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### ► To cite this version:

Dubravka Glasnović Gracin, Goran Trupčević. Time as a resource in mathematics education: Comparing teacher and student perspectives. Thirteenth Congress of the European Society for Research in Mathematics Education (CERME13), Alfréd Rényi Institute of Mathematics; Eötvös Loránd University of Budapest, Jul 2023, Budapest, Hungary. hal-04417470

**HAL Id: hal-04417470**

**<https://hal.science/hal-04417470>**

Submitted on 25 Jan 2024

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# Time as a resource in mathematics education: Comparing teacher and student perspectives

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*Time is a non-material resource important both for students and teachers because having time to teach and learn is a prerequisite for successful instruction. In spite of its importance, time as a resource is an underdeveloped field of study in mathematics education research. The study presented in this paper focuses on exploring time from two related perspectives: a mathematics teacher and her students. The study encompassed their experience with time in different aspects of mathematics education as well as the interactions of time with other resources. The findings indicated that the teacher and her students highly value time as a resource, and their views and experiences of time correspond in many aspects. Well-designed and extensive teacher lesson plans affected the efficient use of student time, particularly time-consuming activities such as teamwork and problem solving.*

*Keywords: Resources, mathematics education, student perspective, teacher perspective, time.*

## Introduction

Resources in mathematics education refer to the material and non-material means used by teachers and students to support mathematics teaching and learning. Adler (2000) presented a framework for categorizing resources into basic, human, material, and social and cultural. Basic resources refer to necessary means such as buildings, water, and electricity. Human resources encompass teachers and their knowledge-base, parents, collegiality, etc. Material resources include school mathematics materials (e.g., textbooks, software), technologies (e.g., computers), mathematical objects (e.g., proofs) and everyday objects (e.g., money). Social and cultural resources refer to language (e.g., verbalisation, communication) and time (e.g., timetable).

Time as a resource is of great importance for effective mathematics teaching and learning (Ben-Peretz & Bromme, 1990; Glasnović Gracin & Jukić Matić, 2021; Hargreaves, 1994). The literature review on time in education reveals some important aspects of time, such as time as a teacher resource, time as a student resource, and interactions of time with other resources (Glasnović Gracin & Trupčević, 2022). Time is an important teacher resource because teachers need time for lesson planning, the teaching process, reflection, evaluating students' work, professional development, and other support activities (Clarke et al., 1996; Hargreaves, 1994; Kilpatrick et al., 2001). Time is also important as a student resource, it plays a significant role in the term "opportunities to learn" (Carroll, 1963). Berliner (1990) distinguished between various types of student time such as allocated time, engaged time, time-on-task, academic learning time, etc.

Instructional time, as a non-material resource is the focus of many studies and discussions in the context of education in general (e.g., Ben-Peretz & Bromme, 1990; Hargreaves, 1994). However, it is much less frequently the focus of studies in mathematics education research. The study by Glasnović Gracin and Trupčević (2022) focused on mathematics teachers' experiences with time as

a resource and its interactions with other resources. For this purpose, a large-scale examination of teachers' opinions was undertaken, involving 1,252 teachers who teach mathematics in primary, middle, and high schools in Croatia. The participants pointed to geometry topics as being particularly time-consuming in terms of their lesson preparation and enactment. Also, problem solving and teamwork activities require much more time than they have at their disposal in lessons. The study also involved interviews with 12 teachers which revealed some of the reasons for the lack of time presented in the quantitative examination, such as the comprehensiveness of the mathematics curriculum and the amount of time needed for the acquisition phase of lessons. The results also showed that time is in constant interaction with other material and non-material resources. Material resources such as textbooks and technology make lesson preparation and enactment more efficient because they may save time and improve the structure of the lesson.

The study only looked at teachers' views on time, the student perspective was not examined. Time is important as both a teacher and student resource, and the teacher's time in some parts interacts with his/her students' time. However, teachers' and students' perceptions of the classroom have not been studied jointly very often, most research deals with only one or the other (den Brok et al., 2006).

The study presented in this paper focuses on time from the perspectives of one teacher and her students and raises the following two questions: How do the teacher and her students experience different aspects of time in mathematics education (regarding mathematical content, lesson planning, enactment, and homework)? How do they experience the interaction between time and other resources?

## **Theoretical framework**

Time as a teacher resource was clearly positioned in Adler's (2000) categorization of resources in school mathematics. Based on Adler's (2000) and Glasnović Gracin and Jukić Matić's (2021) frameworks, Glasnović Gracin and Trupčević (2022) developed a framework for examining teachers' perceptions of time as a resource in mathematics education. It consists of the following categories: planning and preparation, lesson enactment, and interaction of time with other resources. Planning and preparation covers three subcategories: planning, lesson preparation, and mathematical content. Lesson enactment refers to lesson phases, student time, homework, teaching approaches, and mathematical content. Interaction of time with other resources refers to the subcategories textbooks, technology, colleagues, and professional development.

## **Methods**

The study presented in this paper is a case study involving one female mathematics teacher and eight of her students. The teacher has 22 years of teaching experience in lower secondary education in Croatia (Grades five to eight). The participating students were six-graders (age 12) of a city school in Zagreb and this teacher had been teaching them mathematics since Grade 5. The aim was the in-depth examination of participants' views and experiences on time as a resource in mathematics education. This teacher was one of the 12 teachers interviewed in the previous study. Her answers differed greatly from the other participants: she needed much more time for preparation than the others, she did not use the textbook for lesson planning or enactment, and she used many more time-consuming approaches such as group work and problem solving, and in her free time participated in

international teacher professional development programs. Therefore, the aim of this follow-up case study was to compare the students' views and experiences on time with their teacher's statements. The participating students were chosen based on their interest in the study and in order to include a range of academic achievement. The study encompassed a semi-structured interview with the teacher, and, after its analysis, an interview in a focus group with eight students. The interview questions for the teacher are listed in the previous study (Glasnović Gracin & Trupčević, 2022) and its categories are presented in the Theoretical Framework of this paper. The interview questions for the students followed the same categories and structure, but were modified to be appropriate for Grade 6 students. This made it possible to compare the teacher's and students' answers. The interviews were transcribed and analysed according to the qualitative content analysis methodology, using codes that are in line with the interview categories and subcategories.

## Results

### Different aspects of time in mathematics education

*Mathematics topics.* The teacher was asked which mathematics topic, in her opinion, is not given enough time in the curriculum over the year. Like other participants in the previous study (Glasnović Gracin & Trupčević, 2022), the teacher highlighted geometry.

Teacher: For instance, I need more time for geometry, for sure. I don't think it's planned well, the children need more time for visualization of the problems and I would maybe like to have time for more hands-on activities.

Unlike the teacher, the students did not mention geometry in the context of not having enough time. However, some of the students did say that they needed more time for fractions, but the reason for this may be that their teacher was absent when they were learning fractions.

Student5: Well, the given time is ok, it's ok for me.

Student6: Maybe ... for fractions.

Student2: I agree, fractions. But mostly because we had the substitute teacher. And we didn't, or at least I didn't, understand. But our teacher put tasks with explanations in the (virtual) classroom, and it helped me a lot.

However, students did mention geometry as a domain that they don't like, where they are not doing well, and in which time passes slowly. This may be the reason for the teacher's concerns.

*Time spent on teacher's lesson planning.* Lesson planning requires time, and the participating teacher said that she really needs a lot of time to plan lessons, especially to reflect on how particular concrete models would help students to understand abstract ideas.

Teacher: I want them to be involved, to be interested, to provoke their curiosity... and I need a lot of time for that. (...) Most time is taken up on introducing new concepts and discovery learning, models, making these models, and in-depth thinking about how this model would help students understand.

Then the teacher was asked how much time she needs for lesson preparation.

Teacher: I overdo it definitely, I spend too much time on lesson planning. My weekend is... 5 hours a day working on lesson planning, plus about 2 to 3 hours (during the week). But there are times when I need to do something completely from the beginning (...) For example, if a session lasts for 80 minutes, I need twice that for preparation.

In the interviews, we were not only interested in what students think about their time, but also the teacher's time. Therefore, they were asked: "Do you think that your teacher spends a lot of time preparing lessons? Why do you think that?" The participants were clearly aware of the time their teacher invests in preparation:

- Student5: Yes (she prepares a lot), because she always makes her own worksheets and presentations, and all those fun tasks where we have to figure out what it's about.
- Student7: Yes, she does... And she told us before, that she does it all herself, and it is obvious that she cares, all of her tasks are fun.
- Student6: I find it fascinating that all of her presentations have more than 50 slides.

The students were also asked how much time they think the teacher spends on lesson preparation.

- Student7: Well, if I... if I had to prepare for a lesson like that, then it would take me about... eight hours for one lesson. And she must have at least two or three classes every day. I don't know how she does it.
- Student3: Well yes, because you know, the presentations... everything is clear... I don't remember the last time that I had to look at the textbook or on the Internet at home, because I didn't understand the teacher's explanations. I would say that she prepares, including worksheets and so on, well at least eight hours for one lesson.

Both the teacher's and the students' answers showed that the teacher invests a lot of time in lesson preparation, and that her 12 year old students are aware it. Also, the time invested in preparation meant that the students were given "interesting activities". Time as a teacher resource is shown here as well-spent and appreciated by the participating students.

*Organization of time in lesson enactment.* Lesson enactment is the "place" where teacher and student time directly meet to a certain extent. The participants were asked if the organization of the lesson provides enough time for the learning of new content. The teacher explained that in the acquisition phase she tries to involve the students straight away by using group work. In this way, she said, each student can work at their own pace.

- Teacher: We all have a discussion at the beginning, but after that they work in pairs or groups (...) And I walk around the class and talk to students about what they are doing, and they work at their own pace. When they finish one task, they move on to the next one. So at the end of the lesson are the conclusions, we go through everything they were supposed to do. Some of them will maybe have done more than that, but everyone will have gone through the key elements that I planned. So, as far as time estimation is concerned, it's very difficult, because everyone works at their own pace, but I estimate approximately what is important for everyone, how much time it will take.

The students mostly confirmed that they have enough time to learn new content in the lesson, but they can also attend a supplementary lesson once a week<sup>1</sup>. In this way, the teacher achieves her aim that each student works at their own pace, and that all of them accomplish the key aims.

- Student3: I always have enough time. And there is also the supplementary class, so if someone does not understand what we did in the lesson, they can go to that...

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<sup>1</sup> This 45-minute supplementary lesson ("dopunska nastava") is part of the Croatian education system and is held by the class mathematics teacher once a week. It is intended for students who did not understand the content presented in class.

Student7: I find it's enough, because we go through the presentation and after that we do the worksheets ... But when it's a more difficult subject, for example we have been learning congruence (of triangles), we had that for two lessons because it was difficult.

Student6: Sometimes she goes too fast, but most of the time it's ok.

Although the teacher believes that there is a lack of time for practice and working on tasks due to the large amount of content, this was not something the students noticed.

Teacher: We have a lot of content, so what's missing is maybe time for some practice.

Student5: Somehow... she makes sure that we have enough time.

Student2: I think we have enough time and I think that she somehow makes it easier for us to remember something or do something faster.

Participants were also asked whether a student who has difficulties with the tasks gets more time to work through them. And what about students who are very fast, what do they do in this "free" time? The teacher explained that she tries to allow everyone to work at their own pace, while ensuring that everyone covers the key content.

Teacher: I always have additional things prepared for those who are more interested or who are faster. Because I think there should be no idle time. On the one hand, you have students who simply need more time, (...) So there is content that I want everyone to do, and if anyone finishes that, they can do more.

Accordingly, students said that, if they ask, the teacher provides additional explanations and examples. Students who needed more time may attend the supplementary class where they do not have to stay for the whole lesson if they don't need to, which is another indicator of individualization.

Student7: Well, there is enough time in class, and she always tells us to come to the supplementary lesson, but we don't have to stay for the whole lesson.

Regarding the enactment time, the results show that the teacher's considerable investment of time in lesson preparation results in efficient enactment time. Both she and her students claim to have enough time for the acquisition of new content. But although the teacher said that she would like more time for students to practice, this was not something that the students themselves picked up on. The extra time afforded in the weekly supplementary lesson may have filled this gap.

*Homework.* One of the questions referred to the time devoted to homework. The teacher said that she always tries to cover everything the students need in the class, so she doesn't give much homework.

Teacher: My homework is not very extensive. I choose what I think is most important. (...) I try to cover everything during the lesson. So it's just to let them practice a little.

When asked to estimate the time her students spend on homework, the teacher answered "15 minutes, at most half an hour". The students confirmed that the homework assignments are not extensive.

Student6: After every lesson (we get homework), but very little.

Student3: Maybe two tasks after each lesson, or about five if an exam is coming up. Usually it takes me maybe 15-20 minutes if there is more homework. Maybe 10. But if there is a task that needs more time and requires a little more precision and patience, like geometry, then it can take a little longer. But somehow it goes fast.

Student5: The same for me... For homework she gives us the same types of tasks we did in the lesson. So we usually know it.

Although she does not check all the homework, the teacher asks the students at the beginning of each lesson if anything was not clear. Students confirmed this practice.

Teacher: I do a review (at the beginning of the lesson), I solve things they ask me to, answer any questions they have... I always have time for that.

Student6: We don't check all the homework, but she asks us if anything was not clear.

Student5: At the beginning of the lesson (she asks us) if we have any questions, and if so, then she explains it to us...

Non-extensive homework may confirm that most of the tasks are done in school. The interviews again showed that the teacher's investment in lesson planning (teacher time) resulted in well-organized enactment leading to her students feeling that they did not need to spend more time on the topic or to do extensive homework (student time).

### **Interactions of time and other resources**

The use of different resources may impact both teacher and student time. The interviews showed the interactions of the use of textbooks, technology (material resources) and communication (non-material resource) with time from the teacher's and the students' perspectives.

*Textbooks.* The teacher considers that the available textbooks do not make her teaching more efficient. Therefore, she does not use the textbook in the classroom at all. This is one of the reasons why she prepares so much. In order to avoid investing even more time in the preparation of homework, the teacher assigns it from the textbook.

Teacher: I actually don't use the textbook. Well, I take a look at it, particularly the tasks, so that I can assign homework. But unfortunately the textbooks available at the moment do not fit my needs.

The participating students confirmed that they only use textbooks for homework. One student explained that he finds the textbook helpful at home, because it contains the solutions to tasks.

Student7: Never, we never use it during the lesson. I use it at home when I do homework.

Student5: We don't use the textbook in the lesson, we use presentations, worksheets and the boards. But if she assigns homework, it is always from the textbook. Or on work sheets. But mostly from the textbooks.

Student3: The textbook helps me a lot sometimes. If I don't understand a task, I look at the solutions, and I try to solve the task on my own.

*Technology.* Technology is a material resource that can make teaching and learning more efficient. The teacher confirmed that she uses technology to save time. She uses it to prepare lessons, during the lesson, and for the students' learning at home.

Teacher: Well, technology is my friend. Firstly, because you make materials and you have them permanently, and if you want to change something, and I make changes all the time, then it's much faster. Besides that, I think that it improves communication with students. Also, when someone is ill, I put my presentations in the (virtual) classroom.

The students confirmed the teacher's approach. They use the virtual classroom, presentations and videos, which help them in efficient learning. Especially if they were absent from school.

Student2: I think that it (technology) helps a lot because the teacher's presentations are excellent and... at home... I was absent for a week... and then I watched that video in the virtual classroom, which wouldn't exist without technology, and so...

Student3: Well yes, it (the virtual classroom) is helpful because the teacher puts some questions there. It doesn't have to just be during the lesson, she can put it there any time, also over the weekend. And I take a look at it a bit, and it's great.

*Communication.* Apart from material resources, the communication with other persons (students, adults) also may be a resource in education which makes learning more efficient.

Interviewer: Some teachers don't like students to work in groups or pairs, they say, we waste time that way, because the students talk too much (not about mathematics). Do you think that too much time is wasted in working in pairs?

Student6: I don't think so, I think there is more benefit from it. I am aware that some time is lost, because we chat sometimes. But the teacher always puts a limit on the time we have for the activity. And so we have to do it in time. And after that, we can chat.

Student3: I think that the communication with other students actually saves us time. Yes, because we are organized in random groups, they consist of some who understand and some who don't. And then, instead of the teacher explaining one by one, we explain it to each other within the group. And so the teacher saves much more time, and us too.

The interviews revealed that both the teacher and the participating students consider technology and communication as useful resources that save time and make both teaching and learning more efficient. The teacher is not satisfied with what the textbook offers so she does not use it for lesson enactment, a decision which undoubtedly affects the amount of time spent preparing lessons. However, she does assign homework from the textbook. Some of the students find the textbooks helpful because of the task solutions.

## **Discussion and conclusions**

The study presented in this paper showed how a teacher's experience of time in teaching and learning mathematics can be reflected in her students' experience of time, and vice versa. And while the teacher's and students' time come together in lesson enactment, it is seen from different perspectives, having different aims. The teacher's decisions in the lesson preparation phase had an effect on the student's time, something which the participating students were aware of to some extent.

The review of the literature (e.g., Clarke et al., 1996; Kilpatrick et al., 2001) highlights the issue concerning contemporary activities (e.g., group work, problem solving, discovery learning) which are preferable and valuable, but time consuming. This issue was the motivation for conducting this study, as the participating teacher frequently uses such activities in her classroom. The results showed that, in this case, successful teaching with time-consuming activities is possible, but because of the lack of textbook support, the lesson preparation time is lengthy. However, the participating students recognized and appreciated this effort. Technology helped the teacher and students both in and out of the classroom. The participating students also highlighted that teamwork, in spite of the risk of wasting time chatting, may in fact save time if organized well, because students may help each other and explain the content if someone does not understand it.

The preceding study (Glasnović Gracin & Trupčević, 2022), which focused only on the teachers' experiences with time as a resource, highlighted geometry as a particularly time-consuming mathematical topic. This was confirmed by the teacher in this study. The participating students mentioned geometry as a domain in which "time passes more slowly" and one student claimed that doing geometry homework can last a little longer than other mathematics domains.



The study presented in this paper aimed to highlight the importance of time as a teacher and student resource through one case study. It raised some new questions, such as whether time is a student resource in the same way as it is a teacher resource. In order to answer this question, future research will include exploring time through classroom observations and analysing teachers' lesson plans. Also, the next steps will encompass a deeper insight into the role of time in teaching and learning various mathematical content. In this way, a better overall picture of the issues concerning time in mathematics education could be obtained.

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