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The model of a smart education system: gamification of teaching through digital dialogue

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Abstract: The two starting points of this research are the Socratic dialogue method and the "forgetting curve." Hermann Ebbinghaus. On the other hand, it is known that it is Socrates' dialogue is a method of philosophical inquiry and interaction that he employed to encourage his interlocutors to think more deeply and analyze their beliefs. This method is based on asking questions that lead to the discovery of truth, relying on logical and critical discussions. The second starting point is Hermann Ebbinghaus's Forgetting Curve, which emphasizes that resumption of material is most important in the first few minutes after learning, because then the speed of forgetting is the highest. Without repetition, as much as 50–70% of information can be forgotten in the first hour. Early restoration slows down this process and allows for longer-lasting memory. This paper is part of a more extensive research, in search of a teaching concept that would realize the ideal of Socratic dialogue and ensure the highest level of retention of the exhibited material, in accordance with the recommendations Hermann Ebbinghaus with the help of modern digital technologies. At the same time, the application of gamification in teaching increases the motivation and interest of students for active learning in the teaching process.

Keywords: digital dialogue; gamification in teaching; interactive teaching; hybrid learning

1 INTRODUCTION

Smart education systems are an innovative educational model that integrates technology, digital tools and resources to improve the quality of teaching and the entire educational process. This system uses intelligent technologies, such as artificial intelligence, data analytics, gamification, and digital dialogue, to provide personalized and interactive education. The main goal of a smart education system is to create a dynamic environment that supports collaboration, critical thinking, and active learning, while optimizing the learning process and administration. Smart education systems allow all students to have access to a variety of educational resources and customized content, thereby increasing engagement and learning success.

The increased flow of information and social media technologies have created enormous benefits for researchers in the current era. In the age of scientific invention, increasing the diversity of data generation and its efficient use and maintenance are becoming a significant challenge for information systems (IS) researchers and educational design practitioners. These challenges encourage the development of ideas that lead to new technological inventions, the inclusion of which makes it possible to create new systems by which we can provide better education. Information technology has entered the education system with a bang. [2]

Educational methods and information technologies are still searching for the optimal combination of software and pedagogical solutions. Every day, work is being done to introduce new technologies into educational experiences. We can point to experiments, pilots, and prototypes, but all in all, they are small-scale, with no guarantees, or often without the means to advance. Virtual reality is used to bring science to life, transport lessons on virtual travel, and market universities to potential future students. [3]

All of these devices create a variety of data, also known as big data. Big data varies in its scope, speed, variety, variability, and dynamism. What's more, big data, generated on social media and through various IoT devices, has created much greater opportunities for users and different decision-makers to better understand the problems. [4]

Over the past few decades, technology has changed the way education works. The standard hybrid learning model is implemented through a combination of the Distance Learning System (DLS), as a specific hardware and software solution, and face-to-face teaching. Such systems are used to increase student interaction and classroom lessons, obtain critical opinions from each student individually, and create an environment for cooperative and active learning. [5]

Exploring the interaction between classroom dialogue and digital technology is a growing field of study. Most research on the impact of digital technology on productive dialogue in the classroom is based on the sociocultural perspective of education. [6]

Teaching dialogue and its development are based on different "resources". First of all, dialogue implies the participation of people, and the teaching context is characterized by the presence of a relatively large number of participants of different knowledge, experiences, origins, interests, etc. We understand these differences as the richness and source of the content of dialogue in teaching, and the dialogic exchanges between different perspectives and positions as the basis for assigning meaning, joint learning and cognition, i.e. as a starting point for education and upbringing. In this sense, the dialogic potential of the lesson is defined as an

underused resource, but also as a potential that can be actualized in learning activities with others, more precisely through the exchange they achieve, thus encouraging their own development, but also the development of the interlocutor. [7]

The Socratic Dialogue is a method of philosophical inquiry and dialogue used by Socrates to encourage his interlocutors to think more deeply and analyze their beliefs. This method is based on asking questions that lead to the discovery of truth, relying on logical and critical discussions.

On the other hand, "dialogic teaching" and "dialogic pedagogy" mean an approach to teaching based on the active, extended involvement of students and teachers in speech interaction in the classroom, so that teaching and learning become a collective endeavor, in which knowledge and understanding are shared (rather than teachers using speech only to convey the content of the curriculum and assess its acquisition by students). [8]

Classroom dialogue is a tool that can be used to help students build knowledge as they explore and build on their own and others' ideas. In this way, the conceptualization of learning is expanded, going beyond the idea of acquiring knowledge to include the involvement of students in knowledge-building practices. [9] [10]

The concept of Digital Dialogue (DD) as a system for creating a higher degree of interaction between subjects - through Wi-Fi (Wireless-Fidelity) technology, mobile software applications and devices, and teaching methods, which include Web Based Training (Internet Based Test - iBT), ensures that the entire course of the teaching process during a single course is transferred to electronic form. Enriched with interactive multimedia and placed in the appropriate databases. The dynamics of the activities are still controlled by the lecturer in interaction with the students. [11]

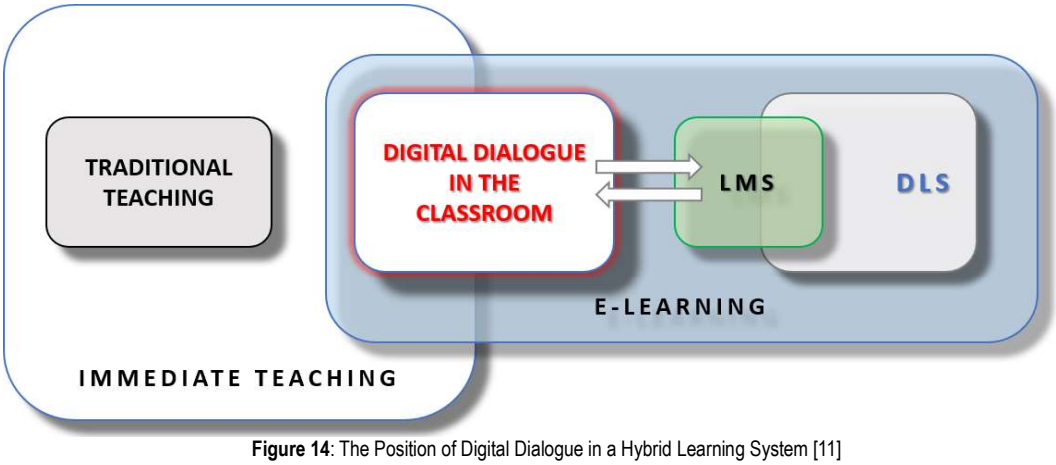

Figure 14: The Position of Digital Dialogue in a Hybrid Learning System [11]

This work is based on research Cognitive science in relation to Hermann Ebbinghaus's "forgetting curve" and the application of the concept of digital dialogue in the classroom. Research shows that a structured approach to time management can significantly improve knowledge retention by introducing regular intervals to refresh and validate accepted material. Today, the Ebbinghaus chart is becoming a way to estimate the time it takes people to learn a new skill and evaluate performance. [1][12]

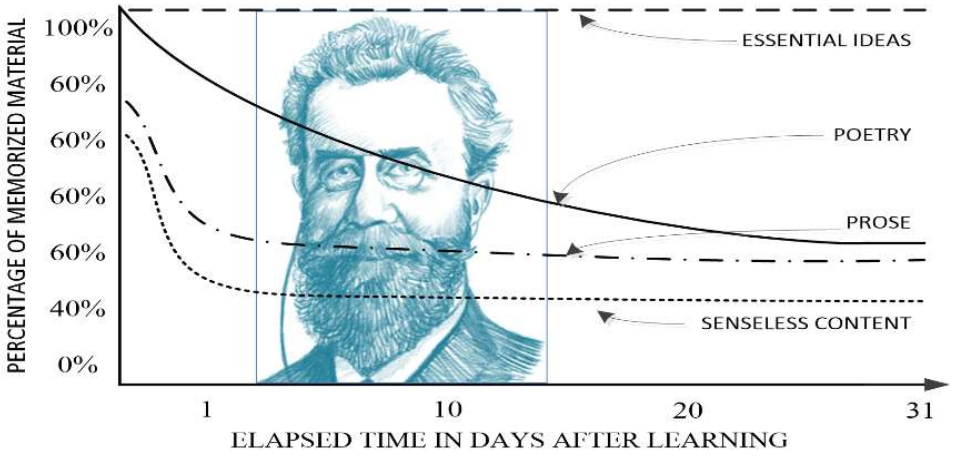

Figure15: Ebbinghaus's forgetting curve [1] [12]

There are several studies that confirm the effectiveness of the concept of digital dialogue in teaching, as measured by knowledge tests, by analyzing activities and the number of interactions in class, and by exploring the optimal time allocations of dominant roles in the classroom [13] [14]. This paper, however, explores the elements of gamification of the teaching process, when digital dialogue is applied in class. Gamification naturally aligns with digital dialogue, as both involve problem-solving, logical reasoning, and iterative learning. Integrating game elements into information technology-focused activities can make abstract concepts more appealing and accessible to students. [15]

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2 METHODOLOGY AND DESCRIPTION OF THE RESEARCH

This research is part of a larger project, entitled "Digital Dialogue in a Hybrid Learning System", which includes examining the effects of digital dialogue in teaching from different aspects. Some of the results of these studies have been published at conferences and in journals [16]I. However, this paper contains new, unpublished data and a different analysis of the collected data is applied. [17] [15]

For the research sample, data were collected from departments that use digital dialogue and those that use traditional methods. It is ensured that the sample is representative and that both approaches are equally represented. The research was conducted in the school year 2022/23 at the ETŠ "Nikola Tesla" Secondary School in Niš, Serbia. In a *period* of 14 days, in 3 hours, 9 lessons with traditional teaching and 9 hours with the application of digital dialogue were recorded. Three departments of the same grade were selected, educational profiles Computer Electrical Technician and Information Technology Electrical Technician, 3rd grade. Classes have approximately the same number of students (from 25 to 30). The study was conducted by three teachers who taught the same classes but with different subjects. Those classes in which the type of teaching is carried out - the processing of new material is chosen. [16]

In the classes that are implemented by the method of digital dialogue, the teacher who leads the classes, according to the regular curriculum, asks a short question every 3 to 6 minutes, related to the teaching material just presented. At that moment, through a specially created web application - Digital Dialogue, the question is forwarded to all students. The Digital Dialogue application was created with the aim of encouraging intensive interaction between students and teachers, and increasing student retention of the presented material.

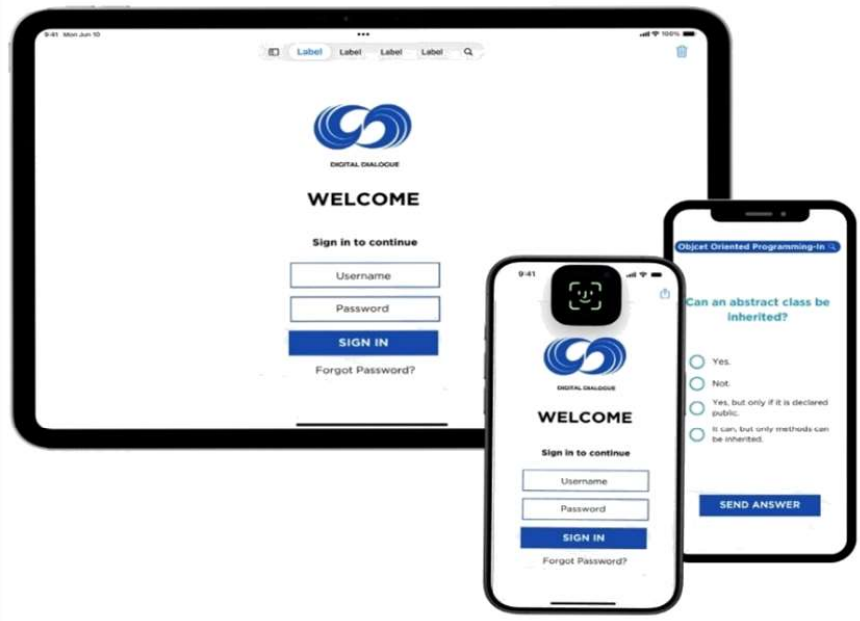

Figure16: Layout of the Digital Dialog application

By using a special application for digital dialogue, all students send answers in real time. Teachers' questions in digital dialogue are short and specific, so the time for students to answer is very short, most often with a choice of one of the offered answers.

For each lesson, the activities of students and teachers were measured: the time in which the teacher speaks, the time in which the students speak and the time of silence. In order to make measurements accurate, a Java desktop application was created with which the moments of interruption of the teacher's activity are marked and the activity of students begins, and vice versa. The application records the events during the class, visually presents them and samples the results for the purposes of statistics at intervals of 1 to 5 minutes. At the end of the measurement, the Java application calculates the average values for all 18 classes held and provides the export of the data, in the appropriate format, for further analysis.

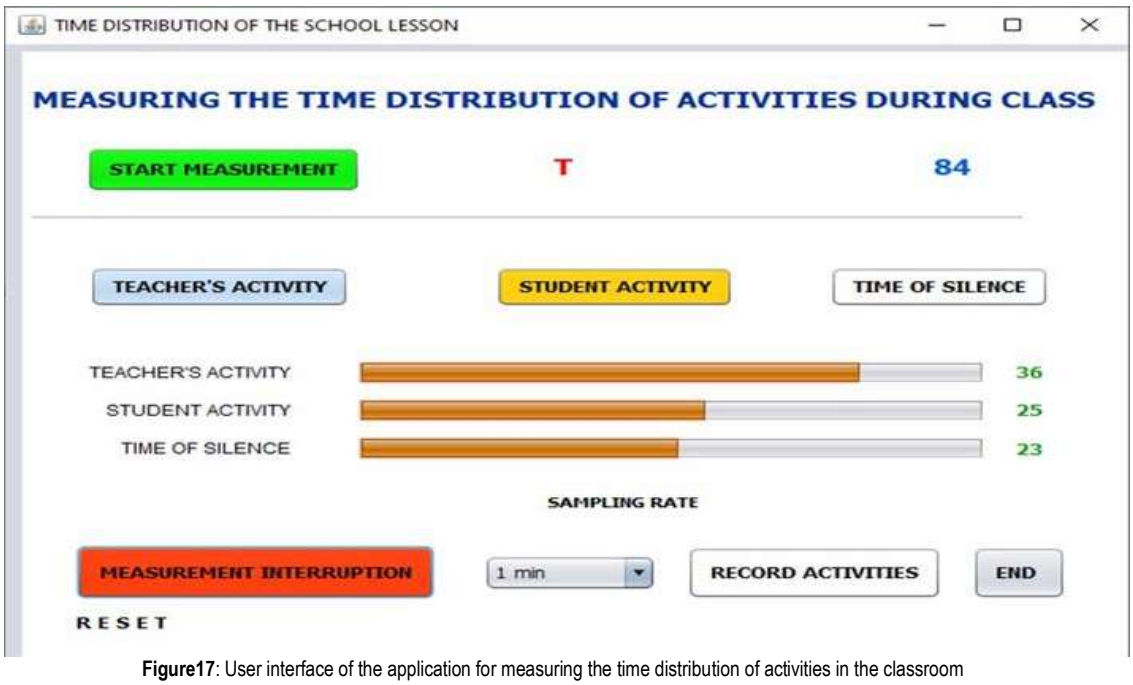

Figure17: User interface of the application for measuring the time distribution of activities in the classroom

After the classes, each of the students answered a few questions and evaluated, from the aspect of gamification, the classes in which digital dialogue was applied with a grade from 1 to 5. The ratings were related to the following attributes:

Point system and motivation

The competitive aspect

motivation for better results

Is it more fun than the traditional

Scoring speed and responsiveness

RESULTS

Figure 4 shows the results of measuring interaction in teaching with digital dialogue (D-group) and traditional method (T-group). Here are the results for all 18 hours:

- Total number of questions from teachers
- Total number of responses received
- A period of time in which the teacher dominates
- A period of time in which students dominate
- A period of silence

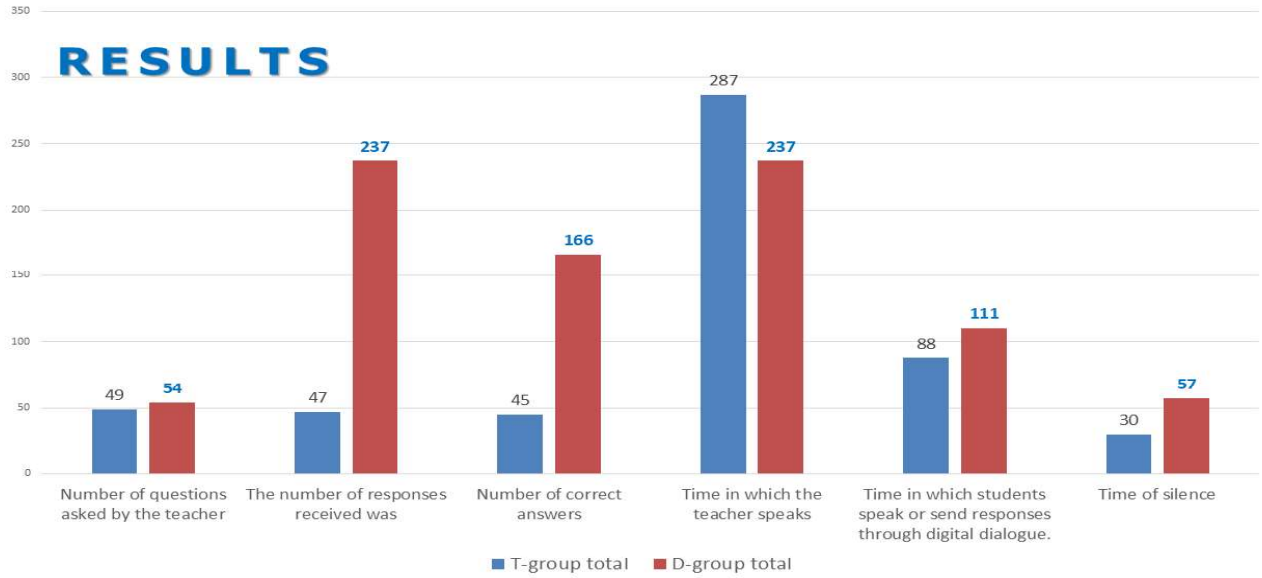

Figure18: Results of interaction measurements

Based on the characteristics of the sample, after collecting the data, a T-test was selected to determine statistical significance. For each of the 5 measured values, the null hypothesis (H0) was established, which states that there is no statistically significant difference between the mean values of these two groups. This hypothesis is rejected if $p < 0.05$. For most of the measured values, an alternative hypothesis was confirmed, with the claim that there is a statistically significant difference in the calculated values of the different teaching methods used. Only for the total number of questions asked

during the class, there is no statistical significance in the difference.

Figure 5 shows the grades with which students evaluated the teaching by applying digital dialogue from the aspect of gamification. A total of 78 students participated in the study. For each of the attributes of gamification in teaching, an average score in the range of 1 to 5 was calculated.

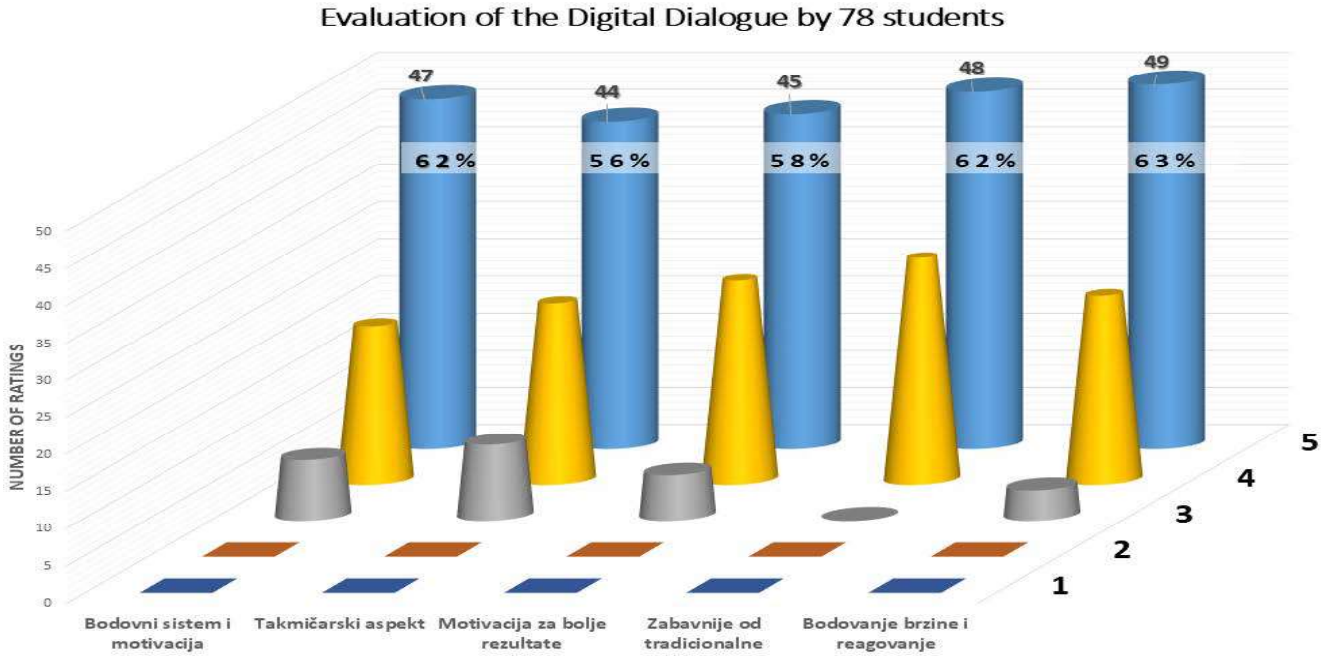

Figure19: Evaluation of digital dialogue by 78 students

DISCUSSION AND CONCLUSION

Based on the data presented, it is observed that the digital dialogue method encourages more engagement and interaction among students, with more questions asked by the teacher and many more answers received. The teacher in the digital method speaks significantly less, allowing students more time to express themselves. This is confirmed by the fact that the average time when students speak is 20% longer in digital dialogue classes. The most significant difference is expressed in the data on the number of answers received by students and the number of correct answers received.

It can be concluded that modern technology provides excellent tools for the implementation of the concept of digital dialogue. The advantages it brings are reflected in the new attributes of the teaching process:

- Inclusivity in Answering: In classic Socratic dialogue, questions were often addressed to individuals, but the ideal might be to ask questions that allow for everyone's participation. This inclusivity ensures that no student is passive and that everyone has the opportunity to express themselves.
- Technology support: Testing, surveying, and digital platforms allow you to instantly collect responses from all students. These tools can collect real-time responses and visualize the results for quick analysis, which is in the spirit of Socrates' idea of detecting common beliefs and contradictions.
- Reflective dialogue: after everyone has given their answers, the ideal would be for the following questions to take into account the bigger picture of the answers collected. This achieves deeper shared learning through discussion based on differences and similarities of opinion.
- Real-time feedback
- Adaptation to individual answers: while all students participate in the dialogue, additional questions can be further directed towards students with different views, thus following Socrates' tradition of examining different views.
- Self-assessment: Students are encouraged to recognize their weaknesses and work on them.

Digital dialogue carries all the key attributes of gamification such as: the use of a points system, progress indicators, cooperation or friendly competition, strengthening understanding through activity, nurturing the community through tables, feedback mechanisms, continuous evaluation, challenges aligned with learning goals, focus on educational value.

Based on the above, we can conclude that digital dialogue is a system in which abstract concepts become more attractive and accessible to students, and makes the teaching process itself more interesting and productive.

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