INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 12, Issue 3, (2023) E-ISSN: 2226-6348

Game On: Designing and Analysing an RPG Educational Game for Compilers Algorithm Understanding in the Metaverse

Fadzlin Ahmadon, Hajar Izzati Mohd Ghazalli, Anis Afiqah Sharip

Universiti Teknologi MARA Melaka, Malaysia

Corresponding Author Email: hajarizzati@uitm.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARPED/v12-i3/19160 DOI:10.6007/IJARPED/v12-i3/19160

Published Online: 19 September, 2023

Abstract

This paper explores the design, implementation, and evaluation of an educational game in the context of computer science education, using a Role-Playing Game (RPG) format and deploying it through a metaverse platform. Although gamification and game-based learning have shown promise in raising student motivation and engagement, the integration of the metaverse into these educational games has yet to be fully explored. This study fills this gap by describing the development of an RPG educational game, with a particular emphasis on the compilers design unit of a Computer Science course. The game incorporates educational elements alongside gameplay components to capitalize on the inherent motivation that games inspire. This study explores the feasibility of using widely available platforms like Gather and Google Docs Editor to develop interactive and engaging learning experiences, drawing on the literature on games, play, motivation, and the potential of the metaverse in education. Additionally, the research seeks to analyse student feedback through thematic analysis, providing insights into the utility and educational value of the game. This study contributes to the educational game design field by investigating the use of metaverse platforms for educational game design and evaluating students' opinions. It also offers advice for educators and instructional designers in improving online learning experiences.

Keywords: Role-Playing Game, RPG, Educational Game, Gamification, Game-Based Learning, Metaverse, Computer Science Education, Thematic Analysis, Engagement, Motivation, Immersive Learning.

Introduction

Traditional ways of learning could be changed by educational games, particularly those with role-playing elements, which encourage critical thinking, problem-solving, and teamwork through immersive narratives. However, more research is required to see how well these games may be incorporated into contemporary educational technology. Our research addresses this pressing need in education. In a time when virtual learning environments and digital tools rule the classroom, educators are always looking for new and creative ways to get students involved and promote active learning. The need for dynamic and interactive

learning systems was highlighted by the COVID-19 epidemic, which accelerated the transition to online and blended learning. In this work, we investigate how RPG-based learning might be used to better meet these changing needs for education and improve the quality of learning for students—especially when combined with platforms such as Gather. Our work enriches the body of knowledge in education by revealing the pedagogical advantages of immersive, narrative-driven experiences. Additionally, it offers helpful advice on how to use Gather and Google Docs Editors for game-based learning in the metaverse that can be adjusted to a variety of educational settings. Multiple parties may benefit from our research including policymakers that may make well-informed decisions on technology integration, educators that can acquire new insights into motivating and engaging students, and educational institutions that can enhance their online learning environments. This paper details our research journey in designing and implementing an RPG-based class activity on the metaverse, and assessing early feedback through thematic analysis. Through investigating the connections between game-based learning, educational technology, and user experience, our research offers significant perspectives on effective teaching methodologies.

A. Background and Motivation

Numerous studies have highlighted the potential of gamification and game-based learning to enhance student motivation, engagement, and learning outcomes (Gee, 2003; Kebritchi et al., 2010). However, research into utilizing the benefits of the metaverse on these educational games is still insufficient. While there are numerous metaverse platforms accessible for use today, there is a gap in comprehending the potential and current adoption of these platforms within a pedagogical context. This study fills that void by detailing the design, development, and evaluation of an RPG educational game for teaching a computer science topic within a metaverse platform.

The game designed and implemented in this research combines the elements of gameplay, such as problem-solving tasks and progression through levels or maps, through an RPG-based class activity. The game implemented in this study aimed to tap into the intrinsic motivation and enjoyment that games often evoke (Dicheva et al., 2015). The background and motivation for this study draw upon relevant literature on the intersection of games, play, and motivation in the context of learning, and the potential of metaverse in enhancing collaborative learning, experiential activities, and dynamic environments in an immersive simulation.

According to theories of game-based learning, the inherent characteristics of games, such as challenge, autonomy, and immediate feedback, can foster a sense of flow and promote deep engagement with the learning material (Connolly et al., 2012; Denny, 2013). The topic chosen for the design and development of this game comes from a Computer Science course on compilers design. Specifically, the section under focus has to do with finding the selection sets of a Context-Free Grammar where students need to solve a series of 12 steps, connected tasks (Bergmann, 2017). This task-oriented nature of the activity provided clear objectives and incremental goals, mirroring the structure commonly found in successful games.

Additionally, the immersive and narrative-driven nature of the RPG-based activity aligned with research on the power of storytelling and fantasy themes to increase engagement, motivation, and interest in learning (Ike et al., 2021; Luo et al., 2021; Mehm et al., 2013). By placing the learning content within a fantasy world where students played the role of heroes on a quest to save a princess, the activity aimed to create a compelling narrative framework that could enhance students' motivation and willingness to invest effort in the learning process.

Finally, the access to a virtual space as provided by metaverse platforms has been deemed fitting for a platform to implement game-based learning. Research highlighted enhanced engagement, greater collaboration and social interaction, and high level of interest, enjoyment, and satisfaction with the implementation of game-based learning on metaverse platforms (Kaur et al., 2023; Lee, 2023).

B. Research Objectives

The research objectives of this study were two-fold. Firstly, the study aimed to investigate the feasibility of designing and implementing an educational game using platforms available to educators, with a specific focus on the metaverse platform Gather and office productivity suite Google Docs Editor. The objective was to assess the practicality and effectiveness of utilizing these platforms for creating engaging and interactive learning experiences in an online environment.

Secondly this research aimed to demonstrate the evaluation of this game in class and analyse feedbacks given by students through thematic analysis. Thematic analysis enables a thorough examination of the feedback data (Braun & Clarke, 2006), and can be applied to various forms of qualitative data (Burgess & Jones, 2017). Researchers can acquire an in-depth understanding of the various elements of the game being discussed by participants by identifying and evaluating themes in the feedback (Burgess & Jones, 2017; Jones et al., 2023).

C. Significance of the Study

Through these research objectives, the study aimed to contribute to the field of educational game design by exploring the feasibility of leveraging widely accessible platforms of both metaverse and productivity suites and assessing students' impressions of the developed game. The findings of this study would provide valuable insights for educators and instructional designers seeking to create engaging and user-friendly educational games using accessible tools and the metaverse, thereby enhancing the learning experience for students in online environments.

1. Literature Review

This literature review examines relevant concepts and research related to this paper's focus on designing and implementing an educational game using platforms available to educators, specifically Google Docs Editors and Gather. It explores the role of games, play, and motivation in learning, highlighting their potential to engage and motivate learners. The review delves into the use of Role-Playing Games (RPGs) and discusses the suitability of different platforms for creating educational games. It also emphasizes the importance of incorporating immersive and narrative-driven elements in educational games and conducting usability evaluations to ensure a user-friendly experience. By reviewing existing research in these areas, this section provides a solid understanding of the theoretical foundations and practical considerations for developing educational games.

A. Games, Play and Motivation in Learning

Games, play, and motivation are key elements that have been widely explored in the field of learning and education. Games, in their various forms, are recognized for their potential to engage and motivate learners. Research suggests that incorporating game elements into educational contexts can enhance students' interest, motivation, and overall learning outcomes (Connolly et al., 2012; Denny, 2013; Serrano, 2019). Games provide opportunities

for active participation, problem-solving, and decision-making, which promote a sense of autonomy and ownership over the learning process (Connolly et al., 2012; Denny, 2013).
Motivation plays a crucial role in the learning process as it influences students' engagement, persistence, and performance (Dicheva et al., 2015). Games have the potential to create a motivating learning environment by offering immediate feedback, engaging atmosphere and features that nudge users to actively process the educational content (Bodnar et al., 2016; Erhel & Jamet, 2013; Say & Bag, 2018). Additionally, the social aspects of games, such as collaboration, competition, and teamwork, can enhance motivation and promote a sense of belonging and community among learners (Barab et al., 2012).
By understanding the dynamics of games, play, and motivation in learning, educators can leverage these elements to create engaging and effective educational experiences. The incorporation of game-based approaches can enhance student motivation, promote active learning, and foster a positive learning environment. Therefore, exploring the relationship between games, play, and motivation in the context of educational game design is crucial for the development of engaging and impactful learning experiences. In the following sections, we will further explore the specific use of Role-Playing Games (RPGs) in education and the role they play in motivating and engaging learners.

B. Role-Playing Games in Education

Role-playing games (RPGs) is a promising medium for innovative and engaging pedagogical methods. This section examines how role-playings are used in educational settings, starting with their integration in regular classrooms and moving on to gamified role-playing and their use in online learning environments.

i. Role-Playing in Classrooms

Role-playing is a common method that is used in classroom. It is an active learning method that require greater students' involvement and dynamism in learning. Many classes have used role-playing to incorporate drama, games, simulations, and demonstrations of numerous real-life scenarios (Erturk, 2016). Numerous research has documented its application in teaching nursing, marketing, language, information technology, ethics, and biology among others (Bhattacharjee & Ghosh, 2013; Brown & Chidume, 2023; Erturk, 2016; Prince, 2006; Yavaşlar & Demirci, 2018).
Role-playing is used by educators to immerse students in learning by allowing them to take on different roles and perform scenarios related to the subject matter. Students are challenged to examine situations (Yavaşlar & Demirci, 2018), make decisions (Bhattacharjee & Ghosh, 2013), and explore many points of view (Bhattacharjee & Ghosh, 2013) using this strategy, which encourages critical thinking abilities. Role-playing also allow students to anticipate situations that might be faced in real-life, which allow them to have a better understanding of diverse scenarios and helps to reduce their anxiety (Prince, 2006).
Classroom role-playing also promotes collaborative learning since students work together to solve complicated problems within their given roles. This collaborative method fosters teamwork (Qiu et al., 2018), communication, and negotiation skills in students (Huertas-Valdivia, 2021), preparing them for real-world collaborative undertakings. Furthermore, role-playing improves students' public speaking and presentation skills (Sugito et al., 2017) by allowing them to express themselves as diverse personalities.
By incorporating role-playing into the traditional classroom environment, students are empowered to actively participate in their learning journey, bringing enthusiasm and

excitement into teachings (Lincoln, 2008). This strategy takes advantage of the immersive and experiential nature of this method, allowing students to interact with the topic beyond textbooks and lectures.

ii. RPG Educational Games

Role-playing is also employed in the field of gamification in education. Gamification is the technique of integrating game mechanics and components into the educational process in order to increase student motivation and engagement (Mee Mee et al., 2020). A specific type of gamification called role-playing games (RPGs) enables students to take on numerous roles and engage in a fictional world or situation. In role-playing game, players participate in narrative acting, make planned decisions, and undertake character development (Gatsakou et al., 2021). There are several ways RPG can be implemented, which are tabletop RPG using pen and paper, Live Action Role-Playing (LARP) and electronic media RPG (Gatsakou et al., 2021). Many courses exist that help educators to transform their syllabus into a playable RPG. RPG in education is augmented with the usage of technology. In this method, students can be engaged in role-play session that has been setup by instructors using online tools such as Skype (Cook et al., 2017). Educators have also developed RPG educational games for their classes using game authoring tools such as RPGMaker (Jiwo & Aini, 2023; SALOMÃO et al., 2018; Setiyani et al., 2021) and ARQS. Additionally, teachers have also gamified existing metaverse platforms such as Roblox, Second Life and Gather for an RPG experience with their students. Using these platforms, students chose avatars to represent themselves, travel the digital world and complete quests that are aligned with their learning objectives.

Findings on the advantages of using computer-based RPGs in education are numerous. Research reported positive discoveries such as increased engagement and enjoyment (Wang, 2020), well accepted by students and promoting active learning (Ferreira), increased motivation and learning performance (Chen & Ren, 2013; Setiyani et al., 2021), among many others. However, there are also some concerns that were raised which include potential challenges to students without appropriate instructions and guidelines (Wang, 2020), not catering to all learning styles, and requiring significant development time and resources (Mulyadi & Mat Zin, 2019).

C. Gamifying Metaverse Platforms for Education

Since the latest iteration of the Metaverse concept - a 'digital reality environment beyond physical reality' (Sarıtaş & Topraklıkoğlu, 2022), was introduced, educators have begun to consider implementation scenarios and goals for their educational materials. Research on Metaverse has also increased in popularity in the post-Covid-19 period (Tlili et al., 2022). Acceleration Studies Foundation (ASF) in its roadmap, categorised the metaverse into four different types which are Augmented reality, Lifelogging, Mirror world, and Virtual worlds (Bridges et al., 2007). Relevant to this research is the category of 'Virtual worlds', described as the metaverse that simulates an inner world. In this virtual world, users explore a space using their avatars (Samala et al., 2023). The avatars communicate with each other and achieve the goals that have been decided. Virtual worlds type Metaverse allow users to have immersive experiences and improve strategic and comprehensive thinking skills, and increase problem solving skills (Bridges et al., 2007; Kye et al., 2021). Most importantly, virtual worlds type Metaverse support collaboration and communication with peers. Example of virtual worlds include popular MMORPGs such as PUBG, DOTA2, Fortnite, social media platforms like

ZEPETO and Roblox, and virtual space platforms like Gather and Second Life (Kye et al., 2021; Park & Kim, 2022; Samala et al., 2023)

The category of metaverse best suited for a gameful experience is virtual worlds (Park & Kim, 2022). Several immersive experience experiments have been documented including a survival world game for promoting tourism using Roblox, and a maze world experience for luxury brands promotion using ZEPETO (Park & Kim, 2022). Virtual worlds type of metaverse has also been used by educators to enhance educational learning. In South Korea, the Ministry of Culture, Sports and Tourism installed a "virtual reality sports classrooms", and virtual reality technology has been used to allow physical education lessons to continue during fine dust and bad weather situations, teaching sports such as yoga and golf (Yu, 2022). Another paper documented the teaching of radiological anatomy using Second Life platform to medical students. Students interact with the virtual environment of Second Life which include interactive 3D environments, allowing them to visualize and contextualize complex concepts in radiological anatomy (Park & Kim, 2022).

In conclusion, the Metaverse holds immense potential for transforming education by providing immersive, interactive, and collaborative learning experiences. The next section of this paper will delve into the design and implementation of a computer science lesson using the Gather metaverse platform.

2. Findings and Results

Three activities were undertaken in the development of the research for this paper. These activities include design, implementation, and evaluation. In the design phase, exercises from chosen topics were mapped to the storyline and gameplay of an RPG. This involves careful matching of the step-by-step tasks students are expected to do with the missions and maps of the game. The second phase is implementing the completed design through available educational platforms. The platforms chosen are Gather, and Google Docs Editor. Once the construction of the game was completed, an evaluation session involving students were undertaken in which they were tasked to complete the mission of the RPG and answer questions to assess their experience.

A. Designing an RPG-based Computer Science Class Activity

The subject this activity is from is 'Principles of Compilers', a fundamental Computer Science course. There are two objectives of this activity, 1) finding selection sets of a Context-Free Grammar, and 2) extract the output from a given input string - two fundamental skills for compilers constructions. The algorithm in which the selection sets can be discovered is based on the description from the textbook of this course, Compiler Design written by Seth D. Bergmann (2017) and published by Rowan University. The book list down twelve interconnected steps that need to be undertaken to derive all the selection sets. Figure 1 shows the dependency graph from the information extracted from the book.

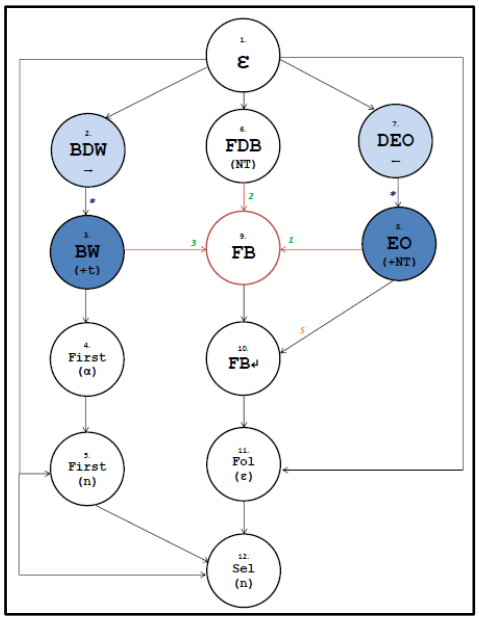

Figure 1: Dependency Graph in Algorithm for Finding Selection Sets

Adapted from Bergmann, 2017

Table 1 shows the descriptions of the steps in Figure 1 and its previous steps dependency. As displayed in this table, the workings of this algorithm require students to have a good understanding of each step as correct end results are reliant on accurate implementation of all the previous steps. In another word, the accuracy of subsequent steps can only be achieved if the previous steps are correctly derived.

Table 1

Algorithm to Find Selection Sets of Context-Free Grammar

Step	Activity	Details	Dependency
Step 1	ε	Find all nullable rules and nullable nonterminals	None
Step 2	BDW	Compute the relation Begins Directly With for each non-terminal	Step 1
Step 3	BW	Compute the relation Begins With	Step 2
Step 4	First (α)	Compute the set of terminals First(α) for each symbol α in the grammar	Step 3
Step 5	First (n)	Compute First of right side of each rule	Step 1, 4
Step 6	FDB	Compute the relation Is Followed Directly By	Step 1
Step 7	DEO	Compute the relation Is Direct End Of	Step 1
Step 8	EO	Compute the relation Is End Of	Step 7
Step 9	FB	Compute the relation Is Followed By	Step 3, 6, 8
Step 10	FB ↲	Extend the FB relation to include endmarker	Step 8, 9
Step 11	Fol (ε)	Compute the Follow Set for each nullable nonterminal	Step 1, 10
Step 12	Sel (n)	Compute the Selection Set for each rule	Step 1, 5, 11

In the original paper-based implementation of this tutorial during class, students have no way of detecting if there's mistake on earlier steps before submission. Students are only able to notice the mistakes they made once the tutorial has been graded and returned. Figure 2 shows example of a partial student's submission of this exercise. As the correctness of the selection sets derived in this exercise is crucially dependent on correct output of all steps, ability to detect mistakes on earlier steps may allow students to reflect and confidently work out the solution. Therefore, among requirements of this game include iterative completion of tasks, and ability to check accuracy of submitted answers during play.

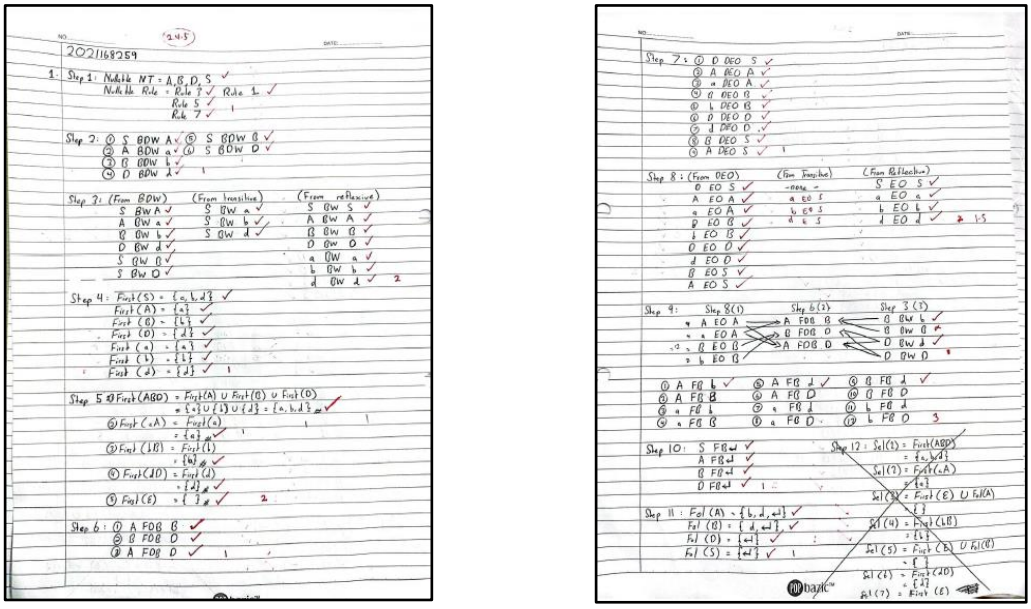

Figure 2: Example of a Paper-based Submission of Finding Selection Sets Exercise

While there are twelve specific steps that students need to complete for selection sets extractions, we decided that only six different steps answers will be examined during play. As all these steps are dependent on each other, we resolved that five checkpoints in the game would be sufficient to check accurate implementation of the algorithm. As for verifying correct input to output strings translation using the selection sets that have been derived, the game must be able to check this as one of the last missions of the game.

In addition to the learning objectives requirements of the game, the second requirement involve implementing elements inside the game to reflect the Role-Playing Games (RPG) genre. Some common elements of an RPG include narrative or story, characters, dialogues, exploration, quests, experience and levels, combat system, and inventory (Bostan et al., 2020; Dickey, 2007; Roman et al., 2011; Tychsen et al., 2006). To convincingly portray the activity as an RPG, this game includes characteristics that can be found in an RPG game, mapped to the main objective of this activity - an exercise in finding selection sets to a Context-Free Grammar. Table 2 shows the outline of this game design, that implements both the lesson objectives and elements featured in RPG genre.

Table 2
Design of Game Implementing Lesson Objectives and RPG Elements

Item	Game Design	RPG Element	Details
A1	Mission	Story/Quest	Player is given the mission to find selection sets of a grammar to decipher the code to save a princess
A2	Maps	Exploration	Player starts the game in a camping base before moving to the maps which include a town, a cave to escape from and finally a ship
A3	Password Doors	Quest	Player needs to submit correct answers before door to next map can open
A4	Villagers, Warriors, Healers	Characters	Game has non-playable characters in addition to other players. Characters can be found throughout the maps.
A5	Investigation	Dialogues	Player talks to non-playable characters to receive items and clues to complete mission
A6	Badges, Potion	Inventory	Player receives badges with correct answers and can collect item
A7	Choose Route	Levels	Player is shown correct route once all badges have been collected
A8	Coded Path	Quest	Player must decipher a code using the Context-Free Grammar to correctly follow a path to save the princess

Table 2 shows the planned game designs that took into consideration elements that made up an RPG game. These designs are then coordinated with the class activity of finding selection sets of a Context-Free Grammar to better outline the flow of the game.

Table 3 shows another design - the implementation of the class activity mapped to planned game designs of Table 2.

Table 3
Mapping of Algorithm Activities to Game Designs

Item	Algorithm Activity	Algorithm Step	Details	Game Designs
B1	Review grammar	Pre-step	Find Context-Free Grammar by interviewing villagers in the map.	A1, A2, A4, A5
B2	BW	Step 3	Player finds warrior to submit answers to Step 3, receive the password to open door to next map and 'Adventurous' badge	A2, A3, A4, A5, A6
B3	First(α)	Step 4	Player finds warrior to submit answers to Step 4, receive the password to open door to next map and 'Courage' badge	A2, A3, A4, A5, A6
B4	First (n)	Step 5	Player finds warrior to submit answers to Step 5, receive the password to open door to next map and 'Charisma' badge	A2, A3, A4, A5, A6
B5	FDB	Step 6	Player finds warrior to submit answers to Step 6, receive the password to open door to next map and 'Wisdom' badge	A2, A3, A4, A5, A6
B6	EO	Step 8	Player finds warrior to submit answers to Step 8, receive the password to open door to next map and 'Loyal' badge	A2, A3, A4, A5, A6
B7	FB ↲	Step 10	Player finds warrior to submit answers to Step 8, receive the password to open door to next map and 'Inspiring' badge	A2, A3, A4, A5, A6
B8	Translate input string to output	Post-step	Player is revealed the correct cave door after all badges are collected, translates code to follow path to the princess	A6, A7, A8

This section has shown our effort in designing an RPG game for the class activity of finding selection sets of a Context-Free Grammar. With both the game designs and chosen algorithm activities finalized, the efforts moved to implementing this design into the chosen platforms.

B. Implementing an RPG Educational Game using Gather and Google Docs Editors

The main platform chosen for implementing the design of the game in this paper is Gather. Gather is an interactive real-time virtual space that imitates real life interactions. It allows users to create their own avatars and move these characters around a customisable space, interacting with one another. It features proximity activation of audio and video whereby

connection is automatic within five map tiles of each other. It is a platform that gamifies the working environment, imitating the experience of playing an RPG (Bashir, 2021).

Most relevantly to the development of this project, Gather features an exceedingly customisable Mapmaker, which allow almost endless customisation of maps and objects. More excitingly, Gather is highly compatible to existing game assets made by the enthusiastic game developers' community such as those found in the popular itch.io website (GVguide, 2022). The Gather platform provides many map templates and objects but any further customisation necessary can be done through the many open-source and free resources from within the game developers community. For example, map editing can be done using free tilesets downloaded from itch.io, using Tiled application as the map editor (Thorbjørn, 2023), before importing it to the Gather Mapmaker. With this rich number of resources available, there are many games design and academic research possibilities. A search through academic databases reveals many recent papers with Gather implementation especially in learning as research subjects.

Most of the design features listed in Table 2 can be directly implemented using Gather platform except items A6 and A7. The following sections document implementation of the RPG game design using Gather and Google Docs Editor.

i. Game Design Implementation using Gather

The game, named 'Cave Escape' was developed through Gather's Mapmaker, which is a powerful tool allowing users to customize almost all layouts and interactivities of the virtual space. In the implementation of this game, fourteen maps were used. Each of these maps are called 'rooms' in Mapmaker. All the maps were not designed from scratch, instead they were taken from Gather's own repositories with some modifications using Tiled Map Editor and Adobe Photoshop. The usage of fourteen maps in this game in addition to reflect the iterative actions in finding selection sets of a Context-Free Grammar, also supports 'Exploration' element of an RPG.

Most of the challenges in the maps such as Swamp Trap and Craters Trap were done using 'Portal' tile effect in Mapmaker while Maze Garden was made using the 'Impassable' tile effect. Hiding the cave entrance and princess real appearance was done using the 'Object Interactions' property of custom objects in Mapmaker. This way, the graphic of the object can be swapped when players are close to the target. Adding dialogues and links to Google Forms were also done using 'Object Interactions' property. One of the key features of this game is Password Door. This is a feature of Mapmaker that is available by activating Extensions. Passwords to doors in maps are displayed once they've successfully correctly answered the questions in Google Forms.

Figure 3 andFigure 4 show the screen captures of the maps during gameplay on Gather.

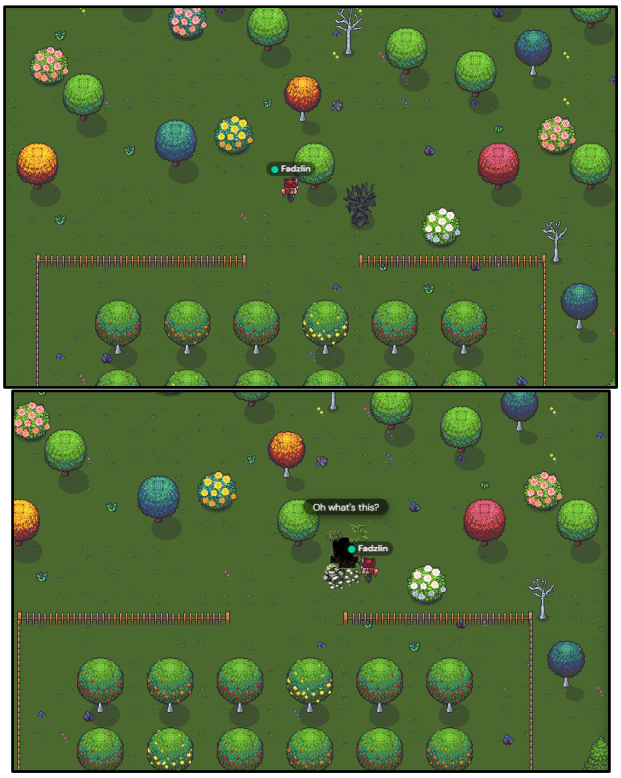

Figure 3: Player in 'Market' map looking for the Context-Free Grammar

The 'Market' map is the biggest map in the game, there are many areas in which players need to explore, and there are many non-playable characters (NPC) players need to talk with to receive the grammar and revive potion. This makes it challenging to complete alone and players are expected to cooperate with team members.

Players must enter password received after correctly answering questions based on Algorithm Activity. The door will unlock, and players can go through the door and move to the next map. This door stays open for a few seconds so players and teammates can move together.

Figure 4: Player in maps facing locked doors

Players must be careful when walking in the game as falling through the lake or choosing a wrong path will results in being stuck in an underground swamp. To escape the swamp, players enter the key received when claiming 'Revive' potion at password door. Once players have completed the collection of all six badges, they will reach a five-way split paths, each representing a natural element. Players must choose the correct path based on the clue that appear in their inventory with the badges completion.

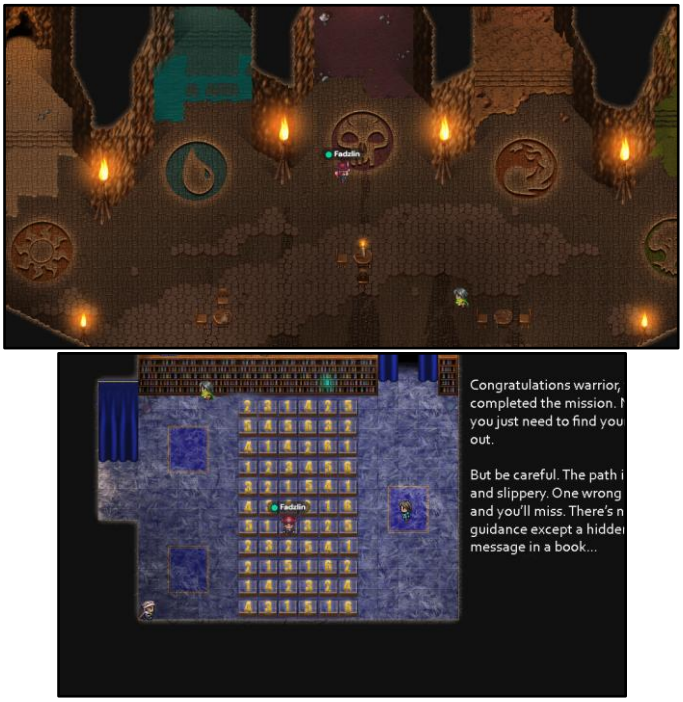

Figure 5: Player completing the correct path missions

Players are presented with the final mission after selecting the correct path: they must successfully translate an input string using the Context-Free Grammar and selection sets that have been derived. A series of numbers will be produced as the output of this activity. Players can reach across the room safely by following the numbers provided by the grammar output. A misstep, however, will lead to the swamp.

By using Gather and especially Mapmaker, majority of the game designs have been implemented. However important designs such as Inventory to store potion and badges, and mechanism to check students submitted answers need workarounds beyond Gather's available features. Therefore, the implementation of this game also includes utilization of Google Form and Google Sheet services from the office suite of Google Docs Editor.

ii. Game Design Implementation using Google Docs Editor

Players start the game in a group and each group members share an Inventory together. To implement this, all groups are privately given a link to a Google Sheet that act as their inventory. Players are informed not to reveal their links to other groups. When players start the game, the inventory is empty except for their own Secret Code. They'll see that they've collected zero badge and no potion. Figure X shows an inventory for Group 1. The badges and potion icons are grey in colour when they just started playing, signifying they haven't been collected. However, as players progress and have collected the necessary badges, the inventory changes to reflect this. All the icons will gain colours, number of badges collected is updated, and the completion path clue is also displayed.

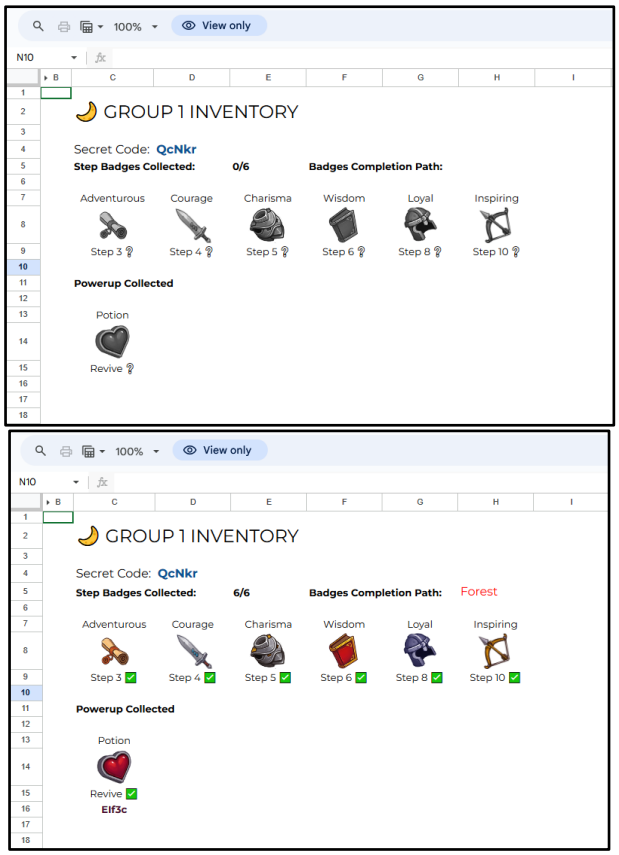

Figure 6: Inventory of Group 1 before and after game completion

Together with Google Sheet, Google Form is used as a mechanism to check students' answers to the Algorithm Activity. Gather allow embedding of websites which includes any Google Documents, Sheets and Forms. This enables the opening of the website directly inside Gather within an *iframe*. As such, it makes usage of Google Form to check students answers sensible. To implement this, Regular Expression feature of Google Form response validation is used where only exact answers are accepted. Students must follow the format stated in the field description or their answers will be rejected. If they have provided correct answers, the next button will be enabled, and they will receive the keys to open the password door on their current map. Figure 7 on left shows implementation of answers checking where students answer is incorrect, and Figure 7 on right shows the screen shown once correct answer has been given and 'Next' button is pressed. The words shown can be used to open the password door. Players should also submit the form to collect the badge which will be immediately reflected in their inventory.

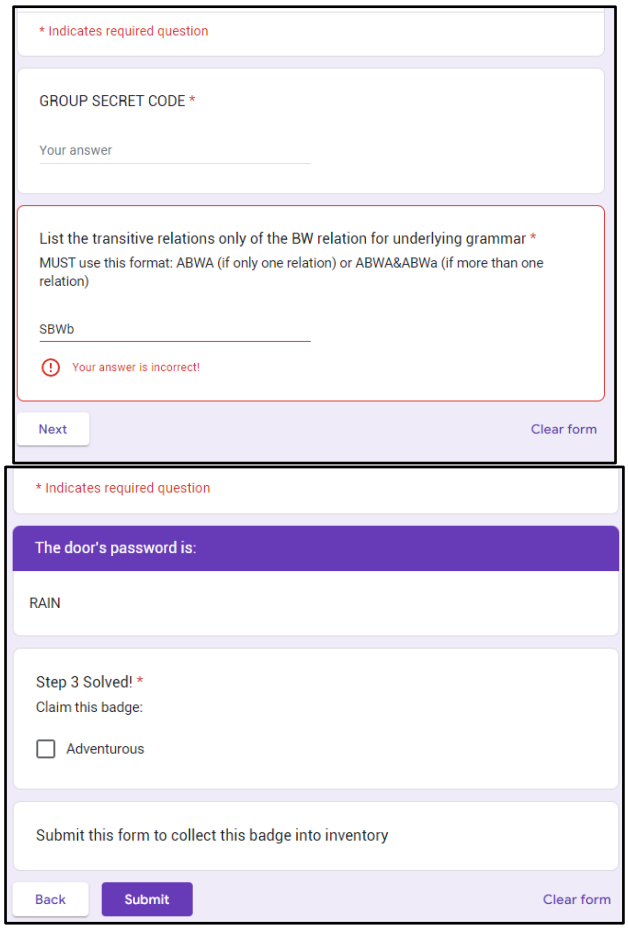

Figure 7: Google Form's Response Validation checks students' submission

This Google Form mechanism is used for all designs of game that collect badges and open Password Door. In total, there are six forms for badges and one form for potion used for this game. All forms have a single Google Sheet spreadsheet as destination for responses. This spreadsheet, named as 'Main System' act as the administrator control for this game. Main System has multiple sheets receiving responses from all forms. It also has multiple sheets, each representing a group inventory. Each group inventory sheet will process the data from badges and potion forms using simple Google Sheet formulas to update the number of badges or potion the group has collected.

Main System is also connected to multiple separate Google Sheet spreadsheets to serve two purposes: that each group has its own personal link, and the formulas and calculations details stored in Main System are masked from students. Each of these spreadsheets serving as inventory receive almost immediate updates of information because the data are duplicated using 'IMPORTRANGE' formula, instead of publishing the Google Sheets as a webpage. Google Sheets only update published webpages every five minutes which is very slow in a gaming setting. All inventory spreadsheets files shared with students are placed with limitations including being view-only, and disabling the download, print or copy options for viewers.

In addition to being the repositories for processing all the data of groups inventory, Main System also stores setup information including codes for groups and revive potion. Figure 8 shows all the Google Docs Editors documents in this game environment and how they are connected to each other.

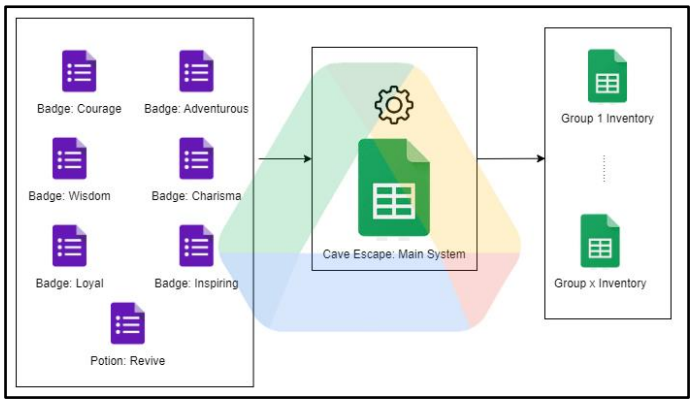

Figure 8: Connections between Google Forms and Google Sheets inside Cave Escape Game

The designs of the RPG game have been successfully implemented using two platforms: Gather and Google Docs Editor. Because these two platforms are online, all changes are reflected immediately and available for usage. White box testing was conducted to check proper integration between all Google Docs documents, and the proper flow of gameplay on Gather. Once this testing was completed, the game was ready for classroom use.

C. Thematic Analysis of Game Evaluation with Students

The completed Cave Escape game was used in a class session with students for evaluation. These students were enrolled on the course for the semester and running the test session works as a way of getting students' early perceptions of the game. The class was divided into six groups, and using Google Meet's breakout room features, they were split into six private rooms. Instructions were given in the main room, and group inventory links were distributed in each private room. Students were asked to cooperate with group members to solve the missions and not reveal whichever hints they received to other groups. The activity took around 120 minutes for the whole class of 33 students to complete. After completion, they were asked to fill up a form with two open-ended questions: "*What do you like about this experience*?" and "*What do you think can be improved?*".

Thematic analysis method was applied to the results. Thematic analysis was chosen as method for analysing this qualitative data because of its flexibility, and ability to generate insights from open-ended survey questions. Figure 9 shows a group of students screen-captured after finishing their missions.

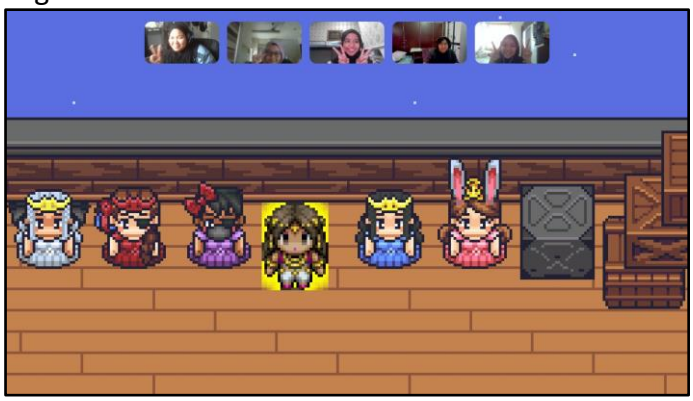

Figure 9: Players in a group taking a picture with the rescued princess

i. Emerging Themes from Analysis of Liked Aspects

Analysis of participants responses about liked aspects of the game experience results in four emerging themes. These themes are “Engagement and Fun”, “Learning While Playing," “Teamwork and Communication,” and “Novelty and Unique Experience.” The significant of each theme is discussed below while Table 4 shows each theme, related participants, coded keywords, and their frequencies.

- ***Engagement and Fun***

Participants consistently highlighted the engagement and enjoyment they experienced while playing Cave Escape. Expressions such as “exciting," “fun,” and “enjoyable” were frequently used by participants to convey their positive sentiments. This theme underscores the game’s ability to capture participants’ attention and create an immersive and enjoyable learning environment.

The emergence of the “Engagement and Fun” theme can be credited to the inherent appeal of gamification and interactive experiences. Challenges, rewards, and competition are common elements of a game that encourage active participation by engaging players on an innate level. The addition of game dynamics and elements of surprise such as falling into swamp in Cave Escape may also have had a role in the participants’ favourable responses.

Table 4
Emergent Themes, Descriptions and Keywords from Liked Aspects

Themes Liked	Participants	Description	Keywords (Frequency)
Engagement and Fun	01, 02, 04, 05, 06, 08, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33	Participants enjoyed the entertaining and enjoyable aspects of the game, finding it fun and engaging.	Exciting (1), Fun (16), Enjoyable (1), Challenging (2), Playing (1), Adventure (1), Mysterious (1), Excitement (1), Thrilling (1), Connect (1), Treasure hunt (1), Interactive (1)
Learning while Playing	02, 05, 08, 09, 11, 16, 18, 21	Participants appreciated the educational value of the game, as it allowed them to learn while actively participating.	Learning (2), Playing (2), Apply knowledge (1), Learn together (1), Syllabus (1), Study (1), Brain boost (1), Learn something (1)
Teamwork and Communication	03, 04, 06, 07, 08, 12, 19, 21	Teamwork and communication were key aspects participants liked, as they were able to collaborate with classmates to solve challenges.	Communicate (2), Discuss together (1), Connect with friends (1), Work together (1), Interaction (1), Brainstorm (1), Friendship (1), Bond (1)

Novelty and Unique Experience	05, 06, 10, 11	Some participants found the game experience novel and unique, offering a fresh way to learn and interact with classmates.	New experience (1), Unique (1), Adventure game-like (1), Interactive activity (1), Exciting (1), Memorable (1), Different place (1), Adventure (1)

- ***Learning while Playing***

Many players recognized the educational elements that were included in the game, demonstrating their capacity to learn while playing the game. The fact that terms like "learning", "playing", and "apply knowledge" were used by participants implies that they saw the game as a valuable instrument for reinforcing academic topics.

The "Learning While Playing" theme is consistent with modern educational theories that strongly emphasise experiential and active learning. Cave Escape game allowed players to practice and apply theoretical knowledge in a realistic setting by combining learning objectives with gameplay. This theme emphasizes how game-based learning has the ability to improve comprehension and retention.

- ***Teamwork and Communication***

The theme of "Teamwork and Communication" stood out strongly, and participants valued the game's cooperative elements. Key phrases like "communicate," "discuss together," and "work together" demonstrate how important successful communication and teamwork are to the participants, and their recognition of these elements in their experience of playing Cave Escape.

The game's emphasis on cooperation probably helped this theme take shape. Cave Escape frequently needs cooperation and communication among players to explore the map and solve questions, encouraging teamwork and idea sharing. This theme reinforces the importance of social interactions for improving learning experiences and echoes real-world scenarios that require efficient teamwork.

- ***Novelty and Unique Experience***

Several players praised the game's novelty and unique experience. The use of phrases like "new experience," "unique," and "adventure game-like" highlights the fact that players appreciate how creative the game's style is.

The emergence of the "Novelty and Unique Experience" theme can be credited with participants' interest and keenness in new approaches to learning. Participants' curiosity was probably sparked by the use of game elements and an interactive plot, which offered a change from traditional teaching techniques. This theme highlights the potential of innovative teaching methods to captivate students and produce lasting experiences.

ii. Themes for Areas for Improvement

Analysis of feedback on areas participants feel can be improved surfaced some themes that could be focused on for future enhancements. The themes that were discovered include "Technical Issues", "Clarity of Instructions", "More Challenges", "Platform and System", and

"Extended Time". Table 5 lists each theme, related participants, coded keywords, and their frequencies.

Table 5
Emergent Themes, Descriptions and Keywords from Improvement Suggestions

Themes for Improvement	Participants	Description	Keywords (Frequency)
Technical Issues	07, 12, 31	Participants experienced technical problems and suggested improvements to address them.	Lagging (1), Slow internet (1), Technical problems (2), Game performance (1)
Clarity of Instructions	01, 31	Participants had difficulty understanding instructions and recommended clearer guidance.	Clearer instructions (1), Instructions (1)
More Challenges	02, 08, 10	Participants wanted the game to be more challenging and suggested adding additional difficulties.	More challenges (2), Difficulties (1)
Platform and System	06, 20	Participants provided suggestions to streamline and enhance the platform and system used.	Streamline (1), Enhance (1), Platform (2), System (1)
Extended Time	18, 31	Participants felt that more time would be beneficial for exploring and engaging with the game.	More time (2), Extended time (1)

- ***Technical Issues***

Participants brought up technical difficulties they ran into while using the educational game. Terms like "lagging," "slow internet," and "technical problems" are used, underscoring their frustration unable to fully receive the game experience.
It is possible to relate the "Technical Issues" theme to differences in participant technological setups and network circumstances. As participants in this testing session was based at their own houses, differences in network quality and machine setups could not be avoided.

- ***Clarity of Instructions***

Participants commented that the game's instructions needed to be made clearer. This theme highlights the desire of participants to navigate the challenges successfully.
The need of clear instructions in encouraging effective involvement can be credited with the birth of the “Clarity of Instructions” theme. Concise, well-organized instructions are essential for improving learning in a classroom setting.

- ***More Challenges***

Some participants asked for the game to be more difficult. Keywords like "more challenges" and "difficulties" indicate that participants want the gameplay of Cave Escape to be more challenging. The participants especially liked the 'swamp' feature of the game.
The theme of "More Challenges" fits with the fact that educational games can simulate a wide range of complex situations. It is possible that people look for bigger tasks because they want to solve problems in as many different ways as possible.

- ***Platform and System***

Participants suggested the implementation of the game uses fewer platforms. They requested that smaller number of platforms be used because this game testing session was implemented using Telegram (for announcements to go into Google Meet), Google Meet, and Gather. This might have been difficult for those with lower technical specifications of their computer setups.
The emergence of this theme shows the importance for the game experience to go smoothly to support the best engagement and interaction.

- ***Extended Time***

Some participants suggested for an extension of the game's time limit. The "Extended Time" theme reflects participants' desire for more time to complete the game's challenges and interactions. The "Extended Time" theme emerged in response to participants' desire for extended learning experiences. More time aligns with the goal of increasing engagement and exploration. While all groups managed to complete the gameplay within the two hours session, perhaps some participants felt it was done in a rush.

iii. Thematic Map and Evaluation Discussions

The overall thematic analysis of participants' feedback on Cave Escape provides significant insight into the multiple facets of their experiences. The thematic map in Figure 10, which incorporates both liked aspects and improvement suggestions, provides an overall summary of the most profound sentiments expressed by participants.

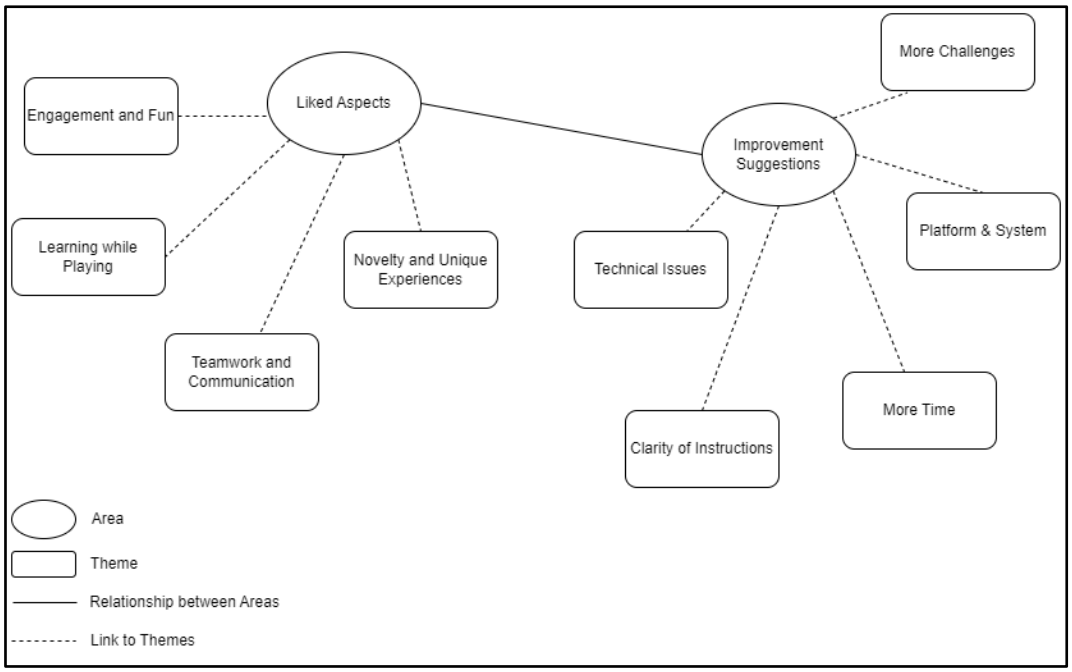

Figure 10: Thematic Map of Respondents Analysis from Game Evaluation

The participants' shared enthusiasm for "Engagement and Fun" demonstrates the critical role of engaging gameplay in fostering an enjoyable learning environment. "Learning While Playing" demonstrates the power of combining education and entertainment to improve knowledge retention. The appreciation for "Teamwork and Communication" indicates to the educational value of collaborative learning experiences, while the appreciation for "Novelty and Unique Experience" highlights the power of innovation in learning.

On the opposite side, the specific suggestions for improvement made by participants, such as addressing "Technical Issues" and improving "Clarity of Instructions," provide valuable lessons for bearing in mind the differences of students' technical setups and importance of clear instructions. Their call for "More Challenges" encourages the creation of stimulating content. Additionally, the emphasis on improving the "Platform and System" underscores the importance of a seamless web experience.

Moving forward, these findings suggest that the success of educational games is dependent on striking a balance between engagement, education, and technical efficiency. The educational impact of the game could be enhanced by increasing technological reliability, providing clearer guidelines, and incorporating intellectually demanding elements. The thematic map provided here may function as a guidepost, directing future iterations of Cave Escape toward more effective and rewarding learning experiences.

3. Conclusion and Future Works

In this paper, the design, implementation, and evaluation of an educational game made for a computer science exercise are described. Cave Escape is a role-playing game (RPG), and it has many features that are common of RPG genre. These elements include a storyline, quests to be completed, an inventory system for managing items, non-playable characters to interact with, a levelling system to progress the player's journey, and opportunities for exploration within the game world. The game's design meticulously mirrors the systematic approach of the algorithm used for finding selection sets of a Context-Free Grammar – the exercise selected to be transformed into an interactive game. Steps of the algorithm was translated

into game design with the goal of minimizing confusion and facilitating the achievement of the exercise's learning objectives.

After the game's design was completed, the phase of turning it into a workable implementation was started. Gather and Google Docs Editor were both utilized in this stage, each being leveraged for their convenience and strengths. Gather was chosen because it is an online space that closely resembles the appearance and interactions of an RPG game, making it a good fit for this project. This platform made it possible for students to gather within a virtual space, creating a metaverse in which they could move around as avatars. Gather's Mapmaker feature, with its extensive functionality, allowed for the seamless realization of most of the game design. The rest of the designs were included using embedded objects from Google Docs Editors, including both Google Form and Google Sheet. The game design was successfully implemented because of the integration of these platforms, making it ready for evaluation.

The game evaluation employed convenience sampling by engaging students currently enrolled in the Compilers course. The students were divided into six different groups, and they were encouraged to work together in their groups during gameplay. Two hours were allotted for the session, during which everyone took part and finished all the missions. Participants were asked for feedback after the game completed, including both the things they liked and what needed improvement. Thematic analysis of the participants' feedback on the aspects they liked revealed memorable themes like "Engagement and Fun," "Learning while Playing," "Teamwork and Communication," and "Novelty and Unique Experience." On the other hand, a review of the suggestions for enhancements revealed several themes, including "Technical Issues," "Clarity of Instructions," "More Challenges," "Platform and System," and "Extended Time." The evaluation's findings were insightful, providing important information that will be helpful in further improving and developing the game.

This research contributed to the game-based learning field through a fusion of educational content and game mechanics. The systematic translation of algorithmic steps into gameplay employs an innovative approach, demonstrating the combination pedagogy with entertainment. This study also proved the feasibility of combining readily available metaverse platform like Gather and online productivity tools such as Google Docs Editors for the authoring of educational products that can be quickly implemented with little to no coding ability required. Meanwhile, the thematic analyses done on students' feedbacks lead to recommendations that might be relevant for other educators. According to participant feedback, putting an emphasis on teamwork, making instructions clear, and fixing technical issues makes sense. Teachers can skilfully incorporate engagement, cooperative learning, and active investigation into their courses by utilizing the themes that have been discovered.

Future works should investigate the potential for deploying the RPG asynchronously in addition to addressing the issues raised by the students. Of importance is the need for clearer instructions, which is consistent with the literature review on RPG in education. By allowing students to play the game activities on their own schedule, they can potentially choose the time of day when their internet connection is at its best and complete the task at their own pace. Determining whether the original experiment differed significantly from this one requires analysing the feedback from this experimental session, which in and of itself can be a fascinating analysis exercise. As a conclusion, this research offers a basis for deeper investigations into the use of RPG in educational settings, particularly on a metaverse platform.

Acknowledgement
The corresponding author can be contacted at hajarizzati@uitm.edu.my.

References

Barab, S., Pettyjohn, P., Gresalfi, M., Volk, C., & Solomou, M. (2012). Game-based curriculum and transformational play: Designing to meaningfully positioning person, content, and context. *Computers and Education*, *58*(1). https://doi.org/10.1016/j.compedu.2011.08.001

Bashir, D. (2021). How Virtual Office App 'Gather Town' is Changing the Way We Work and Play. *IGN Southeast Asia*. https://sea.ign.com/ign-sea/174057/news/how-virtual-office-app-gather-town-is-changing-the-way-we-work-and-play

Bergmann, S. D. (2017). *Compiler Design: Theory, Tools, and Examples* (1st ed.). Open Educational Resources. https://rdw.rowan.edu/oer/1

Bhattacharjee, S., & Ghosh, S. (2013). Usefulness of role-playing teaching in construction education : A systematic review. *Annual International Conference Proceedings*, *2001*.

Bodnar, C. A., Anastasio, D., Enszer, J. A., & Burkey, D. D. (2016). Engineers at Play: Games as Teaching Tools for Undergraduate Engineering Students. In *Journal of Engineering Education* (Vol. 105, Issue 1). https://doi.org/10.1002/jee.20106

Bostan, B., TİNLİ, B., & ÇATAK, G. (2020). Worldbuilding Components and Transmedial Extensions of Computer Role-Playing Games. *Kültür ve İletişim*, *23*(45). https://doi.org/10.18691/kulturveiletisim.709869

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2). https://doi.org/10.1191/1478088706qp063oa

Bridges, C., Hummel, J., Hursthouse, J., Moss, R., Society, A. C., Antilla, T., Book, B., Cheng, H., Constable, G., Dyson, E., Farmer, R., Garnett, G., Gruber, E., Keller, J., Marks, R., Poulin, M., Smart, J., Swords, J., White, P., … Hanke, J. (2007). Metaverse Roadmap Overview. *Metaverse Roadmap*.

Brown, L. G., & Chidume, T. (2023). Don't forget about role play: An enduring active teaching strategy. *Teaching and Learning in Nursing*, *18*(1). https://doi.org/10.1016/j.teln.2022.09.002

Burgess, J., & Jones, C. M. (2017). "Is It Too Much to Ask That We're Allowed to Win the Game?": Character Attachment and Agency in the Mass Effect 3 Ending Controversy. *Bulletin of Science, Technology and Society*, *37*(3). https://doi.org/10.1177/0270467618819685

Chen, M. P., & Ren, H. Y. (2013). Designing a RPG game for learning of mathematic concepts. *Proceedings - 2nd IIAI International Conference on Advanced Applied Informatics, IIAI-AAI 2013*. https://doi.org/10.1109/IIAI-AAI.2013.51

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers and Education*, *59*(2). https://doi.org/10.1016/j.compedu.2012.03.004

Cook, A. S., Dow, S. P., & Hammer, J. (2017). Towards designing technology for classroom role-play. *CHI PLAY 2017 - Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. https://doi.org/10.1145/3116595.3116632

Denny, P. (2013). The effect of virtual achievements on student engagement. *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2470654.2470763

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A

systematic mapping study. *Educational Technology and Society*, *18*(3).

Dickey, M. D. (2007). Game design and learning: A conjectural analysis of how massively multiple online role-playing games (MMORPGs) foster intrinsic motivation. *Educational Technology Research and Development*, *55*(3). https://doi.org/10.1007/s11423-006-9004-7

Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers and Education*, *67*. https://doi.org/10.1016/j.compedu.2013.02.019

Erturk, E. (2016). Role play as a teaching strategy. *Journal of Enterostomal Therapy*, *5*.

Gatsakou, C., Bardis, N., & Drigas, A. (2021). Role playing vs RPGs as teaching strategies in educational procedure. *Technium Social Sciences Journal*, *26*. https://doi.org/10.47577/tssj.v26i1.4896

Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment (CIE)*, *1*(1), 20–20. https://doi.org/10.1145/950566.950595

GVguide, E. (2022). *Gather.town Compatible 32x32 Tilesets*. Itch.Io. https://itch.io/c/1904339/gathertown-compatible-32x32-tilesets

Huertas-Valdivia, I. (2021). Role-Playing a staffing process: Experiential learning with undergraduate tourism students. *Journal of Hospitality, Leisure, Sport and Tourism Education*, *29*. https://doi.org/10.1016/j.jhlste.2021.100334

Ike, T. C., Hoe, T. W., & Yatim, M. H. M. (2021). Designing Elements for Immersive User Experience in Educational Games Using the Entertainment Game Development Approach. *Review of International Geographical Education Online*, *11*(4). https://doi.org/10.33403/rigeo.8006787

Jiwo, R. B., & Aini, A. F. (2023). Rancang Bangun Media Pembelajaran Berbasis Game menggunakan RPG Maker MV. *Sains Data Jurnal Studi Matematika Dan Teknologi*, *1*(1). https://doi.org/10.52620/sainsdata.v1i1.8

Jones, M. L., Barnish, M. S., Hughes, R. R., Murray, A. K., Mansour, O., Loni, T., Vickery, H. M., Evans, M. L., Green, L., & Verdezoto, N. (2023). Exploring the potential of using simulation games for engaging with sheep farmers about lameness recognition. *Frontiers in Veterinary Science*, *10*. https://doi.org/10.3389/fvets.2023.1079948

Kaur, N., Singh, V., Mahajan, N., & Garg, N. (2023). Game Based Learning - Immersive teaching and Learning platform through Metaverse. *Proceedings of 2023 3rd International Conference on Innovative Practices in Technology and Management, ICIPTM 2023*, *Iciptm*, 1–6. https://doi.org/10.1109/ICIPTM57143.2023.10118239

Kebritchi, M., Hirumi, A., & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education*, *55*(2), 427–443. https://doi.org/10.1016/J.COMPEDU.2010.02.007

Kye, B., Han, N., Kim, E., Park, Y., & Jo, S. (2021). Educational applications of metaverse: Possibilities and limitations. In *Journal of Educational Evaluation for Health Professions* (Vol. 18). https://doi.org/10.3352/jeehp.2021.18.32

Lee, S. M. (2023). Second Language Learning through an Emergent Narrative in a Narrative-rich Customizable Metaverse Platform. *IEEE Transactions on Learning Technologies*. https://doi.org/10.1109/TLT.2023.3267563

Lincoln, D. J. (2008). Drama in the Classroom: How and Why Marketing Educators Can Use Nonverbal Communication and Enthusiasm to Build Student Rapport. *Marketing Education Review*, *18*(3). https://doi.org/10.1080/10528008.2008.11489048

Luo, V., Klinkert, L. J., Foster, P., Tseng, C.-Y., Adams, E., Ketterlin-Geller, L., Larson, E. C., &

Clark, C. (2021). A Multidisciplinary Approach To Designing Immersive Gameplay Elements for Learning Standard-Based Educational Content. *Extended Abstracts of the 2021 Annual Symposium on Computer-Human Interaction in Play*, 67–73. https://doi.org/10.1145/3450337.3483467

Mee Mee, R. W., Shahdan, T. S. T., Ismail, M. R., Abd Ghani, K., Pek, L. S., Von, W. Y., Woo, A., & Rao, Y. S. (2020). Role of gamification in classroom teaching: Pre-service teachers' view. *International Journal of Evaluation and Research in Education*, *9*(3). https://doi.org/10.11591/ijere.v9i3.20622

Mehm, F., Göbel, S., & Steinmetz, R. (2013). An authoring tool for educational adventure games: Concept, game models and authoring processes. *International Journal of Game-Based Learning*, *3*(1). https://doi.org/10.4018/ijgbl.2013010105

Mulyadi, M. T., & Mat Zin, N. A. (2019). MMORPG Game Framework Based on Learning Style for Learning Computer Netwoking. *Asia-Pacific Journal of Information Technology & Multimedia*, *08*(01). https://doi.org/10.17576/apjitm-2019-0801-06

Park, S., & Kim, S. (2022). Identifying World Types to Deliver Gameful Experiences for Sustainable Learning in the Metaverse. *Sustainability (Switzerland)*, *14*(3). https://doi.org/10.3390/su14031361

Prince, R. H. (2006). Teaching engineering ethics using role-playing in a culturally diverse student group. *Science and Engineering Ethics*, *12*(2). https://doi.org/10.1007/s11948-006-0030-y

Qiu, T., Liu, H., & Yin, E. (2018). Learners' Experiences on Role-Playing Collaborative Learning Supported by ELS: A Case Study of Virtual Company Program. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *10949 LNCS*. https://doi.org/10.1007/978-3-319-94505-7_22

Roman, M., Sandu, I., & Buraga, S. C. (2011). OWL-Based Modeling of RPG Games. *Studia Universitatis Babes-Bolyai*, *56*(3).

SALOMÃO, J. S., Dos SANTOS, C. E., GIANCOLI, A. P. M., & AMATE, F. C. (2018). Development of a Serious Game to Assist in Teaching History. *DEStech Transactions on Computer Science and Engineering*, *wcne*. https://doi.org/10.12783/dtcse/wcne2017/19904

Samala, A. D., Usmeldi, Taali, Ambiyar, Bojic, L., Indarta, Y., Tsoy, D., Denden, M., Tas, N., & Dewi, I. P. (2023). Metaverse Technologies in Education: A Systematic Literature Review Using PRISMA. *International Journal of Emerging Technologies in Learning*, *18*(5). https://doi.org/10.3991/IJET.V18I05.35501

Sarıtaş, M. T., & Topraklıkoğlu, K. (2022). Systematic Literature Review on the Use of Metaverse in Education. *International Journal of Technology in Education*, *5*(4). https://doi.org/10.46328/ijte.319

Say, S., & Bag, H. (2018). Correction on The Evaluation of the Effect of a Newly Designed Computer Game on 7th Grade Students' Motivation Towards Science and Aggression. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(4). https://doi.org/10.29333/ejmste/84880

Serrano, K. (2019). The effect of digital game-based learning on student learning: A The effect of digital game-based learning on student learning: A literature review literature review. *Graduate Research Papers*.

Setiyani, S., Sumarwati, S., Sagita, L., & Fadhlurrohman, D. (2021). The incredible boong gi: Educational game RPG for mathematical understanding ability. *International Journal of Education and Learning*, *3*(2). https://doi.org/10.31763/ijele.v3i2.217

Sugito, S., Susilowati, S. M. E., Hartono, H., & Supartono, S. (2017). Enhancing Students'

Communication Skills through Problem Posing and Presentation. *International Journal of Evaluation and Research in Education (IJERE)*, *6*(1). https://doi.org/10.11591/ijere.v6i1.6342

Thorbjørn. (2023). *Tiled Map Editor*. Itch.Io. https://thorbjorn.itch.io/tiled

Tlili, A., Huang, R., Shehata, B., Liu, D., Zhao, J., Metwally, A. H. S., Wang, H., Denden, M., Bozkurt, A., Lee, L. H., Beyoglu, D., Altinay, F., Sharma, R. C., Altinay, Z., Li, Z., Liu, J., Ahmad, F., Hu, Y., Salha, S., … Burgos, D. (2022). Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis. In *Smart Learning Environments* (Vol. 9, Issue 1). https://doi.org/10.1186/s40561-022-00205-x

Tychsen, A., Hitchens, M., Brolund, T., & Kavakli, M. (2006). Live action role-playing games: Control, communication, storytelling, and MMORPG similarities. *Games and Culture*, *1*(3). https://doi.org/10.1177/1555412006290445

Wang, Y. H. (2020). Exploring the effects of designing a role-playing game with single and peer mode for campus learning. *Educational Technology Research and Development*, *68*(3). https://doi.org/10.1007/s11423-019-09726-8

Yavaşlar, E., & Demirci, C. (2018). Vocabulary role play: An active learning strategy for vocabulary teaching. *European Journal of Education Studies*, *4*.

Yu, J. E. (2022). Exploration of Educational Possibilities by Four Metaverse Types in Physical Education. In *Technologies* (Vol. 10, Issue 5). https://doi.org/10.3390/technologies10050104