The 10th Conference on Mathematics in Engineering: Theory and Applications
Novi Sad, December 12-14th 2025

LEARNING MATHEMATICS THROUGH AN EDUCATIONAL ROLE-PLAYING VIDEO GAME[1]

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https://doi.org/10.24867/META.2025.11 professional article

Abstract. This paper presents an educational adventure role-playing video game designed to support learning of mathematics, focusing on linear equations and systems of linear equations. The game integrates curricular content into an interactive environment where students solve problems as part of the storyline. By providing immediate feedback, autonomy, and opportunities for active learning, it promotes critical thinking, problem-solving, and engagement.

AMS Mathematics Subject Classification (2020): 97B50, 97U50

Key words and phrases: Educational video games, mathematics learning, linear equations.

1. Introduction

Humans are inherently creative and social, capable of shaping their environment while exploring rich inner worlds of imagination. Traditional art forms, such as literature, music, and painting, have long provided means to experience alternative realities. In the contemporary era, video games have emerged as a digital bridge between imagination and reality, offering immersive worlds where players can experiment, solve problems, and engage in complex narratives [4]. They foster cognitive, social, and emotional skills, including decision-making, problem-solving, communication, and adaptability, while providing safe spaces for exploration and failure [1, 2].

In education, video games offer dynamic and interactive environments that support active learning, personalized pacing, and the development of critical thinking and computational skills [5, 7]. By combining engaging narratives with problem-solving, games can complement traditional instruction and facilitate the practice of curriculum content in motivating ways.

[1] This research has been supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia under grants No. 451-03-137/2025-03/200134 (Mirjana Brdar); 451-03-137/2025-03/200125 and 451-03-136/2025-03/200125 (Goran Radojev).

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Building on these principles, we developed "Secrets of Algebria", an educational role-playing game (RPG) designed to integrate mathematics learning with adventure gameplay. The game focuses on linear equations with one variable and systems of linear equations with two variables, embedding curricular tasks within a rich narrative and interactive mechanics. Players solve problems through story-driven challenges, supported by a mind map technique that visually organizes steps, concepts, and relationships, helping students structure reasoning and understand solution processes.

This study presents the design and features of the game, highlighting how educational content, RPG elements, and interactive tools can be combined to create a motivating and effective environment for mathematics practice. The game demonstrates the potential of educational video games as a complementary tool for enhancing learning outcomes and developing 21st-century competencies in students.

2. Main results

Video games serve as an exceptionally effective medium for promoting self-directed learning among players—and, by extension, among students in informal learning contexts—owing to their distinctive attributes. They create a safe and engaging environment where experimentation and failure carry no real-world consequences, while simultaneously granting learners a high level of autonomy. These characteristics enable students to advance at their own pace and receive immediate, continuous feedback within the game setting, fostering the development of a wide range of cognitive and metacognitive competencies [6].

Figure 1: Theodora's shop in Tangent Valley

Building on these principles, the video game "Secrets of Algebria" was created as an innovative and, thus far, unique digital environment for mathematics learning and knowledge acquisition. Conceived as a complementary didactic resource to be used in parallel with regular classroom instruction, the game runs on Windows-based computers and enables students to engage in independent exploration and practice of mathematical topics. Its content focuses on linear equations with one unknown and systems of linear equations with two unknowns. While fundamental concepts are introduced during standard lessons, practice activities are delivered through the game, serving as an interactive extension of homework. Additionally, a built-in theoretical module supports students who may have missed classes, allowing them to study the material independently.

The technical part of educational RPG video game was developed between May 2024 and February 2025 by Mikloš Kovač using the RPG Maker MV software. Throughout this period, a fully functional game was created, incorporating all the typical features of the RPG genre while embedding mathematics curriculum content. The game falls within the RPG (role-playing game) genre, specifically of the adventure type, and features turn-based combat mechanics. Set in a richly designed fantasy world, it incorporates all the characteristic elements of a traditional RPG experience. Players control a team of four characters—a warrior, an arcanist, a mage, and a cleric—who progress through successive levels by earning experience points, enhancing their attributes according to class roles, and acquiring new weapons, armor, and spells. The combat system emphasizes logical reasoning and strategic planning, while the option to save progress promotes continuity and regular engagement. Additionally, each save records the total time the student has spent playing.

To fulfill its educational goals, the game introduces an imaginative setting known as Algebria. The central narrative revolves around a young sorceress—exceptionally talented yet deeply averse to mathematics—who, in an act of defiance, attempts to imprison and erase mathematics from the world. Although her plan is only partially successful, she manages to seal a fragment of mathematics' very essence within a magical medallion, disrupting the balance of the realm. In response, four heroes—metaphorical representations of typical students with limited mathematical confidence and motivation—set out on a journey to retrieve the medallion and restore harmony to Algebria.

The storyline unfolds in Tangent Valley (Figure 1), a village that serves as the game's main hub and visual centerpiece. Within this setting, players can explore several themed locations, including the tavern The Playful Logarithm, the shop At the Obtuse Angle, the school The Merry Integral—where students can review or catch up on missed lessons—and the Mathematics Gym, designed to assist players in problem solving through the use of mind maps.

Mathematical challenges are seamlessly integrated into the game's narrative. Each time a player encounters a treasure chest containing rewards such as experience points, items, or equipment, they must solve a word problem to unlock it. Correct solutions grant access to the reward, while skipping the task reduces the amount of experience points and resources obtained. To assist students in solving these problems, the game incorporates a mind map technique (Figure 2), which visually organizes the steps, relevant concepts, and relationships between elements of the problem. This approach helps learners structure their reasoning, understand the solution process, and make connections across different mathematical ideas. In certain sections, mandatory tasks

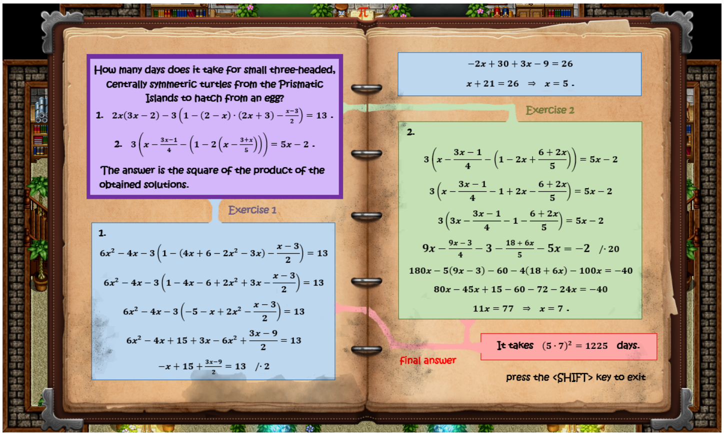

Figure 2: An example of a task solution using the mind map technique

are presented—two standard mathematical problems accompanied by short, humorous instructions—which must be solved and combined to progress further. By combining interactive gameplay with visual problem-solving support, the game effectively balances entertainment with curriculum-aligned practice.

Mathematical challenges are intricately embedded into the game's narrative structure. Whenever a player discovers a treasure chest containing rewards such as experience points, items, or equipment, they are prompted to solve a word problem in order to unlock it. Providing the correct solution grants access to the reward, whereas skipping the task reduces the amount of earned experience and available resources. In this way, the game effectively merges its entertainment components with systematic practice of mathematics aligned with the school curriculum.

Figure 3: Layout of the menu with equipment and basic characteristics of the hero

The distinctive advantage of this approach lies in its capacity to reveal different levels of student engagement—specifically, whether learners limit themselves to the mandatory tasks necessary for game progression or take additional initiative by completing optional challenges. While the game can indeed be finished without solving optional problems—since experience points, equipment, and treasures are also gained through required tasks—students who choose to skip them forfeit part of the overall experience points and valuable rewards that facilitate advancement.

In addition, the game includes a variety of NPCs (non-player characters) who enrich the narrative world through humorous dialogues and mathematically themed riddles. Every conversation and task bears a clear mathematical reference. Items collected throughout the game—such as armor (Robe of Hypothesis, Armor of Determinants), weapons (Sum of Fate, Dance of Variables, Revenge of the Right Triangle, Song of Fractions, Function of Forgetting, Perimeter of the Full Moon, Radius of Dawn), jewelry (Power of Algorithms, Trigonometric Thought, Arithmetic Whisper), and consumables (Linear Owl's Egg)—are all named after mathematical concepts (Figure 3). The heroes' spells and special abilities likewise carry symbolic mathematical names, including Spark of Equivalence, Flame of Logic, Irrational Strike, Ballad of Theorems, Blade of the Golden Ratio, and Mirror of Symmetry, thereby reinforcing the game's immersive mathematical atmosphere.

3. Conclusion

In this study, we presented the educational RPG Secrets of Algebria, a unique game designed to integrate mathematics learning with engaging role-playing elements. By combining curriculum-based tasks on linear equations with adventure gameplay, the game allows students to practice mathematics in an interactive, motivating environment. Its design supports independent learning, problem-solving, and student engagement, while maintaining a balance between education and entertainment. This game demonstrates the potential of digital tools to complement traditional mathematics instruction, offering an innovative approach that connects abstract concepts with immersive, hands-on experiences.

This RPG video game now needs to be tested among high school students. It is necessary to determine how much time students will spend on average playing the game, as well as how many tasks they will complete on average. After that, it should be examined whether students who use the game achieve better results in the subject area covered by the game compared to students who learned in the traditional way, using an experimental and a control group. It is also extremely important to determine to what extent such games should be included in teaching, especially considering that among high school students there is a large number of individuals who are addicted to video games [3].

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