Digital Dialogue in Practice: Statistical Analysis of Teacher and Student Activities by Time and Number of Interactions

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Abstract: *This paper presents the results of research, which deals with the specifics of teaching using the digital dialogue method, in relation to traditional teaching. The research was conducted by three teachers, who recorded and wrote down their observations during the lessons. To quantify and categorize the obtained data, a modified Flanders' interaction analysis was applied. In a period of 14 days, in 3 classes, 9 classes held with traditional teaching and 9 classes with the application of digital dialogue were recorded. The goal of the research was to obtain more precise information about how digital dialogue improves the quality of teaching, as well as to propose measures for its improvement based on this information. By analyzing the recordings, the most significant activities of the participants and teachers during the lesson were highlighted. Based on the obtained results, a T-test was used to compare the degree of interaction for these two applied teaching methods. The research required the calculation of several significance parameters, so a special Java application was created for that purpose. The results of the analysis indicate significant differences in the distribution of time and the level of activity of students and teachers, depending on the teaching method.*

Keywords: *digital dialogue; mobile learning; interaction in teaching; classroom dialogue*

1. INTRODUCTION

Interaction in the classroom is verbal communication, which includes the teacher and students, as educational subjects, whose roles change during the learning process. Classroom interaction plays an important role in the learning process. Through interaction, the teacher can exchange ideas or information, share feelings or experiences, but also socialize [1]. One of the goals, which is expected to be achieved through the application of IT (Information Technologies), is to increase the level of communication among the participants of the teaching process.

From a sociocultural perspective, education and cognitive development are cultural processes; knowledge is not only possessed individually, but is created and shared among members of communities; and the ways of creating knowledge are shaped by cultural and historical factors. Support for this perspective comes from recent research suggesting that human intelligence is essentially social and communicative. An important implication of the sociocultural perspective is that it encourages the search for the causes of educational success and failure in the nature and quality of the social and communicative processes of education, and not only in the intrinsic abilities of individual students, didactic presentation, the skills of individual teachers or the quality of the resources used. This means that the quality of spoken interaction between students and teachers, as well as between students, can be of key educational importance [2]. Interaction in the classroom through dialogue is the subject of much contemporary research.

Dialogue today means having a written or oral conversation between two or more people. From that aspect, we can view the classroom as a place of various forms of dialogic interaction [3]. At the same time, dialogue can be said to be related to metacognition, as a process that leads to conceptual changes in learning and helps to retain what has been learned for a longer period of time [4]. We define it as a method, a way, a path, a procedure that helps correct reasoning and cognition [5].

On the other hand, digital classrooms are defined by the use of electronic devices or platforms such

as social media, multimedia and mobile phones to teach students [6]. Digital learning is a learning strategy that uses technology to complement the entire curriculum and enables students to learn more easily and quickly (Fig. 1). Instead of recording what the teacher taught, most of the curriculum is delivered to students through an engaging and interactive platform. Despite its many facets, education is fundamentally a form of communication. The Internet has resulted in the growth of new communication channels, which have expanded the possibilities for transmission and access to educational information. These media and virtual places serve as learning facilitators [6].
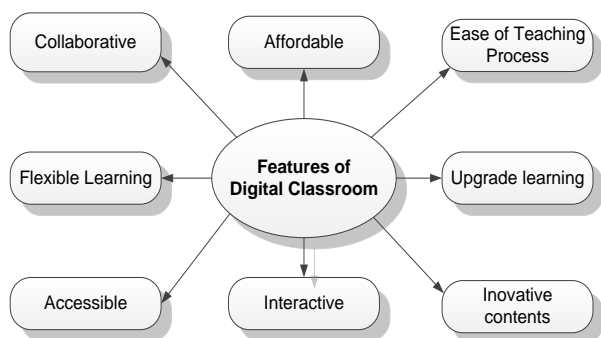
Figure 1. *Features of Digital Classroom [6]*

Most functions related to teaching are realized through verbal communication. Of course, non-verbal communication exists and is not unimportant. But non-verbal communication occurs less often than verbal communication and they are usually highly correlated. The first step towards systematic classroom management is made when the teacher understands how to control his verbal communication, so that he can use his influence as a social force. Unfortunately, this kind of knowledge and the corresponding skill do not always go together [7]. Verbal communication in the classroom does not always mean dialogue in class with an increase in the degree of interaction.

Dialogue in teaching is an educational approach that emphasizes two-way communication between teacher and student as a key element of the learning process. This approach is based on an interactive exchange of ideas, opinions, questions and answers, which help in better understanding and critical thinking. The goal of dialogue in teaching is to create a dynamic and engaging educational environment where students actively participate in their own learning [8].

"Dialogic teaching" and "dialogic pedagogy" mean an approach to teaching based on the active, extended involvement of students as well as teachers in spoken interaction in the classroom, so that teaching and learning become a collective endeavor, in which knowledge and understanding are shared construct (instead of teachers using speech only to convey the content of the curriculum and assess its acquisition by students) [9]. The use

of digital technology to support dialogic pedagogy requires more research; research in this area is in its infancy, despite some encouraging results. Many schools are now introducing tablets and other similar mobile devices to support teaching and learning [9].

With the development of a new concept of direct teaching - the application of digital dialogue in the classroom, teachers are given the opportunity to achieve a significantly higher degree of involvement of educational subjects. Digital dialogue, as a modern and perspective concept, has become accessible primarily thanks to the introduction of digital devices and technological innovations in the education system [9]. It enables a system for creating a higher degree of interaction between teaching subjects - through wi-fi (wireless-fidelity) technology, mobile software applications and teaching methods that include learning and testing via the Internet (Web Based Training, Internet Based Test - IBT). At the same time, it enables the entire flow of the teaching process, during one course, to be transferred into electronic form, enriched with interactive multimedia and documented in appropriate databases [10]. Such systems are used in order to increase the interaction of students and lessons in class, obtain critical opinions of each student individually and create an environment for cooperative and active learning [11].

The concept of digital dialogue completes the system of hybrid learning by enabling to overcome the shortcomings of electronic learning and direct traditional teaching. Realization of digital dialogue in the classroom, as an asymmetric communication process, integrated into a hybrid learning system, is not only the application of new didactic tools, but it implies numerous changes in the educational process, such as new teaching methods, different teacher preparation, technical equipment of classrooms and offices, new competences of teachers, etc. [10].

Several studies have confirmed that digital dialogue significantly improves the quality of teaching as measured by knowledge tests [12]. However, there is little research that clearly identifies those key features of digital dialogue that contribute to teaching effectiveness. This research tries to find the key specificities of digital dialogue, which make it more effective than traditional teaching, by applying a modified Flanders' lesson analysis [7].

2. METHODOLOGY

The research is based on the methodology and results of the experiment described in [13], with additional modifications and extensions. Previous research [13] obtained more data that were not processed in the analysis and were not presented. In this paper, the research includes additional data and uses a different statistical analysis. The

recording and measurement was carried out in the 2022/23 school year, in the secondary state school, ETŠ "Nikola Tesla" in Niš. The research was conducted by 3 teachers who taught the same classes, but different subjects. The focus was on research - how the 45-minute class time is spent on different activities, in different teaching scenarios.

The activity marked as Pt - the time in which the teacher speaks, includes parts of the lesson in which the teacher presents the material, asks questions, gives assignments and draws conclusions. It is expected that during that period of the lesson, students carefully follow the presentation, if necessary, note down key terms, but do not participate in a dialogue with the teacher.

At the moment when one of the students makes a remark or a question or when he answers the teacher's question, the previous activity is interrupted and the new activity is marked as Ut - the time in which the students speak. The time in which students answer the teacher's questions, through digital dialogue, is also recorded as Ut.

Quiet time - an activity marked Tt, is recorded in the parts of the lesson when the teacher writes the lesson, the students talk quietly to each other.

In a previous study [13], the experiment included the following steps:

- sample selection: three 3rd grade classes of the educational profiles Computer Electrical Technician and Information Technology Electrical Technician. Classes have approximately the same number of students (from 25 to 30).
- application of the methodology of recording the teaching process in the classroom,
- recording and quantifying the activities of students and teachers,
- analysis of video material.

In this paper, a modified Flanders' methodology and coding system (Flanders' Interaction Analysis System - FIAS) was applied, which are used for the study and analysis of verbal interaction in the classroom, according to [7]. Also, FIAS is often used to evaluate teaching effectiveness, identify educational styles and improve teaching methods.

In the classes that were implemented using the digital dialogue method, the teacher who led the class, according to the regular curriculum, asked a short question every 3 to 6 minutes, related to the teaching material just presented. At that moment, through a specially created web application, the question is forwarded to the students. At the beginning of class, all students started a dedicated application for digital dialogue [14], and logged into their account. They answer the teacher's question through their mobile devices. The teacher himself decides when to interrupt the time for students to

answer, depending on the difficulty of the question and the number of answers received. After that, the teacher's presentation continues until the next question.

The teacher who observed and recorded the activities in the classes performed the following procedures:

- Observation: observes and records verbal interactions in the classroom at 60-second intervals; every 60 seconds, one of the current activities in the classroom is entered: Pt - time in which the teacher speaks, Ut - time in which students speak and Tt - time of silence.
- Record the number of questions the teacher asks and the number of answers he receives. Correct and especially incorrect answers are recorded separately.
- Coding: each verbal act is classified according to one of these categories.
- Analysis: data is analyzed to determine the pattern of interaction between teachers and students.
- Quantifying and comparing results from a database of digital dialogue and class videos.

If the term - analysis itself is defined as the process of breaking down a concept into simpler parts, in order to show its logical structure, in this study it refers to the process of breaking down the concept of interaction in the classroom, especially the part where teacher speaks.

A statistical analysis of the time distribution of student and teacher activities was applied to the obtained data. In all 9 classes held, for each of the teaching methods, the total time during which students spoke and the time during which the teacher spoke was calculated. In addition, the average frequency of teacher and student activities during one 45-minute lesson was also determined.

In the sample, two small independent groups were formed (classes conducted using the traditional method, labeled T-group and classes using the digital dialogue method, labeled D-group), approximately equal, with a normal distribution.

Teaching in the T-group is done in a traditional way. This implies the use of a blackboard and chalk, possibly a projector or a smart board, as teaching aids.

In the D-group, teaching was carried out using a special application for digital dialogue in teaching. This application consists of several modules, and in this experiment two modules were used: a module for the lecturer and a module for students [14].

The teacher started the application module for lecturers on his mobile phone and selected the appropriate, already prepared lesson.

The students also launched the appropriate student app module on their mobile devices and waited for the teacher-provided question to appear on the screen.

Modules for teachers and students are client applications that in digital dialogue software represent an interface through which data is passed to other components. The entire teaching process during one lesson is recorded in the database.

For each of the measured values, the initial hypothesis is: there is no significant difference between the mean values of the T and D groups. The alternative hypothesis claims that there is a significant difference between the means of these two groups. A conventional significance level of 0.05 was introduced (there is a 5% probability of error).

Based on the characteristics of the sample, the T-test was chosen to determine statistical significance. Due to the specifics of data processing, a special Java application was created for calculating significance parameters - *p*.

In the development of the application, the Java class library was used:

org.apache.commons.math3.stat.inference.T-Test;

from the hypothesis testing class collection:

Package org.apache.commons.math3.stat.inference.

By comparing the average values of these two experimental groups, the results were obtained in response to the question of whether the differences between the traditional teaching method and the digital dialogue method are statistically significant.

3. RESULTS

Table 1. shows the overall results of measuring activities in the classes held. It includes the number of questions asked, the number of answers received, as well as the time during which the teacher, students speak or the time of silence. The time is expressed with an accuracy of up to one minute. Marks "T-group" and "D-group" describe the number of classes with traditional teaching, that is, classes held using digital dialogue, respectively.

Table 1. *The results of measuring participation in speaking time and the number of questions and answers*

MEASURED VALUES	T-group total	D-group total
Number of questions asked by the teacher	49	54
The number of responses received was	47	237
Number of correct answers	45	166
Time in which the teacher speaks	287	237
Time in which students speak or send responses through digital dialogue.	88	111
Time of silence	30	57

A p value was calculated for each of the measured values from the table (Table 2).

Table 2. *T-test results for each of the analyzed activities*

CLASS ACTIVITY	*P* - VALUE
number of questions asked	p= 0.179
	there is no significant difference
number of responses received	p= 1.124E-15
	there is a significant difference
the time when the teacher speaks	p= 0.001
	there is a significant difference
the time when the students speak	p= 0.012
	there is a significant difference
quiet time	p= 0.023
	there is a significant difference

4. DISCUSSION

Based on the data provided, different aspects of teaching between the two methods can be compared to answer the question of how different they are in practice. For each of the 5 measured values, a null hypothesis (H0) was set, which reads: there is no statistically significant difference between the mean values of these two groups. This hypothesis is rejected if $p < 0.05$. In this case, it means that there is a statistically significant difference between the digital and traditional methods.

Number of questions asked by the teacher: in both methods, the teacher asks a similar number of questions, with slightly more questions in D-group total (54) than in T-group total (49). Since the p-value (0.179) is greater than 0.05, we do not reject the null hypothesis. This means that there is no statistically significant difference between the digital and traditional methods regarding the number of questions asked.

Number of responses received: there is a significant difference in the number of responses received, with D-group total (237) showing a much higher number of responses than T-group total (47). This suggests that digital dialogue may be encouraging more student responses. Since the p-value (1.124e-15) is significantly less than 0.05, we reject the null hypothesis. This means that there is a statistically significant difference between the digital and traditional methods regarding the responses.

Number of correct answers: similar to the number of answers, D-group total (166) shows a significantly higher number of correct answers compared to T-group total (45). This may indicate that the digital method not only encourages more responses, but also increases response accuracy.

The p-value (1.124e-15) is significantly less than 0.05, so we reject the null hypothesis. This means that there is a statistically significant difference between the digital and traditional methods regarding the number of responses received.

Time in which the teacher speaks: in T-group in total, the teacher speaks longer (287 minutes) than in D-group in total (237 minutes). This may mean that in the traditional method the teacher is more of a central figure. Since the p-value (0.001) is less than 0.05, we reject the null hypothesis. This means that there is a statistically significant difference between the digital and traditional methods in the time the teacher speaks.

Time students' speak: students speak more in D-group overall (111 minutes) than in T-group overall (88 minutes). This may indicate that digital dialogue gives students more space to express themselves. Since the p-value (0.012) is less than 0.05, we reject the null hypothesis. This means that there is a statistically significant difference between the digital and traditional methods according to the time students speak.

Quiet Time: Quiet time is longer in D-group total (57 minutes) than in T-group total (30 minutes). Since the p-value (0.023) is less than 0.05, we reject the null hypothesis. This means that there is a statistically significant difference between the digital and traditional methods regarding the duration of silence time.

5. CONCLUSION

Based on the data presented, it can be concluded that the digital dialogue method encourages more student engagement and interaction, with more questions asked and many more answers received.

Based on the T-test, the only result in which there is no statistically significant difference is the comparison according to the number of questions asked. The results for the other 4 parameters show that there is statistical significance, which implies that the null hypothesis (H0) is rejected and the statement that there is a statistically significant difference between the digital dialogue and the traditional method in the number and intensity of interactions during teaching is accepted.

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 students speak is 20% longer in digital dialogue classes.

Silence time in digital dialogue is also longer, which may indicate different class dynamics in a digital environment, where there may be more time for reflection or technical breaks in digital teaching. On the other hand, it can also indicate more breaks or less interaction between teacher and student.

The most significant difference is expressed in the data about the number of answers received by students and the number of correct answers received. This result is probably one of the answers to the effectiveness of digital dialogue on knowledge tests.

When it comes to the number of correct answers, the comparison was not made in percentages, in relation to the total number of answers received. This was done on purpose, because the practice in traditional teaching is for the teacher to ask for an answer from the student who has already raised his hand. In that case, the ratio of correct and obtained answers is usually 100%, so the comparison of these two teaching methods has no significance.

The presented information tells us that the digital and traditional methods are different in most observed aspects, except when it comes to the number of questions asked during classes. The research results can be useful for further analysis and improvement of teaching methods, in order to maximize the positive effects of both methods.

The application of the modified Flanders analysis provided more information, such as, for example, the frequency of teacher and student activity in the class, i.e. in which parts of the class the teacher spoke more and in which the students spoke more. However, although all the obtained data could not fit into this paper, they can be an interesting topic for some further research.

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