FOLIA 364

Annales Universitatis Paedagogicae Cracoviensis

Studia ad Didacticam Mathematicae Pertinentia 14(2022)

ISSN 2080-9751
DOI 10.24917/20809751.14.7

Eliza Jackowska-Boryc, Anna Pyzara

Comparison of feedback in mathematics lessons in on-line and classroom teaching in the opinion of students*

Abstract. Feedback is one of the pillars of formative assessment. It is a comment (conveyed in various forms) to the work done. Thanks to it, both students and teachers obtain information that allows them to direct their further work. Instead of giving the student a summative assessment (in the form of a grade), the teacher can formulate a formative assessment in the form of feedback. In order to provide the student with good feedback, the teacher should emphasize what the student did well, which needs to be corrected, give tips on how to correct mistakes and shortcomings, and indicate directions for further work.

In teaching math, feedback is very helpful. Students making mistakes often do not understand what they are and do not know how to correct them. Also, when the student is unable to solve a given task, he often does not know how to look for clues to solve the problem. Thanks to the feedback, the student receives this information. On the other hand, the teacher, while conducting the lesson, finds out whether the problem he has explained has been understood, or whether he has to explain it again in a different way. It is essential for the effective teaching of mathematics.

As a result of the covid pandemic, most schools introduced on-line teaching. Teachers were forced to use remote teaching tools, whether they knew them before or not (then they had to learn them quickly). Due to the new situation faced by teachers and students, the role of feedback in teaching, in particular in teaching mathematics, may have changed. The response to this is the study presented below, which compares the importance of feedback from mathematics lessons to on-line and classroom teaching.

*2010 Mathematics Subject Classification: *97D60*
Keywords and phrases: *feedback, formative assessment, on-line teaching*

1. Introduction

We can view mathematics education as steering the learning process of mathematics. This process should follow the teaching principles set out by well-established pedagogical theories, as specified for teaching mathematics. In teaching mathematics, the principle of "active and conscious participation of the student in the teaching process" is particularly important. Stimulating the student's activity and awareness, and thus taking into account the aforementioned principle in teaching mathematics, is the basic condition for effective teaching (Krygowska, 1977, part 2, p. 3).

The implementation of this principle in the teaching process is possible thanks to formative assessment. Its basis is to increase the student's awareness of the course of his learning, and thus motivate him to be active. Formative assessment is also known as supportive assessment or formative learning. What exactly do we mean by "formative assessment"? The Center for Civic Education provides the following definition:

Formative assessment is the process of obtaining information by the teacher and the student during teaching that will allow them to recognize what the learning process is going on, so that the teacher modifies further teaching, and the student receives feedback to help him learn[1].

Formative assessment is made up of many interacting elements. Teacher using formative assessment:

- defines the aims of the lesson and formulates them in a language understandable to the student,
- establishes the assessment criteria, i.e. what will be taken into account when assessing the student's work,
- uses effective feedback,
- distinguishes between the functions of summative assessment (degrees) and formative assessment (feedback),
- builds a learning atmosphere - learns how to learn,
- can formulate key questions (making students think),
- can ask questions involving the student in the lesson,
- introduces self-assessment and peer assessment.

All of these elements are significant for formative assessment, but in this paper we will focus on the ones that are closely related to feedback, so the first three elements (Sterna, 2014).

[1] https://pomagajsieuczyc.ceo.org.pl/tematy/ocenianie-ksztaltujace/

1.1. Lesson's goals and success criteria

An important component of formative assessment is to define lesson objectives and communicate them to students. At the beginning of the lesson, the teacher gives the goals in a language that the students understand – in this way, the student learns what he should be able to do after the lesson and what he should direct his actions towards. However, at the end of the lesson, the teacher and the students check whether the goals have been achieved. For this purpose, the method of summative sentences can be used. In teaching mathematics, it is particularly difficult to make lesson objectives understandable to students (Sterna, 2006, p. 12). This is due to the specificity of mathematical language, not always student-friendly.

The lesson's objectives are closely related to the assessment criteria (also known as success criteria), i.e. what the teacher will take into account when assessing the student's work. The criteria help students prepare for the test and get the job done so that the goal set by the teacher is met (Bąbel, 2007, p. 62).

In mathematics, it is not easy to define precisely the requirements, because we do not want to give the content of the tasks before the test, but we must strictly define what skills the student should have (Sterna, 2006, p. 12). According to D. Sterna, mathematics teachers more and more often give success criteria, thanks to which students get information about what is expected of them.

2. Feedback

Feedback is the basis of formative assessment. The feedback must be closely related to the evaluation criteria. Good feedback has four ingredients:

1. Appreciating the good elements of the student's work,
2. Indication of what needs improvement,
3. Tips on how to correct mistakes,
4. An indication of the direction in which the student should continue working.

Each of these components plays a significant role in increasing the student's achievement (Wiggins, 2012; Gregorczyk, Swat-Pawlicka, 2011).

1. Appreciation of the good elements of work is the most important piece of feedback. It helps to identify the strengths of the student's work, and at the same time is the basis for motivating him to further activities (Wenda, 2018, p. 50). Especially in teaching mathematics, it is important to appreciate what the student has done well (especially for students who have difficulties with mathematics), as it shows that mathematics can be learned (by working according to the guidelines), which motivates for further work. In addition, pointing to good elements at work allows the student to realize what he or she already knows. It turns out that the student is not always aware of this (Sterna, 2006, p. 12).

2. Identifying what needs improvement. Teachers are great at pointing out mistakes and shortcomings. We should not always point out all the mistakes, but select the most important ones to give the student one or two challenges to work on. In this way, there is a greater chance that the student will be able to complete

them than if we list these challenges ten. Let's work with small steps that the student will be able to complete.

3. Tips for correcting mistakes. When pointing out mistakes, we should also show the student how to correct them. In teaching mathematics, feedback plays an important role, because when students make a mistake, they often do not know or understand what they did wrong. It is important to provide specific tips on how the student is to improve their work, as well as how to improve.

4. Indication of the direction in which the student should continue working. The following tips are very important for a gifted learner to develop further once he has obtained a good grade. These tips may concern interesting facts, show the applications of mathematics, or be specific tasks to be practiced (Gregorczyk, Swat-Pawlicka, 2011).

Feedback containing the above elements is a formative assessment, and can be an alternative to summative assessment (grades). It is worth considering whether a student's work must always be marked with a grade. It turns out that good feedback brings much better results. Research conducted by J. Hattie (2011) shows that providing feedback to students significantly contributes to increasing student achievement. The feedback is to indicate what the student already knows and help him ADD new skills and knowledge to those he already had. Grades are based on pointing out students' mistakes (Wenda, 2018; Wiggins, 2012).

Grades are important in summarizing the knowledge acquired by the student. In the process of acquiring knowledge, it is beneficial to provide feedback. This way we can evaluate: homework, repetitions, cards, tasks performed during the lesson, projects, in an informative way. It is important that the student receives feedback before summing up.

The feedback will be effective if it is provided systematically. It should be handed over whenever it is possible, but also the sooner the better – the student will be able to effectively use the feedback if he receives it soon from his / her activity. This requires a lot of teacher's work, but frequent and quick transfer to the feedback is possible thanks to peer assessment and the use of ICT technology (Wenda, 2018).

Research on the automatic feedback shows that the use of technology significantly reduces the time it takes to transfer a formative assessment. Additionally, these studies showed that systematically communicated feedback had a positive effect on the mathematical achievement of students and increased their results (Barana, Marchisio, 2016; Faber, Luyten, Visscher, 2017).

Feedback can be provided not only by the teacher – students can evaluate each other's work (peer review). Another type of feedback is the information provided to the teacher by the students during the lesson. The teacher can obtain information from the students to modify further teaching. The lighting method is helpful here (Sterna, 2014; Wiggins, 2012).

2.1. Forms of feedback

Feedback can take many forms. The most common forms of feedback are:

- verbal feedback,

- letter (extensive written commentary),
- table (with success criteria),
- writing each of the feedback's elements in different colors directly on the text,
- simplified forms:
  - for two stars and one wish,
  - a sandwich.

Simplified forms of feedback are often used in the younger grades. They contain two good sides of the job (two stars) and something that could be done better or different (a wish). Older students appreciate more extensive feedback. Below are two examples of feedback for high school students. The first is in the form of a letter, while the second is based on the success criteria table (Sterna, 2014).

3. The place of formative assessment and feedback in teaching

Worldwide research shows the positive impact of feedback (and formative assessment at all) on learning outcomes. In a report prepared by the OECD (Organization for Economic Development and Cooperation, 2005) we can read: "Numerous quantitative and qualitative studies indicate that the use of formative assessment in teaching is one of the most effective interventions to improve learning outcomes." Also, research by J. Hattie (2011) has shown that elements of formative assessment produce the greatest results in increasing student achievement, in particular, the most significant interventions are self-assessment and feedback.

Both numerous individual studies and meta-analyzes show that feedback results in medium to very high gains in students' knowledge. All efforts to improve feedback (or formative assessment at all) have significant and significant benefits in science. Use of feedback indicated much greater positive effects in the increase of students' knowledge and skills than in the case of other educational methods (Bennett, 2011; Black, Wiliam, 2010).

Ginsburg, emphasizing the role of feedback, states that teachers must have assessments that will give them knowledge about a child's performance, thinking, educational potential and motivation to learn. The author also claims that these messages should not be mere dry facts that bring nothing to the teaching, but should make sense for the teacher and should contribute to the practical work of the teacher in the field of mathematics teaching. According to Ginsburg, these are the functions of feedback, which has the ability to act, that is, to effectively direct and improve teaching (Ginsbrug, 2009).

Scientists are wondering whether feedback can be effective if the theory and development of this concept are developed regardless of the field of science. For feedback to be as effective as possible, it requires a combination of general principles, strategies and teaching techniques with processes and knowledge relevant to the field. A solution to this problem may be to provide formative assessment

materials for key ideas or core concepts within a given specialization, which should be the same for each curriculum (Bennett, 2011; Black, Wiliam, 2010; Shilling, 2010).

Scientists agree that teaching with feedback is most beneficial for weak and deficient students (Shilling, 2010). The impact of formative assessment on students' achievement and interest in terms of their perceptions of the usefulness of feedback was tested in mathematics lessons in a study conducted in Germany. Students found progress messages from teachers to be very useful, giving them greater confidence in achieving better results in the upcoming test and causing much greater interest in the topics. The results show that formative assessment can change the individual perceptions of students about the usefulness of summative assessment. Moreover, it helps to positively assess one's own competences (Rakoczy et al., 2019).

In mathematics, ICT is sometimes also used to study the impact of feedback on student progress. E-learning courses were used at the Department of Mathematics at the University of Turin to research this assessment. The on-line training used the Maple T.A. automated grading system, through the Moodle learning management system. As part of the course, high school students were given instructions that had to be followed step by step to find out how to solve a given task, and then young people performed similar tasks on their own, for which they received automatic feedback. Students and teachers were satisfied with the use of this tool for automated formative assessment, and noticed an increase in the level of learning as well as its usefulness in preparing for final exams. In their opinions, teachers positively assessed this form of teaching. As advantages, they mentioned, among others: shortening the time of task assessment, automatic provision of personalized feedback, a huge number of exercises to be shared, increased motivation, greater objectivity in assessment and increased awareness of students regarding their own abilities. Similar results were obtained when testing the Snappet tool (Barana, Marchisio, 2016; Faber, Luyten, Visscher, 2017).

Some research in Poland concerns the impact of feedback in mathematics didactics (Jackowska-Boryc, Pyzara, 2020). There is a need to fill this gap, especially since the Learning School Program (SUS) has been operating in Poland since 2000, run by the Center for Civic Education and the Polish-American Freedom Foundation promoting the use of formative assessment (in particular feedback) in schools. However, there is no scientific research in Poland assessing the impact of this approach in the field of mathematics didactics – we intend to supplement it, which resulted in this publication.

Detailed research is needed to verify the impact of feedback on the effectiveness of mathematics teaching. This need is justified by the fact that the applicable law (in Poland) obliges teachers to provide students with full feedback (The ordinance of the Ministry of National Education of August 3, 2017, (paragraph 12), (Journal of Laws 2019.0.1481 – art.44b. Education system).

Thus, every teacher should provide feedback to his students. An additional motivation for teachers may be the fact that formative assessment (an important element of which is feedback) not only activates students, but also increases their achievement and helps to equalize educational opportunities. (Bąbel, 2007, p. 61).

3.1. Implementing feedback in the teacher's work

In order to use feedback (or formative assessment at all), teachers need knowledge about it. It is necessary to build a solid foundation for understanding and applying this promising teaching concept, which is possible either by self-learning or by taking courses or vocational training programs on the subject. According to Black and Williams, the lecturer will not take advantage of new learning ideas, even if they are very attractive, when it is entirely in their hands to implement this innovation. This is because teachers are too busy in the classroom to implement new teaching methods on their own. The researchers say a solution to this problem could be the gradual training of educators in local groups that would work together to develop responses to problematic issues. (Black, Wiliam, 2010; Rakoczy et al., 2019).

Another problem for teachers may be issues related to modern technology. Technological development forces them to change and modernize their teaching methods, which lead to the improvement and streamlining of the teaching process. Thus, the introduction of applications enabling automatic feedback, training for teachers are organized. Research has shown that the conducted training opened teachers to the use of applications enabling automatic feedback (Barana, Marchisio, 2016; Faber, Luyten, Visscher, 2017).

4. Methodology

Research conducted so far shows the positive impact of feedback on the acquisition of knowledge and skills by students. In 2020, due to the emergence of the pandemic caused by the covid-19 virus, the current way of teaching has changed rapidly and dramatically. In most countries in the world (including Poland) on-line teaching has been introduced. Within a few weeks, teachers had to adapt to the form of distance education, despite the fact that most of them had not previously had contact with this form of teaching.

Due to the new situation in which teachers and students find themselves, the role of feedback in teaching, in particular in teaching mathematics, may have changed. The answer to this situation is the research presented below.

Purpose of research

The main objective of the study is to compare the feedback in on-line and classroom teaching, based on students' opinions. The research aims to check whether the introduction of a form of distance teaching has significantly affected the way feedback is provided in mathematics lessons of surveyed students. For this purpose, the school realities of on-line teaching in Poland were checked and the opinions of students regarding the feedback in mathematics lessons during on-line and classroom teaching were examined. The following specific objectives have helped to further investigate the issue:

- How do the students of different types of schools understand the concept of feedback?

- Is there a difference in giving feedback during on-line and classroom teaching based on students' opinions?

Organization of research

The basic research method was a diagnostic survey and the research technique was an anonymous survey, conducted in May 2021. The questionnaire was prepared in a paper version and was filled in by students of primary and secondary schools located in the Lubelskie Voivodeship. The surveyed students took part in extra classes in mathematics (activities supporting and extending knowledge) conducted by employees of the University of Maria Curie-Skłodowska in Lublin. These were students who voluntarily came to classes offered by the university and were not randomly selected. The students studied in different grades of primary and secondary school and were taught by different teachers who were unable to verify. Therefore, the group of surveyed students was not random but intentional. Completing the survey was voluntary, so it is to be hoped that the answers given were truthful. The time of completing the survey was not limited.

The survey consists of two parts: the first part aims to recognize the research group and school realities during on-line teaching; the second part concerns the study of students' opinions on feedback in classroom and on-line teaching. The questions in the survey are of different types: open-ended questions, single-choice or multiple-choice closed questions. The main topic of this notion is feedback, hence in this paper we analyzed those questions that were related to the opinions of the surveyed students on feedback. The results are based on descriptive analysis and predictive analysis. The analysis was based mainly on the comparison of percentages of responses received. The main criterion was students' opinion and understanding of the definition of feedback. The results will be presented in tables and graphs. The content of the survey questions will be given when analyzing the surveyed students' answers.

4.1. Characteristics of the research group

The research group could be determined by the answers to the initial two questions, i.e.:

1. What kind of school do you attend?
   (a) primary school,
   (b) secondary school (high school or vocational school, without differentiation).
2. Where is your school located?
   (a) large city (over 200 000 citizens),
   (b) small city,
   (c) village.

It turned out that 179 students of Polish schools from the Lubelskie voivodeship took part in the survey, including 55 high school students and 124 primary school students. The survey was filled in by 95% of students coming from a large city. In Lubelskie voivodeship there is only one large city where the number of citizens outreach 200 000, hence we state that 95% of the respondents were residents of Lublin, only 3 people were from a small city and 5 people from the village. The opinions of the remaining 5% of students were taken into account in the analysis.

4.2. Circumstances of conducting research – school realities during on-line teaching

The characteristics of the conditions of on-line teaching (description of school realities) are possible thanks to the surveyed students' answers to the following questions:

1. How many on-line math lessons have you had in a week while on-line teaching?
2. How many minutes did the on-line lesson last?
3. How often during on-line teaching did you write math papers (e.g. tests, homework) that were evaluated?
   (a) once a week,
   (b) once every two weeks,
   (c) once a month,
   (d) twice per semester,
   (e) less than twice in the entire on-line teaching.
4. Was your work written honestly during on-line teaching?
   (a) yes,
   (b) partly,
   (c) no.

The surveyed students' responses showed that most of the lessons were in the form of on-line teaching. Students usually had 4 to 6 math lessons per week. On-line lessons had different durations. Usually, it was in the range of 30–45 minutes (94% of respondents this is 168 students) that was similar to time during classroom teaching, but there were also longer lessons (7 people reported that the lessons lasted up to 60 minutes; and 4 indicated that the length of the lesson was up to 90 minutes – two combined lessons). It is worth mentioning that about 50% of students (89 students) declare that the time of on-line lessons was reduced to 30 minutes, the rest indicate time between 30–45 minutes. Thus, in half of the respondents, the time of contact with the teacher was reduced by about $\frac{1}{3}$, this is about 10–15 minutes.

About half of the number of students (89 students) at the time of on-line teaching did written work for assessment once every two weeks; 27% (48 students) of people once a month, 24% (43 students) once a week and 2 (out of 179) people claimed that they were assessed twice a semester. This means that in most cases, surveyed students were assessed regularly, and if they got feedback on their work they should also get it regularly. However, the issue of independent written work turned out to be a problem. 64% of respondents (115 students) declare that they wrote works without cheating, while the remaining people admitted to cheating (36% of respondents, 64 students). Primary school pupils are more likely to declare honest work than secondary school students (67% of pupils in primary school (83 students from 124) and 57% in secondary school (31 students from 55)), which may be the focus of other research.

5. Results

The main question that the authors wanted to answer is this: Is there a difference in giving feedback during on-line and classroom teaching based on students' opinions? The analysis of the survey helped to find the answer. The results are presented as percentage and numbers (numbers in brackets represent the number of students) in the tables and bar graph. The answers in tables are divided into general responses and secondary school, and primary school surveyed students.

We will analyze mainly the answers to closed questions, except for the first one, which was an open-ended question and must be included in this part. A detailed analysis shows the division of answers of primary school students (124 people, 69% of respondents) and secondary school students (55 people, 31% of respondents), as well as overall results.

Let us emphasize again that the results were based on the opinions of the students of the research group and do not apply to the entire population. Note that the results are presented as percentages that were rounded to nearest units. The numbers in parentheses indicate the exact number of students who gave each answer.

The first question about the feedback was "What does feedback mean to you? How do you understand the term "feedback"?". It was an open question to verify that surveyed students understood the concept correctly. Based on the definition of feedback, the answers to the question were divided into the following categories:

- does not understand the meaning,
- does not give a formal definition, but intuitively understands the meaning,
- gives the correct definition,
- statements that contain elements of good feedback: "What did you do right?", "What did you do wrong?", "How to correct mistakes?", "How to develop your skills?".

The results of the survey in this question are as follows.

Category	General	Primary school	Secondary school
does not understand the meaning	56% (100)	71% (87)	24% (13)
does not give a formal definition, but intuitively understands the meaning	11% (20)	15% (18)	2% (2)
gives the correct definition	15% (27)	12% (16)	22% (11)
statements that contain elements of good feedback: "What did you do right?", "What did you do wrong?", "How to correct mistakes?", "How to develop your skills?"	18% (32)	2% (3)	52% (29)

Table 1: Presentation of the answers to the question "What does feedback mean to you? How do you understand the term feedback?".

The question concerned the understanding of the definition of feedback by the surveyed students. It turned out that many of students gave the definition of the term "feedback" in relation not to the educational process but in general as an opinion on a given topic, e.g. the way of doing some work, behavior or statements of other people, e.g. *Feedback means a statement by a participant in a conversation in which he or she discloses his or her observations about the behavior and statements of another participant in the conversation.* Very often, surveyed students identify the feedback with the answer, information from the teacher about the student's work or what has been done, as well as with the explanation by the teacher of a given question or answer to the sender of the performance of a given activity or work. Sometimes surveyed students refer to one of the characteristics of the formative assessment without knowing that the full feedback must contain all four characteristics. More than 85% (87 students) of all surveyed students who are not familiar with the concept of feedback are primary school students. On the other hand, as many as 53% (of all students who correctly defined the concept of feedback, intuitively understands the meaning or their statements contain elements of good feedback) were secondary school students. This means that secondary school students, from the surveyed group, are more aware of what feedback is and what its characteristics are but the difference is not meaningful as far as percentages are concerned. If the number of students in two levels of school were similar, we would obtain more reliable results.

The next question was about lesson goals: "How often in math lessons did the teacher give the lesson goals?" It was a closed question in which each student could choose one of five answers: in almost every lesson, once or twice a week, once or twice a month, once or twice a semester, never. Each of the above answers had to be given for on-line teaching and separately for classroom teaching.

Analyzing the responses of all students regarding on-line teaching, we obtained the following Table 2.

Category	**General**	**Primary school**	**Secondary school**
in almost every lesson	71% (127)	48% (27)	82% (100)
once or twice a week	12% (21)	16% (9)	9% (12)
once or twice a month	3% (6)	6% (3)	2% (3)
once or twice a semester	1% (2)	4% (2)	0%
never	13% (23)	26% (14)	7% (9)

Table 2: Presentation of answers to the question "How often in math lessons did the teacher give the lesson goals during on-line classes?".

The conclusions of this analysis show that, overall, the vast majority of surveyed students were given lesson goals in almost every math lesson. Then, the second largest group was the one who declared that they had never received lesson goals while on-line teaching. Now let us look at the detailed analysis of this question. Comparing the responses of students from both types of schools, it can be seen that both primary and secondary school students gave the answer that during on-line teaching, the teacher gave its goals in almost every lesson. In secondary school, more respondents expressed this opinion than in elementary school, while among students of both types of schools.

In addition to formulating lesson objectives during on-line teaching, we also examined the frequency of formulating lesson goals during classroom teaching. The general and detailed results carried out on the surveys of primary and secondary schools students are presented in Table 3.

Category	**General**	**Primary school**	**Secondary school**
in almost every lesson	72% (129)	54% (30)	80% (99)
once or twice a week	12% (21)	11% (6)	12% (15)
once or twice a month	2% (4)	7% (4)	0%
once or twice a semester	3% (6)	5% (3)	2% (3)
never	11% (19)	23% (12)	6% (7)

Table 3: Answers of primary and secondary school surveyed students to the question "How often in math lessons did the teacher give the lesson goals during classroom teaching?".

Analyzing the answers, it can be seen that the type of classes in both primary and secondary school did not affect the frequency of entering lesson goals in class. Summing up the answers to this question, it can be seen that the formulation of lesson goals depends on teachers of surveyed students, not on the type of the classes.

The next question was about the forms of feedback that are used in math lessons by the teacher. It was a multiple-choice question in which students could choose any form from the following: short verbal commentary, short written commentary, table with skills listed, detailed description, detailed verbal comment, grade, for both on-line and classroom teaching. Among the forms were the following options: short verbal commentary, short written commentary, table with skills listed, detailed description, detailed verbal comment, grade. The general answers to this question are set out in Table 4.

Category	**On-line**	**Classroom**	**Same in both modes**	**Not chosen**
Short verbal commentary	11% (20)	22% (39)	42% (75)	25% (45)
Short written commentary	26% (47)	12% (21)	30% (54)	32% (57)
Table with skills listed	3% (5)	5% (9)	8% (14)	84% (151)
Detailed description	8% (14)	12% (21)	13% (23)	67% (121)
Detailed verbal comment	6% (11)	15% (27)	17% (30)	62% (111)
Grade	6% (11)	2% (4)	74% (132)	18% (32)

Table 4: General answers to the question "What are the forms of feedback used in your math classes?".

The general opinions of surveyed students in Table 4 show that the most common way to provide feedback the same in two modes, is through grades and a short verbal comment. When we analyze the responses from this question in terms of the lesson mode, it turns out that in classroom teaching feedback was given as short verbal commentary, and in on-line teaching as short written commentary. This may mean that in the opinion of students, during classroom teaching, the teacher could give quick verbal hints during the lesson, while during on-line teaching, this form was much more difficult, which is why students more often received feedback in paper form. It can also be seen that in the opinion of students, feedback is equated with the grade, which is why this answer was chosen most often. It is worth adding that the choice of evaluation as a form of feedback in our research resulted from the lack of knowledge of the exact definition of this concept. This is one of the limitations of our research.

An analysis of the same question among the answers of primary school students is presented in the Table 5 below.

Summing up the opinions of primary school students on the types of forms of feedback that are the same in two modes, we can see that grade and a short verbal commentary are the most common. Unfortunately, these forms do not coincide with the idea of Formative Assessment. The table with listed skills appeared the least frequently, despite the fact that this form of feedback brings the best results. If we consider separately on-line teaching and classroom teaching, it appears that during on-line teaching the most popular feedback form was short written commentary, while for classroom teaching short and detailed verbal commentary. In this type of comparison the table with listed skills was rarely applied. According

Category	On-line	Classroom	Same in both modes	Not chosen
Short verbal commentary	14% (25)	18% (32)	44% (79)	24% (43)
Short written commentary	27% (48)	14% (25)	22% (39)	37% (67)
Table with skills listed	2% (4)	6% (11)	6% (11)	86% (154)
Detailed description	9% (16)	14% (25)	12% (21)	65% (117)
Detailed verbal comment	7% (13)	18% (32)	12% (21)	63% (113)
Grade	7% (13)	3% (5)	66% (118)	24% (43)

Table 5: Answers of primary school students to the question "What are the forms of feedback used in your math classes"?

to the opinion of the surveyed primary school students, the most common form of feedback they had to deal with was grade and verbal commentary (short or detailed). This result is largely consistent with the general opinion of surveyed students. The answers of secondary school students are presented in Table 6.

Category	On-line	Classroom	Same in both modes	Not chosen
Short verbal commentary	2% (4)	33% (59)	39% (70)	26% (46)
Short written commentary	24% (43)	6% (11)	51% (91)	19% (34)
Table with skills listed	2% (4)	6% (11)	13% (23)	79% (141)
Detailed description	6% (11)	7% (13)	15% (27)	72% (128)
Detailed verbal comment	4% (7)	9% (16)	28% (50)	59% (106)
Grade	2% (4)	0%	91% (162)	7% (13)

Table 6: Answers of surveyed secondary school students to the question "What are the forms of feedback used in your math classes?".

The most frequently chosen form of feedback, regardless of the mode, was grade, although short written commentary and short verbal commentary also appeared frequently. The least frequently selected option was a table with skills listed, which is consistent with the opinions of primary school surveyed students. However, when we consider the on-line teaching and the classroom teaching separately, it turns out that the opinions of secondary school surveyed students are different. In on-line teaching, students most often received feedback in the form of short written commentary, while in classroom teaching it was short verbal commentary. We can see from this analysis that most often surveyed secondary school students get feedback from the teacher's grade. Quite often, teachers use short comments, verbal or written, while other forms of feedback are the least frequently used.

Another question asked to the students was "How often did they get feedback on their written assignments during on-line teaching?". It was a single choice question and students could choose from four answers: "I didn't get even once", "I got a few times", "I got once" and "I got after every written job". Contrary to the previous questions, this has been limited to on-line teaching only. This question was not intended to be a comparison between the two teaching modes, but to answer the question of how often there was feedback on written assignments under unfavorable on-line teaching conditions. As previously, the research group was divided into primary school students and secondary school students. The results are presented in Table 7.

Category	**General**	**Primary school**	**Secondary school**
I didn't get even once	42% (75)	36% (44)	57% (31)
I got a few times	35% (63)	38% (47)	28% (16)
I got once	7% (13)	8% (10)	6% (3)
I got after every written job	16% (28)	18% (23)	9% (5)

Table 7: Presentation of answers to the question "How often did they get feedback on their written assignments during on-line teaching?".

As can be seen from Table 7, about 60% of all students were given an answer, while more than 40% of surveyed students did not get any answer at all. We will now focus on a detailed analysis of this question. It can be seen that primary school students most often chose the option *"I got a few times"*, followed by *"I didn't get even once"*. It is not known how often they received feedback, whether it was provided systematically, or how it was most often provided. As for the responses of secondary school students, the vast majority believe that they have not received any feedback at all. According to students' opinions, only 28% of students said they received feedback several times. When analyzing the results, it can be noticed that the opinion about giving feedback to written work during on-line teaching in both research groups was very similar, that is, feedback was not given or was given rarely. Most often, students equated it with evaluation, so the fact of giving infrequent feedback may result from infrequent evaluation. It is important to pay attention to the forms of feedback. If we analyze the students' responses in terms of not only the number of feedback but also the form, it turns out that all the respondents that after each written assignment are given feedback as a form of response, they indicated the grade. Especially in the opinions of primary school students, the situation was a bit different. Among surveyed people who declared that they receive feedback after each written paper, as many as 84% indicated a grade. This is further evidence that both surveyed students and their teachers often interpret feedback as an assessment and it is the most common form of communicating a student's progress.

Another question for students was "To what extent the students used the feedback provided by their math teacher in distinguishing between classroom and on-line teaching?". It was a single choice question where the student could choose from five options for both classroom and on-line modes. The answers were as

follows: 1 (I didn't use it), 2 (Rarely), 3 (Sometimes), 4 (Often), 5 (I always used it). The analysis was carried out separately among primary and secondary school students. The results for this question are presented in Table 8.

Category	**General**		**Primary school**		**Secondary school**	
	on-line	**class-room**	**on-line**	**class-room**	**on-line**	**class-room**
5 (I always used it)	27% (48)	28% (50)	27% (48)	29% (52)	26% (47)	26% (47)
4 (Often)	25% (45)	37% (66)	26% (47)	34% (61)	22% (38)	46% (82)
3 (Sometimes	26% (47)	21% (38)	24% (43)	22% (39)	30% (54)	17% (30)
2 (Rarely)	9% (16)	6% (11)	10% (18)	7% (13)	7% (13)	4% (7)
1 (I didn't use it)	13% (23)	8% (14)	13% (23)	8% (14)	15% (27)	7% (13)

Table 8: Presentation of answers to the question "To what extent the students used the feedback provided by their math teacher in distinguishing between classroom and on-line teaching?".

Overall, the majority of surveyed students said that regardless of the mode in which lessons were conducted, students always, often or usually applied feedback from the teacher. In the case of primary school students, we can also see that the vast majority of surveyed students said that they use the feedback always, often or sometimes similarly to secondary school students. It is worth noting, however, that in the responses of surveyed students of both types of schools, more of them replied that they often used the feedback in the classroom mode than on-line.

After analyzing the responses from both research groups, it can be noticed that the majority of surveyed students used feedback more intensively during classroom education, regardless of the type of school. During on-line teaching, more respondents did not use feedback in a proper form or did it very rarely. This may indicate great difficulties related to the participation in the classes itself.

Surveyed students were asked "What kind of teaching system did you get more feedback from?". 56% (100 students) of them answered that in classroom teaching, while 44% (79 students) said that during on-line teaching. Likewise, the votes among respondents who interpret the concept of feedback well (34 students), 53% stated that they received feedback more often in classroom education, and 47% in on-line teaching. On the other hand, among respondents who correctly understand feedback (15 students), as many as 73% indicated that they received feedback more often during classroom education. Moreover, 70% of surveyed students said that classroom teaching improves the provision of feedback in math lessons. The same percentage of responses was found in the group of surveyed students who understand the notion of feedback correctly.

The next question in the survey was a multiple-choice question and concerned the feedback's elements conveyed in on-line and classroom teaching ("After receiving the feedback, did you know: What did you do right ?, What did you do wrong ?, How to correct mistakes ?, How to develop your skills?"). The students' responses clearly show that in classroom teaching, students received more informa-

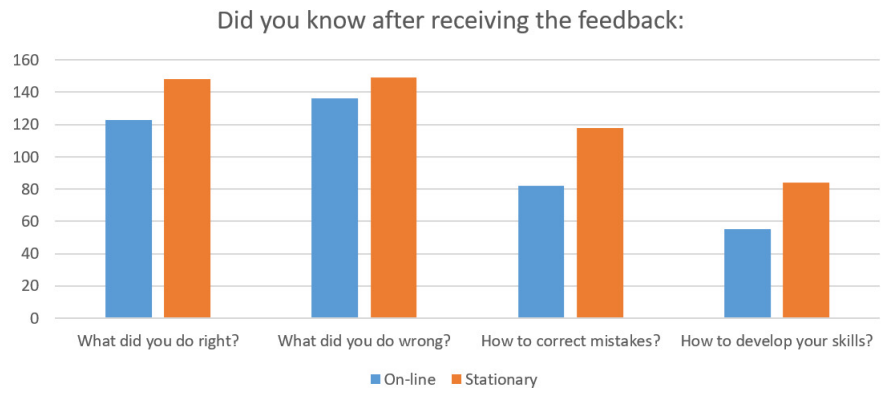

Figure 1: Answers of the students to the question about the feedback elements conveyed in stationary (classroom) and on-line teaching.

Category	On-line	Classroom
What did you do right?	68% (122)	80% (143)
What did you do wrong?	75% (134)	82% (147)
How to correct mistakes?	45% (81)	65% (116)
How to develop your skills?	30% (54)	46% (82)

Table 9: Presentation of students' answers to the question on the elements of feedback provided in classroom and on-line teaching.

tion about the state of their knowledge. 46% (82 students) of feedback provided in class was full feedback (they contained 4 elements), while in on-line teaching only 30% (54 students) of feedback was full. Regardless of the form of teaching (on-line or classroom), surveyed students most often found out where they made mistakes and what they did right. 80% (143 students) of students in classroom teaching knew what they did right and what did wrong, while in remote teaching, 75% (134 students) of the surveyed students knew what they did wrong, and 68% (122 students) of the students also knew what they did right. A clear difference between transferring to the feedback in classroom and remote teaching concerns information on how to correct mistakes – in classroom teaching such information was received by 65% (116 students) of surveyed students, while in remote teaching only 45% (81 students) of the respondents. Thus, surveyed students received more feedback elements in classroom teaching, which means that the introduction of on-line teaching contributed to the deterioration of the quality transferred to the feedback.

6. Discussion and Conclusions

Due to the global change to on-line teaching (caused by the coronavirus pandemic), teachers faced new challenges (but also opened up new opportunities). Both teachers and students were forced to adapt almost overnight to the form of distance work. Teachers were not globally prepared to work in this mode, so they had to learn to function in the new reality in a short time, i.e. to use new technological tools both to conduct classes effectively and to verify students' knowledge. Research on surveyed students' opinions showed that half of the respondents had their lesson time reduced to 30 minutes, and the majority of the remaining students had lessons slightly shorter than those that were held in the classroom (45 minutes). Thus, the contact time between the students and the teacher was reduced. During on-line teaching, surveyed students' knowledge and skills in mathematics were systematically tested by teachers, but many students admit that they did not do it alone when doing their written assignments.

Remote teaching meant that teachers also had to adapt the transfer of feedback to the new teaching conditions. Thus, the main aims of the study were to compare the difference in giving feedback during on-line and classroom teaching based on students' opinions and verify how the students of different types of schools understand the concept of feedback.

Based on the conducted research and surveyed students' opinions, we can see the difference in giving feedback in mathematics lessons in distance teaching and in classroom teaching. In addition, the following observations can be made:

- Most of the surveyed students do not understand the meaning of feedback.

According to students from the researcher group feedback is often identified with the answer, information from the teacher about the student's work or what has been done, as well as with the teacher's explanation, explanation of a given question or response to the sender of the given activity or work. Sometimes surveyed students refer to one of the feedback's characteristics without knowing that the complete feedback must contain all 4 characteristics (Jackowska-Boryc, Pyzara, 2020). Very often surveyed students interpret the feedback as assessment and it is the most common form of communicating information about the student's progress. Moreover, most of the respondents are not trained to obtain feedback from themselves. It is worth paying attention to the fact that surveyed students are intuitively aware of partial feedback, as indicated by their answers regarding the possibility of asking questions or helping the teacher, as well as arguments regarding the feedback elements ("I always knew what I was doing wrong and what I was doing right").

- There is a significant difference between on-line and classroom teaching as far as giving the feedback is concerned.

The conducted research shows that polled students more often received feedback during classroom teaching and then also they used it more, regardless of the type of school. The responses showed that the surveyed students received

more feedback's elements in classroom teaching, which means that the introduction of on-line teaching contributed to a deterioration of the quality transferred to feedback in mathematics lessons. Moreover, surveyed students claim that their mathematics teachers used feedback very rarely during distance teaching. The vast majority of surveyd students stated that classroom teaching is better conducive to acquiring knowledge, although there were also other voices. Moreover, regardless of the form of teaching, surveyed students most often found out where they made mistakes and what they did right, i.e. the feedback consisted mainly of two elements out of four.

When it comes to improving research, it is worth expanding the research group to students from other cities in the Lubelskie Voivodeship or extending the coverage to the entire country. It is worth introducing the randomness of the research group, for example by sending a questionnaire to schools and encouraging them to complete it. In addition, it is worth considering conducting research among people who understand the concept of feedback well. If there are people in the research group who do not know the concept of feedback, it is worth providing its full definition at the beginning of the survey. In this way, the research will concern a group of people with a similar level of awareness. A significant improvement would be the introduction of other analytical tools such as statistical tests or more advanced data analysis.

Further directions of research may concern other types of feedback (student-student, student-teacher). It is also worth asking a general question whether the type of teaching (distance or classroom) according to students is more conducive to giving feedback, and if so, which one.

References

Barana, A., Marchisio, M.: 2016, Ten good reasons to adopt an automated formative assessment model for learning and teaching Mathematics and scientific disciplines, *Procedia – Social and Behavioral Sciences*, **228**, 608–613.

Bąbel, P.: 2007, Kształtująca ocena oceniania kształtującego [Formative assessment of formative assessment], *Psychologia w szkole 4*, 61–64.

Bennett, R.E.: 2011, Formative assessment: a critical review, *Assessment in Education: Principles, Policy & Practice*, **27**(5), 5–25.

Black, P., Wiliam, D.: 2010, Inside the Black Box: Raising Standards Through Classroom Assessment, *Phi Delta Kappan*, **92**(1), 81–90.

Faber, J.M., Luyten, H., Visscher, A.J.: 2017, The effects of a digital formative assessment tool on mathematics achievement and student motivation: Results of a randomized experiment, *Computers & Education*, 106, 83–96.

Ginsburg, H.P.: 2009, The Challenge of Formative Assessment in Mathematics Education: Children's Minds, Teachers' Minds, *Human Development*, **52**(2), 109–128.

Gregorczyk, M., Swat-Pawlicka, M.: 2011, Ocenianie kształtujące: Informacja Zwrotna w OK [Formative Assessment: Feedback in FA], Zeszyt 3, CEO.

Hattie, J.: 2011, Visible learning for teachers, *Taylor&Francis*.

Jackowska-Boryc, E., Pyzara, A.: 2020, Znaczenie informacji zwrotnej w nauczaniu matematyki [The importance of feedback in teaching mathematics], *Współczesne problemy nauczania matematyki 8*, 29–54.

Krygowska, Z.: 1977, Zarys dydaktyki matematyki [Outline of mathematics didactics], part 2, WSiP, Warszawa.

Rakoczy, K., Pinger, P., Hochweber, J., Klieme, E., Schütze, B., Besser, M.: 2019, Formative assessment in mathematics: Mediated by feedback's perceived usefulness and students' self-efficacy, *Learning and Instruction*, **60**, 54–165.

Sterna, D.: 2006, Ocenianie kształtujące na lekcjach matematyki [Formative assessment in mathematics lessons], *Gazeta Szkolna,* **50**(352), 12.

Sterna, D.: 2014, Uczę (się) w szkole [I teach at school], *Centrum Edukacji Obywatelskiej, Warszawa.*

Sterna, D. i inni.: 2015, Dobre praktyki w konspektach lekcji przedmiotów matematyczno-przyrodniczych Fizyka MateMatyka [Good practices in lesson plans for mathematics and natural sciences Physics Mathematics], *Centrum Edukacji Obywatelskiej, Warszawa.*

Szyling, G.: 2010, Ocenianie kształtujące, czyli o niejednoznaczności [Formative assessment, i.e. about ambiguity], Teraźniejszość i przyszłość oceniania kształtującego*, gRUPA TOMAMI, Kraków,* 118–129.

Wenda, A.: 2018, O docenianiu twórczego pisania, czyli o wspierającej sile informacji zwrotnej [About appreciating creative writing, i.e. the supporting power of feedback], *Polonistyka*, 49–53.

Wiggins, G.: 2012, Seven Keys to Effective Feedback, *Feedback for Learning*, **70**(1), 10–16.

Formative assessment; improving learning in secondary classrooms, Organization for Economic Co-operation and Development CERI, OECD (2005).

https://pomagajsieuczyc.ceo.org.pl/tematy/ocenianie-ksztaltujace/

Eliza Jackowska-Boryc
Uniwersytet Marii Curie-Skłodowskiej
w Lublinie
e-mail: eliza.boryc@poczta.umcs.lublin.pl

Anna Pyzara
Uniwersytet Marii Curie-Skłodowskiej
w Lublinie
e-mail: anna.pyzara@umcs.pl