HOW SCIENCE AND MATHEMATICS TEACHERS VIEW STUDENTS' ATTITUDE TOWARDS THEIR SUBJECTS AND ITS RELATION WITH TEACHING METHODS

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Abstract

The primary methods of science education are still the classical methods (demonstration, explanation, questioning, modelling) in Hungary, which are more suitable for conveying academic knowledge. Innovative methods that allow for more holistic thinking, interdisciplinarity, and common work between students (group work, pair work, discussion, game, project) are less popular among science teachers. However, complex methodological approaches based on the principles of constructivist pedagogy appearing more often in the classroom such as inquiry and problem-based learning. The empirical research sample consisted of teachers (N=140) teaching grades 5-8 in Heves County (Hungary) in 2023, divided into four subsamples: biology teachers, chemistry teachers, physics teachers, and mathematics teachers. The questionnaire-based research pointed out that the most frequently used lesson methods are the question-and-answer method, the teacher's lecture and presentation. It should also be emphasized that new methods have appeared in the lessons to a small extent (discussion, project method, research-based learning). The study showed some correlation as well. Teachers who build the learning-teaching process on research-based or project-based methods that focus on student activity report a much more positive student attitude towards their subject.

Keywords: *teaching methods, science subjects, primary teachers*

1. INTRODUCTION

Studies on students' attitudes towards their subjects have become increasingly popular worldwide since the 1970s. According to Csapó (2000), subject attitude refers to the attitude towards the subject and the willingness to learn the subject. The results of attitude researches show a similar picture: humanities, computer science and foreign languages are typically at the top of the ranking, while mathematics and natural science subjects are in the second half of the list. (Csapó 2000, Csíkos 2012, Chrappán & Malmos 2016, Chrappán 2017, Kurniawan et al. 2019, Czető 2022). Among the natural science subjects, the most popular is biology, and the least popular is physics, which is generally ranked at the bottom of the entire subject ranking (Papp & Józsa 2000, Csíkos 2012, Chrappán & Malmos 2016, Chrappán 2017).

If we look at subject attitudes in terms of grades, it can be said that subjects are inversely proportional to the time spent at school, and this is especially true in the case of natural science subjects. (Csapó 2000, 2002, Fernengel 2002, Korom 2002). According to the latest Hungarian research, this reduction is smaller than before, and in the case of mathematics, stagnation is more noticeable. (Czető 2022). Previous research has shown a correlation between students' attitude towards the subject and students' subject achievement (Ballér 1973, Báthory 1989, Orosz 1992, Csapó 2000, Osborne et al. 2003, Farooq et al. 2008, Csíkos 2012). It is therefore not surprising that the most negative attitudes towards subjects emerged in those types of institutions where significantly lower performances were measured on criterion-referenced measures (e.g. vocational education) (Csapó 2000, Pap et al. 2024). There is a causal relationship between subject preference and good subject performance, but the reverse is not necessarily true. If we examine the usefulness and interest of the subject, it can be stated that mathematics and natural science subjects are rather boring, difficult and useless according to primary and secondary school students. (Takács 2000) However, students generally consider natural science subjects to be more useful rather than like them. The biggest difference in usefulness and likeability is in mathematics according to the research with students. The loss of students' interest towards the subject as the grades increase is most noticeable in the case of biology and chemistry see Fekete (2014), Malomos & Chrappán (2016), Pap et al. (2024). If we compare this with the fact that the subject that is most popular in high school is typically the one that students are most likely to continue studying, the

lack of willingness to continue studying in these areas in university is not surprising (Csapó 2000, Csíkos 2012, Pap et al. 2024).

Students' attitudes towards a subject are influenced by many factors. Research primarily emphasises the teacher's personality and the way they organize their lessons. Teacher's kindness, helpfulness, interesting classroom activities, and fairness of assessment all contribute to the subject's popularity. (Osborne et al. 2003, Chrappán 2017, Borsodi 2021). The positive correlation between teacher attitude and students' performance are also proven in mathematics (Farooq et al. 2008). Csapó (2002) also pointed out that the popularity of the teacher's personality does not predict good subject performance, but an unfavourable relationship with the teacher does affect performance.

If we study the lesson organisation procedures, methods, and strategies, we can get one of the answers as to why the subjects examined in this study are less popular. The main pedagogical methods of science education are still the classical methods (demonstration, explanation, questioning, modelling), which are more suitable for conveying academic knowledge according to B. Németh et al. (2012), and Schlachter & Teperics (2022). More innovative methods (group work, pair work, discussion, games, research -based learning) that allow for more holistic thinking, interdisciplinarity, and cooperative work are less common in these subjects (Falus et al. 2001).

As far as mathematics is concerned, frontal explanation, individual work and discussion are the most typical methods (Radnóti 2006). Survey data on international students' assessment also shows this kind of monotone, mostly frontal learning organization (Szalay, Szepesi & Vadász 2016), and Pap et al. 2024). Homework is usually based on memorization in the form of assignments from workbooks or problem sets, and assessments are typically based on memorization in the form of papers as detailed by Radnóti (2006), Szalay, Szepesi & Vadász (2016). It is also true that in the methodological examples, more complex classroom approaches based on the principles of constructivist pedagogy, such as research and problem-based learning, are increasingly prominent in the various natural science subjects. (Korom & Orosz 2020, Veres 2021, Dobróné, Futóné, Gőz, & Revákné 2015, Kissné 2016, Nagy & Nagy 2016, Korom & Nagy 2021, Korom & Németh 2020, Tóth 2015, Radnóti & Adorjánné 2016, Radnóti & Hasznosi 2018, 2020, Korom & Radnóti 2020). Beke (2011) examined the impact of project work on science subjects and found that students generally improved their performance in science subjects as a result of project work. Digital transformation can offer further opportunities for science education, especially in the areas of demonstration, simulation, practice and inquiry-based learning. (Szűts, Racskó, & Lengyelné 2022).

2. MATERIALS AND METHODS

2.1. Materials

The study presents the summary results of a pedagogical research with the involvement of teachers teaching mathematics and natural science subjects in grades 5-8 (N=140) in Heves County (Hungary) at Eszterházy Károly Catholic University in 2023. During the research, we sought answers to the following questions:

- How do mathematics and science teachers think about the attitude towards the subject in case of students, parents, colleagues and themselves?

- What are the differences among mathematics and science teachers in terms of use of teaching methods?

- What are the differences among mathematics and science teachers in terms of use of evaluation methods?

- What is the relationship between mathematics and science teachers' views on students' attitude towards their subject and the type of teaching methods that are used?

2.2. Research sample

The population of the research is composed of mathematics and science (physics, chemistry, biology) teachers in primary schools (grades 5-8) in Heves County (Hungary). When determining the research

sample, we worked with a category system for two variables. One was the settlement type used by the Hungarian Central Statistical Office. The other was the average student performance in the 7th grade in the field of natural science according to the Ministry of Education (Education Office 2022). It was classified on a scale corresponding to four levels in comparison to the average result of the institution type matched to the settlement type. Therefore, when designing the research sample, we used stratified, random sampling. The distribution of the institutions involved by settlement type is as follows: 53% rural, 36% urban, 11% county seat. The number of teachers involved in the research was 140.

The teachers participating in the research (N=140) were divided into four subsamples: biology teachers (N=30), chemistry teachers (N=24), physics teachers (N=27), and mathematics teachers (N=59). Based on this, the proportion of the sub samples compared to the total sample was as follows: biology 21%, chemistry 17%, physics 19%, and mathematics 42%. In terms of gender, 66% of the research sample is female, 34% male. According to teaching experience, it can be stated that 3% of the teachers in the sample are in their first year of teaching, 6% have been teaching for 1-3 years, 10% have 4-9 years of teaching experience, 20% have 10-19 years of experience, 30% have more than 20 years of teaching experience, and 34% have more than 30 years of teaching experience. This ratio also shows parallels with national trends (cf.: Varga 2022). (Table 1.)

	This is my first year of school (3%)	1-3 year (6%)	4-9 year (10%)	10-19 year (20%)	20-30 year (30%)	more than 30 years (34%)
Biology	7%	3%	23%	20%	30%	17%
Chemistry	4%	0%	4%	8%	37%	46%
Physics	0%	7%	11%	7%	22%	52%
Mathematics	2%	9%	5%	24%	30%	30%

Table 1. Study sample according to teaching experience

Regarding the education of teachers, it can be seen that there is a significant number of teachers who have a teaching qualification other than the field in which they teach, or a qualification related to a scientific field but not a teaching qualification. This figure is particularly high among physics teachers (45%). At the same time, this is related to the problem areas outlined in the literature synthesis: students' attitudes towards subjects and the related career choices. In terms of the subjects examined, the situation is best for biology teachers, but as we have explained based on previous researches, student attitudes towards biology are the most positive compared to the other subjects examined in our study. This is also in line with national data. For all these reasons, our research sample is considered representative at the county level and in some respects (gender of teachers, teaching experience, qualification for the subject taught) at the national level (Varga, 2022).

2.3 Research method

The research was based on an online questionnaire. The background variables of the questionnaire asked about the type of settlement of the institution and the characteristics of the teachers (gender, teaching experience, qualification). The rest of the questionnaire was compiled in accordance with previous literature focuses. The frequency of the different lesson and assessment methods were examined on a 4-point scale (1=Almost never; 2=In less than 50 percent of lessons; 3=In more than 50 percent of lessons; 4=Almost in every lesson)

The pedagogical methods and strategies examined in the research are:

teacher explanation, question-and-answer method, teacher lecture, ppt presentation, individual work, pair work, group work, experiment presented by the teacher, student experiment, discussion method,

drama pedagogy, homework, project method, student presentation, lesson differentiation, research-based learning, external fieldwork, video demonstration, game, students solving tasks at the blackboard, teacher demonstration with a model, modelling, creative activity by students.

The evaluation methods examined in the research:

term paper, oral response, test, quiz, final paper, project, homework, independent research practice, diligence task, digital applications (Kahoot)

The teachers' opinions were measured on a 5-point Likert scale along the statements regarding the subject attitude of students, parents and colleagues (1=I completely disagree; 2=I tend to disagree; 3=I understand both; 4=I tend to agree; 5=I completely agree)

Statements included in the research:

Statements regarding teachers' view about students' attitude towards the subject:

I think students like my subject.

Students who need the subject for their further studies like the subject better.

Students like the subject better than other subjects.

Students like the subject less than other subjects.

Students find the subject interesting.

Students find the subject boring.

I am satisfied with the students' motivation towards the subject.

Students find the subject dry.

Students find the subject useful.

Statements regarding teachers' view about parents, colleagues and own attitude towards the subject:

I think parents find the subject important.

I think colleagues from other majors find the subject important.

I am motivated to teach the subject.

If I could choose now, I wouldn't choose to teach this subject.

3. RESULTS

The research results are presented along with the research questions.

3.1. How do mathematics and science teachers think about the attitude towards the subject in case of students, parents, colleagues and themselves?

The question was measured on a 5-point Likert scale using the statements regarding the attitude towards the subject. The data showed that biology teachers (M: 4.0, SD: 0.640) felt that their subject was liked by students at a significantly higher rate ($p<0.005$) than chemistry (M: 3.3, SD: 0.806), physics (M: 3.1, SD: 0.892), and mathematics (M: 3.1, SD: 0.759) teachers. Despite this, biology teachers are only moderately satisfied with students' motivation towards the subject (M: 3.23; SD: 0.817), similarly to the other groups of teachers surveyed. Physics teachers seem to be significantly ($p<0.05$) the most dissatisfied in this area (M: 2.52; SD: 0.893). Physics teachers are also the ones who admit to being the least motivated to teach the subject ($p<0.05$). (However, we have shown in the research sample that among them there are the highest proportion of those who teach without a specialist teaching qualification).

Biology teachers feel significantly ($p<0.001$) that their subject is more popular with students than other subjects (M: 3.57, SD: 0.728). Mathematics teachers feel this the least (M: 2.51; SD: 0.817).

Regarding the interest of the subject, biology teachers (M: 4.20; SD: 0.664) and chemistry teachers (M: 3.80; SD: 0.741) feel significantly ($p<0.01$) that their subject is interesting to students. Physics (M: 3.52; SD: 0.893) and mathematics teachers (M: 3.24; SD: 0.652) feel this the least. This is confirmed by the fact that physics teachers (M: 2.48; SD: 1.051) and mathematics teachers (M: 2.58; SD: 0.747) claim the highest proportion that students find their subject boring. At the same time, all teaching colleagues see their own subject as similarly, rather useful. However, mathematics teachers (M: 4.24; SD: 0.751) feel significantly ($p<0.01$) higher that colleagues from other subjects also consider their subject important, while chemistry teachers feel the least (M: 3.29; SD: 0.751).

Biology teachers (M: 4.61, SD: 0.661) agree the most with the statement that students who need the subject for their further education also like the subject more. According to mathematics teachers, further education and liking the subject are the least valid, they significantly ($p<0.005$) less agree with the statement, which is understandable, since the subject is a basic requirement for many different careers.

As for the views of teachers regarding parents, mathematics teachers perceive an outstandingly significant ($p<0.01$) higher proportion that parents consider the subject important (M: 3.90; SD 0.977). Physics (M: 2.59; SD: 1.010) and chemistry (M: 2.63; SD: 0.770) teachers feel this way the least.

The following can be stated for the entire sample. Those who perceive parents consider their subject important also perceive the subject as more useful from the students' point of view ($r=0.499$; $p<0.001$). The teacher's own motivation for teaching their subject shows a slight correlation with higher pedagogical education ($r=0.316$, $p<0.001$). Those teachers who believe that students find the subject useful ($r=0.480$; $p<0.001$) and interesting ($r=0.556$, $p<0.001$) perceive at a higher rate that their students prefer the subject they teach more than the others. They are typically the ones who are also more satisfied with the student attitude ($r=0.470$, $p<0.001$). Teacher's motivation is related to what they think about students find their subject useful ($r=0.399$; $p<0.001$).

3.2. What are the differences among mathematics and science teachers in terms of teaching methods used?

The frequency of application of lesson organisation methods was examined on a 4-point scale (1=Almost never; 2=In less than 50 percent of lessons and sessions; 3=In more than 50 percent of lessons and sessions; 4=Almost in every lesson and session.) The average values related to each subject are illustrated in Figure 1.

Looking at the average values for the entire sample, it can be said that the teacher's explanation in frontal form is the most frequently used lesson method among the respondents, present in almost every lesson. Teachers often use the question-and-answer method, the teacher's lecture, the presentation, and differentiation in more than half of the lessons. Among the work forms, individual, pair and group work occur in similar proportions, typically in 50% of the lessons. External fieldwork and drama pedagogy are least present in mathematics and science lessons. At the same time, new methods have also appeared in science lessons, although to a small extent, such as discussion, project method or research-based learning.

There were significant differences between subjects regarding the frequency of lesson methods. Individual work ($p<0.005$) and homework ($p<0.01$) appear significantly more frequently in mathematics teachers' lessons than in the other target groups surveyed. Problem solving by students at the blackboard is least common in biology teachers (M: 1.83; SD: 0.531) and significantly ($p<0.001$) most common in mathematics teachers (M: 3.02; SD: 0.820). Games are used significantly ($p<0.05$) higher by mathematics teachers (M: 2.41; SD: 0.673) and least common in physics lessons (M: 1.85; SD: 0.770). However, the presentation method ($p<0.05$) and video demonstration ($p<0.001$) are used significantly less frequently by mathematics teachers than by others. The experiment presented by the teacher is the least common among mathematics and biology teachers. (Fig. 1.)

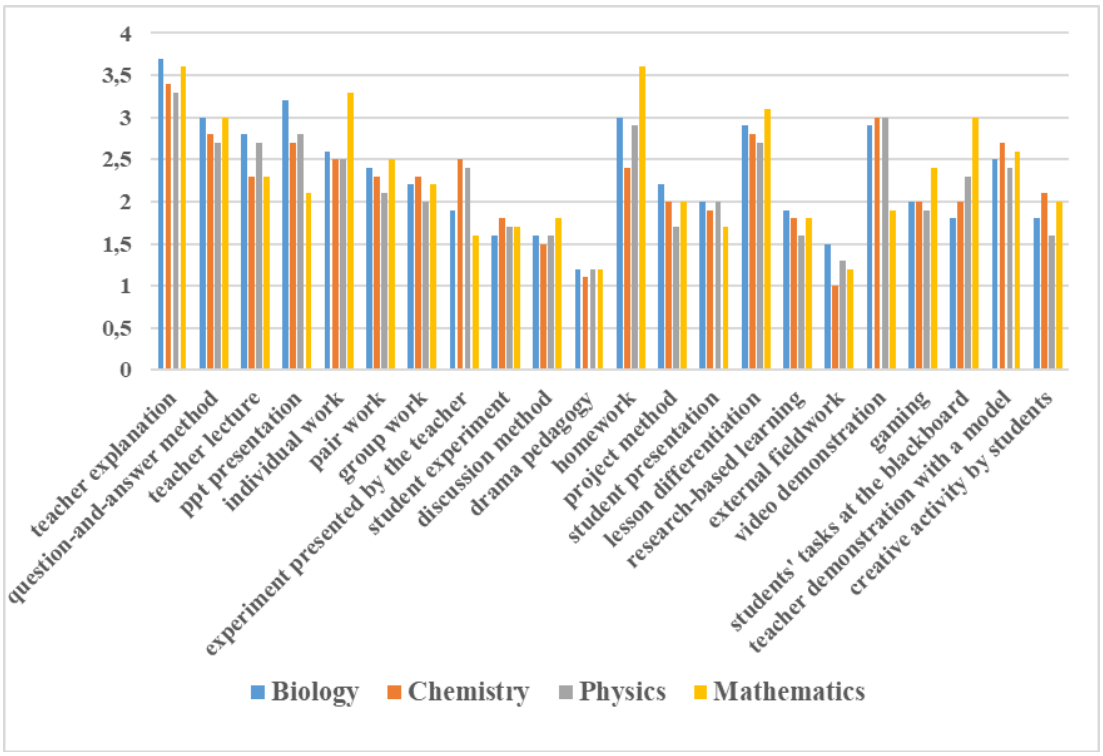

Fig. 1. Frequency of lesson methods among biology, chemistry, physics, and mathematics teachers

Interesting correlations emerged between the frequency of lesson methods in the entire sample. The strongest correlation emerged between the use of group and pair work. Based on the results, it seems that those who use group work in their lessons also prefer to use pair work and vice versa ($r=0.557$; $p<0.001$). A similarly strong correlation was found between student experiments and teacher-led classroom experiments ($r=0.546$; $p<0.001$), as well as modelling and research-based learning ($r=0.490$; $p<0.001$). Furthermore, it can be said that those who use teacher explanation also make use of the teacher's lecture ($r=0.321$; $p<0.001$) and the question-and-answer method ($r=0.424$; $p<0.001$). The correlation between the frequency of using video demonstrations and presentations is also similar ($r=0.416$; $p<0.001$). It is a weaker correlation, but it is still important to mention the correlation between differentiation and the use of games ($r=0.333$; $p<0.001$).

3.3. What are the differences among mathematics and science teachers in terms of evaluation methods used?

The frequency of use of forms of control and assessment was examined on a 4-point scale (1=Almost never; 2=In less than 50 percent of lessons and sessions; 3=In more than 50 percent of lessons and sessions; 4=Almost every lesson and session.)

The most typical forms of control and assessment among the respondents were the homework assignment, the final thesis and the short essay. Based on the data, it can be said that there was no significant difference in the frequency of use of control and assessment forms by subject. Only homework was somewhat overrepresented among biology teachers, but the significance here was not strong either ($p<0.05$). Considering the entire sample, it can be stated that the frequency of use of test and quiz ($r=0.435$, $p<0.001$) and of essay and test ($r=0.374$, $p<0.001$) shows a correlation.

3.4. What is the relationship between mathematics and science teachers' views on students' attitude towards their subject and the type of teaching methods used?

After analysing the relationships between the perceptions of science and mathematics teachers regarding students' attitudes towards the subject and the frequency of evaluation method, the following can be stated. Teachers who believe that students like their subject more often use project methods ($r=0.320$;

p<0.001) and research-based learning when organising their lessons (r=0.315; p<0.001). Teachers who use research-based learning are typically more satisfied with students' motivation towards the subject and vice versa (r=0.347; p<0.001). Also, teachers who feel that their subject is more liked by students than other subjects encourage students to engage in independent research more often (r=0.324; p<0.001). Furthermore, teachers who believe that students find their subject interesting are less likely to use students' problem-solving at the blackboard in class (r=-0.347; p<0.001).

4. DISCUSSION

In our study, we presented the results of a county-level and, to some extent, nationally representative teacher research conducted in 2023. The aim of the research was to explore teachers' views on students' attitudes towards their subjects and to map the methodological procedures they used in the classroom. The research questions concerned, on the one hand, teachers' opinions on students' attitudes towards subjects and, on the other hand, the type and frequency of pedagogical methodological procedures used in the classroom. At the same time, the aim of the research was to point out the possible connections that may exist between teachers' opinions on students' attitudes towards their subject and the classroom methods used by teachers. The research sample was 5-8th graders in Heves County. The sample consisted of teachers (N=140), divided into four subsamples: biology teachers, chemistry teachers, physics teachers, and mathematics teachers. The research was conducted using an online questionnaire.

Regarding the subjects examined, it can be said that overall, the most frequently used lesson methods are the question-and-answer method, the teacher's lecture and the presentation. The least used methods are external fieldwork and drama pedagogy. It should also be emphasized that new methods have appeared in the lessons to a small extent (discussion, project method, research-based learning). Significant differences emerged most markedly in the subject of mathematics. Individual work and homework, as well as games appear with a significantly higher frequency in the lessons of mathematics teachers than in the other target groups surveyed. At the same time, the presentation method and video demonstration are used the least by mathematics teachers. In terms of the frequency of application of control and assessment forms, the diligence task, the final thesis and the short thesis are most typical of the subjects examined.

The following answer can be given to the question of how teachers' perceptions of students' attitudes towards the subject are related to the method applied in the lesson: Teachers who build the learning-teaching process on research-based or project-based methods that focus on student activity report a much more positive student attitude towards their subject. Therefore, how a teacher perceives the student attitude related to the subject they teach is correlated to the choice of classroom methods and work forms they lead. Teachers who feel that students like their subject more often encourage students to engage in independent research practice more often than in other subjects. A teacher's motivation for teaching also shows a correlation with how they perceive students' motivation towards their subject.

We believe that with the research results presented in this study, we have succeeded in further refining the results of previous research on student attitudes towards subjects and supplementing them by revealing some causal factors.

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