Mastery Learning and the Impact of the COVID-19 Pandemic on Teaching and Learning Mathematics in Romanian Schools

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Abstract

COVID-19 pandemic has had a great influence on educational systems all over the world. The changes which occurred during the last year and a half were related to adapting the teaching-learning process to the online environment, to students' and teachers' behaviour regarding the way they got involved in educational activities, and to the lack of proper training for both categories. The mastery learning model can be adapted to the new teaching and learning conditions, being a great advantage, especially for students who encounter different difficulties in learning mathematics. The purpose of this qualitative research was to determine how effective the implementation of a mastery learning strategy is for both in-class and online math lessons. The implemented mastery learning strategies found a fertile ground in this new learning environment and have revealed that math anxiety and test anxiety were reduced due to the constant use of formative assessments and to the opportunity to revise contents that had not been previously understood.

Key words: COVID-19 pandemic, mastery learning, motivation, performance, mathematics

1. Introduction

Teachers and researchers all over the world are struggling to find the best means for adapting the educational process to the new conditions imposed by the COVID-19 pandemic. An educational strategy that has proven its efficiency is related to the mastery learning model (Golding & Grima, 2021; Nsengimana et al., 2021; Ramadhani et al., 2021). This model can be easily adapted to both in-class and online lessons, and it is of real help, especially when it comes to teaching and learning mathematics, a school subject which is often avoided by students due to its high level of difficulty.

The current research aims at presenting the advantages of using mastery learning techniques in teaching mathematics, at adapting these techniques to the new teaching and learning conditions, and at highlighting the impact of the COVID-19 pandemic on learning mathematics with respect to math anxiety and to test anxiety.

A short description of mastery learning models implemented in several schools is presented first. The studies mentioned here proved that mastery learning models still represent the key to success for most students because they can complete activities at their own pace, they get the chance to learn again the contents they did not understand, and they also get the chance to show that they can improve their results.

A qualitative study was conducted in a secondary school in Romania. The instruments used were semi-structured interviews, active observation charts, and students' journals. The participants were 26 sixth graders who took part in both in-class and online lessons.

2. Literature review

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2.1. Definition of Mastery Learning Approach

John B. Carroll (1963, 1989) and Benjamin S. Bloom (1968) were the first to emphasize the importance of a learning process which would allow all students to reach their maximum learning potential. The mastery learning models they created have been adapted and implemented in schools all over the world. Carroll's model supported the idea that students succeed in obtaining good results not only due to their skills, but also due to the time allotted for completing a certain learning task (Carroll, 1963). If that time is enough, it is used properly, and the students are engaged in that particular activity, they will definitely succeed in completing it.

In Carroll's model there were five variables that were considered to lead to a successful learning process (Carroll, 1989). Aptitude was seen as the time a student needs to learn something. The opportunity to learn was seen as the time a student is given to learn something. Perseverance was seen as the time a student would spend on completing a specific task. The quality of instruction was related to the methods and instruments a teacher used to engage students in the learning process. The ability to understand instruction referred to the skills needed to understand certain steps to be followed in a teaching-learning sequence (Carroll, 1989, p. 26). The ability to understand instructions is conditioned by the way the learning materials are presented, the instruments used, and the skills teachers have. Teachers have to find the best means to explain contents and instructions, and they have to adapt their explanations if they see that students do not understand them properly.

John Carroll (1989) advocated the importance of considering each student's learning pace. Learning aptitude is based not only on the time a student needs to learn, but also on previous learning and knowledge, and on the learning characteristics of each student.

The mastery learning model consists of applying initial assessments, selecting essential contents, and dividing them into small learning sequences, formative assessments applied at the end of each learning sequence, completing remedial or enrichment activities, and applying summative assessments.

Benjamin Bloom (1968), in his mastery learning model, replaces the idea of reaching a maximum learning potential with that of reaching a potential that is considered to be the most appropriate for a certain level. He keeps the five variables described by Carroll (1989), but he emphasizes the importance of determining the aptitude of each student. Bloom thought that only students with the appropriate skills can learn complex notions while students who lack those skills can never learn such notions no matter how much time they are given (ibid).

2.2. The Advantages of Using Mastery Learning Techniques in Teaching Mathematics

Numerous studies (Skaalvik, 2018; Harsy et al., 2021; Musa & Maat, 2021) have shown that mastery learning techniques contribute to anxiety reduction when it comes to learning mathematics. Benjamin Bloom (1976) in his book *Human Characteristics and School Learning* states that teachers have to convince themselves first that 95% of the students can learn properly, reaching the desired level in their learning. There is a great prejudice still present in some educational systems which implies the fact that not all students can learn, but only those who have the right skills and abilities. Only those students are supposed to be able to find success in the educational process. What Bloom tried to show was that almost every student can learn well if the learning conditions are appropriate for him / her to learn. Some of the most important learning conditions were related to time, aptitude, opportunity, and perseverance (ibid). If teachers continue to move on even though students fall behind with their learning, the gaps between students of the same age will become deeper and deeper. Eventually, some will succeed while some will fail. It is worth noting that Bloom's proposals have been considered by numerous educators and teachers worldwide. The studies published (Vermylen et al., 2017; Conley, 2020; Cundiff et al., 2020; Parker & Roumell, 2020) all over the world so far have proven that.

In *Improving Science and Technology Education Achievement Using Mastery Learning Model*, Özden (2008) states that *mastery learning* is an 'instructional philosophy' which is based on believing that all children can learn properly if they have the necessary time and if the teaching methods are the appropriate ones. One essential aspect is that the learning has to happen in the classroom. Teachers sometimes assign a lot of homework and expect students to learn almost everything at home. That should

not be the case. It is important that students learn during classes most of the things that they are required to learn. The role of science and technology is essential in the development of each child due to a simple reason: 'if a child is not familiar with the nature around him, he will never get the chance to like either nature, or life itself" (ibid, p.62).

Among the advantages of using mastery learning strategies in the classroom, Özden (2008) mentions the need that students form their skills and learn the contents they are required to learn at their age. Every stage of the learning process is built on the abilities students have managed to develop in a previous stage. At the same time, stating the objectives at the beginning of the learning sequence lets students know what they have to do in order to get great results. If the activities are developed for small learning units, the results will be more easily analysed, and students' progress will be more obvious. This is just one method used for reducing failure among students.

Some researchers and practitioners based their work on Bloom's learning model which emphasized the urgent need of dividing the contents into consecutive learning units and of stating the objectives clearly and concisely in order to lead to new learning opportunities. Teachers' role is critical when it comes to forming a positive attitude towards mathematics and not only. Any negative aspect related to learning a particular school subject will eventually lead to failure.

For instance, the study conducted by Aslan et al. (2013) involved a group of 400 children who were approximately 6 years old. Its main purpose was to analyse the impact of kindergarten teachers' anxiety and mathematical beliefs on students' progress in this school subject. The results showed that there is no significant impact of teachers' anxiety regarding mathematics on skill formation among pre-schoolers. This happened due to the fact that teachers at this level have to introduce to students elementary concepts and also due to the fact that these students are too young to be aware of this kind of behaviour, i.e., which regards anxiety. However, a connection was found between teachers' beliefs and students' results when it came to solving problems (ibid).

One necessary skill for every student has been critical thinking. Mastery learning techniques are effective because their main features include cognitive interactivity, feedback, repetition and a longer amount of time dedicated to learning. Feedback is an advantage for both teachers and students. If teachers provide constant feedback and try to reach the learning objectives, they can have a clear picture of the instructional process, of the results, and of the performance level each student has reached. Also, students will not leave aside the concepts that they did not understand but will complete some remedial activities where it is necessary (Siddaiah-Subramanya et al., 2017).

Some educational studies conducted over the years have tried to show why some students learn mathematics more easily than others who are constantly struggling with this school subject.

In Mastery Learning of Early Childhood Mathematics through Adaptive Technologies, Betts (2019) confirms the connection between all mathematical skills which are formed during early education, the knowledge students are supposed to acquire at this level, and their success in school and later in life. Students learn mathematical concepts differently and there are certain gaps which deepen over the years. That is why it is essential for every student to stay in their zone of proximal development until they are able to form the necessary skills to move on to the next level. It takes time to create competencies and moving on to the next unit or to the next form makes these gaps deeper ever more for those students who failed acquiring the necessary knowledge to do that. Mathematics needs strict patterns more than any other school subject. Each new concept is based on something that has been previously learnt. There are two educational programmes meant for students in early education, i.e., Number Worlds and Building Blocks, developed by McGraw Hill Education PreK-12, a company established in 1988. The most recent platform is ABCmouse Mastering Math™ which is meant for pre-schoolers and for students in the first and second forms. Individualized instruction is used for every particular student. There are some other useful apps such as Mastery Math which students can use without a teacher's help. The activities are based on games and students have the opportunity to explore different learning environments according to their needs (Betts, 2019).

When it comes to learning in the classroom, Bloom (1976) advocated the use of remedial and consolidation activities for students who failed acquiring the expected level of knowledge even though that meant that some students had to wait for their colleagues to finish or had to complete some enrichment activities. In the online environment, students who succeed in completing all activities move on to the next level without waiting for the others to reach the same level. This is a great advantage of digital applications.

Mathematical skills formed during early education are the key to success and can reduce or even eliminate the differences between students' learning, each of them eventually managing to reach the minimum level in the educational process (Betts, 2019).

The stage of forming mathematical skills was set for children between 3 and 5 years old. It is necessary to acknowledge the importance of mathematical education for both students and the society.

Mastery learning strategies have been applied successfully over the years with great contributions to developing students' different skills. The main goal of applying these strategies is to improve learning results. There are some stages that can be considered when applying a mastery learning strategy: choosing experimental and control groups, setting the objectives, choosing the appropriate information to be taught, applying formative and summative tests, providing feedback, and completing remedial and enrichment activities.

2.3. Adapting mastery learning strategies to current learning conditions

Bloom's mastery learning model, dating back to 1968, is currently being adapted to new educational requirements using different educational platforms by millions of students all over the world. Each platform has its own algorithm for monitoring the level of performance of students who use it. Doroudi (2020) states that the N-Consecutive Correct in a Row (N-CCR) model used by ASSISTments platform and a simpler version of this model used by ALEKS platform are great choices for implementing some mastery learning strategies based on online resources.

MATHia platform uses the BKT model (Bayesian Knowledge Tracing) which implies giving support and testing opportunities until the probability to reach the required level of performance is above 0.95. The N-Consecutive Correct in a Row (N-CCR) model was previously used by Khan Academy which is currently implementing a mastery learning strategy that involves a learning process based on reaching mastery levels. Students' motivation is maintained because they manage to get a good score without being forced to start the entire learning sequence from the beginning when one of their answers is not correct (Doroudi, 2020).

The third model Doroudi (2020) has analysed is the TOW (Tug-of-War) model. It is based on collecting points for correct answers and losing points for wrong answers. Students have to keep on trying to collect points until they reach a minimum level of knowledge according to their age and to what they are supposed to know at that particular stage.

Another approach of the mastery learning model was analysed by Putri and Sanjaya (2021) in a study conducted with a group of 50 eighth-graders from a school in Indonesia who were asked to create some educational videos. The advantages implied by this model are numerous. First of all, creating an educational video is a challenge because students have to be really confident about the information they have to present and explain. They have to prove that they know what they are talking about in order to be able to explain those things to other students. Secondly, the entire process is based on the active involvement of students in the teaching-learning sequence. They have to find and use knowledge appropriately and not simply to memorise some concepts. The use of digital instruments stimulates students to be more creative while realising what new ideas they have when it comes to creating their own teaching material. At the same time, they are motivated by the fact that what they do also helps other students learn (ibid).

When it comes to implementing a mastery learning model, one has to set some objectives which regard specific contents to be taught. Another important aspect is to eliminate or at least to reduce the number of students who fail in a specific subject. One way to check students' progress is to constantly apply formative assessments. In order to help students to overcome several difficulties, teachers must bear in mind to develop remedial and enrichment activities.

2.4. The connection between math anxiety and students' performance

The mastery learning model is based on the implementation of an educational strategy which is supposed to lead students to getting the best results. For this reason, it is necessary to find the causes which led students to avoiding mathematics in school. Teachers often hear students saying, "Math is really hard!", "I feel like I know nothing when it is time to solve a problem", "I am not really good at math". Math anxiety is affecting the entire educational process. Analysing this phenomenon will be the starting point for applying a mastery learning strategy. The goal is to make students form mathematical competencies.

In *Math Anxiety: Personal, Education and Cognitive Consequences*, Ashcraft (2002) defines math anxiety as "a feeling of tension, apprehension, or fear that interferes with math performance" (p.181). A behaviour often encountered is avoiding this school subject. The results of the online and in-class tests and students' feelings during the tests were analysed and it was noticed that students develop anxiety in the second half of the remaining time and during online tests (ibid). Formative assessments are a real advantage from this perspective, since they test short-term memory. They are short tests which, if taken constantly, lead to learning concepts and managing negative emotions, i.e., being afraid of taking a test and being anxious.

A few years later, Ashcraft analysed the connection between 'working memory (short term memory), math anxiety, and math performance' (Ashcraft & Krause, 2007, p. 243). Students' concern regarding this school subject influences the cognitive process because the memory resources which allow carrying out simple operations are affected by anxiety. This phenomenon makes students feel unable to complete certain activities and avoid mathematics. Some risk factors for developing anxiety are present in the classroom. One of these is being afraid of going to the whiteboard and solving a problem in front of the classmates and the teacher. The method that teachers use in this case plays an important role (Ashcraft, 2007).

Math anxiety is generally developed in the sixth form, unlike other phobias which appear when a child is six or seven years old, according to psychologists. Risk factors are considered to be a higher level of difficulty, teachers who give little or no cognitive or motivational support to students during classes and who only focus on presenting the information that their students are supposed to learn (Berch & Mazzocco, 2007).

The studies conducted to identify the factors which influence learning mathematics have proven that math anxiety is a learning disability which implies a poor focusing capacity and low self-esteem. All these lead to poor results in standardized tests especially if the level of difficulty is high (Berch & Mazzocco, 2007).

A large study conducted in Turkey (Birgin et al., 2010) was based on analysing math anxiety in a group of 220 students (73 sixth-graders, 73 seventh-graders, and 74 eighth-graders). It is considered that this period is critical due to the fact that students can become anxious at these ages. Within this research, students answered the ten questions of the MASESS questionnaire (Mathematics Anxiety Scale for Elementary School Students) (Bindak, 2005), applying a 5-point Likert scale. The questionnaire had items such as "I am afraid of asking questions in mathematics", "I am anxious that I will not pass my course because of mathematics", "Even though I understand mathematics now, I am worried that it will become more difficult in the future" (Birgin et al., 2010, p. 655). The purpose of this study was, on the one hand, to analyse math anxiety and, on the other hand, students' enjoyment level when it comes to teaching methods, learning mathematics, and getting support from their parents. For this second part of the study, students were asked to select an option for such statements as "Indicate the level of your satisfaction regarding the method used for teaching mathematics" (options from 'low' to 'high'), "Indicate the level of enjoyment regarding the teaching method" (options from 'low' to 'high'), "Indicate how often your parents help you with mathematics" (options from 'never' to 'always') (Birgin et al., 2010, p. 655). The results have shown that male students in the eighth form manifest a low form of enjoyment

regarding the teaching method and mathematics itself, get support from their parents, but have the highest level of anxiety. On the other hand, female students in the eighth grade manifest a high form of enjoyment regarding the teaching method and mathematics itself, and have a lower level of anxiety than boys. It was found that the teaching method has a significant negative effect on math anxiety for the sixth and seventh graders, being the second strongest negative factor after the level of acquired knowledge. The results of this study can be used by teachers to create remedial programmes and educational strategies which would make students more motivated to learn mathematics (ibid).

Another research (Daneshamooz et al., 2012) was conducted on three groups of students from Azad University. This study was based on a collaborative teaching-learning method, on *e-learning*, and on in-class learning. The analysis has highlighted a significant negative correlation between math anxiety and performance and a significant positive correlation between 'the working memory capacity' and performance. The most important aspect was that those students who learnt through cooperation had better test scores than students in the other groups. This method improved their working memory and reduced the level of math anxiety. The results of this study showed that it is essential to control the level of anxiety in order not to block the working memory. Students' interaction led to a higher ability to solve math problems (Daneshamooz et al., 2012).

3. The impact of the COVID-19 pandemic on learning mathematics

All the changes in the last year and a half and the impact of the COVID-19 pandemic on the educational system require some solutions for adapting the educational process to the new conditions. The mastery learning model can be an appropriate solution regardless of the school subject.

The **hypothesis** of the current study was that if mastery learning techniques are applied in the selected learning unit, i.e., the properties of triangles, then students will be able to analyse geometric shapes in order to highlight some properties of the triangles.

3.1. Methods

The purpose of this research was to identify the changes that occurred in the teaching-learning process due to the influence of the COVID-19 pandemic. The methods used in this case study were both quantitative (initial and summative assessments) and qualitative (semi-structured interviews, active observation, and students' journals).

3.2. Background information

The current case study was conducted in a secondary school in Romania, i.e., *Nae A. Ghica* Secondary School based in Rucăr, Argeș County. The activities completed in the current study were developed according to the competencies mentioned in the national curriculum.

3.3. Participants

The participants in the study were 26 sixth-graders (12 boys and 14 girls). All 26 students took part in activities meant to reveal the changes that took place in the educational environment due to the COVID-19 pandemic.

3.4. Procedure

The main questions asked in the current study were related to students' motivation, to the way they react when time pressure is absent, to being able to trust their own skills, to providing feedback to the teacher regarding their attitude towards the new teaching approach and the feelings they experienced when they were engaged in different activities.

Some **research questions** that needed an answer were the following:

- ✓ How effective are mastery learning strategies for students who learn at *Nae A. Ghica* Secondary School?

- ✓ What was the procedure of applying a mastery learning strategy?
- ✓ How were the activities organised?
- ✓ What resources were needed?
- ✓ What motivated the students to learn effectively?
- ✓ What difficulties may be encountered when a mastery learning strategy is implemented?
- ✓ Have the students' results improved?

The case study may reveal some important aspects about teaching mathematics and about the changes that occurred over the years in the way students think and focus. Math results, either poor or good, can be related to effective or ineffective teaching methods. When teachers analyse the educational process including from the perspective regarding the way they teach, they can identify the appropriate individual solutions for all students to get great scores.

Activity journals were created for each student in the experimental group. The journals were actually a personal notebook in which each student had to choose an option for some questions at the end of each activity or at the end of each school day. The questions used were "What did you like in your math lesson today?" (the teaching method, the activities, working in groups, working individually, the assessment), "What did you not like in your math lesson today?" (the teaching method, the activities, working in groups, working individually, the assessment), "How did you feel during the activities?" (excited, motivated, bored, sad), "What would you like to be different in your next math lesson?" (the teaching method, the activities, the homework, the assessment), "Would you like to take part in more group activities or to work by yourself?" (group activities, individual work), "Did you get the chance to have your opinion heard during the activities?" (yes / no).

The active observation was meant to provide understanding of the experience students had during in-class and online activities. It allowed the study of a direct teacher-student relationship, a direct connection between them and the possibility to analyse students' behaviour during the activities. It was related to monitoring the teaching sequences and also the assessments given by the students, the teaching methods, students' involvement, the objectives stated for each lesson, students' competencies, the way of organizing activities (individually or in groups), and necessary resources. Observation charts were completed after each lesson.

Table 1 Observation chart

A. Teaching Approach

Mastery learning

B. Students' behaviour

(1 – extremely poor, 2 – poor, 3 – average, 4 – good, 5 – excellent)

	1	2	3	4
Students' involvement				
Motivation				
Focus				
Teamwork				
Ability to follow instructions				

Asking for help

C. Objectives and competencies

(1 – extremely poor, 2 – poor, 3 – average, 4 – good, 5 – excellent)

	1	2	3	4
Achieving objectives				
Developing students' competencies				

D. Types of activity

Individual Group

E. Necessary resources

Worksheets

Electronic devices

Overhead projector

Digital books

Digital applications

F. Assessment

Formative assessment

3.5. Results and analysis

3.5.1. Results of initial and summative assessments

Besides the formative assessments which were applied at the end of each learning sequence to make students aware of their strengths and weaknesses regarding the learning process, an initial test was applied at the beginning of the study and a final test was applied at the end of the study in order to check if students' results have improved.

The results of the initial and summative assessments are shown in the table below.

Table 2 Results of initial and summative assessments

Students	Initial Assessment	Summative Assessment
Student A	85	→ 100
Student B	80	→ 94
Student C	85	→ 97
Student D	73	→ 96
Student E	75	→ 80

Student F	73	→ 82
Student G	100	= 100
Student H	54	→ 65
Student I	63	← 55
Student J	97	→ 100
Student K	44	→ 72
Student L	70	← 65
Student M	90	→ 96
Student N	73	← 62
Student O	73	→ 95
Student P	100	= 100
Student Q	94	= 94
Student R	73	→ 96
Student S	85	→ 100
Student T	44	→65
Student U	100	← 90
Student V	63	← 65
Student W	78	→ 85
Student X	30	→ 52
Student Y	73	→ 85
Student Z	78	← 85

Most students (17) managed to get higher scores. Some of them (3 students) got the same scores in both assessments and some other students (6) actually got lower scores in the final assessment due to a number of reasons such as a high level of math anxiety, poor understanding of explanations, difficulty in completing tasks, lack of interest and motivation when it came to being engaged in different activities.

3.5.2. Results of interviews

The questions used in the interviews were the following.

1. How did you feel during the activities?
2. How did you find the tests?
3. Did you get along with the peers within your group?
4. How did you feel during the test?
5. Did the tests help you identify the things that you knew and the things that you still have to learn?
6. How did you find the tasks that you had to complete?

Table 3 Results of interviews

Answers	No. of answers Less on 1	Lesson 2	Less on 3	Less on 4	Less on 5	Lesson 6
excited	16	19	19	22	26	25
motivated	14	15	19	21	22	24
bored	10	9	7	5	0	1
sad	0	1	0	2	0	0
very easy	7	3	6	3	2	4
easy	14	18	16	20	21	21
neutral	0	0	1	0	1	0
difficult	3	4	2	1	1	0
very difficult	2	1	2	2	0	1
yes	21	25	24	26	26	24
no	5	1	2	0	0	2
excited	15	18	13	17	20	18
engaged	14	19	10	14	20	21
bored	0	1	0	2	0	0
scared	18	22	21	24	25	24
yes	21	19	25	26	26	26
no	5	7	1	0	0	0
exciting	15	18	13	17	20	18
motivating	14	19	10	14	20	21
boring	0	1	0	2	0	0
difficult	7	8	5	3	2	2

The data collected through interviews revealed the fact that the students' level of motivation was higher after the third lesson when they became more engaged in the learning process. Also, the number of students who stated that they found formative assessments quite difficult decreased. They became motivated and engaged in the activities due to the methods and the instruments used, and also due to the possibility to work in teams. The most important aspect is that students had the opportunity to identify their strengths and weaknesses, considering the fact that after the third lesson all students answered affirmatively when they were asked whether the tests helped them identify the things that they knew and the things that they still had to learn.

Figure 1. *How did you feel during the activities?*

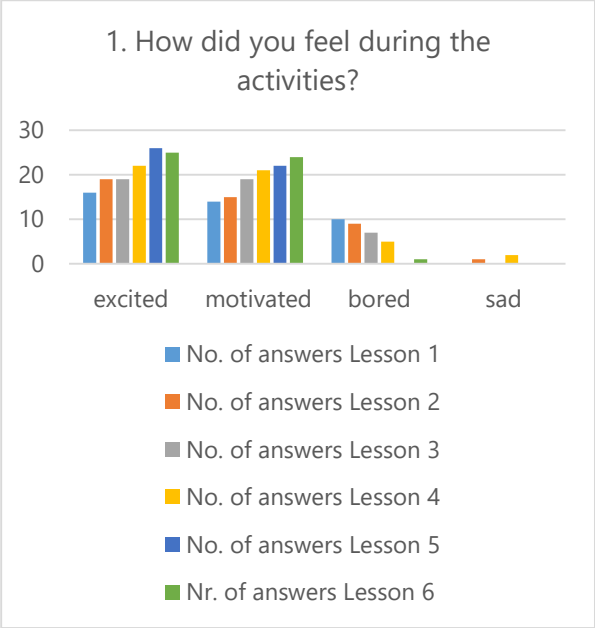


Figure 2. *How did you find the tests?*

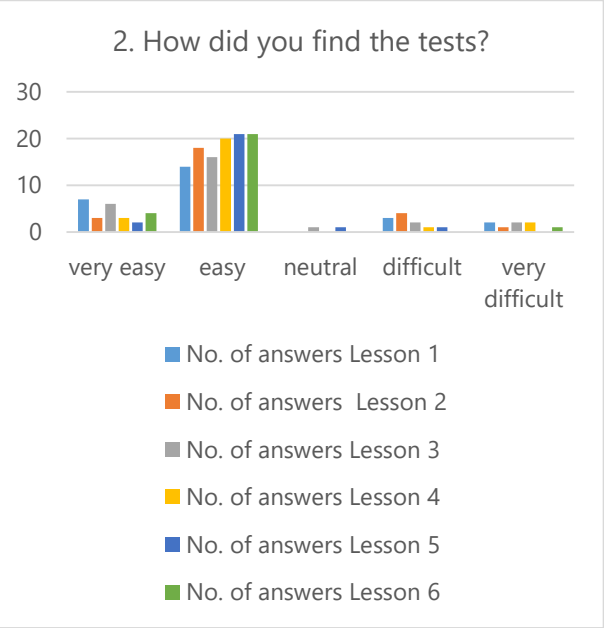


Figure 3. *Did you get along with the peers within your group?*

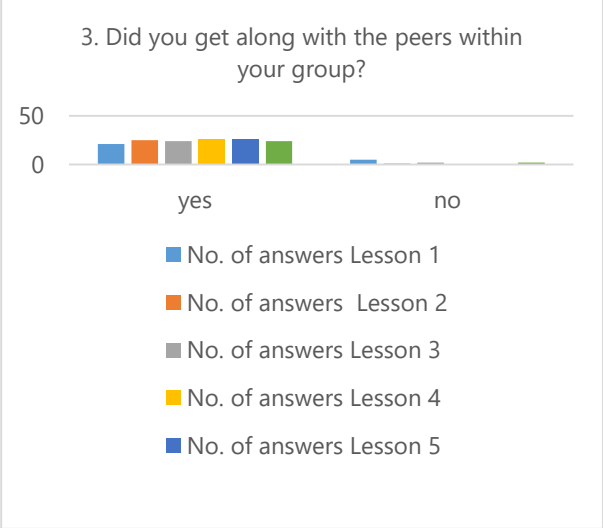


Figure 4. *How did you feel during the test?*

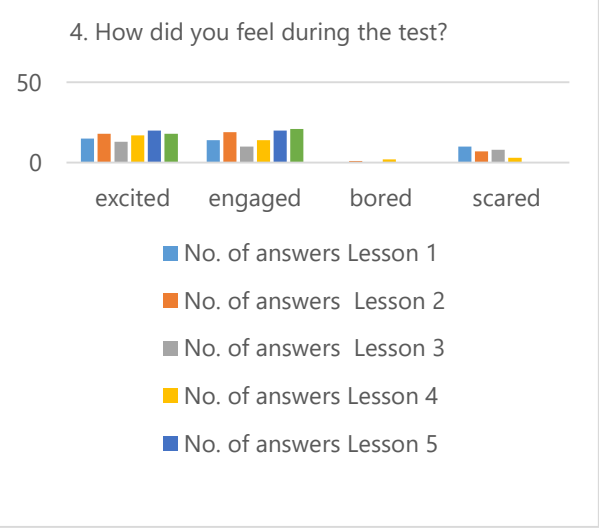


Figure 5. Did the tests help you identify the things that you knew the things that you still have to learn.

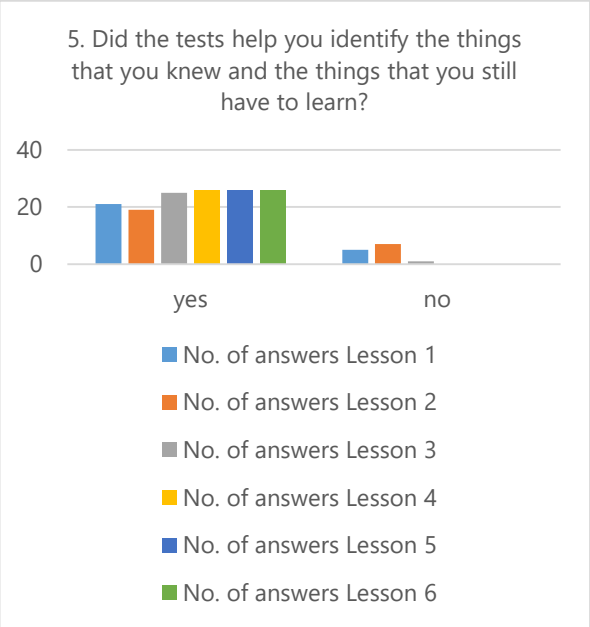
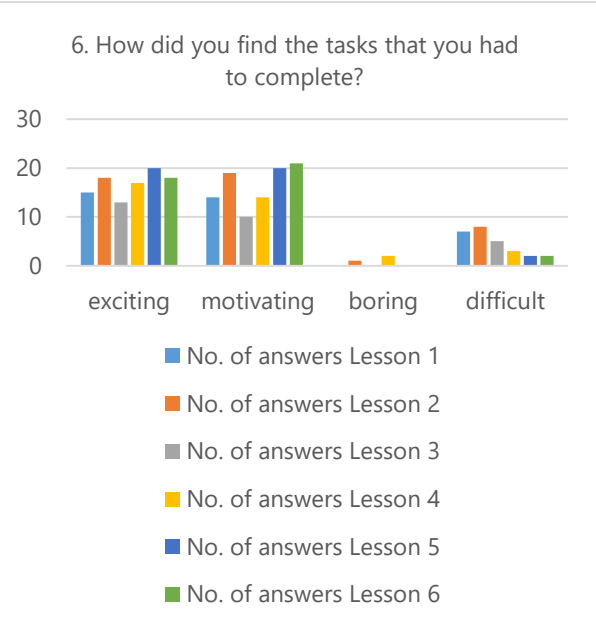


Figure 6. How did you find the tasks that you had to and complete?



3.5.3. Results of students' journals

At the beginning of this current research, students felt reluctant when it came to completing some of the tasks they received, and they also preferred working by themselves. When they became familiar with the new teaching approach, they became more engaged in the learning process. Another important aspect is related to the fact that they got used to taking regular formative assessments and, since this became part of the learning process, students didn't perceive them anymore as being stressful or unpleasant. Even though some students felt bored or sad when they had to complete the activities at the beginning of the research, less and less felt that way after the first two lessons. Also, almost all students felt that they got the chance to have their opinions heard during the activities and they stated they prefer working in groups more than working individually.

The questions used in students' journals were the following.

1. What did you like in your math lesson today?
2. What did you not like in your math lesson today?
3. How did you feel during the activities?
4. What would you like to be different in your next math lesson?
5. Would you like to take part in more group activities or to work by yourself?
6. Did you get the chance to have your opinion heard during the activities?

Table 4. Results of students' journals

	No. of answers					
Answers	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
the teaching method	5	8	4	18	21	25
the activities	12	9	14	24	26	26
working in groups	2	7	14	13	19	25
working individually	25	13	18	24	19	7
the assessment	5	8	12	18	22	24
the teaching method	21	18	22	8	5	1
the activities	14	17	12	2	0	0
working in groups	24	19	12	13	7	1
working individually	1	13	8	2	7	19
the assessment	21	18	14	8	4	2
excited	16	19	19	22	26	25
motivated	14	15	19	21	22	24
bored	10	9	7	5	0	1
sad	0	1	0	2	0	0
the teaching method	21	18	22	8	5	1
the activities	14	17	12	2	0	0
the homework	22	24	18	7	3	2
the assessment	21	18	14	8	4	2
group activities	18	20	20	22	21	21
individual work	8	6	6	4	5	5
yes	7	13	18	22	25	26
no	19	13	8	4	1	0

Figure 7. *What did you like in your math lesson today?*

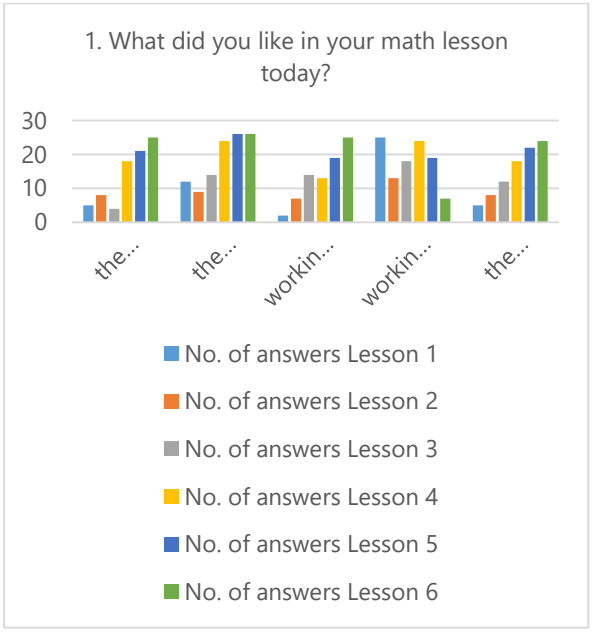


Figure 8. *What did you not like in your math lesson today?*

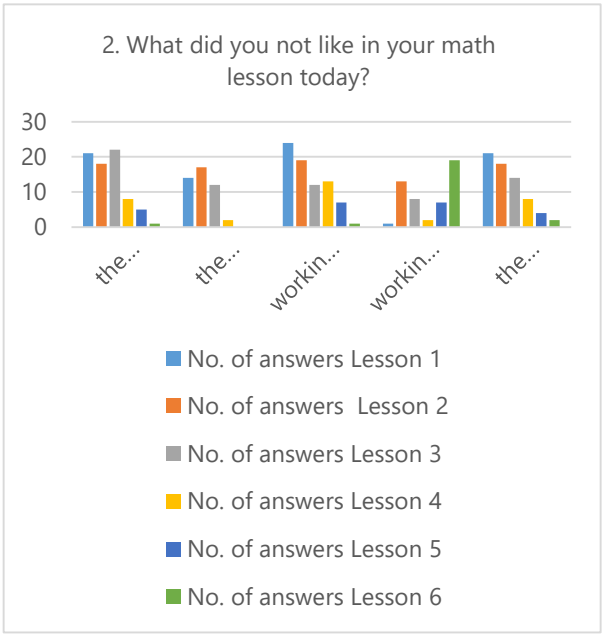


Figure 9.

How did you feel during the activities?

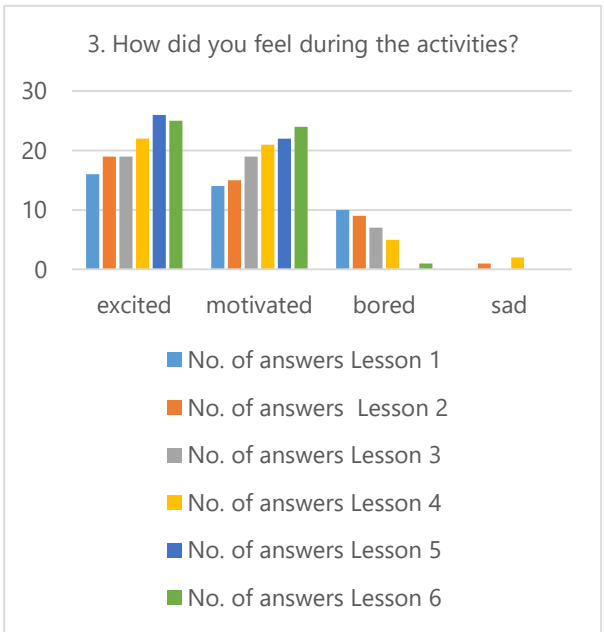


Figure 10.

What would you like to be different in your next math lesson?

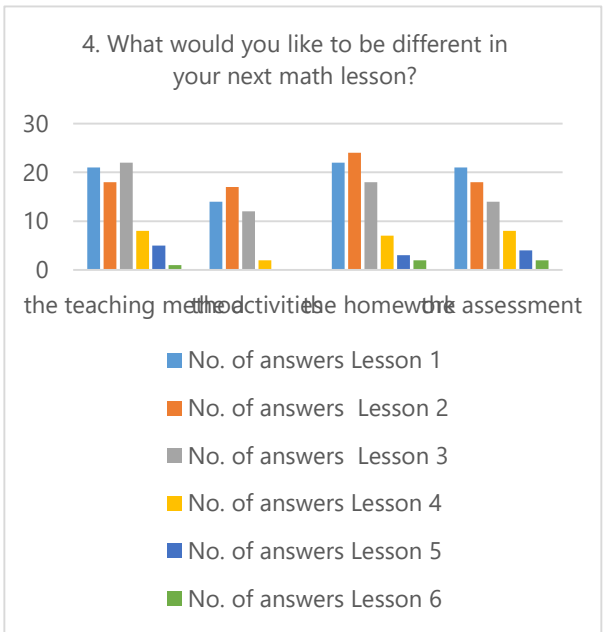


Figure 11.

Would you like to take part in more group activities or to work by yourself?

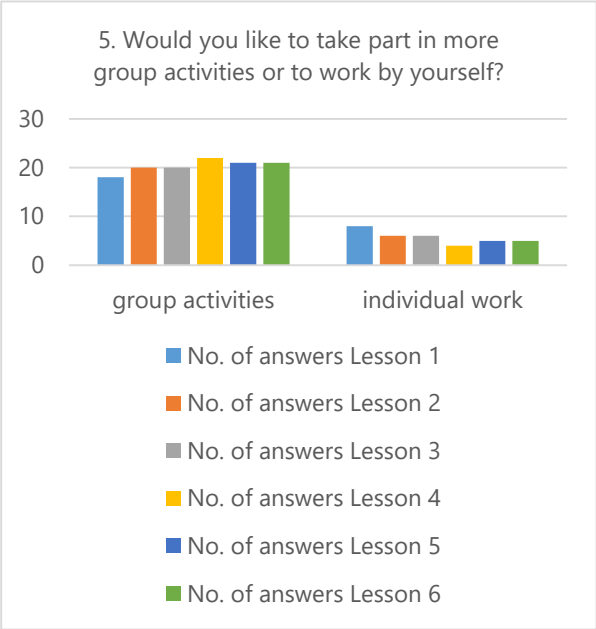
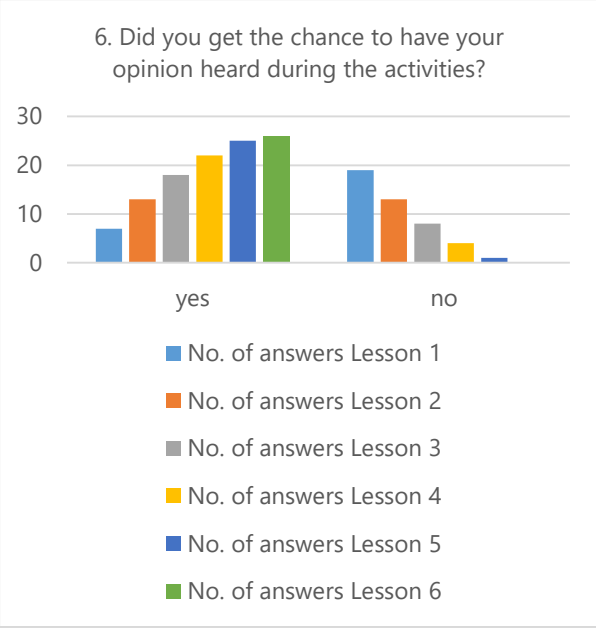


Figure 12.

Did you get the chance to have your opinion heard during the activities?



3.5.4. Results of observation charts

The analysis of the activities students in the sixth grade have completed aimed at highlighting the connection between mastery learning strategies and students' results, in-class learning and learning at home, the use of formative and summative assessments, educational methods which focus on the teacher or interactive methods which place students in the centre of the learning process, the allotted time, and the time needed for learning.

The active observation charts were completed after six lessons of mathematics within the selected learning unit, i.e., the properties of triangles. The mastery learning strategy which was used here implied dividing the learning unit into smaller learning sequences, one for each type of triangle (isosceles, equilateral, scalene), applying formative tests after each learning sequence, and providing support for those students who needed it. The teacher supported students when they were involved in group activities and noted in the observation charts the information related to their behaviour, their attitude towards completing working tasks and towards their colleagues, and also some of the reactions and feelings they had regarding a new formative test. For the in-class lessons, social distancing has represented the major difficulty in organising the teaching-learning sequence. Also, some students panicked due to the fact that these restrictions interfered with their way of being and acting.

Table 5. Results of observation charts

A. Teaching Approach

LESSON	L1	L2	L3	L4	L5	L6
Mastery learning	✓	✓	✓	✓	✓	✓

B. Students' behaviour

(1 – extremely poor, 2 – poor, 3 – average, 4 – good, 5 – excellent)

	1						2						3						4						5					
LESSON	L1	L2	L3	L4	L5	L6	L1	L2	L3	L4	L5	L6	L1	L2	L3	L4	L5	L6	L1	L2	L3	L4	L5	L6	L1	L2	L3	L4	L5	L6
Students' involvement	✓								✓					✓								✓							✓	✓
Motivation							✓	✓													✓							✓	✓	✓
Focus							✓							✓	✓							✓	✓							✓
Teamwork	✓	✓							✓							✓	✓							✓						
Ability to follow instructions													✓	✓							✓	✓							✓	✓
Asking for help						✓				✓	✓									✓	✓				✓					

C. Objectives and competencies

(1 – extremely poor, 2 – poor, 3 – average, 4 – good, 5 – excellent)

	1						2						3						4						5					
LESSON	L1	L2	L3	L4	L5	L6	L1	L2	L3	L4	L5	L6	L1	L2	L3	L4	L5	L6	L1	L2	L3	L4	L5	L6	L1	L2	L3	L4	L5	L6
Achieving objectives																			✓	✓		✓					✓		✓	✓
Developing students' competencies													✓							✓	✓							✓	✓	✓

D. Types of activity

LESSON	L1	L2	L3	L4	L5	L6
Individual	✓	✓	✓	✓	✓	✓
Group	✓	✓	✓	✓	✓	✓

E. Necessary resources						
LESSON	L1	L2	L3	L4	L5	L6
Worksheets	✓	✓	✓	✓	✓	✓
Electronic devices	✓	✓	✓	✓	✓	✓
Overhead projector	✓		✓	✓		✓
Digital books	✓	✓		✓	✓	
Digital applications	✓	✓	✓	✓	✓	✓

F. Assessment						
LESSON	L1	L2	L3	L4	L5	L6
Formative assessment	✓	✓	✓	✓	✓	✓

The active observation charts were also completed during the online activities, but only the attitude towards the tasks and students' reactions regarding new formative assessments were considered since it was more difficult to notice their behaviour.

Online classes were an advantage because the students and the teacher could see each other's facial expressions, technology was used in every single activity, and the students could complete the tasks at their own pace. Online math lessons had the following structure: the lesson started with an educational video related to the new contents and students received some interactive activities to complete. The selected contents for this study, i.e., the properties of triangles, were explained using GeoGebra, an educational software. This app was used for both in-class and online lessons. The drawings made in this app allowed the students to practise every time they needed to do that.

Online lessons allow students to study learning materials each time they encounter difficulties in understanding them. Digital activities hold a great advantage because they can be completed by students until they get the right answers. This is the reason why several educational platforms have had a great success lately. Nevertheless, the importance of high-quality educational process must not be neglected. It is not enough to provide digital activities, the content of those activities must also be relevant for the teaching-learning process. Even though the online environment offers a wide range of educational resources, they must be thoughtfully selected.

Some formative tests were created in Quizziz, Kahoot, and Wordwall, because students are more motivated when they use technology. These tests lowered the level of test anxiety.

At first, the students were not so keen on writing in their journals since it represented an extra task. After a while, they got used to the method and seeing that the teacher considered all their opinions they continued to write in them.

They also received access to interactive worksheets which allowed them to study the aspects that were not clearly understood before.

The difficulties were related to time management because creating and organising learning activities properly according to mastery learning models are time-consuming. For each learning activity the students also had to complete one extra worksheet depending on their needs (remedial, consolidation or enrichment worksheet).

A negative aspect all students mentioned in their journals was homework. As a consequence, the teacher's attitude has changed. The learning objectives, the tasks, and the level each student had to reach were clearly stated at the beginning of each activity. The students became more motivated to finish all their tasks in the classroom in order not to get any homework. Those who did not succeed at first received some charts with remedial activities.

4. Discussion

The findings of the current study were compared to the results of some other recent studies.

Table 6. Characteristics of chosen studies

Study	School Subject	Topic
Current study	mathematics	mastery learning strategies; math anxiety
Golding & Grima (2021)	mathematics	mastery learning strategies; math anxiety
Nsengimana et al. (2021)	mathematics	online learning; math anxiety
Oginni et al. (2021)	mathematics	mastery learning strategies
Siaw et al. (2021)	mathematics	mastery learning; math anxiety
Yuliani et al. (2018)	mathematics	mastery learning strategies; math anxiety
Furner & Gonzalez-DeHass (2011)	mathematics	teaching methods; math anxiety

In a study conducted in England, Golding and Grima (2021) showed that since the beginning of the Covid-19 pandemic teachers have dealt with issues such as "the inability to develop children's mathematical language and reasoning, difficulty in addressing new areas requiring conceptual development and in monitoring deep progress in mathematics" (p. 1). Their research revealed that students benefited more from tasks completed in small groups and also from tasks completed at home, in an environment that lacked time pressure. Even though the students who participated in the study were less confident during the online classes due to a poor understanding of mathematics, they became more confident when they were able to go to school mainly due to an efficient teacher-students relationship which was based on permanent communication, great interest in developing the most appropriate teaching materials that could be used both in class and online, and great interest in children's needs regarding the learning of mathematics (ibid).

Another study (Nsengimana et al., 2021) conducted in Rwanda regarded the use of online resources in learning mathematics during the Covid-19 pandemic. The researchers collected data from interviews and discussions with master students. Learning mathematics in an online environment had some disadvantages such as "the absence of practical abilities, inadequate support for structured exercises, few open resources, and inadequate access to online resources" (p. 1). This study has shown that during the online classes the students' behaviours could not be adequately controlled by the teacher and that had a negative effect on the learning process. What was more, the students' confidence could not be built without the physical presence of both the students and the teacher in the classroom (ibid).

Oginni et al. (2021), in their article *Effects of Mastery Learning Strategy on Secondary School Students Performance in Mathematics*, identified the fact that students get better results when the educational process implies a mastery learning strategy. The 60 students involved in their study managed to improve their scores due to the fact that they "were allowed to collaborate, to share knowledge and ideas, and to actively participate in the lessons" (p. 62). One reason for the success of implementing a mastery learning strategy was that "larger and more complex learning goals were divided into concise and easier steps" (ibid, p. 62), helping to build the students' confidence regarding the learning of mathematics.

The study conducted by Siaw et al. (2021) in Malaysia showed that there is "a weak positive correlation between students' anxiety levels and their mathematics performance" (p. 47). The students' behaviour regarding the process of learning math was analysed through a questionnaire. The results obtained by the students in their final assessment revealed that a high

level of math anxiety can actually be a factor for a higher motivation in learning mathematics. These results showed that the students with a high level of math anxiety were more determined to improve their scores (ibid).

Another study conducted in Indonesia (Yuliani et al., 2018) showed that the level of math anxiety is higher for eighth-graders, but it can be reduced by using interactive methods and proper explanations, by giving a great importance to students' interests and by "setting short-term goals" (p. 4). The teachers' role was considered to be crucial for increasing the students' confidence when learning mathematics and for improving their results.

The research carried out by Furner and Gonzalez-DeHass (2011) revealed that "teachers can play an active role in both helping to prevent and reduce mathematic anxiety" (p. 237). They can also "help students develop their confidence and ability to do math" (ibid, p. 237), improving their results.

These studies have shown that there is a connection between math anxiety and students' performance and also that teachers have an important role in the learning process. They have to choose the best methods and instruments to help all students feel more comfortable and more confident when it comes to learning mathematics.

5. Conclusion and Recommendations

The mastery learning model can be easily adapted to both in-class and online teaching. The time variables, i.e., students' aptitude, perseverance, and opportunity, are the key to success in implementing this model.

The strict rules imposed by the COVID-19 pandemic led to important changes in students' and teachers' behaviour. Social distancing inside the classroom did not allow students to complete group activities. This kind of work was completed only in online activities where students could work in groups even though they were not in the same location (through Zoom breakout rooms).

One great advantage of implementing mastery learning strategies whether during in-class or online lessons is that teachers can divide learning units into smaller learning sequences, monitoring the level of competency for each student.

On the other hand, math anxiety and test anxiety were reduced due to the fact that the students got used to getting constantly engaged in formative assessments. This also contributed to the growth of students' self-esteem.

The current study has proven that the students' attitude and results in mathematics have improved significantly. Also, the level of math anxiety and test anxiety lowered due to the use of a mastery learning strategy which allowed the students to revise the contents they did not understand, complete some remedial activities and study at their own pace. Therefore, it would be highly recommended for teachers to try to implement a mastery learning model (dividing the learning units into smaller learning sequences, applying formative tests, working in groups, providing feedback, and using proper digital applications) within their lesson, regardless of the educational environment.

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