

# Differentiated Learning and Digital Game Based Learning: The KIDEDU project

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## ABSTRACT<sup>1</sup>

The present paper discusses the current developments with regards to digital game-based learning and its applications in the primary education. Furthermore, it presents the KIDEDU project initiated at the University of Piraeus, in order to provide a student-appealing means for cultivating mathematical aptitude.

**Keywords:** Digital game-based learning, distance learning, differentiated learning, guided discovery learning.

## 1. INTRODUCTION

Modern societies dictate the need for lifelong learners who possess a deep knowledge of subject matter as well as broader social skills. This necessity appeals for a deeper understanding regarding the interconnection between pedagogy and the learning process. Paniagua and Istance [1] claims that focusing on pedagogies alters the teachers' approach from a merely technical role, seeking to attain the goals of the curriculum to that of an expert in the teaching process. Furthermore, the importance of innovation in the teaching process is an undisputed reality. Innovation in teaching entails creativity as well as novelty on behalf of the teacher, who is expected to adapt their style and teaching approaches in accordance with the updated technology as well as the social developments taking place. Universities and schools are currently developing and employing new teaching approaches, and technology-driven innovations to enhance the students' cognitive ability and knowledge. Kalyani and Rajasekaran [2], notes that innovation in the teaching process is essential both for the present and the future of education, given that it allows students to attain their full potential.

In this context, the notions of differentiated teaching are quickly gaining momentum. The Greek schooling communities have gained increased cultural diversity as well as substantial socio-economic variety in recent decades. These changes have resulted in growing heterogeneity within the classroom, especially in the Attica prefecture, which in turn has raised the demand for differentiated instruction. According to Panteliadou and Antoniou [3] the term differentiated instruction denotes the systematic approach, which is assumed in the design of the teaching process and addresses the learning needs of the learners on an individual basis. Consequently, differentiated teaching approaches are capable of adequately facing the raised

diversity of a mixed school classroom, which is formed in the context of social change and dynamic requirements [4]. Several studies have acknowledged the benefits of the adoption of differentiated instruction methods. Such studies include Smith and Throne [5], Hall et al. [6], Theisen [7], and Johnsen [8]. However, the Greek primary and secondary schools still lack in relevant initiatives. As noted in Mavroudi [9], differentiated instruction as well as individual learning strategies are only partially implemented in the Greek state schools, which is attributed to the misconceptions in the teachers' part as well as the limited resources and training initiatives. In addition, Papadakis and Ziskos [10] argue that scarcity in the implementation of differentiated instruction can be attributed to the time-demanding nature of the process, considering both the preparation and the class conduct.

The advantages of adopting new means of technology such as computers and IT-tools for educational purposes are well-understood. Such tools offer the agility and the potential to be customized in their interface, in accordance with the user's preferences. Moreover, adopting IT tools in the teaching process, especially during the early stages of education, familiarizes the individual with new and dynamic means of technology from an early age, which is very important given the absorbing capabilities at this age. Finally, the study by Hsu [11] claims that the use of computers in the academic environment for teaching purposes as well as the contact of students with technology is crucial.

Another key idea that renders highly relevant to the scopes of modern teaching is that of guided discovery learning. Primary and secondary schools have been placing considerable effort in the development as well as in the practice of new teaching approaches. These approaches often involve significant innovations, which rely heavily on advanced technology means, to develop the cognitive ability of the individual and to achieve the efficient skills development and facilitate the transfer of knowledge in a group scale. The study by Kalyani & Rajasekaran [2] stresses the importance of innovative teaching for both for the present and the future of education, given that it helps students reach their full potential. In more detail, in accordance with Neber [12] the notion of discovery learning indicates a general instructional approach, which represents the first broad development of constructivist learning intended for the school-based learning environment. Another key issue with regards to discovery learning is analyzed in Holland et. al [13], which argues that learners have to generate units and structures of abstract knowledge, often using their personal inductive reasoning, regarding non-abstracted learning materials. Furthermore, the level of guidance that needs to be provided varies adaptively, since it depends on the complexity of the targeted knowledge, the difficulty of the learning material, and the cognitive and motivational prerequisites of the learners. It is

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<sup>1</sup> The author acknowledges the support of the University of Piraeus.

therefore well understood that the level of guidance or structuredness of the learning environment is not fixed in strict terms, but rather it constitutes a variable and non-defining characteristic of discovery learning. Furthermore, Neber [12] claims that the application of discovery learning methods may provide the way one to achieve higher levels of thinking, which per se, is one of the primal goals of education. In line with the principles of discovery learning, several methods have been designed and implemented. Amongst these methods, the ones that are met most commonly include, learning by examples, learning by design or design-based learning, and learning by experimentation or scientific inquiry.

The study by Neber [12] argues that computer-based learning environments offer specific advantages for proximally adapting techniques and teaching structures relating to online information regarding frequencies and qualities of learners' activities. In this respect, initiatives that are relevant to guided discovery learning and make use of IT tools demonstrate vital prospects. However, the application of such initiatives in the Greek educational system is still practically non-existing. The University of Piraeus through the KIDEDU project aims to create a new framework deviating from conventional teaching methods that combines guided discovery learning and differentiated teaching seeking to provide a flexible and efficient alternative approach to the conventional practices currently employed in the Greek education.

## 2. THE KIDEDU PROJECT

### Existing Gaming Approaches

The academic community acknowledges the role of game-based learning and hence has devoted considerable effort in the development of relevant games. We summarize these efforts in Table 1, which is provided in the Appendix. We note here that none of the respective games is intended for primary education purposes. Furthermore, none of these games utilizes 3D digital technologies. Therefore, new approaches are needed in order to provide up to date means of education, which are both appealing to the younger generations and capable of cultivating constructive and mathematical thinking.

### KIDEDU–Play Create Learn

The University of Piraeus has commenced the project KIDEDU (Play Create Learn) aiming to reform the traditional curricula in mathematics, currently in use in the Greek primary schools. The project involves a series of interactive games intended to pupils between six and twelve years of age. These games are rich in context and design, and they utilize 3D animations and realistic visual and sound effects. Regarding their educational objectives, the games seek to equip pupils with the fundamental concepts of basic operations, and they aim to familiarize pupils with conceptual tools and ideas from the areas of graph theory, combinatorial optimization and decision modelling. More particularly, the games seek to create an appealing and constructive educational framework, which is effective in developing the quantitative skills of the pupils. The project results in an innovative and student-friendly learning mode, which makes use of up-to-date digital technology, making it rather enchanting for the younger students. It thus substitutes the conventional means of teaching, including books, blackboards, notebooks and pencils and creates a stimulating

learning mode which is very relevant in the context of guided discovery learning.

The literature in cognitive theory discusses the conditions and the driving forces guiding the learning processes of the individual. Learning processes entail stimuli and experiences from the environment, which activate the cognitive mechanisms. Hence, the key question becomes how this connection between the stimuli of the environment and the intrinsic cognitive mechanisms, may be facilitated and lead to optimal cognitive results. The principal goal of KIDEDU is to create an appealing and effective framework which stimulates the learning mechanisms and allows students to develop advanced quantitative skills, employing the principles of guided discovery learning.

### Contents of the Project

The instruments and concepts of the “Planet Earth” game, in the context of the curriculum for children aged between 6 and 12, involve:

- Solar system
- Planet Earth
- Weather and climate
- Water cycle
- Cycle of rocks
- Plants
- Evolution of life
- Human evolution
- The human body
- Ecology and ecosystems
- Greenhouse Effect
- Acid rain
- Ozone hole

The instruments and concepts of the “Everyday Arithmetic” game include:

- Addition - Subtraction (number analysis)
- Multiplication - Division
- Length - Weight - Applications
- Fractions
- Percentages
- Factorization
- Equations
- Corners
- Geometric shapes - Solids – Symmetry
- Length - Area – Volume
- Time - Applications
- Money - Applications

- Statistics - Applications
- Information Management
  - a. Complex problems of Mathematics using Informatics
  - b. Problems combining Mathematics and Geography

### 3. LEARNING OBJECTIVES AND CLASS CONDUCT

Research has shown that teaching, involving games and computers, is cost-effective even though it costs more than conventional pedagogy [14]. The relevant curricula are cost-effective, since they bring students to a certain level of proficiency in relatively short times and are, in general, favored by the students. In the same line, computer-based study systems seem to be more effective than games or simulations, especially with regards to students of low performance. Furthermore, students prefer being taught at their own personal pace, which seems to increase their performance.

One of the main advantages of game-based teaching is that students assume a less passive role during the classes, compared to conventional teaching conduct. This less passive role is well accepted to facilitate the learning process and yields better learning outcomes.

Computer-based lesson formats provide an alternative for class conduct, wherein the participation of the student is rather intensive, regardless of the size of the classroom. However, the design of the relevant teaching tools should be done bearing in mind the diverse learning objectives as well as the principles of pedagogy.

In this respect, the use of multimedia provides ample prospects. The relevant applications combine the attributes of databases with up-to-date tools for visual and sound effects. Interactive multimedia applications allow the end users to control the learning process, accessing the relevant materials, and choosing amongst alternative game paths.

The main pitfall of game-based teaching relates to the use of the games involved, which by no means should deviate from the scopes of the lesson. The games are not supposed to provide one more leisure activity for the young students but rather offer a student-engaging means of class conduct.

### 4. CONCLUDING REMARKS

Conventional wisdom postulates that the effort of the individual is the main driving force behind successful performance. Students claiming to devote substantial amounts of time at a module, usually achieve high grades. However, computer-aided teaching involving games has been shown to be almost as effective as conventional teaching although it is probably more costly [14]. At the same time, contemporary research shows that computer-based study systems seem to be more effective than games and simulations alone, particularly for students exhibiting weaker performance [15].

The development of software exclusively designed for educational purposes is at its very early stages in Greece as well as in Europe. Rigid educational systems combined with

insufficient teacher training with regards to the new technologies, make the incorporation of new software applications in the teaching process a rather challenging task.

Traditional educational programmes are effective because students can reach a standard level of qualification sufficiency within specific timelines. Nevertheless, such programmes have shown to be unpopular with students, who in their part, enjoy being taught according to their own preferences, which in many cases yields increased performance. Even though research has produced controversial results as regards the advantages of applying computers in mathematics and natural science modules, technology-aided teaching is here to stay. In this respect the KIDEDU project provides a pioneering approach, aspiring to bring new practices in the Greek education system.

### 5. REFERENCES

- [1] A. Paniagua, D. Istance, **Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies**, Educational Research and Innovation OECD Publishing, 2018.
- [2] D. Kalyani, K. Rajasekaran, “Innovative teaching and learning”, **Journal of Applied and Advanced Research**, Vol. 3, No. 1, 2018, pp. 23–25.
- [3] S. Panteliadou, F. Antoniou, “Teaching Approaches and Practices for Students with Learning Difficulties”, Volos, 2008.
- [4] H. Mulroy, K. Eddinger, “Differentiation and literacy”, Paper presented at the Institute on Inclusive Education, Rochester, 2003.
- [5] G.E. Smith, S. Throne, **Differentiating instruction with technology for K-5 classrooms**, New York: ISTE (International Society for Technology in Education), 2007.
- [6] T. Hall, N. Strangman, A. Meyer, “Differentiated instruction and implications for UDL implementation”, Report for the National Center for Accessing the General Curriculum (NCAC), 2003, Available: <http://www.cast.org/ncac/>
- [7] T. Theisen, “Differentiated instruction in the foreign language classroom: Meeting the diverse needs of all learners”, **Communique**, Vol. 6, 2003, pp. 1-8.
- [8] S. Johnsen, “Adapting instruction with heterogeneous groups”, **Gifted Child Today**, Vol. 26, No. 3, 2003, pp. 5-6.
- [9] A. Mavroudi, **Implementing differentiated instruction in the Greek state primary school: Teachers’ attitudes and preferred differentiated strategies**, In E. Agathopoulou, T. Danavassi, L. Efstathiadi (Eds.), *Selected Papers on Theoretical and Applied Linguistics from ISTAL*, Thessaloniki 24-26 April 2015 (Vol. 22, pp. 372-385). Thessaloniki, Greece, 2017.

- [10] S. Papadakis, V. Ziskos, "Design and Implementation of Differentiated Instruction Digital Scenarios in LAMS", **MIBES Transactions** Vol. 9, No. 2, 2015, pp. 39-48.
- [11] Y.S. Hsu, "Using the internet to develop students capacity for scientific inquiry", **Journal of Educational Computing Research**, Vol. 31, No. 2, 2004, pp. 137-161.
- [12] H. Neber, **Discovery Learning**. In Seel, L. (Ed.), *Encyclopedia of the Sciences of Learning* (pp. 1009-1012). New York: Springer Science & Business Media, 2012.
- [13] J.H. Holland, K.J. Holyoak, R.E. Nisbett, P.R. Thagard, **Induction. Processes of inference, learning, and discovery**, Cambridge: MIT Press, 1986.
- [14] E. Tsami, **The use of New Technologies in Teaching Economics**, Phd Thesis, University of Piraeus, 2009.
- [15] E. Tsami, "Teaching Statistics in the time of the COVID-19 Pandemic", 15th International Multi-Conference on Society, Cybernetics and Informatics: IMSCI 2021 Florida, July 18-21, 2021.

## Appendix

**Table 1: Existing Games**

Game	Description	Source
University Management – “Virtual U” (Management Education)	The specific game simulates the administration processes of academic institutions.	<a href="http://www.virtual-u.org/">http://www.virtual-u.org/</a>
The Stock Market Game	Gamers are required to invest (hypothetically) \$ 100,000.	<a href="http://www.smgww.org/">http://www.smgww.org/</a>
Gazillionaire	A strategy game wherein the gamer tries to make as much money as possible thru buying and selling space goods on exotic planets.	<a href="http://www.lavamind.com/index.html">http://www.lavamind.com/index.html</a>
World Game of Economics	A game wherein each student assumes the role of a country and tries to make the right decisions to improve some economic indicators.	<a href="http://www.worldgameofeconomics.com/">http://www.worldgameofeconomics.com/</a>
Dino Age	Interactive painting game based on the theme of dinosaurs that allows gamers to choose and paint the dinosaur of their choice. The dinosaur is subsequently projected on a display screen to walk in the dino age.	<a href="http://www.gooest.net/product_detail.aspx?id=198">http://www.gooest.net/product_detail.aspx?id=198</a>
Little Star Earth "Dream"	Interactive game that is based on the picture book “Little Star Earth dream”. The game guides the students through the character’s journey to find dreams and involves game activities which develop the gamer’s imagination but also cultivate competitiveness.	<a href="http://www.gooest.net/product_detail.aspx?id=184">http://www.gooest.net/product_detail.aspx?id=184</a>