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Time Argonaut: A Game to Practice Telling Time in English for Rural School Students

Annavelle M. Dicky, Bong S. Fen, Harrison K.K.S, Hephzibah R. Sangan, Nadia Raca & Ng, K. J*.
Faculty of Cognitive Sciences & Human Development, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak.

ABSTRACT

This article describes the design and development of an educational game for primary school students in a rural area of Sarawak. Students from rural Sarawak areas face several challenges contributing to demotivation when learning Mathematics and Sciences, including poor English proficiency, limited accessibility to the internet and gadgets, lack of genuine opportunities to practice English in real life, and teachers' English proficiency. In this study, a gamified learning module was designed to teach about time and tailored to students' needs. 25 Primary One students from a rural Baram, Sarawak school were recruited through crowdsourced convenience sampling for the study. Playday was conducted with the students to collect their feedback, and results were obtained from observation and feedback. Results from the playday showed that the students perceived that the game was fun and motivated them to learn about clock reading and time, engaging them to collaborate in learning and promoting teamwork in learning. The integration of gamification in teaching creates a meaningful learning process for students. It is recommended to examine the effectiveness of gamification at the secondary school level in future studies and explore the effectiveness of different game designs and game mechanisms.

Keywords: mathematics, rural schools, collaborative learning, primary school

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Email address: ngkiajee@gmail.com (Ng, K.J)
*Corresponding author
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1 INTRODUCTION

Mathematics literacy is crucial for daily life, for instance, counting money, numbering, measuring, weighing, and telling time. Among these mathematical skills, the ability to tell time is one of the most critical common skills we apply daily, and it allows us to be on time in executing our daily routine, such as going to school, working, mealtime, and bedtime.

According to Malaysia' Mathematics academic syllabus, students must learn about the concept of time in their Primary 1. Students are expected to be able to tell time using analogue and digital clocks, name the days in a week, and name the months (Ministry of Education Malaysia, 2015). As our country moves towards globalization, The Ministry of Education of Malaysia has taken a bold step in re-adopting the Teaching and Learning of Science and Mathematics in English (or by its Malay acronym, PPSMI) in 2021. Despite the support from society, implementing the policy remains contentious due to several reasons, including the contention that PPSMI will increase the difficulty for rural students to understand the learning contents (Othman et al., 2020).

Focusing on rural elementary students' learning difficulties in Mathematics, the team has interviewed the teachers from a rural primary school located at Baram, Sarawak, to understand the learning issues that the students from the school face. From the interview with the schoolteachers, the researchers found that the teachers find it challenging to teach Year 1 Mathematics, particularly the concept of time, in which the students are facing learning difficulties due to language barriers and difficulties in reading analogue clocks. Based on the aforementioned learning difficulties, the team has adopted a gamification approach to minimize the learning gaps and conducted the playday in November 2022.

Two central problems are identified, which are (a) students are having difficulties in spelling and writing the name of the week and the name of the month in English, and (b) students are having difficulties reading analogue clocks. By applying gamification as a support tool in learning Mathematics, precisely the concept of time, the team hopes to provide a more engaging and practical learning experience for the students while improving their academic performance.

2 BACKGROUND

As defined by the Department of Statistics Malaysia (2021), rural areas in Malaysia have a population of fewer than 10,000 people aged 15 years old and above. Schools in Malaysia are distinctively categorized into urban and rural. It is reported that high propositions of rural schools performed poorer than the urban school (Ministry of Education, 2013) due to several reasons faced by the teachers and students in rural areas. Challenges faced by teachers in rural schools in Malaysia include limited access to the internet and Wi-Fi, the difficulty level of the subjects, the infrastructure of the schools, and the resources for teaching materials in the schools (Perman, 2021). Besides, the difficulties of learning and teaching the English language and subjects taught in English (mainly Mathematics and Sciences) in rural areas are also widely acknowledged. It is because students from rural areas are "less likely to be highly motivated or have parents who speak English compared to their urban counterparts" (Cambridge English, 2013, p. 17). It could cause

distress to the teachers when students from rural schools are demotivated in learning, have limited genuine opportunities to use English, and do not need to use English in daily contexts. As a result, extra time is needed to aid the students in grasping the knowledge better, such as translating the teaching contents to their native language while teaching them to answer the test in English (Ab Aziz, 2019). Other factors that contribute to the difficulties in teaching in rural areas include the English proficiency of the teachers, constant changes in educational policy, parents' English proficiency, and the technical support available (Renganathan, 2021).

Since 2021, the Malaysian education ministry has implemented the teaching and learning of Science and Mathematics in English, also known by its Malay acronym, PPSMI, to improve English proficiency among primary and secondary school students in Malaysia while they learn the content. While there are people who are in favour of the enactment of this policy, its effects on students remain contentious. Chan and Tan (2006) commented that using English in teaching Mathematics and Sciences in Malaysia could be viewed as a distinct disadvantage to the rural schools that are mostly populated with Indigenous people. Many people negatively perceive PPSMI, given that students from rural areas may find learning Science and Mathematics in a second language overly challenging, and many teachers are not trained to deliver classes using English as a teaching medium (Selamat et al., 2010). From teachers' perspective, using English as a teaching medium can be an issue as many students struggle to understand the teaching content when it is explained in English (Yahaya et al., 2009).

In Malaysia, Mathematics is a core subject in all primary schools. However, in teaching and learning activities, the Ministry of Education (MOE) reformed the national curriculum and learning approach for teachers to use computer support tools for students with poor mathematics skills (Ministry of Education Malaysia, 2013). Teachers can use technology resources such as educational computer games to make STEM learning more appealing than conventional strategies. Previous research has proven games and game-like formations contribute to education in Mathematics, especially for primary and secondary school students (Kharuddina & Azid, 2021; Abidin et al., 2019; Izzati Syahir et al., 2020). However, instructional games are essential for all learning profiles since the gamification learning approach helps students to build on the learning concept that is easier to understand (Ruiperez-Valiente et al., 2020).

3 METHODS & MATERIALS

In this study, the game design thinking approach is adopted. This approach is extended from design thinking (explained in the next section) and involves using play and gameplay in the design process (Minoi et al., 2019). As shown in Figure 1, the team went through five stages in designing the games: Empathize, Define, Ideate, Prototype, and Test. Additional sub-stages under the five main stages in Game Design Thinking are geared towards designing a game, including the game mechanism and strategies, the prototypes, and how to embed the learning contents into the game.

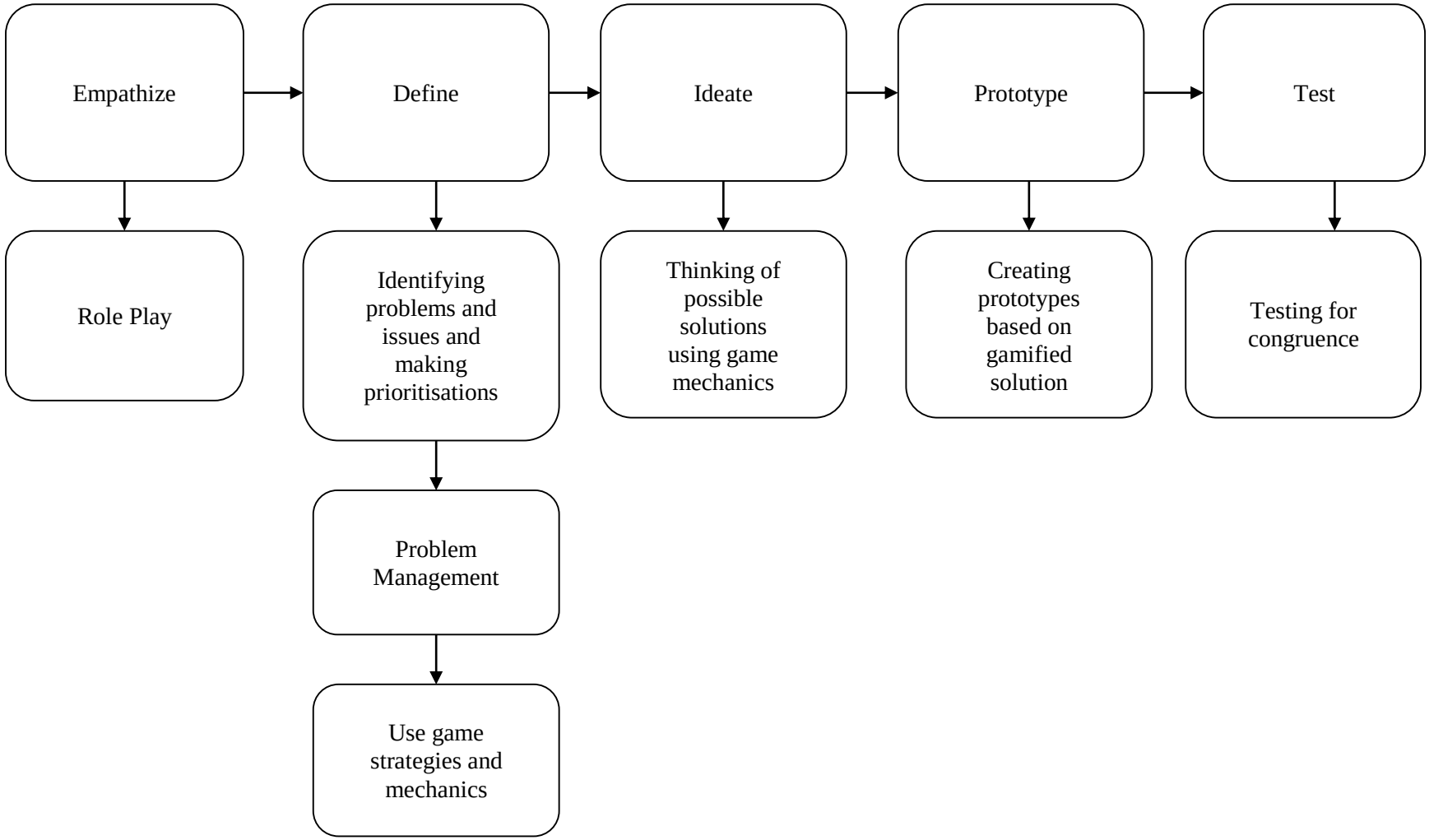

Figure 1. Game design thinking (Source: Minoi et al., 2019).

This study is a developmental research design in motivating Primary One students in a rural school to learn time, a topic in Mathematics that is appraised as challenging to them in aspects of language used, identifying the correct order of days, and reading time. Quasi-experimental designs were used to design and develop the learning materials. Hence, only five students are selected based on their performance in each class, known as *Pentaksiran Bilik Darja*h. The data of *Pentaksiran Bilik Darja*h was taken from their subject teacher of two different classes in the same school. *Pentaksiran Bilik Darjah* is a continuous assessment after the learning session (Ministry of Education Malaysia, n.d.) Diethelm (2019) stated that Design Thinking's purpose is shifting unfavourable conditions like "unfulfilled yearnings, hopes, and desires of people in time and place" to satisfactory conditions. This is known as crowdsourced convenience sampling. Game Design Thinking approach is chosen in the process of development as it promotes a systematic process in stages such as Empathize, Define, Ideate, Prototype and Test. In addition, Frugal elements are also used in the developing process known as Prototype. The study of Mallibhat et al. (2022), which also integrated Frugal elements, mentioned that "Prototyping becomes much more significant in the case of mechatronics products, towards finding flaws, reducing waste and usability testing early." It shows that prototyping is one of the critical elements in creating more straightforward and intelligent systems. Therefore, Iterative Prototype, a Frugal element, was applied in developing the learning materials as this element boosts the student's ability to reason, understand underlying concepts and find solutions to complex problems, in this case, the subject of Mathematics. Below is the type of Frugal card of the element used.

Figure 2. Frugal education card: prototype and its explanation.

Table 1. The development process of design thinking.

Stages	Explanation
Empathize	Identification of problems in Mathematics among Year One students was made by interviewing the subject teacher and observing and analysing the students' work.
Define	A few problems were identified from the students' point of view, such as being unable to relate the correct activity with the correct time, unable to form the correct order of the day and misreading the time of the day. Later, the problems are narrowed down to only one main problem: the difficulty in learning time in Mathematics in English.
Ideate	Ideates were drafted and discussed to solve the identified problem among researchers. The solution towards the main problem was to create hybrid learning by using technology tools such as Genially, which is accessible with or without an internet connection and hands-activity. It is because the school was in a rural area where non-accessible to the internet connection. Therefore, two types of learning games were created.
Prototype	The researchers created two types of learning games that included a selected Frugal element known as an Iterative Prototype. **Learning game 1: Create your clock** The task initiates the students' understanding of the learning topic of the day. It is hands-on work for the students. At the same time, the students also used the clock as their reference in learning the second game. **Learning game 2: The time Argonaut** The classic 'snake and ladder' board game inspires the learning game. The game aims to reach and complete as many "task points" as possible. Several "Task" and "Power-Up" features are pictured on the board. In this game, the theme and design were inspired by the "Among Us" game. This makes this game more interesting because the "Among Us" game is one of the most well-known and played by children and young adults. This Time Argonaut game, however, is very accessible offline.
Test / Evaluation	In this stage, the students are divided into 'Imposter' and 'Crew'. Before that game, the learners are introduced to the learning topic by having a casual conversation with the

	teacher like "What is the day today", "What day is your Physical Education class?", "What did you think of the weather last night?", "What time is your recess time?" for five minutes. The learning session was conducted for an hour. **For the first 15 minutes:** ● The students were to revise back what they had learned and know about time by answering questions from the teacher. ● The pupils were given a box containing a paper plate, glue, scissors, and numbers for the student to let each individual create their Clock face in 10 minutes. In the next learning phase, the students attempt The Time Argonaut game. The students played the game for 40 minutes. The students were given dice to take turns and a scoreboard to keep track of the points. The students complete the task correctly and more, Wins. **The last five minutes:** The students were asked to provide feedback on the learning materials and the learning effectiveness using the technology tool, Genially.
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4 FINDINGS

During Play Day, twenty-five primary one (7 years old) students participated in playing the Time Argonaut. They were divided into two (2) teams; Crew and Imposter. The same questions and tasks were given to both teams, and one (1) teacher monitored them. The students were given sets of power cards as well to aid them during gameplay. The game was conducted in hybrid mode, with the gameboard being online and task completion being physical. The gameboard was inspired by the famous game Among Us, which is familiar to children and young adults.

Figure 3. Students are grouped into "imposter" on the left and "crew" on the right.

Figure 4. Students collaborate to solve the questions.

Table 2. Scores of the students in the activity.

Questions	Crew	Imposter
Q1: Can you please, tell me how to spell m-i-n-u-t-e?	1	1
Q2: Create a clock face	1	1
Q3: Rearrange the days of the week	1	1
Q4: How many days in a week?	1	1
Q5: What is the time you see in this picture?	1	
Q6: Write the clock	1	
Q7: Sing the days song	1	1
Q8: Trace the number of the clock and say it out loud		1
Q9: Ask your friend what activity was conducted at the particular time		
Q10: Please paste the right time with the suitable activity		

The scores were used to evaluate the students' understanding of the taught topic, which is time. The students were observed to display basic comprehension and understanding of the topic and instructions the teacher gave during the teaching period and Play Day, respectively. The teacher, however, had to use both English and Bahasa Melayu when giving instructions, as the students were more fluent in the latter. The score in Table 1. shows that the students mastered the basic of the topic, as both teams scored more than half of the questions.

Based on the observation, the students also collaborated among team members as everyone completed the tasks (questions the researchers set) and encouraged one another. Self-directed was also observed among students when they could navigate and move their respective avatars on the gameboard.

During the Play Day, the students were observed to be excited when playing the game and would do their best to gain a point in a form of a Star. Once they achieved a point, a Star will be given to them, which they would paste on the scoreboard. The students demonstrated extrinsic motivation, motivating them to complete the task to win.

5 DISCUSSION

Gamification in learning offers engaging activities that increase motivation and enhance collaborative activity. Students that motivated are more likely to participate actively in group activity to share their ideas and knowledge than in conventional learning. Based on the observation, the same group of students are more likely to discuss together and provide advice to peers to complete the learning task. It can create a sense of meaningfulness and relevance, encouraging students to work together. According to Nurutdinova et al. (2021), gamification

allows non-linguistic students to develop their vocabulary and grammar skills. The engaging gamification element ensures a positive communication activity occurs in the learning activity that leads to collaboration and communication among students. Another two quasi-experimental studies also showed a similar result regarding gamification in promoting collaboration among primary-grade students. Both studies showed that the gamification approach significantly positively affected students' collaboration skills compared to the traditional approach (Chou et al., 2020; Cheah et al., 2021). Lu et al. (2021) also reviewed forty-five studies regarding gamification and collaboration learning in primary education; they concluded that gamification could positively affect students' social collaboration activities, such as working together, sharing ideas, and learning from one another.

Besides, gamification in this mathematics learning module prompts students to work together to solve problems. Based on the playday observation, students learn from each other by sharing their knowledge and skills and collaborating with peers to tackle challenges during the learning activity. Students work together and discuss with their peers how to complete the sub-task in game 2 (Time Argonaut) to accomplish the learning task. Moreover, students become more actively engaged in the learning activity with their team members. More interaction and collaboration occur as every team member engages in the activity to complete the task together. From the observation, some students tried to advise other team members playing in the Time Argonaut session. By working together to achieve a common goal, students can develop critical collaborative skills, such as communication and teamwork. According to Wang et al. (2018), gamification learning has been found to positively impact collaborative learning, promoting teamwork activity and the development of critical collaborative skills such as communication and problem-solving. Overall, gamification learning can enhance collaborative learning by creating a fun and engaging learning environment, promoting teamwork and communication, and providing students with meaningful feedback.

The study has some limitations that may impact the validity of the results. First, it only focuses on a specific group of students, 25 Year 1 students. Since the readiness for learning and competencies of students from other schools and areas may differ, the results cannot represent the readiness for learning of students from other areas. Additionally, there are differences in the level of understanding of the instructions and the English proficiency, possibly due to the neglect of identifying the English proficiency among the students before Play Day.

Besides, our study also has some limitations regarding the game mechanism. In our gameplay, we provide the rewards of giving a mark to the teams who correctly answered the questions proposed to them. After that, if the team could not answer the question, the question would be proposed to the opponent team, and if the opponent team managed to answer it correctly, the marks would be counted as the opponent team. Although collaboration does involve this process, we realize that it can be enhanced by increasing the flexibility of the game rules, especially the reward. We recommended increasing the rewards for opponents who correctly answered the questions to differ the rewards level in two conditions. For example, we can increase the reward to two marks for the opponent team who correctly answers the question to increase the desire and attention of the opponent team even if it is not their part of the involvement.

6 CONCLUSION

This game was created to aid in students' interactive learning of mathematics and to aid in the explanation of mathematical concepts by teachers. Text, visuals, sound, and animation are just a few multimedia features that make learning math more engaging for students. The frugal element of prototyping is integrated into designing the games to ensure that the outcome can be rapidly assessed and refined based on the feedback of the users, in which the materials used are low-cost and technology-based. According to the findings, the game mechanism of this game needs to be improved, and there needs to be more internal animation generated that offers substantive explanations so the learner may comprehend more fully. The results of this study show that gamification is a useful pedagogical tool for giving students instruction tailored to their needs. Gamification can both teach and reinforce previously taught concepts while engaging students (Rabah et al., 2018). It gives teachers a better chance to tailor the educational experience for each student. Students can see their progress with the idea being taught, which is one of the key advantages of gamification in the learning process. Thanks to this, students will benefit from knowing more about their progress during the educational process. Additionally, it enables students to track their advancement on specified assignments, which motivates them.

Students' attitudes toward problem-solving abilities can be improved using gamification in education and the development of fundamental numeracy skills, ultimately improving their overall mathematics performance. It cannot be overstated that gamification, which is more student-centred, represents a constructivist approach to learning. It opens the possibility of personalized learning and makes it much simpler to implement differentiated training. Gamification enables students to engage with mathematical concepts more interactive and enjoyable manner, which helps them build their critical thinking skills and increase their confidence in their abilities. However, this study's math content only reaches the primary school level. Further study that extends the application of gamification to the secondary school level is needed. It is recommended to explore the effectiveness of different game designs and game mechanisms to identify the most effective gamified teaching content for Mathematics subject for Year 1 students.

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