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Preparation of Tests from the Subject of Mathematics According to Bloom's Taxonomy

Senad Orhani [a*]

[a1] *Faculty of Education, University of Prishtina "Hasan Prishtina ", Prishtina 20000, Kosovo*
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A B S T R A C T

This scientific paper aims to analyze and describe the use of Bloom's Taxonomy in the preparation of tests in the subject of mathematics. Bloom's taxonomy is a well-known pedagogical model that helps structure learning objectives at different levels of complexity. This study aims to identify how the levels of Bloom's Taxonomy, from basic knowledge to more complex cognitive skills, can be successfully integrated into the creation and assessment of mathematics tests. The methodology of this research includes an in-depth analysis of the literature, where previous studies that have used Bloom's Taxonomy in the field of mathematics education have been reviewed. Also, a comparative analysis of mathematics tests prepared using Bloom's Taxonomy compared to tests prepared with other pedagogical models has been developed. In the results of this research, it is evident that the use of Bloom's Taxonomy in the preparation of mathematics tests brings progress in the clarity of learning objectives and the level of difficulty of the tests. This study provides a valuable contribution to education practitioners and educators who are interested in improving test preparation methods for developing students' mathematics skills

Keywords: Bloom's Taxonomy, Mathematics, Methodology, Teachers, Tests

1. Main text

In the way of improving the quality of education and developing students' cognitive skills in the subject of mathematics, this study aims to examine and apply Bloom's Taxonomy as an effective tool in test preparation. Bloom's Taxonomy, a hierarchical structure designed to classify learning objectives at different levels, provides a rich theoretical basis for test designers to define and develop appropriate questions for certain cognitive levels. Previous analyses have shown that using a structured approach, such as Bloom's Taxonomy, can help increase the quality of tests and develop students' skills in a gradual and balanced way.

Bloom's taxonomy is a hierarchical model that categorizes learning objectives at different levels of complexity, from basic knowledge and understanding to advanced evaluation and creation (Mcleod, 2023). The purpose of a teacher's use of Bloom's Taxonomy is to encourage higher-level thinking in their students by building on lower-level cognitive skills. Behavioral and cognitive learning outcomes are provided to highlight how Bloom's taxonomy can be incorporated into broader educational goals or guidelines. Key phrases can be used (eg, Example assessments) to encourage these skills during the assessment process (Bloom, 1969).

The importance of Bloom's Taxonomy for this study is emphasized by its values and influences in the process of preparing tests in the subject of mathematics. The levels of Bloom's Taxonomy are gradual, starting from the most basic levels of memory and reaching the most advanced levels of analysis, synthesis, and evaluation. This gradualization provides a progressive approach to developing students' skills. Bloom's taxonomy is appropriate for the subject of mathematics given the complexity and types of cognitive skills that must be developed in students in this area. This model provides a well-defined tool for identifying and assessing mathematics objectives. Using Bloom's Taxonomy helps design test tasks that assess specific student abilities. By determining the required cognitive levels, test designers have the opportunity to prepare questions that challenge students appropriately for their level.

Bloom's taxonomy was developed to provide a common language for teachers to discuss and share learning and assessment methods. Specific learning outcomes can be derived from the taxonomy, although it is most commonly used to assess learning at a range of cognitive levels. The table below defines each cognitive level from higher to lower-level thinking.

Fig 1. Levels of Bloom's Taxonomy(Andreev, 2023)

The taxonomy explains that before you can understand a concept, you must remember it; To apply a concept, you must first understand it; To evaluate a process, you must first analyze it; To create something new, you must have completed a full evaluation(Shabaturaj, 2013)

In the study of Anderson , Krathwohl and Bloom (2011), the use of Bloom's Taxonomy defines a standard for evaluating the effectiveness of test preparation and student progress. This helps in understanding the impact of using this taxonomy on the development of students' mathematical skills. In this way, Bloom's Taxonomy serves as a powerful and appropriate framework to guide the preparation of tests in the subject of mathematics in this study, bringing a structural and gradual approach to the development of students' (Anderson, Krathwohl, & Bloom, 2001)cognitive skills.

Learning outcomes are what you want your students to learn, either as a result of a specific lesson or on the grander, more general scale of the entire course. Learning outcomes target knowledge, skills or attitudes for change. Bloom's taxonomy specifically targets these by seeking to increase knowledge (cognitive domain), develop skills (psychomotor domain), or develop emotional skills or balance (affective domain). Learning outcomes may be identified by someone outside the teacher, such as state or departmental standards. The taxonomy provides a basis for developing sub-goals and evaluation methodology to meet these goals. It is important to note that learning outcomes are goals and not activities performed to achieve these goals. Outcomes can be categorized into broad, global outcomes that may take many years to achieve and provide direction for education, educational goals that guide curriculum development over the weeks or months it takes to complete a specific course, and learning goals that focus narrowly on the everyday. activities, experiences and exercises used in a specific curriculum (Bloom, 1969).

To distinguish at which level of Bloom's Taxonomy the tasks in the subject of mathematics can be defined, we need to understand the levels of this taxonomy and use them in the context of the subject of mathematics. The main levels of Bloom's Taxonomy are:

Memory (Level 1 - Recall) - At this level, students simply remember information without transforming it. Tasks at this level may include questions that require the determination of facts, mathematical formulas, or basic processes.

Example: "Assign the value of the unknown $x$in the mathematical equation: $3x + 5 = 20$"

Comprehension (Level 2 – Deeper Understanding) - At this level, students demonstrate deeper understanding of information and ability to explain mathematical concepts. Tasks may include interpretation of results, definitions of mathematical terms, or analysis of how to solve a problem.

Example: "Describe in words the process of solving a system of two linear equations"

Application (Level 3 - Application) - At this level, students apply their knowledge to solve concrete problems. Tasks may involve applying a mathematical formula to a given situation or solving a mathematical problem.

Example: "Use the circle area formula to find the area of a circle with radius $5cm$".

Analysis (Level 4 – Deep Analysis) - At this level, students examine the components and relationships between mathematical elements. Tasks may include analysis of a complex mathematical expression, comparison of solution methods, or identification of critical components of a mathematical model.

Example: "Compare methods of solving quadratic and linear equations"

Assessment (Level 5 - Assessment) - At this level, students assess and critique mathematical knowledge using defined criteria. Tasks may include evaluating changes in a mathematical argument, identifying errors in a solution, or evaluating the effectiveness of a strategy used.

Example: "Evaluate the argument for why a particular solving method is more effective than another in the context of a mathematical problem."

Creation (Level 6 - Creation) - At this level, students have the ability to create something new, using knowledge and skills acquired at lower levels of the taxonomy. Creativity in mathematics can be demonstrated through complex and challenging tasks.

Example: "Create an independent math project to explain the concept of the Pythagorean theorem in a creative way. Include a description of your research, a graphical illustration, and a concrete application of the theorem to a real mathematical situation."

Using these levels of Bloom's Taxonomy in the preparation of mathematics coursework can help provide a necessary diversity and address the variety of student abilities.

1.1 The purpose of the research

The purpose of this study is to investigate and evaluate the impact of using Bloom's Taxonomy in the preparation of tests from the subject of mathematics. This research aims to identify ways in which this theoretical model can be applied to improve the quality of test questions and, through them, to influence the development of students' mathematical skills.

In this context, an important goal is the development of a specialized model for determining the levels of Bloom's Taxonomy in the specific context of the mathematics subject. This model aims to assist test designers in understanding and using the structure of Bloom's Taxonomy to construct questions that reflect gradualness and progressivity in the development of mathematical knowledge.

Specifically, the study seeks to answer questions on the effectiveness of this taxonomy in increasing the quality of tests, through literature with a practical and usable model for test preparation in mathematics, examining the benefits and challenges of applying Bloom's Taxonomy. in this context.

Ultimately, the main goal is to provide a valuable contribution to educational practitioners, test designers, and educators by suggesting an effective tool for improving the learning process in mathematics through a sophisticated and strategic use of Bloom's Taxonomy - it.

2. Literature Review

Learning mathematics involves a continuous process of solving different types of tasks. In this way, students manage to understand the learning content provided by the curriculum and build their knowledge in mathematics. Each task contains something unknown, something the student did not know and what he learns by solving the task. The task is basically a request, an order, an incentive to find unknown data, numbers, sizes from known data and conditions (Markovac, 2001). In this way, the mathematical task becomes the basis of new knowledge. According to Kurnik (2000), a task is a complex mathematical object, the structure of which is not always so easy to analyze, and consists of five points: conditions, objective, theoretical basis, solution and revision (Kurnik, 2000). On the other hand, the teaching planning process begins with setting goals. Educational goals define clearly and concretely what should be achieved by teaching (knowledge, skills, attitudes), or describe what the student should learn. Upon successful completion of the course syllabus, the student will be able to perform certain activities at a socially acceptable level. Therefore, the choice of educational goals is the most important decision in curriculum design and curriculum development (Kovačević, Mušanović, & Vasilj, 2010).

However, learning outcomes or student achievement are not statements that explicitly enumerate and describe educational content or say what students and teachers should do in teaching. Student achievement focuses on students and their activities. For this reason, they are always expressed with active verbs (identify, describe, analyze, compare, sort, apply, etc.) that express the students' activity. Student achievement is important to teachers, students and parents. They provide teachers with a clear and precise basis for determining the content they will teach, the teaching methods and strategies they will apply, determining the activities students should know, determining test tasks for assessing achievement and progress of students and evaluation of the implementation of the curriculum they implement. They provide students with a clear and concrete overview of what they should know and be able to do at the end of each topic, unit, class, educational cycle or schooling, a clear framework that guides their learning, a clearly articulated basis for preparing for exams, or checking their achievements. Finally, they are important for parents because they allow them to gain a clear picture of what type and depth of knowledge, skills and values children will be able to acquire at school, and allow successful support and monitoring of progress. of their child, etc (Jurić, Mišurac, & Vežić, 2019).

Various taxonomies of educational objectives have been compiled to classify goals in education. The term taxonomy comes from the Greek words tassein (nominate) and nomos (law, science), and denotes a scientific discipline that categorizes and classifies something based on the similarities and differences of the taxonomic unit (Simpson, 1972). One of the most famous classifications of educational goals is called Bloom's taxonomy of educational goals. It was named after the American psychologist Benjamin Samuel Bloom, who together with his collaborators presented it in 1956. The main goal of Bloom's taxonomy is to create a consistent system that starts from the logic-content, pedagogical and psychological principles and the principles of learning and teaching. Also, the purpose of this taxonomy is to facilitate communication in the field of functionalizing the goals and tasks of educational processes, with special emphasis on teaching (Diković & Piršl, 2019).

The taxonomy of educational objectives should help teachers speak the same language and thus facilitate the exchange of information about their curricular developments. and assessment equipment. However, currently the revised versions are more often used. Let's see the differences between them by analyzing the following figure:

Fig 2. Bloom's Taxonomy(Andreev, 2023)

The terminology has recently been updated to include the following six levels of learning. These 6 levels can be used to structure learning outcomes, lessons and assessments (Shabatura , 2022):

Remembering: Retrieving, recognizing, and recalling relevant knowledge from long-term memory.

Comprehension: Constructing meaning from oral, written and graphic messages through interpretation, exemplification, classification, summarisation, inference, comparison and explanation.

Application: Carrying out or using a procedure for execution, or implementation.

Analyzing: Breaking down material into component parts, determining how the parts relate to each other and to an overall structure or purpose through differentiation, organization, and attribution.

Evaluation: Making judgments based on criteria and standards through inspection and criticism.

Creation: The joining of elements to form a coherent or functional whole; rearranging elements into a new pattern or structure through generation, planning, or production.

When we talk about Bloom’s taxonomy, action verbs related to cognitive categories and processes are often mentioned. Instructors use these verbs to describe the activities necessary to achieve the educational objectives corresponding to each level. There is a list of Bloom’s Taxonomy verbs created by the University of Arkansas. Using these verbs can help teachers clearly navigate what students need to do to demonstrate their mastery of the objective (Andreev, 2023; Heick , 2021).

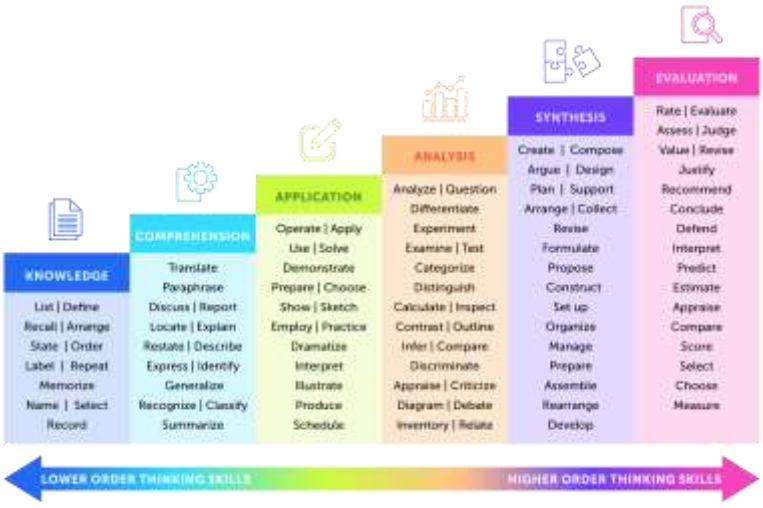

Fig 3. Bloom’s (Andreev, 2023) Taxonomy verbs

Perhaps the earliest taxonomy developed for educational assessment was that produced by Bloom et al . (1956). Designed for general application in all school subjects, many in mathematics education have found it particularly unsuitable for mathematics e.g., (Kilpatrick, 1993). In general, it has also been suggested that Bloom’s Taxonomy fails to identify levels of learning compared to designing different types of questions (Freeman & Lewis, 1998)and that its hierarchical nature is deficient, as some levels in it can be considered interdependent. (Anderson & Sosniak, 1994). Kadijević (2002) strongly encourages the operationalization of taxonomies during assessment design, which can be used to guide and promote an adequate teaching of mathematics and to achieve a comprehensive assessment of its outcome (Kadijević, 2002). Various taxonomies have been proposed; some designed for general assessment, some for math assessment. However, as with most educational frameworks, caution should be exercised.

The little published empirical research in this area has statistically validated the use of taxonomies, which means that its reliability cannot be properly reflected in student outcomes (Kadijević, 2002). However, the most important difficulty associated with the use of taxonomies is related to the classification process itself, specifically: It is difficult to place some questions in only one category. More involved questions may include routine and procedural calculations such as part of the resolution process. Also, it is difficult to know what skills and thinking are used by individual students to answer a question. (Kadijević, 2002).

Research results Nengsih, Nurrahmah and Alamsyah (2018) show that the mathematical problem-solving ability of students who learn problem solving using Bloom's revised taxonomy is better than those who are taught using solo taxonomy. In conclusion, there is a significant effect of teaching problem solving using Bloom's revised taxonomy on students' mathematical problem-solving skills (Nengsih, Nurrahmah, & Alamsyah, 2018).

3. Materials and Methods

The methodology of this research is carefully structured to ensure a systematic and reliable approach to the application of Bloom's Taxonomy in the preparation of tests from the subject of mathematics. The steps of the methodology include:

Literature Review - A literature review is conducted to identify methodologies previously used in the field of using Bloom's Taxonomy in test preparation and to understand the effects of this taxonomy in the context of mathematics.

Determining the levels of Bloom 's Taxonomy - An in-depth analysis of the levels of Bloom's Taxonomy is performed to identify those that are most appropriate for the subject of mathematics. In this phase, a model is drawn up for determining the specific levels for the mathematics subject.

Designing test tasks - For each identified level of Bloom's Taxonomy, test questions are designed that reflect the objectives of each level. This process is carried out in collaboration with experts in the field of mathematics to ensure an optimal fit.

Application of tests - Tests designed based on Bloom's Taxonomy are applied to a selected group of students. These students are tested before and after using models based on Bloom's Taxonomy to assess changes in their skills after using these models.

Interpretation and conclusions - Based on the analysis of the results, the interpretations and conclusions of the study are formulated. The results are discussed in the context of the existing literature and recommendations are offered for future use and research undertaken.

Research objectives

The objectives of this study are to focus on undertaking efforts to understand and evaluate the impact of using Bloom's Taxonomy in the preparation of tests from the subject of mathematics. These objectives include:

Identifying the levels of Bloom's Taxonomy for the subject of mathematics

To determine the specific levels of Bloom's Taxonomy that are appropriate for the subject of mathematics and to design a model for their determination.

Improving the quality of tasks in tests:

To evaluate how the use of Bloom's Taxonomy affects the improvement of the quality of test tasks in the subject of mathematics.

Bloom's Taxonomy:

To evaluate the effectiveness of using Bloom's Taxonomy compared to traditional test design methods.

Assessment of student skill development:

To evaluate the impact of using Bloom's Taxonomy on the development of students' cognitive skills in the subject of mathematics.

Providing input to education practitioners and test designers:

To contribute to the education literature with a practical model for test preparation in mathematics, revealing the benefits and challenges of using Bloom's Taxonomy.

4. Research Results

4.1 Analysis of the results from the literature review

The results of the research in the literature review phase included a compilation of information and a synthesis of knowledge that are important for understanding the context of using Bloom's Taxonomy in the preparation of tests in the subject of mathematics. At this stage, the included literature has emphasized the widespread use of Bloom's Taxonomy as a tool to help define learning objectives and design tests with gradual levels of complexity. Studies show that the use of Bloom's Taxonomy is also suitable for the subject of mathematics. The levels of this taxonomy are strongly related to the mathematical skills and knowledge needed by students. The use of this taxonomy can result in improving the quality of tests and developing students' knowledge in a systematic and gradual way. Several studies have highlighted the criticisms and challenges of using Bloom's Taxonomy, emphasizing

the need for specific adaptations for certain domains and learning contexts. Description of trends in how previous studies have used Bloom's Taxonomy for test preparation in different learning contexts and different subjects. Through literature analysis, the research has identified a good knowledge base for the use of Bloom's Taxonomy in the subject of mathematics and has looked at previous experiences to build a specialized model for determining the specific levels of this taxonomy in this context.

4.2. Analysis of the results when determining the levels of Bloom 's Taxonomy

The results of the research in the stage of determining the levels of Bloom's Taxonomy have brought a detailed approach on the suitability of the levels of this taxonomy for the subject of mathematics. Through an in-depth review of the literature and consultations with experts in the field of mathematics, the levels of Bloom's Taxonomy that best fit the structure and cognitive components of the mathematics subject have been identified. This has led to the development of a specialized grading model for this subject. The prescribed levels are assessed as appropriate for the mathematics subject by including specific aspects of the mathematical demands and cognitive abilities of the students. This has provided a stable basis for the design of mathematics tests. The levels of Bloom's Taxonomy are used in order to ensure gradualness and progressivity in the development of students' cognitive skills in mathematics. Each level is intended to represent a step of building knowledge and skills.

Determining the levels of Bloom's Taxonomy is an important process that aims to assess the achieved level of knowledge and skills of students. The analysis of the results at this stage gives a detailed impression on the performance of the students and their knowledge regarding the levels of the taxonomy. Here are some important aspects that can be included in the analysis of the results:

Determination of levels	**Indicators**
Focus on recall level (Remember)	To assess this level, the results of questions that require basic knowledge and memory can be analyzed. If scores are low at this level, this may suggest a need for more focus on building foundational knowledge.
Deeper understanding (Understand)	Comprehension level analysis may include assessing students' ability to explain concepts comprehensibly. If there is a low level here, there may be a need to focus on more detailed explanation of mathematical problems.
Application of knowledge (Apply)	At this level, analysis can focus on students' ability to apply knowledge to new situations. If there are challenges at this level, it may suggest that students should be treated with more advanced tasks that encourage the use of knowledge in different contexts.
Critical thinking analysis (Analyze)	If you examine the results at the level of analysis, you will see how well students are able to demonstrate critical thinking, identifying and examining the intertwining elements of math problems.
Assessment of high levels (Evaluate)	For the assessment level, analysis may include assessing students' ability to evaluate and compare solutions, making critical assessments of proposed methods and solutions.
Creating something new (Create)	Analysis at the creation level may include assessing students' ability to apply knowledge and skills in creating original solutions and creating new mathematical models.

4.3 Analysis of results from the design of test tasks

The results of this phase of the research have created a stable basis for the design of tests in the subject of mathematics through the use of the levels of Bloom's Taxonomy in order to meet the goals of learning and development of students. Therefore, we are presenting some of them as follows:

Table 1. Surface view problem according to Bloom's Taxonomy

Level	**Surface area according to Bloom 's Taxonomy**
Remember	Estimating, measuring, comparing and recording the surface area in square units of a room
Understand	Calculation of the surface area of a number of common household objects such as the table top, the front of the door, the wall, etc.
Apply	Using these findings, pictures are drawn in proportion to the things the students would like in their room.
Analyze	Using their drawings in proportion, place items in a given room with the maximum remaining space.

Evaluate	Calculation of the amount of paint needed to paint the room, if they use $10\ L$ of paint per square unit.
Create	Calculating the length of border strip required if they were to add a decorative panel to the wall.

This analysis of the task in the subject of mathematics according to Bloom's Taxonomy shows how the levels of this taxonomy are integrated into the demands of the task in a gradual way. Here is an analysis of each level of Bloom's Taxonomy in the context of the surface view task. Remember - At this level, students are required to recall and measure the surface area of a square unit by estimating, measuring, comparing and recording the surface area of the parts of the task.

Understand - At the level of understanding, they need to understand more deeply the interaction of surface area with finding the area of household objects used in the second part of the task.

Apply - Using the knowledge gained, students must apply it to creating proportional figure drawings of household items in their room.

Analyze - In this level, they are required to analyze their drawings and place the objects in the room using the maximum space left. This requires a higher degree of analysis and criticality of the situation.

Evaluate - At the evaluation level, students are required to calculate the amount of paint needed to paint a room using $10\ L$ of paint per square unit. This involves a critical assessment of the situation and the use of knowledge to reach a conclusion.

Create - At the creation level, they are required to create by calculating the length of the border strip required for adding a decorative panel to the wall. This requires a high creative ability and the application of knowledge in a new context.

This model shows how the task is structured to meet the different levels of cognitive demands according to Bloom's Taxonomy, encouraging students to develop their skills in a gradual way and to use mathematics in real situations.

Table 2. The prime number problem according to Bloom's Taxonomy

Level	**Prime numbers according to Bloom 's Taxonomy**
Remember	What is a factor?
	What are prime numbers?
Understand	Why is 11 a prime number?
Apply	What are the prime factors of 135?
	Can a prime number be a multiple of 6?
Analyze	How do you find the prime factors of a given number?
Evaluate	What numbers less than 100 have exactly three prime factors?
	The sum of four even numbers is a multiple of 6.
Create	When is it correct?
	When is it incorrect?

The analysis of this task according to Bloom's Taxonomy shows how each level of the taxonomy is used to search for and explain knowledge and skills related to prime numbers. Here is a breakdown of each phase of the prime number assignment:

Remember - At the recall level, students must recall basic definitions. Questions like "What is a factor?" and "What are the prime numbers?" encourage them to recall basic information about prime numbers.

Understand - At the comprehension level, questions indicate that students need to understand why a number is prime, as in the case of the question "Why is 11 a prime number?"

Apply - At the apply level, students must apply their knowledge to finding the prime factors of a number, as in the question "What are the prime factors of 135?" Also, they must apply knowledge to evaluate whether a number is a multiple of another number.

Analyze - At the analysis level, the question "How do you find the prime factors of a given number?" prompts students to analyze the number and determine its prime factors.

Evaluate - At the evaluation level, students are required to evaluate and identify numbers less than 100 that have exactly three prime factors.

Create - At the create level, students are required to create an expression and evaluate the correctness of a statement, as in the question "The sum of four even numbers is a multiple of 6. When is it correct? When is it incorrect?"

This task includes a wide range of cognitive requirements, making it suitable for the distribution of students' knowledge and skills at different levels of complexity.

4.4 Analysis of results applying the use of Bloom 's Taxonomy

The results of the research regarding the impact of using Bloom's Taxonomy on the improvement of tests and the development of knowledge in the subject of mathematics have brought some important discoveries and conclusions. The use of Bloom's Taxonomy has resulted in the design of test questions that reflect different cognitive levels. This gradual approach has led to an improvement in the quality of the questions, providing a better reflection of students' knowledge levels. Tests designed based on Bloom's Taxonomy have helped in the gradual development of students' cognitive abilities in mathematics. The different levels of this taxonomy have defined a clear progression in student skills from the most basic to the most advanced levels. Test results have shown an improvement in student performance after using Bloom's Taxonomy in test preparation. Students have shown a deeper understanding and knowledge of the subject, which has shown in their results. Tests designed using Bloom's Taxonomy followed the learning goals and standards set for the mathematics subject. This result has marked a harmony between the test questions and the learning objectives. The use of Bloom's Taxonomy has proven the suitability and applicability of this taxonomy in the design of tests in the subject of mathematics. This has brought an important contribution to the improvement of the learning and assessment process in this field. In general, the results of this phase of the research have proven that the use of Bloom's Taxonomy has positively influenced the improvement of tests and the development of students' knowledge in the subject of mathematics.

5. Discussion

In this chapter we will examine and discuss the results of our study regarding the use of Bloom's Taxonomy in the preparation of tests from the subject of mathematics. The main purpose of this study was to evaluate how a structured and gradual approach, based on the levels of Bloom's Taxonomy, can affect the quality and level of difficulty of mathematical tests.

The results showed a gradual progression of students' cognitive abilities through the levels of Bloom's Taxonomy. At the memory level, students must demonstrate good knowledge of basic mathematical facts and procedures. At the levels of understanding and application, they must demonstrate a deeper understanding and the ability to use their knowledge in new situations. At the analysis and evaluation levels, students should demonstrate the ability to analyze and evaluate information using distributed knowledge. Finally, at the creation level, they must demonstrate the ability to apply and combine knowledge in creating new solutions.

Bloom's Taxonomy shows a positive impact on improving students' test scores and skills. A gradual approach focused on taxonomy levels leads to richer tests that reflect students' knowledge and skills in a more complete way. This result underlines the importance of using a clear pedagogical structure to develop students' knowledge and skills in mathematics.

Bloom's Taxonomy levels shows that students benefit from a gradual approach. The levels of memory and understanding served as the foundation for the higher levels of application, analysis, and evaluation. This structured model encourages students to look deeper and better understand the mathematical content, significantly improving the quality of the test.

In conclusion, this chapter has analyzed the results of the study in detail and explained how the use of Bloom's Taxonomy can improve test preparation and the development of knowledge in the subject of mathematics. The discussion has announced a valuable contribution to teaching practices and has highlighted the need for further research to deepen this area.

Identifying the levels of Bloom's Taxonomy for the subject of mathematics is an important process to determine and categorize the cognitive abilities of students in this area. In this context, the aim is to determine the appropriate levels of Bloom's Taxonomy that reflect the depth and complexity of mathematical knowledge. To achieve this objective, the first step is to identify and define the levels of Bloom's Taxonomy for mathematics. The main levels of Bloom's Taxonomy include: At the Remember level, facts, formulas, and basic mathematical procedures are identified. At the Understand level, the interpretation of concepts and the connections between them in mathematics is made. At the Apply level, knowledge is used in solving new mathematical problems and in practical situations. At the Analyze level, the different parts of a mathematical concept and the connections between them are examined. At the Evaluate level, the efficiency and validity of mathematical solutions is assessed. At the Create level, the development of new solutions takes place, using mathematical knowledge in a new context. After identifying these levels, the second step is to design a model that defines how each of them can be expressed in the context of the mathematics subject. This includes a clear definition of the specific qualities and duties associated with each of these levels. The model should be appropriate for the mathematical context and assist teachers and students in understanding and using these levels when teaching and assessing mathematical knowledge. This effort to identify and design a model for the levels of Bloom's Taxonomy in mathematics will contribute to pedagogical knowledge and to the improvement of learning strategies in this area.

The other objective of the research was to improve the quality of test tasks using Bloom's Taxonomy, which aims to evaluate the impact of this taxonomy on improving the quality of test tasks in mathematics. Here is an answer to this objective: Using Bloom's Taxonomy can help create a clear gradation of the difficulty of tasks on tests. The levels of Bloom's Taxonomy provide a hierarchy that begins with recall and ends with creation. This can lead to tasks

that better reflect the depth and complexity of mathematical knowledge. Also, the use of Bloom's Taxonomy levels can help determine the cognitive abilities that should be assessed in test tasks. This specific focus can result in more effectively structured tasks to assess students' knowledge, understanding, and skills in mathematics. Therefore, Bloom's Taxonomy encourages the use of tasks that challenge students to apply and analyze their knowledge in new situations. This can lead to the creation of tasks that reflect the use of mathematics in real contexts and encourage deep analysis of problems. Improvements in the quality of assignments can be evaluated by analyzing the extent to which they address the levels of Bloom's Taxonomy. If assignments are structured in accordance with this taxonomy, then there can be a significant improvement in quality, as they will provide a more complete view of students' abilities. Summaries and feedback from test results can be used to redesign and improve test tasks. If a task fails to address the levels of Bloom's Taxonomy effectively, then there are opportunities to adapt or redesign it to improve its quality. Through the assessment of these elements, it can be observed that the use of Bloom's Taxonomy has the potential to improve the quality of tasks in tests in the subject of mathematics by addressing the depth, complexity, and abilities of students in a more clear and effective way.

The other research objective of evaluating the effectiveness of using Bloom's Taxonomy compared to traditional test design methods aims to evaluate to what extent this taxonomy can bring improvements in the quality and effectiveness of tests in the subject of mathematics. Here is an answer to this objective: Using Bloom's Taxonomy can lead to a clearer and more structured level of difficulty in tests. This helps create assignments that more accurately reflect students' levels of math knowledge and ability. Bloom's taxonomy focuses on different levels of cognitive ability, allowing tests to address all aspects of knowledge development. This is an advantage compared to traditional methods that can be limited to tests with questions of one type. If Bloom's Taxonomy is used successfully, tests can improve the analysis and application of mathematical knowledge. This means that students will be able to apply their knowledge to new situations and explain concepts in more depth. The use of Bloom's Taxonomy can bring objectivity and consistency to the assessment of tests. By using a clear structure, assessment can be fairer and more impartial, as each cognitive level has a clear description. Using Bloom's Taxonomy can help prepare students for tests by providing a graded approach to knowledge levels and encouraging them to develop different cognitive competencies. Tests designed using Bloom's Taxonomy should be able to better assess their impact on the development of students' knowledge in mathematics. This may include tracking their progress from beginner levels to more advanced levels. Comparing the time and resources used to design and evaluate tests based on Bloom's Taxonomy with those of traditional tests can provide a perspective on the effectiveness of this taxonomy. Through a careful and tailored assessment, it can be concluded whether the use of Bloom's Taxonomy has brought about effective improvements in the design and quality of tests in the subject of mathematics compared to traditional methods.

The other research objective of the assessment of the development of students' skills in the subject of mathematics using Bloom's Taxonomy aims to evaluate to what extent this taxonomy model affects the growth of students' cognitive skills. Here is an answer to this objective: Using Bloom's Taxonomy can help create a clear scale of cognitive skills from lower levels of knowledge to higher levels of analysis, evaluation, and creation in mathematics. This can help students in their progressive development. Bloom's taxonomy defines higher cognitive levels as analysis, evaluation, and creation. Using this taxonomy can encourage students to go beyond basic knowledge and cultivate advanced analytical and creative skills in mathematics. Tests based on Bloom's Taxonomy include application and analysis tasks that encourage students to use their knowledge in new situations and examine mathematical concepts in depth. This process can help develop their analytical skills. Through the use of Bloom's Taxonomy, educators can more easily identify those specific skills that students need to further develop. This can help individuals design personalized strategies to address their needs. Tests based on Bloom's Taxonomy prepare students for further skills by offering challenges at higher cognitive levels. This can serve as a springboard for their continued development in mathematics. Bloom's taxonomy emphasizes the relationship between the levels of recall and creation. While students recall and understand, they are also encouraged to create and apply knowledge creatively. This can help in a general development of cognitive skills. Using Bloom's Taxonomy can have a positive impact on students' overall preparation by exposing them to gradual challenges and developing their mathematical skills in a structured way. By evaluating these aspects, the impact of using Bloom's Taxonomy on the development of students' cognitive skills in the subject of mathematics can be evaluated.

The final objective of the research is to contribute to the education literature with a practical model for test preparation in mathematics, revealing the benefits and challenges of using Bloom's Taxonomy - it aims to make a valuable contribution to educational practitioners and designers of tests. Here is an answer to this objective: The answer to this objective will involve developing a practical and appropriate model for designing tests in mathematics using Bloom's Taxonomy. This model will provide a detailed guide for test designers, including concrete steps to adapt the cognitive levels of Bloom's Taxonomy to test tasks. The benefits of using Bloom's Taxonomy will be detailed in the practical model. This section will address how this model helps create tests that reflect the level of difficulty, promote students' cognitive skills, and prepare them for higher-level mathematical challenges. In addition to the benefits, the model will also address the potential challenges of using Bloom's Taxonomy in test design. This includes a mindful look at difficult opportunities and ways to deal with them, ensuring that education practitioners have a full perspective on this methodology. The model will contain case studies and empirical experiences related to the use of the model in practice. This will help validate and reinforce the model, based on results and feedback from real situations in the context of mathematics learning. An important part of the contribution will be providing practical guidance for using the model in the classroom. These guidelines should be clear, understandable, and easy to implement by new practitioners in the field of mathematics education. Finally, the model should provide recommendations for further use and steps for the future. This section may include suggestions for model elaboration, possible improvements, and ideas for future research related to the use of Bloom's Taxonomy in the design of mathematical tests. This response will be a valuable contribution to educational practitioners and test designers by providing a practical and convenient model for preparing mathematics tests using Bloom's Taxonomy.

6. Conclusions

The conclusion of this scientific research regarding the preparation of tests in the subject of mathematics using Bloom's Taxonomy brings an important contribution to the field of education and evaluation methodology. Starting from the analysis of the literature and the research, it is evident that the use of this taxonomy brings many benefits for the test designers and students.

The practical model developed in this research provides a clear and structured framework for designing tests that reflect different levels of cognitive abilities, from recall to creation. This model uses Bloom's Taxonomy as a main guide for designing tasks with levels of difficulty and complexity, thereby encouraging the development of students' mathematical skills.

The benefits of using this taxonomy include creating tests that promote students' substantive knowledge, analytical and creative skills. The level of difficulty helps create a prepared and challenging learning environment, while the focus on higher cognitive levels encourages students to develop deeper skills in understanding and applying mathematics.

Bloom's Taxonomy are also addressed in the research, bringing a clear look at how these challenges can be addressed and overcome in the test design process. This provides a clear definition of rules and guidelines for effective use of the taxonomy.

Through this research, an important contribution to the education literature emerges, providing a usable and relevant model for education practitioners and test designers. This model can serve as a valuable resource and guide for those who are engaged in the preparation of tests in the subject of mathematics, bringing a positive impact on the quality and effectiveness of the learning process.

Implications and recommendations for mathematics teaching methodology

Based on the results of this study, there are some implications and recommendations for mathematics teaching methodology. Using a structured approach based on Bloom's Taxonomy can be a useful strategy for educators to develop students' knowledge and skills progressively. Also, further research is needed to validate and deepen the results of this study in different school contexts and age groups. Educators can provide detailed and clear instruction for each level of Bloom's Taxonomy. This will help students clearly understand what is expected of them at each stage of learning. Creating tests that encourage students' abilities to analyze, evaluate, and create will help prepare them for more advanced challenges in mathematics. The construction of pedagogical models that include a gradual and progressive approach can positively affect the development of students' mathematical competences.

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