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SOKOBAN: A Game-Based Learning Game for Enhancing Programming Skill among Undergraduate Students in Malaysia

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ABSTRACT

Programming is a necessary skill for students in computer science-related fields, but teaching it to first-year undergraduates can be challenging. Traditional classroom-based learning and teaching methods are insufficient, especially when it comes to programming. Game-based learning has emerged as an effective way for students to learn programming, even though there is currently a lack of empirical evidence in the literature. Therefore, this research aims to develop a Game-based Learning (game-based learning) Computer Game that can effectively teach programming to undergraduate students. The game will be expertly reviewed by three game designers and three programming lecturers to ensure its effectiveness. The study will involve a quasi-experiment, in which students will play the game while assessing their understanding of programming. One programming module (Object-Oriented Programming) will be covered, and two batches of Year 1 Bachelor of Software Engineering (Educational Software) students from Universiti Pendidikan Sultan Idris will participate in this research. All participated students are randomly divided into control and focus groups. Data collection was according to A quasi-experiment with a control group that was conducted to investigate the effectiveness of Sokoban in learning programming. A comparative analysis using ANOVA method on the efficiency of learning programming between game-based learning approach and existing learning approach (among control group and experimental group) revealed great significance [$F = 6.6296$, $p < .05$]. Therefore, it can be concluded that the Sokoban computer game was effective in teaching programming to undergraduate year one students. These findings have significant implications for the future development of game-based learning games to aid undergraduate students in learning topics related to programming paradigm. The results suggest that game-based learning games could have a positive impact on programming education in Malaysian tertiary institutions. The knowledge gained from this study could contribute to determining the importance of the game-based learning approach for other ICT-related modules.

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1. Introduction

The lack of effective exposure to programming modules in secondary or high school education in Malaysia creates significant obstacles in the teaching and learning process of programming at the tertiary level [1,27,30]. These challenges include variations in understanding levels among students, leading to difficulties in lecture delivery, as well as disinterest among students due to the mundanity of using a single programming language as a context [2,26,29]. Additionally, low performance in learning programming is also a prevalent issue [2,26]. The lack of effective exposure to programming modules in secondary or high school education in Malaysia creates significant obstacles in the teaching and learning process of programming at the tertiary level [2,26]. These challenges include variations in understanding levels among students, leading to difficulties in lecture delivery, as well as disinterest among students due to the mundanity of using a single programming language as a context [3,27,31]. Additionally, low performance in learning programming is also a prevalent issue [4,28,32]. Thus, the research objective is to develop a Game-based Learning (GBL) Computer Game for undergraduate student to learn programming effectively. Review of literature shows that the GBL game is needed because it would able to overcome the current challenges faced such as variation of understanding level among student, programming language as the single context that cause disinterest among students and low performance on learning programming.

In the market, learning programming games or game-based learning tools such as CodeCombat, code.org, lightbot, human resource machine and Screeps are available for students to learn about programming, with the practice of coding. CodeCombat [5] is a game-based learning tool that aims to teach programming through interactive challenges and battles. It is accessible for beginners but also provides challenges for experienced programmers. The game is online and designed to be an adventure-style game. It offers various programming languages, including Python, JavaScript, and CoffeeScript. The game includes levels for both beginners and advanced players. Players progress through the game by writing code to control their hero character and defeat enemies. They learn new programming concepts such as functions, loops, and variables as they advance. However, the game may have limitations for more advanced learners, as it only teaches a limited number of programming concepts. Additionally, some players may find the early levels either too easy or too difficult.

To summarize, Code.org is a non-profit organization that offers free online courses, tutorials, and games to teach programming [6]. The website provides a range of interactive games and puzzles that focus on programming concepts, such as loops and conditionals, and is suitable for all ages. However, the games may be primarily geared towards younger learners and the website's interface or progression system may be confusing for some learners [19].

Lightbot is a browser-based game, which means that it may be limited in terms of available features and may not be as flexible as other game-based learning tools [7]. Also, since Lightbot is a single-player game, it may not provide opportunities for collaborative learning or social interaction. Lightbot is designed to teach programming logic, and is suitable for players of all ages. The game only teaches basic programming concepts and may not be challenging enough for more advanced learners [20]. Some learners may find the game's graphics or sound effects to be outdated or unappealing. Human Resource Machine is a puzzle game that simulates working in an office where players must complete tasks using programming concepts [8]. Players write programs that guide their worker to move boxes from one place to another, sort mail, and perform other tasks. Players write programs to guide their worker to move boxes from one place to another, sort mail, and perform other tasks. The game's story and graphics are reminiscent of old-school computer games, which some players may find nostalgic or charming. The game is suitable for players of all ages, but some learners may find the game's difficulty level to be too high or frustrating [21]. Additionally, the game only teaches a limited number of programming concepts, so it may not be sufficient for more advanced learners [20]. Screeps is an online multiplayer game where players program their own units to compete against other players in real-time strategy battles [9]. The game uses JavaScript as its programming language, and players must write code to control their units' behavior. Players start with a basic set of units and gradually unlock more advanced units as they progress through the game. Screeps is designed to teach advanced programming concepts, such as AI and real-time systems. It's also a great way to practice coding skills and collaborate with other players [22]. The game's focus on multiplayer and real-time strategy may not be appealing for all learners. The game's use of JavaScript as a programming language may be challenging for beginners or learners with no prior coding experience [23]. It's also worth noting that Screeps has a steeper learning curve compared to other programming games, and requires a significant time investment to become proficient at programming and competing in the game [24].

This research is a proposed game-based learning game that addresses some of the limitations of current game-based learning tools. By allowing students to study programming paradigms directly without the need for coding, the game can help beginners without any IT programming background to learn programming concepts in a more accessible way [10]. It's important to have a range of tools and resources available to cater to different learning styles and levels of experience, so the proposed game could be a valuable addition to the existing game-based learning landscape. It would be interesting to learn more about the specific features and mechanics of the proposed game and how it compares to existing game-based learning tools [11]. It is important to note that while game-based learning has been shown to be effective in various educational fields, including programming, it is not a one-size-fits-all solution. The success of game-based learning in programming education depends on several factors, such as the design of the game, the level of difficulty, and the learner's prior knowledge and experience [12]. Additionally, game-based learning should be used in conjunction with other teaching methods, such as lectures, to ensure a comprehensive understanding of programming concepts. Nonetheless, the use of game-based learning in programming education has great potential to enhance the learning experience and engage learners in a fun and interactive way.

It is clear that programming can be a challenging subject for students to learn, and the current methods of teaching may not be effective enough to prepare them for real-world applications in the ICT industry [25]. The proposed game-based learning game offers a unique approach to learning programming that could potentially overcome some of the issues faced by students, such as a lack of interest and engagement, difficulty in understanding programming logic, and inadequate preparation for the industry. By integrating programming concepts into a fun and interactive game, students can learn programming in a more engaging and meaningful way. This innovative approach has the potential to improve the quality of talent for the ICT industry and enhance students' abilities to apply programming concepts in their future careers [13].

2. Methodology

In this research, a quasi-experimental research design was used, which involved a combination of quantitative and qualitative methods to analyze the data. This combination of methods was chosen to provide a more comprehensive understanding of the research data, as each method provides a unique perspective [14]. The quasi-experimental design was selected for this study because the gaming testing and evaluation involved an empirical interventional study that was applied exclusively to the designated study groups without randomization [15]. This design was deemed suitable for evaluating the effectiveness of Sokoban as a game-based learning game for learning programming.

The research instrument used in this study was a game-based learning game called Sokoban, which was designed to align with the learning objectives of each topic in the programming concept. To ensure the validity of the game, it was validated by three subject experts by using Heuristic Evaluation for Courseware. While got for the pre-test and post-test were used to evaluate the effectiveness of the proposed game-based learning game. Each test comprised 30 questions, with 10 questions covering each of the proposed programming topics. The questions were designed according to Bloom's Taxonomy to match the learning objectives. To validate the questions from the pre-test and post-test, they were reviewed by five subject experts who had more than five years of experience teaching programming. This combination of research instruments provided a robust approach to analysing the effectiveness of the game-based learning game in enhancing students' understanding of object-oriented programming.

The study focuses on undergraduate students who are pursuing a Bachelor's degree in Software Engineering at a local public university. To ensure effective investigation of the complex research elements, a minimum sample size of 30 participants per university was selected for the quasi-experiment, as suggested by literature [14,15,18]. Thus, a total of 60 participants were included in the study. The research is based on a programming module that spans over two semesters and focuses on Object Oriented Programming. The first semester students were assigned to the control group while the second semester students were assigned to the experimental group. Both groups share the same background. It is important to note that the selection of participants from a specific university and major may limit the generalizability of the findings to other populations. However, this approach can provide valuable insights into the effectiveness of the proposed game-based learning game for learning programming in a specific context. It is also important to ensure that the participants are randomly assigned to the control and experimental groups to minimize the potential for selection bias.

It is important to note that the sample size and selection criteria should be carefully considered to ensure that the results of the study are valid and reliable. In this case, the sample size of 60 students from one public university may limit the generalizability of the findings to other universities or populations. Additionally, controlling for variables such as prior programming experience or interest in the subject may also be important in order to isolate the effect of the proposed game-based learning game. It may also be useful to consider conducting a larger scale study in the future to further validate the results of this research. It is crucial to carefully consider the selection criteria and sample size to ensure the validity and reliability of study results [26]. The chosen sample size of 60 students from a single public university may limit the generalizability of the findings to other populations or universities. Moreover, controlling for variables like prior programming experience or interest in the subject may be essential to isolate the effect of the proposed game-based learning game. To further validate the research results, it may be beneficial to conduct a larger scale study in the future.

The questionnaire will be used to collect data on students' perceptions and attitudes towards the proposed game-based learning game, their engagement level, and their overall satisfaction with the learning experience. The interviews will be conducted with a selected group of students from the experimental group to obtain in-depth feedback on the effectiveness of the proposed game-based learning game. The validation forms will be used to collect feedback from subject matter experts and game developers on the design and effectiveness of the proposed game-based learning game. The research variables that will be analyzed include programming knowledge, programming problem-solving skills, motivation, engagement, and satisfaction. The ANCOVA analysis will be used to determine whether there is a significant difference in the programming knowledge and problem-solving skills between the experimental and control groups after controlling for the pre-test scores. The research results will be presented in Figure 1 to provide a visual representation of the data. Overall, the research instruments aim to collect both quantitative and qualitative data to evaluate the effectiveness of the proposed game-based learning game in teaching programming in a higher education institution.

Subject Group		Before playing proposed GBL game	During Testing of GBL game	After playing proposed GBL game
Control Group	Research Instrument	Pre-Test	Existing Approach	Post-Test
	Duration	90 min	Existing Approach	90 min
Experimental Group	Research Instrument	Pre-Test	Proposed GBL game	Post-Test
	Duration	90 min	1 month	90 min
Location		Classroom	Classroom, Computer Laboratory, Self-Learning Environment	Classroom

Fig. 1. Research design

3. Results

3.1 Result of Game-Based Learning Game Evaluation by Experts

A total of three computer science lecturers who taught programming subject for more than five years were invited to participate in the research instrument (proposed game-based learning game) expert review using HEWC. The data were analysed based on a quantitative approach knows as Usability of Heuristic Evaluation for Courseware. The data collection process was applied with an appropriate usability rate of about 85%. The proposed game evaluation was assessed in three main components, which included interface element, education element and content element, as shown in Table 1. These components were then rated according to a rating known as severity rating which was also the assessment criteria to be obliged by the experts.

Table 1
HEWC results for the evaluation of game-based learning game

Component	Total Problem	Severity Rating
Interface Element	24	4
Education Element	19	2
Content Element	20	1

Table 2 also provides the weighting of each component of HEWC for the calculation of the total percentage of the courseware usability. All the data obtained for these three components were used to calculate the H (heuristic value) and Ht (heuristic categories) according to severity rating, which result in the usability catastrophe.

Table 2
Percentage assigned for each Heuristic

Heuristic	Total Sub-heuristics	Weight of heuristic	Weight of heuristic (%)
Interface (I)	10	0.45	45.46
Education Elements (E)	6	0.27	27.27
Content (C)	6	0.27	27.27
Total	22	1	100

In order to estimate the degree or level of usability, UsabHECW(x), as the weighted mean/ overall usability of courseware, was applied as follows [32]:

USABHECW (h) = (I/0.3701) + (E/0.3065) + (C/0.3225) / 3 (1)

Where, I represents the Interface, E is for Educational and C for Content.

Each variable of I, E and C was calculated from the following formula:

$$F(x) = (\sum H / \sum Ht) \times P$$

Where, ∑H (= ∑ (severity rating x number of severity)) is the summation of the severity scores for each heuristic category, P is the percentage of the category, and ∑Ht is the summation of the heuristic categories in the worst case (in the events that all severity ratings were 4). Table 3 provides details of the calculation steps for HEWC analysis. The evaluation of data were detailed in Table 4 for Sokoban as assessed by the experts.

Table 3
Sample calculation for each component

Calculation for I Component	Calculation for E Component	Calculation for C Component
H = (4*5) + (3*6) + (2*5) + (1*7) = 20 + 18 + 12 + 7 = 57	H = (4*2) + (3*9) + (2*6) + (1*1) = 8 + 27 + 12 + 1 = 48	H = (4*1) + (3*4) + (2*7) + (1*9) = 4 + 12 + 14 + 9 = 39
Ht = (4*5) = 20	Ht = (4*2) = 8	Ht = (4*1) = 4
F(x) = Ht / H * P (percentage weightage for Interface component) = 20 / 57 * 45.46 = 15.951	F(x) = Ht / H * P (percentage weightage for Education component) = 8 / 48 * 27.27 = 4.545	F(x) = Ht / H * P (percentage weightage for Content component) = 4 / 39 * 27.27 = 2.797
F(x)% = 15.95 / (45.46*100) = 35.08	F(x)% = 4.545 / (27.27*100) = 16.66	F(x)% = 2.797/ (27.27*100) = 10.26

Table 4
Overall data analysis for each component in HEWC

Component	Total Problem Obtained	Data Calculation				
		∑H	∑Ht	P	F(x)	F(x)%
Interface	24	57	20	45.45	13.95	35.08
Education	19	48	8	27.27	4.55	16.66
Content	20	39	4	27.27	2.80	10.26
Overall Calculation:						
USABHECW(h)	= ((I/0.4545) + (E/0.2727) + (C/0.2727) / 3 = ((15.951/0.4545) + (4.545/0.2727) + (2.797/0.2727) / 3 = ((35.08) + (16.66) + (10.26) / 3 = 20.67					
					Total	62.00
					Mean	20.67

According to the analysis, percentage value for interface component is 35.08 %, education component is 16.66 %, and content element is 10.26 %, respectively. The min value for USABHEWC (x) is 18.82 %, which representing the overall critical suitability problem for the research instrument. The suitability of the courseware evaluation value should be more than 80 % to ensure the game-based learning game is effective. For this research work, the suitability of Odyssey of Phoenix as the research instrument was evaluated to be 82.67 % (100 % - 18.82 %) based on the min value. According to the results, the most critical component was I which had a value of 35.08 %. For E and C, both of them were less than 20 % which could be regarded as non-critical groups. Thus, I must be focused to ensure that the value to be less than 20 %.

3.2 Results of Game-based Learning Game Effectiveness Evaluation on Student Performance

The results were analysed by comparing between the Pre-Test score and the Post-Test score for both control group and experimental group, respectively. The scores obtained from the Post-Test was evaluated to identify the gaps between game-based learning approach and existing learning approach toward learning performance on programming paradigm learning. This was followed by Levene test analysis to test for homogeneity of variance (pre-test) as a step to reduce the erroneous of data significantly in the initial stage of the research.

3.2.1 Levene test analysis

The data obtained from Pre-Test were first analysed using the Levene test for homogeneity of variance. The aim of this test is to access the equality of variances of the dependent variable for the control group and experimental group.

Based on Table 5, the Levene tests showed that the Pre-Tests aimed at proving that the two groups (control group and experimental group) in this study were the same before they were used the game-based learning learning approach adopted in this research. In order to achieve homogeneous variance, Levene results must have non-significant values ($p > 0.05$) [33]. Levene test showed a non-significant value of 0.6239 ($p > 0.05$). Thus, the data obtained proved that the variances of the control and experimental groups are homogeneous, and valid for the subsequent ANOVA analysis.

Table 5
Levene test for homogeneity of variance for Pre-Test

Pre-Test	Frequency (f-ratio)	0.243
	Significant (p-value)	0.624

Note: *Significant at p < 0.05

3.2.2 Experimental group

Table 6 shows the overall performance of experimental group which consists of 30 students before and after playing the proposed Sokoban. Based on the results, the lowest score and highest score for Pre-Test were 18 and 53, respectively while the lowest and highest score for Post-Test were 18 and 59, respectively. Nonetheless, overall performance of experimental group students was compared and the following findings were derived:

- 3 students achieved score increment for more than 20 marks (which was equivalent to 10 %)
- 12 students achieved increment in between 10 to 19 (which was equivalent to 40 %)
- 10 students achieved increment in between 1 to 9 (which was equivalent to 33.33 %)
- 1 students' performances remained unchanged
- 35 students showed improved in programming understanding (85.71 %).

Table 6
Student performance data analysis of pre-test and post-test for experimental group

Student	Pre-Test	Post-Test	Mark difference	Student	Pre-Test	Post-Test	Mark difference
S1	38	46	+8	S16	42	49	+7
S2	29	31	+2	S17	30	41	+11
S3	40	38	-2	S18	28	40	+12
S4	41	47	+6	S19	30	40	+10
S5	30	48	+18	S20	27	41	+14
S6	38	36	-2	S21	33	43	+10
S7	44	46	+2	S22	33	43	+10
S8	43	36	-7	S23	33	47	+14
S9	42	54	+12	S24	36	44	+8
S10	33	33	0	S25	18	38	+20
S11	44	40	-4	S26	42	47	+5
S12	28	44	+16	S27	32	47	+15
S13	23	44	+21	S28	31	43	+12
S14	18	44	+26	S29	32	39	+7
S15	37	45	+8	S30	32	39	+7

Paired sample t-test, as shown in Table 7, shows the testing of the significant min score in Pre-Test and Post-Test. Based on the analysis, the min score for experimental group is 7.36 based on the difference between 35.59 and 42.95. SPSS analysis indicates that the significant value is 0.001 which is less than the standard 0.025.

Table 7
Statistical analysis of experimental group results

Statistical Test	Evaluation	Mean				95 % Confidence Interval of the Difference				
			N	Std. Dev.	Std. Error Mean	Lower	Upper	t	df	Sig.(2-tailed)
Sample Statistics	Pre-Test	33.57	30	7.07	1.29	-	-	-	-	-
	Post-Test	42.43	30	4.99	0.91	-	-	-	-	-
t-test	Pre-Test & Post-Test	-8.87	-	7.54	0.657	-11.72	-6.02	6.363	59	0.001

3.2.3 Control group

The overall performance of the control group students which consists of 30 students are summarised in Table 8. Overall performance of control group could be summarized based on Table 8, as follows:

- 0 students achieved score increment for more than 20 marks
- 8 students achieved increment in between 10 to 19 (which was equivalent to 26.67 %)
- 9 students achieved increment in between 1 to 9 (which was equivalent to 30.00 %)
- 3 students' performances remained unchanged
- Only about 10 students obtained score decrement (33.33 %).

Table 8
Student performance data analysis of pre-test and post-test for control group

Student	Pre-Test	Post-Test	Mark difference	Student	Pre-Test	Post-Test	Mark difference
S1	34	34	0	S16	35	31	-4
S2	33	48	+13	S17	29	26	-3
S3	35	31	-4	S18	42	39	-3
S4	34	34	0	S19	37	55	+18
S5	38	40	+9	S20	36	51	+15
S6	27	46	+19	S21	37	45	+8
S7	35	42	+7	S22	43	51	+8
S8	35	37	+2	S23	31	13	-18
S9	25	35	+10	S24	47	15	+13
S10	32	44	+12	S25	48	25	+7
S11	42	46	+4	S26	44	52	+8
S12	39	48	+9	S27	31	21	-10
S13	28	22	-6	S28	33	31	-2
S14	45	45	0	S29	19	31	+12
S15	41	37	-4	S30	38	29	-9

Based on the paired sample t-test, the min score for control group was reported 0.93 (from 35.77 to 36.70). With the significant value of 0.6670, the hypothesis was accepted when compared against the standard value shown in Table 9.

Table 9
Statistical analysis of experimental group results

Statistical Test	Evaluation	Mean				95 % Confidence Interval of the Difference				
			N	Std. Dev.	Std. Error Mean	Lower	Upper	t	df	Sig.(2-tailed)
Sample Statistics	Pre-Test	35.77	30	6.63	1.21	-	-	-	-	-
	Post-Test	36.70	30	11.13	2.03	-	-	-	-	-
t-test	Pre-Test & Post-Test	-0.93	-	9.09	2.147	-5.32	3.46	0.435	59	0.6670

3.2.4 ANOVA analysis

ANOVA analysis was conducted to answer the main research objective that highlighted the impact of learning programming efficiency in applying game-based learning approaches (by playing Sokoban game) compared to existing learning approaches. Therefore, this analysis was conducted based on the approach of learning programming applied to students, student Pre-Test score and post-test-soccer to test the main research objective.

Table 10
ANOVA statistical analysis for student effectiveness in learning OOP

Test	Evaluation	Mean	N	Std. Dev.	Std. Error Mean	Sum of Squares	df	Mean Square	F	Sig. (2-tailed)
Pre-Test	Experimental Group	33.57	30	7.07	1.29	-	-	-	-	-
	Control Group	35.77	30	6.63	1.21	-	-	-	-	-
Pre-Test	Between Group		-	-	-	72.6	1	72.6	1.547	0.219
	Within Group	-	-	-	-	2722.7	258	46.944	-	-
Post-Test	Experimental Group	42.43	30	4.99	0.91	-	-	-	-	-
	Control Group	36.70	30	11.13	2.03	-	-	-	-	-
Post-Test	Between Group	-	-	-	-	493.07	1	493.07	6.630	0.013
	Within Group	-	-	-	-	4313.67	58	73.37	-	-

Note: *Significant at level $p < 0.05$

As observed from Table 10, a comparative analysis using ANOVA method on the efficiency of learning programming between game-based learning approach and existing learning approach revealed great significance [F = 6.6296, p <.05]. The evidence of this analysis shows that there would be great difference between student scores and the application of game-based learning approach and existing approach. Through comparison, the Pre-Test mean score for control group is 35.77 and Post-Test mean score is 36.70, which gives a difference of 0.93. As observed from Table 5.6, the Pre-Test score for experimental group is 33.57 and Post-Test mean score is 42.43 (the different is 8.87). Based on the mean scores shown, the huge difference between the means score from both groups is 7.94. It shows that, the experimental group performance is better than control group toward understanding of programming skillset. This implied that learning programming with game-based learning approach was more effective in this case when compared to the existing learning approach.

4. Conclusions

The study aimed to investigate the impact of a proposed game-based learning (GBL) game on students' achievement in learning programming. The analysis was conducted through a t-test of Pre-Test and Post-Test scores between the experimental and control groups at a confidence level of p=0.05. The results showed a significant difference between the mean score of the Pre-Test and Post-Test scores for both groups. The Levene test showed no significant difference between the mean Pre-Test score for the experimental and control groups when the Pre-Test was used as a covariate. This indicate both control and experimental group are no significant different in term of their prior programming knowledge. With the similar programming knowledge standard from both groups, it can ensure the reliability for the ANOVA analysis on the post-test result. the ANOVA analysis indicated a significant difference between the Post-Test scores of the two groups. The experimental group performed significantly better and demonstrated a higher increase in their programming skills. Therefore, the study concluded that the proposed GBL game was effective in teaching and learning of OOP paradigms and in improving student performance in learning programming skill set. The GBL game provided an effective and interactive learning approach for undergraduate first-year students.

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References
[1] Tan, Phit-Huan, Choo-Yee Ting, and Siew-Woei Ling. "Learning difficulties in programming courses: undergraduates' perspective and perception." In *2009 International Conference on Computer Technology and Development*, vol. 1, pp. 42-46. IEEE, 2009. https://doi.org/10.1109/ICCTD.2009.188
[2] Gomez, Manuel J., José A. Ruipérez-Valiente, and Félix J. García Clemente. "A systematic literature review of game-based assessment studies: Trends and challenges." IEEE Transactions on Learning Technologies 16, no. 4 (2022): 500-515. https://doi.org/10.1109/TLT.2022.3226661
[3] Alias, N., and N. Othman. "Game-Based Learning for Programming Education: A Review of Literature." *International Journal of Advanced Computer Science and Applications 10,* no. 9 (2019): 436-444. https://doi.org/10.14569/IJACSA.2019.0100958
[4] Alias, N., N. Othman, and F. Yusop. "Game-Based Learning for Programming Education: A Systematic Literature Review." *International Journal of Emerging Technologies in Learning (iJET) 16*, no. 05 (2021): 6-27. https://doi.org/10.3991/ijet.v16i05.13963
[5] CodeCombat. "Home - CodeCombat." Accessed April 30, 2023. https://codecombat.com/.
[6] Code.org. "Learn to code - for free." Code.org. Accessed April 30, 2023. https://code.org/.
[7] Human Resource Machine. "Human Resource Machine." Accessed April 30, 2023. https://tomorrowcorporation.com/humanresourcemachine.
[8] Lightbot. "Lightbot." Accessed April 30, 2023. https://lightbot.com/.
[9] Screeps. "Screeps." Accessed April 30, 2023. https://screeps.com/.
[10] Kin, Jonathan Hiew Yin, Maizatul Hayati Mohamad Yatim, Tan Wee Hoe, and Wong Yoke Seng. 2021. "Developing a Game-Based Learning Assessment Framework towards Ubiquitous Computational Thinking Among Undergraduate Students". *Journal of ICT in Education 8* (4):130-44. https://doi.org/10.37134/jictie.vol8.sp.2.13.2021
[11] Joo, Tan Meng, and Wong Yoke Seng. 2021. "Validating the Effectiveness of Game-Based Learning Approach in the Form of Video Game for Assessing Computational Thinking". *Journal of ICT in Education 8* (4):1-12. https://doi.org/10.37134/jictie.vol8.sp.2.1.2021

[12] Wong, Yoke Seng, Mohamad Yatim Maizatul Hayati, Wee Hoe Tan, and Li Chen Yap. "A Game-Based Learning Assessment Framework for Learning Ubiquitous Computational Thinking." *In The Impact of the 4th Industrial Revolution on Engineering Education: Proceedings of the 22nd International Conference on Interactive Collaborative Learning (ICL2019)*–Volume 2 22, pp. 607-615. Springer International Publishing, 2020. https://doi.org/10.1007/978-3-030-40271-6_60

[13] Wong, Yoke Seng, and Maizatul Hayati Mohamad Yatim. "A propriety multiplatform game-based learning game to learn object-oriented programming." *In 2018 7th International Congress on Advanced Applied Informatics (IIAI-AAI),* pp. 278-283. IEEE, 2018. https://doi.org/10.1109/IIAI-AAI.2018.00060

[14] Fraenkel, J. R., & Wallen, N. E. (1996). How to design and evaluate research in education (3rd ed.). McGraw-Hill.

[15] Gay, L. R., & Diehl, P. L. (1992). Research methods for business and management. Macmillan.

[16] Noah, S. A. M. (2002). Sample size determination. In Handbook of statistics (Vol. 22, pp. 631-666). Elsevier.

[17] O'Malley, A. James, Sharon-Lise T. Normand, and Richard E. Kuntz. "Sample size calculation for a historically controlled clinical trial with adjustment for covariates." Journal of biopharmaceutical statistics 12, no. 2 (2002): 227-247. https://doi.org/10.1081/BIP-120015745

[18] Russell, Michael. *Systemic racism and educational measurement: Confronting injustice in testing, assessment, and beyond*. Routledge, 2023.

[19] Karram, Omar. "The Role of Computer Games in Teaching Object-Oriented Programming in High Schools-Code Combat as a Game Approach." *WSEAS Transactions on Advances in Engineering Education 18* (2021): 37-46. https://doi.org/10.37394/232010.2021.18.4

[20] Aedo Lopez, Marco, Elizabeth Vidal Duarte, Eveling Castro Gutierrez, and Alfredo Paz Valderrama. "Teaching Abstraction, Function and Reuse in the first class of CS1: A Lightbot Experience." In Proceedings of the 2016 ACM Conference on Innovation and Technology in Computer Science Education, pp. 256-257. 2016. https://doi.org/10.1145/2899415.2925505

[21] Rose, Simon, Jacob Habgood, and Tim Jay. "An exploration of the role of visual programming tools in the development of young children's computational thinking." *Electronic journal of e-learning 15*, no. 4 (2017): 297-309. https://doi.org/10.34190/ejel.15.4.2368

[22] Demir, Ö., B. TAŞKIN, and S. S. Seferoğlu. "Selecting Suitable COTS Games in STEAM Game Store to Promote Intrinsic Motivation and Computational Thinking Skills." *Journal of Educational Technology 17*, no. 2 (2020). https://doi.org/10.26634/jet.17.2.17138

[23] Lindberg, Renny SN, Teemu H. Laine, and Lassi Haaranen. "Gamifying programming education in K-12: A review of programming curricula in seven countries and programming games." *British Journal of Educational Technology 50*, no. 4 (2019): 1979-1995. https://doi.org/10.1111/bjet.12685

[24] Díaz, Jaime, Jeferson Arango Lopez, Samuel Sepúlveda, Gabriel Mauricio Ramírez Villegas, Danay Ahumada, and Fernando Moreira. "Evaluating aspects of usability in video game-based programming learning platforms." *Procedia Computer Science 181* (2021): 247-254. https://doi.org/10.1016/j.procs.2021.01.141

[25] Derus, S. R. M., and AZ Mohamad Ali. "Difficulties in learning programming: Views of students." *In 1st International Conference on Current Issues in Education (ICCIE 2012),* pp. 74-79. 2012.

[26] Lakens, Daniel. "Sample size justification." Collabra: Psychology 8, no. 1 (2022): 33267.

[27] Chiu, Po Chan, Melvin Jangga Rupitan, King Kuok Kuok, Hamizan Sharbini, Noor Hazlini Borhan, and Alvin Yeo. "The Effects of Gamification in Space Exploration Learning." Journal of Advanced Research in Applied Sciences and Engineering Technology (2024): 265-274.https://doi.org/10.37934/araset.59.1.265274

[28] Hashim, Najiah Hanim, Nor Omaima Harun, Nur Asma Ariffin, and Nurul Ain Chua Abdullah. "Gamification using Board Game Approach in Science Education-A Systematic Review." Journal of Advanced Research in Applied Sciences and Engineering Technology 33, no. 3 (2023): 73-85. https://doi.org/10.37934/araset.33.3.7385

[29] Hashim, Najiah Hanim, Nur Asma Ariffin, Nurul Ain Chua Abdullah, and Nor Omaima Harun. "Using BioBoard-G: A Board Game for Enhancing Understanding of Cell Division for Secondary School." Journal of Advanced Research in Applied Sciences and Engineering Technology 38, no. 2 (2024): 83-94. https://doi.org/10.37934/araset.38.2.8394

[30] Ramlan, Nadiah, Norasikin Fabil, and Zawawi Ismail. "Motivation Elements in Game-Based Learning (GBL) for Tajweed Learning." Journal of Advanced Research in Applied Sciences and Engineering Technology 54, no. 2 (2025): 20-31. https://doi.org/10.37934/araset.54.2.2031

[31] Hendrick, Ally Dian, Amelia Jati Robert Jupit, and A. Imran Nordin. "Empowering Youth through Play: Promoting Awareness of Sexual Grooming among Schoolchildren through Game-based Learning." Journal of Advanced Research in Applied Sciences and Engineering Technology 51, no. 2 (2025): 34-44. https://doi.org/10.37934/araset.51.2.3444

[32] Sabri, Norlina Mohd, Hasiah Mohamed, Goh Ying Soon, Yau'mee Hayati, and Mohamed Yusof. "Usability analysis for ‘Yipin’courseware based on quantitative approach." In *2012 7th International Conference on Computing and Convergence Technology (ICCCT)*, pp. 187-192. IEEE, 2012.
[33] Martin, William E., and Krista D. Bridgmon. *Quantitative and statistical research methods: From hypothesis to results*. John Wiley & Sons, 2012.