-Whitney U test results of learning performance of the two groups**

Parameter	High School group (N=41)	University group (N=21)	U	Z	p
	Md (Range)	Md (Range)			
Learning performance	50 (10-70)	60 (20-80)	346.5	-1.271	.204

Analysis of learning motivation and psychological attitudes

Mann-Whitney U test investigation was conducted on learning motivation between the two different educational stages, as shown in Table 5.

The results indicate that the intrinsic goal orientation (U = 273.5, z = -2.356, p = .018), task value (U = 223.0, z = -3.099, p = .002), and control of learning beliefs (U = 281.0, z = -2.290, p = .022) had statistically significant difference between the two different educational stages.

However, that the extrinsic goal orientation (U = 350.5, z = -1.205, p = .228), self-efficacy for learning and performance (U = 394.0, z = -.545, p = .586), and test anxiety (U = 372.0, z = -.881, p = .378) was not significantly different between the two different educational stages.

In addition, intrinsic goal orientation in the high school group (Md = 3.5, Range = 2-4.8) was significantly lower than that of the university group (Md = 3.8, Range = 2.8-4.8). Task value in the high school group (Md = 3.5, Range = 1.8-4.8) was significantly lower than that in the university group (Md = 4, Range = 3.8-5), and control of learning beliefs of the high school group (Md = 4, Range = 2-4.8) was significantly lower than that of the university group (Md = 4, Range = 3-5).

Table 5. **Mann-Whitney U test results of learning motivation of the two groups**

Parameter	High School group (N=41)	University group (N=21)	U	Z	p
	Md (Range)	Md (Range)			
Intrinsic Goal Orientation	3.5 (2-4.8)	3.75 (2.8-4.8)	273.5	-2.356	.018
Extrinsic Goal Orientation	3.75 (2.3-5)	3.5 (1-5)	350.5	-1.205	.228
Task Value	3.5 (1.8-4.8)	4 (3.2-5)	223.0	-3.099	.002
Control of Learning Beliefs	4 (2-4.8)	4 (3-5)	281.0	-2.290	.022
Self-Efficacy for Learning and Performance	3.5 (1.8-4.6)	3.5 (1.5-4.4)	394.0	-.545	.586
Test Anxiety	4 (2-4.8)	3.8 (1.6-4.4)	372.0	-.881	.378

Analysis of self-regulated learning

Mann-Whitney U test evaluated self-regulated learning between the two different educational stages, as shown in Table 6.

The results indicate that the goal setting (U = 232.0, z = -2.970, p = .003) and environment structuring (U = 250.5, z = -2.801, p = .005) had statistically significant difference between the two different educational stages. However, the extrinsic task strategies (U = 380.0, z = -.766, p = .443), time management (U = 397.5, z = -.497, p = .619), help seeking (U = 362.0, z = -1.035, p = .301), and self-evaluation (U = 361.0, z = -1.062, p = .288) had no statistically significant difference between the two different educational stages.

In addition, goal setting in the high school group (Md = 3.4, Range = 2-4.8) was significantly lower than that of the university group (Md = 4, Range = 3-5). Furthermore, environment structuring in the high school group (Md = 4, Range = 1.5-5) was

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significantly lower than that of the university group (Md = 4, Range = 3.8-5).

Table 6. **Mann-Whitney U test results of self-regulated learning of the two groups**

Parameter	High School group (N=41) Md (Range)	University group (N=21) Md (Range)	U	Z	p
Goal Setting	3.4 (2-4.8)	4 (3-5)	232.0	-2.970	.003
Environment Structuring	4 (1.5-5)	4 (3.8-5)	250.5	-2.801	.005
Task Strategies	3.7 (2-5)	3.3 (2.3-4)	380.0	-.766	.443
Time Management	3.3 (2-5)	3.3 (1-4.7)	397.5	-.497	.619
Help-Seeking	3.8 (2-5)	4 (1.5-4.8)	362.0	-1.035	.301
Self-Evaluation	2.8 (1.5-4)	3 (1.5-3.8)	361.0	-1.062	.288

Analysis of semi-structured interview

Besides, students from each group participating in the study invite to semi-structured interviews. Qualitative data codes and categories based on mean and standard deviation, according to the high school group (H), the university group (U); male (M) or female (F); high performance (H), medium performance (M), and low performance (L), as shown in

Table 7.

Table 7. ***Descriptive statistics for self-regulated learning of the two groups***

Code	Description
H	High School group
U	University group
M	Male
F	Female
H	High performance
M	Medium performance
L	Low performance

Two questions were arranged for the interview, as seen in Table 8 and

The **feedbacks of high school students and university students in computer programming courses involving Unity**

Analysis of the semi-structured interview results reveals that most participants approved learning program development through Unity as a practical approach. Teaching examples and teacher materials provide throughout the course. Although students had a foundation in learning game development, the game development environment's complexity and programming language may become a learning obstacle for them.

Further, students at different education stages deal with varying challenges after class: high school

Table 9.

In total, 18 students selected to participate in the interviews: six students from the high school students and the university students, while there were two students from three dimensions of learning.

Discussion

students had to face entrance examinations and take advantage of rare leisure time. University students had to take specialized courses and face financial pressures.

In particular, university students have better functional learning conditions than high school

students. A few students may feel that programming and game developers can use as learning directions and goals. Seniors consider

having more self-learning development responsibilities than young learners (Ruthotto et al., 2020).

Learning performance in computer programming courses involving Unity

This study analyzed learning performance in computer programming courses involving Unity between the high school and university groups. The analysis results reveal that there was no significant difference in learning performance between the two groups. These results align with a previous finding that block-based programming and unity learning programming do not have substantial effects on high school students, learning performance (Peng et al., 2020). Therefore, neither learning stages, nor age, programming experience, or programming tools seem to make significant differences in students' learning of basic programming concepts.

Learning motivation in computer programming courses involving Unity

Learning motivation between the different educational stages in computer programming courses involving Unity analysis. The results reveal that the intrinsic goals of orientation, task value, and control of the high school students' learning beliefs were significantly lower than those of the university students.

Motivation is an essential factor in improving student achievement. However, the results demonstrate that specific dimensions affect while others do not. Students did not significantly impact the competition of grades, confidence in the effectiveness of self-learning, and anxiety in learning, which inconsistent with previous studies (Duncan & McKeachie, 2005; R Pintrich et al., 1991).

Compared with high school students, university students' differences in teaching environment and strategies lead to more interest in science, especially with higher task value (Mazumder & Ahmed, 2014; Tüysüz et al., 2010). High school students have a lower learning attitude towards the challenges and curiosity of programming and can bring practical and favorable results after studying programming.

Self-regulated learning in computer programming courses involving Unity

The analysis results of self-regulated learning between the two educational stages reveal that the goal setting and environmental structuring were significantly lower in the high school group than in the university group. The analyzed dimensions had different effects on self-regulated learning because, in Problem-Based Learning teaching, teachers usually let students practice after explaining the concept of the course, identify and solve students' problems one by one with a very positive attitude, and provide immediate assistance and feedback to students to promote a sense of security in learning (Hsu, 2017; Nuutila et al., 2008).

However, compared with high school students, university students present higher learning activities and are more comprehensive in identifying and describing tasks (Lawanto et al., 2013). With the growth and change of the education stage from elementary school to university, students' development in self-regulated learning has become more and more mature (Miles et al., 2004; Ramdass & Zimmerman, 2011). Especially in complex programming courses, university students are more likely to know how to set their own learning goals and environment.

Table 8. **Summary of Interview Results “Do you like to learn computer programming using Unity? Why?”**

Code	Content
HML05	I liked it. When I first learned how to use Unity to write code, I realized the difficulties of debugging and game design, including the importance of “Rigid body” and problems of not including the "collider" function.
HFL03	I did not like it because I had much trouble in understanding these functions using Unity.
HML03	No, it is a bit difficult
UML01	I liked it because design digital game development is one of my dream jobs.
UFL04	I did not like it too much. I was not interested in learning to program in this required course, although the teacher paid much attention to instruct us how to program.
UFL03	I like to design games and related courses and homework, but the lack of talent makes me feel frustrated.
HMM02	Yes, compared to other programming software, this program (Unity) was easy to learn.
HFM03	Okay, I liked playing video games, but not much about programming.
HFM06	Yes, this can increase my skills and improve my English ability.
UMM02	I liked it very much. I found it interesting as this was my time to learn programming using Unity.
UFM01	I liked it. The prototype of the demonstrated version on the teacher’s computer was just like a real game available on the mobile phone. It was pretty cool for Unity to offer this function.
UMM01	I don’t like it. I don’t play computer games very much.
HMH01	Okay, it was great to learn programming skills using Unity, but I thought it was not appropriate to design our games using others’ designed images in this course.
HFH07	Okay, the programming language is complex, and it was too challenging for me to acquire it.

Code	Content
HFH05	English interface is not very understandable.
UMH07	This program made me realize how difficult it would be to design a simple game. Although this was my first time creating digital games, I could catch up with the teacher's lecture more easily. Besides, the slides were easy to follow, and the teacher spoke clearly.
UFH01	It was my first-time learning Unity. Although I had learned web page design related to a few programming skills, learning Unity was great to acquire additional programming skills. I felt satisfied when my programming was able to work.
UMH05	Yes, because the operation is easy to look like Autodesk Maya.

The feedbacks of high school students and university students in computer programming courses involving Unity

Analysis of the semi-structured interview results reveals that most participants approved learning program development through Unity as a practical approach. Teaching examples and teacher materials provide throughout the course. Although students had a foundation in learning game development, the game development environment's complexity and programming language may become a learning obstacle for them.

Further, students at different education stages deal with varying challenges after class: high school students had to face entrance examinations and take advantage of rare leisure time. University students had to take specialized courses and face financial pressures.

In particular, university students have better functional learning conditions than high school

students. A few students may feel that programming and game developers can use as learning directions and goals. Seniors consider

having more self-learning development responsibilities than young learners (Ruthotto et al., 2020).

Table 9. **Summary of interview results "Apart from This arrangement of course contents, do you engage in studying computer programming actively?"**

Code	Content
HML05	No, If I had more time, I would arrange some other time to self-study because it is necessary to follow up is the trend of the times and utilize modern multimedia technologies.
HFL03	No, I want to make fair use of my free time to play online video games.
HML03	No, there is no extra time.
UML01	No, my part-time job occupies most of my free time, and there is not much time for me to review programming skills using Unity.
UFL04	No, I had no interest in learning Unity, and I want to look for other interesting subjects in my free time.
UFL03	Yes, I will study relevant materials and works again to learn.
HMM02	Sometimes, I will look up other resources on Unity.
HFM03	No, I was not into computer programming, but I would learn some other programming skills in the future.
HFM06	No, the schoolwork is busy, and there is no computer in the dormitory.
UMM02	Occasionally during class, I had trouble dealing with debugging, and it felt a bit hard to follow coding skills in the teacher’s presentation.
UFM01	Yes, this was my first-time learning Unity, and some coding skills were still unclear when the teacher just demonstrated it once.
UMM01	Yes, I want to be familiar with each operation.
HMH01	Yes, I was interested in learning 3C. I will look for relevant information on the Internet, although I seldom know how to write code.
HFH07	Occasionally, I found it useful and advantageous if I could see free time to learn C++.
HFH05	No, I need a teacher to understand how to use it.
UMH07	My major is not in the design field, but I will learn coding skills in my free time if somebody offered the chance.
UFH01	If I had more time, I would like to review Unity's functions taught in class.
UMH05	It is because I will watch the teacher's YouTube channel; the content is quite impressive.

Conclusions and Suggestions

Conclusions

To conclude, the present study is preliminary research on different educational stages, ages, and programming experience affect the learning performance, motivation, and self-regulated learning in computer programming courses through Unity.

A significant finding is that most students accept the integration of Unity in computer science courses. Furthermore, the educational stage, age, and programming experience did not affect learning performance. However, in terms of learning motivation and self-regulated learning, high school students yielded lower outcomes than university students. Although students have different academic pressures at various education stages that affect students 'willingness to influence active learning, university students have a more active learning attitude.

The results indicate that high school students are less active in learning programming than university students. It can reason that high school students lack importance and interest in programming courses. Nevertheless, it remains unclear may students did not fill in the questionnaires honestly or just fill in the answers quickly, which affected the research results.

Limitations of this Study

Despite teaching computer programming through Unity advantages, it does have some limitations. First, the high school group consisted of only two students, while the university group consisted of only one class. Therefore, the sample used in this study was small. Second, the sampling method in this study was non-random, and the data had non-normal distribution; thus, the results may be biased. Convenient sampling through non-random sampling may lead to uncertainty in research results (Peterson & Merunka, 2014). Due to sample acquisition limitations in this study, samples have been taken as far as possible (science or liberal arts tracks), and sampling methods are described to assume that models are available (McMillan, 1996). Third, the high school students consisted of third-year high school students facing a university entrance exam (Fuentes et al., 2019). This pressure may have lowered learning motivation, psychological attitudes, and decreased self-regulated learning in non-admission examination courses. Therefore, it affects the enthusiasm of participating in the study and even fills in the questionnaire hastily.

Suggestions for Future Research

Teaching computer programming through Unity in high school is still very much in the exploratory stage, and much more has yet to do. Much more also needs to be about improving high school students learning motivation and self-regulated learning in computer programming courses. This study should provide a descriptive basis for additional research. Further research is, therefore, warranted in different teaching curriculum designs.

Author Contributions

L.-H.P. dealt with conceptualization, methodology, supervision, writing-review, and editing; M.-H.B. dealt with validation, investigation, writing-original draft preparation.

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Conflicts of Interest

The authors declare no conflict of interest.

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