

A design of gamification Artificial Intelligence coding activities to improve cognitive skills among primary students

Nurul Alin Kamarudin, Raja Rina Raja Ikram*, Farah Nadia Azman, Lizawati Salahuddin

Fakulti Teknologi Maklumat & Telekomunikasi, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

*Corresponding e-mail: raja.rina@utem.edu.my

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ABSTRACT – This paper proposed a design of gamification Artificial Intelligence coding activities to primary school students aged 7 to 12 years. The coding activities are aligned with cognitive skills, which can help students stay motivated to master the basics of coding. Interviews with gamification experts and one of the Computer Science Lecturer from Universiti Teknikal Malaysia Melaka (UTeM) were conducted to obtain feedback and suggestions

1. INTRODUCTION

Coding with Artificial Intelligence (AI) can help student learn coding creatively by giving them alternative ideas that lead to the creation of new solutions. Critical thinking is best acquired at the developmental stage of a person, that is, during childhood [1]. AI is defined as the science and engineering of problem-solving with technological innovations such as machine learning and neural networks and it also represents the integration of science, technology, engineering, and mathematics (STEM), which has been highlighted in the current technology-empowered society [2].

This paper proposed a design of gamification AI coding activities that maps to human cognitive skills using AI block-based coding and gamification elements. Three main issues addressed in this study are gamification element that will enhance the learning experience and motivate primary students. Next, the suggestions for strengthening the link between coding activities and gamification elements and what gamification elements should be included that ensures active participation of students.

2. RELATED WORK

An educational setting can be made more engaging by introducing gaming elements [3]. The implementation of the gamification approach is not limited to the integration of game elements into the learning context, it must entail setting targeted learning aims, employing suitable game mechanics, and comprehending the target audience [4].

Structural gamification is the use of game elements while staying on track with learning objectives, such as adding elements such as point scoring, peer competition, teamwork, score tables to drive engagement. Gamification involves making changes to the material, such as adding storylines, challenges, curiosity, riddles, and characters [5]. Gamification contributes to greater improvements in subject comprehension, diligence, and motivation among students [6].

Cognitive skills are mental skills that are used in the process of learning new information, solving problems, and determining the best solution to a problem. Benjamin S. Bloom categorizes cognitive abilities into six hierarchically structured levels: knowledge, comprehension, application, analysis, synthesis, and judgements [7]. The students' exposure to programming can have a significant influence on cognitive abilities such as creative thinking, arithmetic skills, and reasoning [8]. Coding activities can improve students' skills to solve problems, do higher cognitive tasks, and grasp human behaviour [9].

3. METHODOLOGY

Figure 1 The process flow for design of proposed gamification coding activities. In the preliminary study phase, the problem statement is addressed and previous studies from articles published between 2018 and 2022 are chosen to support it. In the analysis phase, literature review was conducted on the topics of coding with gamification and cognitive skills. Lastly, an interview with a gamification subject matter expert was conducted to obtain feedback and suggestion on the proposed gamification coding activities. The feedback from subject matter expert was used to improve the design of proposed gamification activities.

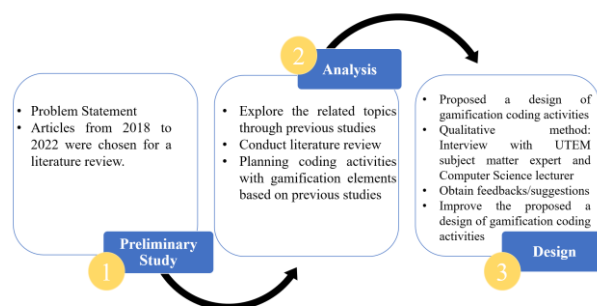


Figure 1 The process flow for design of proposed gamification coding activities.

4. RESULTS

According to the gamification subject matter expert, coding activities derived from the literature review can enhance student learning and motivate students. The coding activities from Figure 2 has been improved by detailing which activities have gamification elements, as illustrated in Figure 3. In response to the last issues, the coding activities can be improved further by including more diverse game aspects in each activity, such as a

score, timer for students to compare their marks with their peers.

Coding element	Data organization	Algorithm	Coding activities	Practices
Cognitive skill				
Remembering	Use Numbers	Events, sequences	A2: Arithmetic operator A2-a: Calculating Grades A3: Variables	Experimenting by Imitation
Understanding	Make a Variable	Event, Loops/conditionals	A1: Card Animation A1-a: Dialogue with Tobi A1-b: Play a sound A1-c: Change Sprite Size A1-d: Change colour A1-e: Make Tobo Walk A3-a: Dialogue with two Sprites A4: If else A6: Object Recognition A7: Human Body Detection A8: Face Recognition A9: Speech Recognition A10: Machine Learning: Face mask detection	Experimenting and Iterating
Applying	Make a block	Event, Loops/conditionals/sensing	A3-b: Sum of two numbers A4-a: Calculating Grades A5: Level up scoring game A5-a: Chick game	Abstracting and Modularizing
Analysing	Flexible application trigger, control, and interaction modules		A8-a: Face Expression A8-b: Face filters	Testing and debugging
Evaluating			A7-a: Gesture-controlled space battle game A10-b: Driver's Hand Signals A10-c: Yoga Activity A-10-d: Apple game	Reusing and Remixing
Creating				

Figure 2 Table that maps cognitive skills to coding activities, which has been adapted from [9] by adding the coding activities.

Each coding activity is represented in Figure 3. For example, A3 has a Narrative Story that allows the student to engage with many Sprites. Game Levels in A5 can be used to indicate the current game level. In A7 and A10, timers and score feedback elements are utilized to track a student's progress and act as indicators for moving to the next level.

Coding Activities	Description
A1: Card Animation	A1-a: Make the Sprite communicate by using conversation. A1-b: To make the Sprite sound, add, choose, or create their own sound from Pictoblox. A1-c: Change the size of the sprites to make them smaller or larger. A1-d: Change the Sprite's color, as well as the backdrop. A1-e: Try out the loop function
A2: Arithmetic operator	Students learn operators like greater than, equal to, and smaller than. Then combining the arithmetic operator with variables coding
A3: Variables	The student will learn how to create a dialogue using variables. A3-a. The student will learn how to make narrative story between many sprites A3-b. Calculate the sum of the values between the two input variables. Variables and operators are used in combination.
A4: If else	The student will create a dialogue that will need them to fill in the blanks. The student attempts to input the correct or wrong answer, and Sprite responds with whether the value entered is correct. A4-a. Using the if else and arithmetic operators, create a subject marks grade where the Sprite will show the grade if the student enters the subject marks.
A5: Game	Make a level up scoring game to catch the star and apple by combining the coding learned.
A6: Object Recognition	Use software extensions and combination with the concepts of variables, loops, and operators.
A7: Human Body Detection	A7-a. Control the game using fingers with score and timer. The student will be informed of their progress with feedback points, such as whether they have reached level 1 or the following level. Combination with variables, loops, and operators coding
A8: Face Recognition	A8-a. Using a computer to learn human expression. Combination with the loops concept A8-b. Create a filter such as crown, spectacles, or animal
A9: Speech Recognition	The student will attempt to switch on or off the light bulb using voice. Use combination with the concepts of loops, and operators
A10: Machine Learning	The student will teach the computer to identify between those who are wearing masks and those who are not. Combination with the loops concept A10-b: Control the movement of the vehicles using hand. When the vehicles arrive at their destination, as well as when they arrive at the game's point to point, the student will receive a score A10-c: When the student does the correct yoga pose, their score will be increased. A10-d: The student will control the Sprite using their body. When the body turn left or right to collect apples, the score increase

Figure 3 Each proposed coding activity is explained.

5. CONCLUSION

The utilization of block-based coding can help the student who have never learnt to get a grasp of AI in the simplest way. Gamification allows students to increase their attention span, develop their creativity, and meet their cognitive needs. It encourages experimentation, discovery, learning through mistakes, comprehension and repetition [10]. Gamification AI coding activities might be an effective way to enhance cognitive skill by helping students to learn faster and apply what they know.

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