Teaching Proposal For Greek Primary School Mathematics And Geology

Eleni Tsami[1*], Petros Skiadas[2], Dimitris Anastasopoulos[3]
[1]School of Finance and Statistics, University of Piraeus, Piraeus, Greece, etsami@yahoo
[2]Department of Digital Systems, University of Piraeus, Piraeus, Greece, pskiadas13@gmail.com
[3]Department of Medicine, University of Ioannina, Ioannina, Greece, jimmy_anataso@yahoo.gr
***Corresponding Author:** etsami@yahoo.gr

Abstract– This paper presents the KIDEDU (Play - Create - Learn) game launched at the University of Piraeus, aiming to provide an attractive means for students to cultivate mathematical competence. It is a teaching proposal for the six (6) grades of the Greek Primary School. The scientific team of the project is trying to make an innovation for the Greek Education and formulates a teaching proposal in this field. The proposal concerns "mathematics" and "geology" and how children 6-12 years old learn to use them in their daily life. The game-based teaching - guiding children to learn in a fun way and solve problems. The game was tested on 6-8 year olds. Then a questionnaire was distributed to the students and they responded to it. According to their responses, students prefer play-based teaching, they learn easily and enjoyably and learn more by playing. The aim is to extend it to all levels of education and make it the main teaching method for all students in schools. A demonstration of the game is provided.
Keywords– Digital game-based learning, differentiated learning, distance learning.

I. INTRODUCTION

In recent years, digital game-based learning (DGBL) has emerged as a powerful educational tool, transforming the traditional classroom into an interactive and engaging learning environment. The evolution of educational technology and the increased emphasis on differentiated and student-centered pedagogies have opened new avenues for innovation, particularly in primary education (Prensky, 2007; Tomlinson, 2014). Within this context, the present paper introduces KIDEDU (Play – Create – Learn), a game-based teaching initiative developed at the University of Piraeus, aiming to enhance the learning experience of primary school pupils in the subjects of mathematics and natural sciences, including geology. The KIDEDU project responds to the growing need for educational practices that resonate with the learning preferences of digitally native children aged 6–12. Traditional instructional approaches often fail to accommodate individual learning styles or maintain learner engagement, particularly in abstract or interdisciplinary subjects such as mathematics and the natural sciences. By leveraging guided discovery learning principles and embedding them within a structured digital game environment, KIDEDU seeks to address these challenges. Pupils are not passive recipients of information but are encouraged to explore, create, and apply concepts through structured gameplay, thereby enhancing both cognitive engagement and intrinsic motivation (Papastergiou, 2009).

The initial implementation of KIDEDU targeted pupils aged 8 to 10 and involved gameplay followed by a structured questionnaire. Preliminary feedback suggests that learners found the experience enjoyable, memorable, and educationally effective. This aligns with contemporary research in digital pedagogy, which supports the integration of game mechanics to promote deeper learning and increased retention (Tsami, 2020).

II. LITERATURE REVIEW

The pedagogical power of games lies in their ability to create low-risk spaces where students can experiment with ideas, make mistakes, and receive immediate feedback. This is closely aligned with the principles of guided discovery learning (GDL). Kirschner, Sweller, and Clark (2006) caution against unguided discovery, especially for novice learners, but acknowledge the effectiveness of discovery-based approaches when appropriate scaffolding is provided. In educational games, this scaffolding can take the form of step-by-step challenges, in-game prompts, or teacher facilitation alongside gameplay.

Natural sciences, much like mathematics, benefit significantly from inquiry-based and exploratory models. Through games, learners can observe virtual phenomena (e.g., erosion, volcanic activity, or ecosystems) and manipulate variables to draw conclusions—activities that mirror scientific investigation processes. In this way, GDL and DGBL together promote both conceptual understanding and scientific thinking skills (van Joolingen et al., 2005). The KIDEDU initiative seeks to tap into this synergy by offering pupils an opportunity to actively construct knowledge through a combination of narrative-based tasks, problem-solving, and creative exploration.

III. THEORETICAL FRAMEWORK & RESEARCH QUESTIONS

The framework of Differentiated Instruction (Tomlinson, 2001) is essential in addressing the diverse needs of learners in the Greek primary education system. The ability of the KIDEDU game to allow learners to proceed at their own pace and choose from various paths or types of challenges makes it especially effective in mixed-ability classrooms. This adaptability reflects a broader pedagogical commitment to inclusive education and supports the development of individual learning profiles.

Importantly, the theoretical framework also recognizes the interdisciplinary nature of science and mathematics education. Learners are encouraged to engage with real-life problems that require cross-curricular reasoning—e.g., applying numerical reasoning to environmental questions or interpreting data in scientific contexts. This integrative approach is in line with modern science education principles that emphasize inquiry, modeling, and systems thinking (Bybee, 2010).

The overarching aim of the study is to evaluate the educational effectiveness and learner perceptions of the KIDEDU game in the context of Greek primary education. Specifically, the study seeks to:

Assess the impact of the KIDEDU game on pupil engagement and motivation in mathematics and natural sciences.

Examine how game-based guided discovery supports conceptual understanding.

Explore the effectiveness of differentiated game mechanics in accommodating diverse learning needs.

Identify potential for scalability and implementation across all primary school grades.

IV. METHODOLOGY

This study adopts a mixed-methods approach, combining the implementation of a serious digital game with the use of post-intervention questionnaires to explore student engagement, conceptual understanding, and learning preferences. The methodological design aligns with contemporary educational research that supports the use of Game-Based Learning (GBL) as a tool to enhance motivation and learning outcomes (Arnab et al., 2012; Gee, 2007) and reflects a constructivist orientation grounded in learner-centred exploration.

The study was conducted in three Greek public primary schools, with a sample of approximately 200 pupils aged 6–8 years, corresponding to the third and fourth grades. The schools represented mixed socio-economic areas, and the student sample included pupils with varied academic abilities. Parental consent and school approvals were obtained, and participation was fully voluntary and anonymized.

This age group was chosen based on developmental appropriateness and cognitive readiness to engage with narrative-based tasks, logical puzzles, and scientific reasoning (Tomlinson, 2001). The diversity of the sample enabled the evaluation of how the game functioned within heterogeneous classrooms, particularly in terms of differentiated instruction.

The game includes a built-in scoring system that rewards correct answers and task completion, encouraging effort and reinforcing intrinsic motivation (De Freitas & Jarvis, 2007). The average gameplay lasts 4–5 hours, typically completed over multiple classroom sessions. Game-based tasks were structured to reflect curricular content and promote guided discovery learning, whereby pupils construct knowledge through problem-solving within a semi-structured narrative environment (Mayer, 2004).

The questionnaire was based primarily on Likert-scale items (1 = strongly disagree to 5 = strongly agree) tailored for young learners, a method widely used for affective and perception-based data collection in primary education (Chatterji, 2003; Cohen, Manion & Morrison, 2011). Items included statements such

as "I enjoyed learning with the game," "I want to play more games like this," and "I understood maths/science better through the game."

V. FINDINGS

Research data was collected from both the questionnaires and the Contractor's personal notes. This data was analyzed and cross-referenced in order to provide evidence relating to the research questions. The most important findings per question are presented in this section.

The initial phase of this research showed that the questionnaire was reasonably well structured, with an average completion time of between 3 and 4 minutes. More specifically:

•   Most of the kids were able to solve the problems of the game and complete the game with ease. Their participation was particularly active and intense, showing enthusiasm during the implementation of the activities. No particular problems were observed in getting familiar with the game.

•   Children's interaction with the application environment was highly engaging, with children quickly reaching high levels of practicality.

•   The educational game encouraged pupils to develop various problem-solving strategies, act in a specific environment, control their actions and understand the consequences of their interaction with it, encouraging critical thinking.

•   When solving the problems, the pupils either followed a specific plan of approach to the solution or flexibly adapted to the requirements of each activity.

•   Pupils mainly preferred to work in pairs. One child helped and guided the other where this was deemed necessary, thus limiting the role of the teachers.

•   The use of images and sound effects played an important role in engaging pupils with the educational game.

Gender: Of the 200 survey participants, 47% were boys and 53% were girls. The gender distribution among participants is relatively balanced, with slightly more girls than boys.
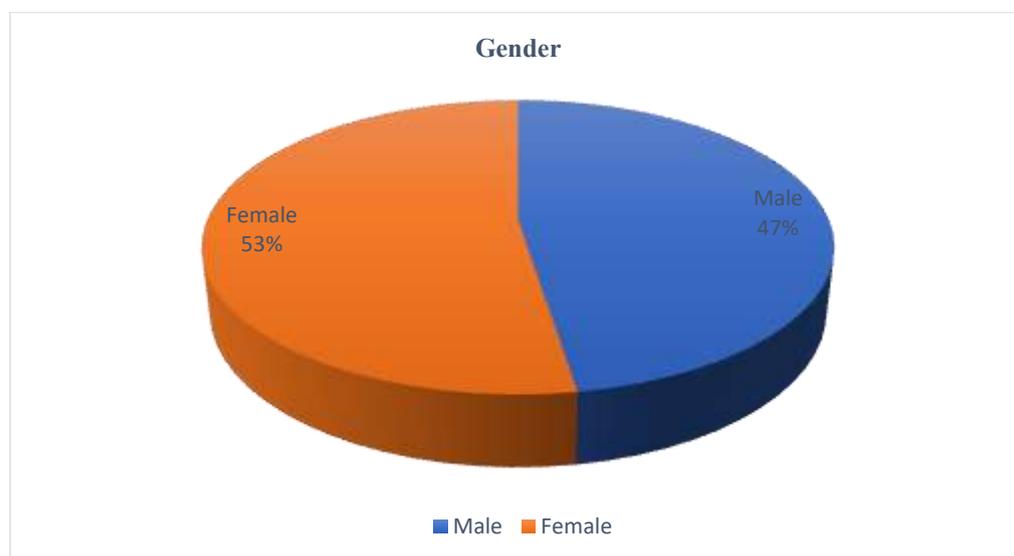

Fig. 1 Gender of the participants

Educational Level: All pupils aged 6-8 years (elementary school pupils).

Use of Technology: 84% (168 out of 200) of the children use a computer or tablet. The large majority of children use a computer or tablet, which shows their familiarity with technology and their ability to effectively interact with the game application.
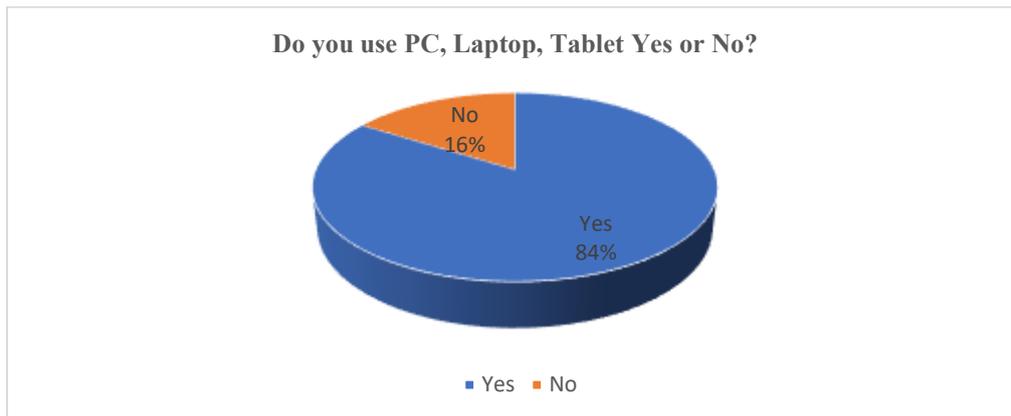
Fig. 2 Use of Technology

The following questions are related to the Game Experience: The children's experience during the operation of the game application was assessed through quantitative analysis of the respective responses. The results collected are detailed below:
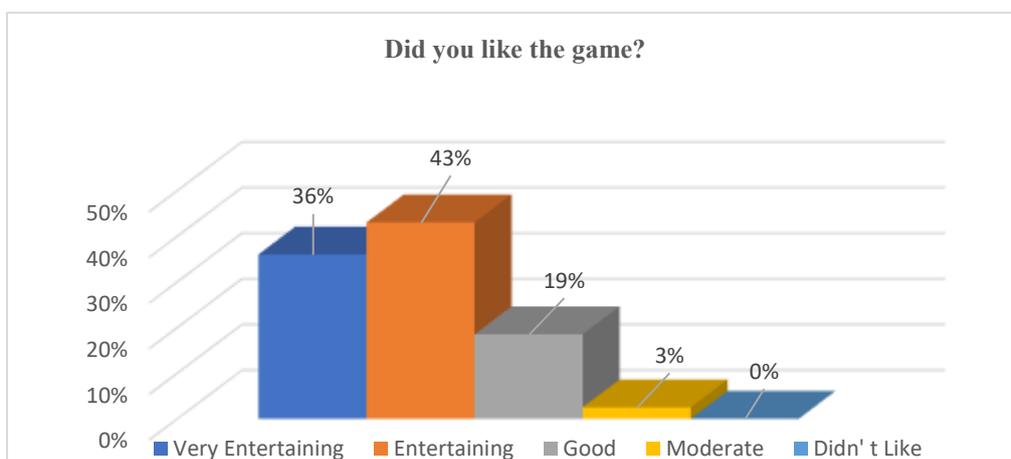

Fig. 3 Game Fun

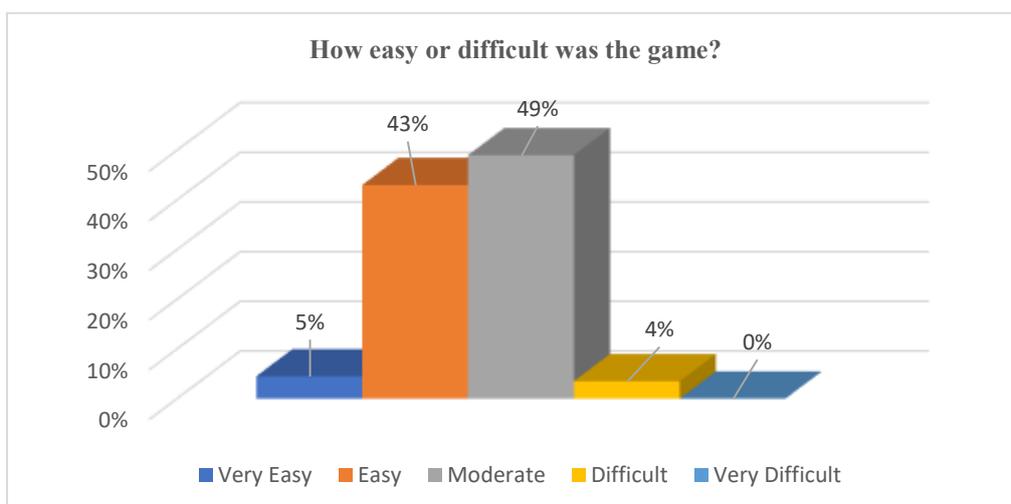**Game Fun:** 79% of children rated the game as fun or very fun.

Fig. 4 Game Difficulty

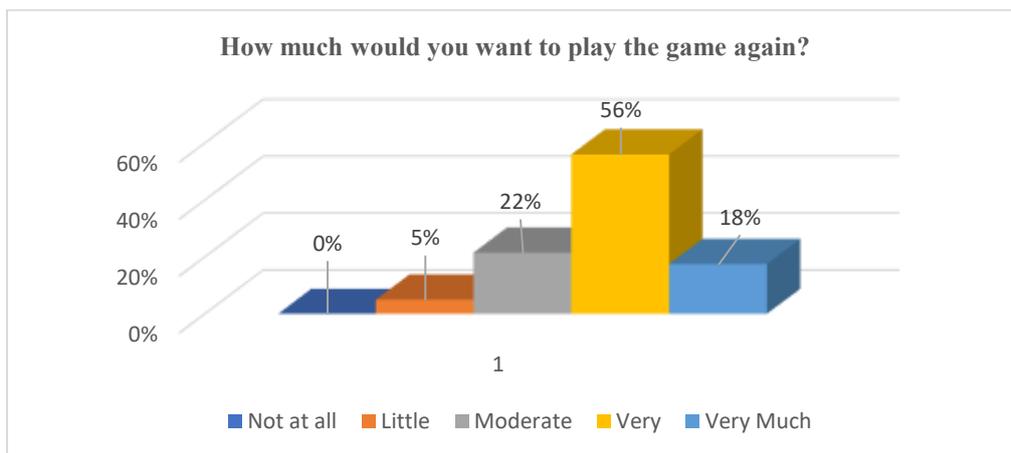**Game Difficulty:** 97% of children found the game very easy, easy of moderate.

Fig. 5 Willingness to Replay

Willingness to Replay: 74% of the participants (very and very much) answered that they want to play the game again.
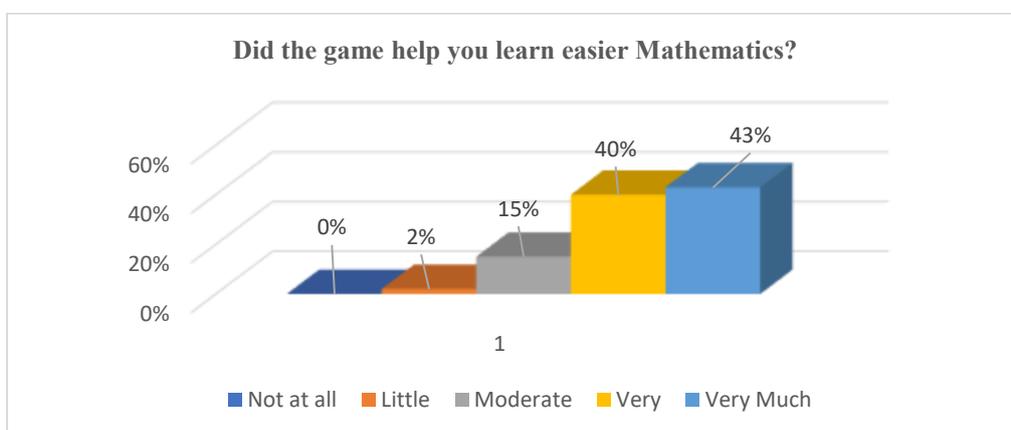

Fig. 6 Easier Learning Mathematics

Easier learning: 83% of children answered that they learned Mathematics easier or much easier playing the game.
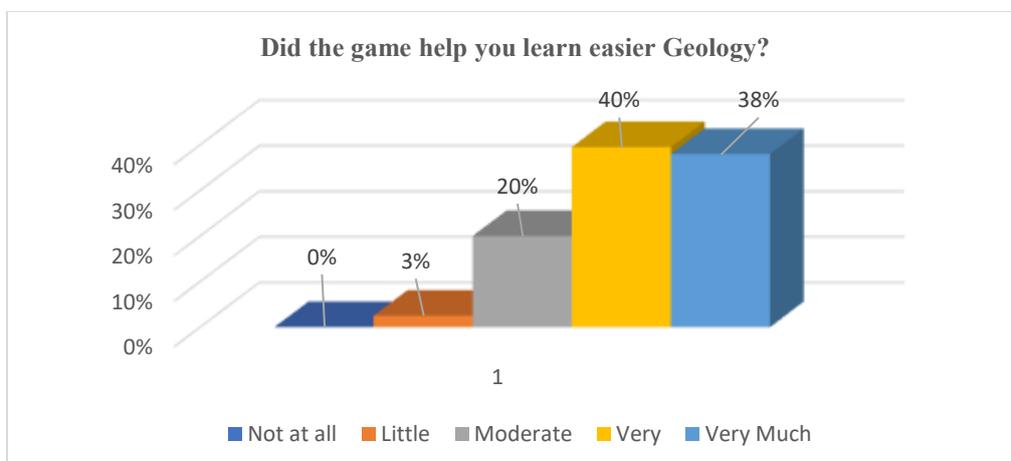

Fig. 7 Easier Learning Geology

Easier learning: 78% of children answered that they learned Geology easier or much easier playing the game.
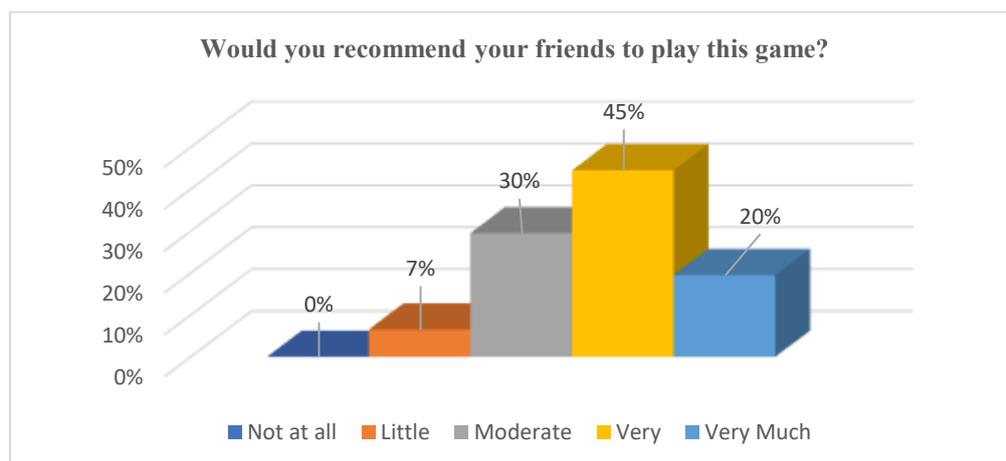
Fig. 8 Recommendation of the game

Game Recommendation: 65% of the participants will recommend (very and very much) the game to their friends.

VI. CONCLUSIONS

This study highlights the effectiveness of KIDEDU in demonstrating how digital game-based learning, underpinned by guided discovery, can enhance pupil engagement and conceptual understanding. Through a narrative-driven, problem-solving digital environment tailored for diverse age groups, the game succeeded in engaging learners, promoting motivation, and facilitating the understanding of mathematical and natural science concepts in a meaningful way.

The investigation of the educational application also showed that the educational game enhances interpersonal communication and team spirit. Pupils are encouraged to collaborate and interact with each other, promoting the development of skills such as problem solving, decision making and critical thinking. In addition, the app provides opportunities to explore and search for information, making learning a more active and participatory process.

In sum, KIDEDU demonstrates that playful learning environments, when grounded in sound pedagogy and thoughtful design, can enrich the educational experience and bridge the gap between formal curricula and the digital lives of today's learners. Moving forward, interdisciplinary collaboration between educators, designers, and policymakers will be essential to unlock the full potential of such innovations.

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