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THE EFFECTIVENESS OF ACTIVE LEARNING METHODS IN TEACHING INTEGERS IN PRIMARY SCHOOL

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Annotation. This study aims to examine the effectiveness of active learning strategies in teaching the concept of integers to primary school students. Although the concept of integers is the foundation for complex mathematical and algebraic operations, students often have difficulty in coping with the abstractness of negative numbers and conventional rote learning approaches.

By utilizing a mixed-methods design, the study used semi-structured interviews with mathematics experts and an online survey of 33 participants to compare traditional learning approaches with active learning strategies. Some of the findings of the study include that active learning, which involves group discussions, activities, and problem-based learning, has a significant effect on student engagement and conceptual learning. Quantitatively, the study found that 46.5% of the subjects learned that active learning had a significant positive effect on their learning, compared to only 12% who learned that active learning had a moderate effect.

The study concludes that active learning strategies, including the use of interactive tools like integer boards, can help bridge the gap between abstract and concrete learning. Although the study has some limitations, including a small sample size, it advocates a paradigm shift to innovative and active learning strategies in teaching the concept of integers in elementary education.

Keywords: Active learning, integers, primary school, mathematics education, student engagement, visual aids.

Introduction. In mathematics, integers are numbers without fractional or decimal parts. They are not merely an abstract category but serve as the basis for understanding more complex concepts and operations. Understanding this in elementary school is critical for developing mathematical thinking. According to Fitri, “operations with whole numbers are the basis for further learning, including algebra, in which students are introduced to the world of positive numbers, zero, and negative numbers.” [1],

However, even such seemingly simple numbers as whole numbers often create significant problems for students. Traditional methods, based on memorization of rules and monotonous completion of exercises, force students to simply “manipulate symbols without understanding their essence.” [2]

The problem in teaching integers is not just their intellectual complexity but also their emotional perception by students. Thus, as Çetin noted, “active learning has a significant positive impact on students’ attitudes toward mathematics, transforming the learning process from passive reception into exploration.” This means that successful learning in integers is directly dependent on the student’s level of academic autonomy [3]

Indeed, as research has confirmed, in the traditional approach, students are just passive receivers of knowledge, while Lessani state: “In the discovery method, students are not passive objects; they create (construct) new mathematical knowledge by reflecting on their physical and mental actions.” This is why memorization of rules does not lead to an in-depth comprehension of the nature of integers [4]

One of the major barriers to comprehending this material lies in the metaphoric nature of symbols. Indeed, as Fuadia have pointed out, “students often struggle because of the dual function of symbols, where a minus sign can denote both the subtraction operation and the negative polarity

of a number.” This again confirms that memorization of rules (such as “minus times minus equals plus”) does not lead to an in-depth comprehension of the material [5]

“These difficulties indicate that there has been insufficient development of conceptual and procedural understandings... Misconceptions about the meaning of negative values and the dual nature of mathematical symbols often interfere with successful learning”. Thus, the interest in the subject diminishes, and the gaps in the knowledge area add to the hurdles in the later stages of learning. [6]

The era of digitalization has arrived, and the modern education system has to reconsider the traditional learning methods. Active learning takes center stage, and the student is no longer a passive listener. He or she becomes an active participant in the learning process, and the abstract concepts of integers can be related to the actual situations.

The use of digital technology has also changed the way the subject is perceived. Syeda, in her work, has clearly mentioned that “the use of interactive software and digital simulations not only simplifies calculations but also helps reduce students' math anxiety, making abstract concepts more accessible to students.” This, in fact, confirms that it is necessary to move away from the use of only paper-based material while learning integers [7]

Visualization and interactivity: A special mention has to be made of the use of visualization and interactivity in the engagement of the students with the subject matter. This is in line with the following points:

Engagement: A study by Çetin clearly indicates that “students' direct engagement in classroom activities can reduce boredom and promote the continuity of the learning process.” [2]

Visualization: The use of special aids like the “integer operations board” can help connect abstract concepts with concrete actions, as mentioned in the work by Haji Ismail, Shahril, and Asamoah in [6].

Tools: The application of counters and worksheets, although not as frequently mentioned, has been seen as an effective tool for enhancing students’ understanding of addition and subtraction. As Sarmila & Rosli have confirmed in their study, the application of visual tools is directly related to an increase in students’ mathematical achievements [8],

The problem is clearly stated, as it is seen as a gap between the application of traditional methods and their relative ineffectiveness. The study examines alternative strategies that can increase students’ engagement.

The findings of the study are extremely important for the development of teaching methodologies, especially in the context of global digitalization. The understanding of the role of active learning in overcoming cognitive and linguistic obstacles will enable elementary school teachers to lay the foundation for their students, which is essential for their success in the field of science [9,10].

Methodsand materials. In mathematics, integers are numbers without a fractional or decimal part. They are important in a variety of operations and everyday life, providing a foundation for understanding more complex concepts. Teaching whole numbers in elementary school is key to building mathematical thinking and future success. However, it can be challenging, requiring innovation in pedagogy to engage students.

Research Design. In this research, it was decided to use mixed methods including both qualitative and quantitative types of research to evaluate the changes in the teaching system according to the topic. As qualitative research, interviews were conducted to understand students' impressions, opinions or views by collecting and investigating non-numerical data. Qualitative research helps to better generate new ideas for study and provides details for deep understanding of their full meaning. In addition, qualitative research seeks to analyze the topic at hand in depth to gain information about people's motivations, attitudes and opinions. Therefore, it was decided to take semi-structured interview with experts in the field of mathematics teaching using traditional and active methods. Semi-structured interviews were chosen as the data collection method because of their effectiveness in identifying actual teaching practices. A similar methodology was successfully applied in the study by Lessani, where qualitative analysis revealed a gap between

theory and the actual use of active teaching methods in the classroom. Quantitative research is based on the fact that people's behavior and attitudes can be expressed using numerical values. This research method allows the results of a sample group to be generalized to the whole group of people or population. Quantitative analysis, which is both structural and statistical, allows conclusions to be drawn and an informed decision to be made about a course of action. Therefore, the survey was conducted in order to draw conclusions about the effectiveness of active learning and to investigate the main current problems in teaching the topic of integers.

Sample Selection and Sampling Strategies. In the vast majority of cases, it is not possible to interview the general population, which is the total number of objects of observation (e.g. all residents of the capital city). In order to solve this problem and to be able to give a conclusion about the whole population, a sample selection was used in this study. To elaborate, in this study I used a non-probability sampling method on the principle of convenience, as this method is the most accessible to the researcher, and it is also easy and quick to conduct online, as no other selection parameters are involved.

Research Methods (Data collection tools). As it was mentioned before, in this study, a semi-structured interview was conducted to get a detailed explanation and professional knowledge about the active method in teaching the topic of integers. Three teachers from different areas of mathematics were interviewed. The purpose of this process was to gather information about the interviewee's perceptions, experiences and understanding of the topic. In this way, it was convenient to analyze the data provided and come to certain conclusions. Another main research tool was an online survey that aimed to interview as many students as possible. Seven questions related to my research questions were created on the Google Forms online platform. In addition, a Likert scale question was included to find out people's opinion about the topic, dichotomous questions to get information about the characteristics of the sample, and multiple choice and filter questions to explore the understanding and perception of the topic of integers using an active teaching method [11,12]

The advantage of interactive methods, as documented in my study, is corroborated by the findings of Fitri. Her study showed that students taught using the RME method demonstrated a deeper understanding of integer operations compared to the control group. The author emphasizes that “the use of real-life scenarios allows students to construct mathematical models independently, which leads to a more lasting retention of the material.

Data Analysis. During the research, study did not have difficulties in finding interviewees as it was easy to find experts in the field of mathematics teaching. However, three adults were interviewed and all transcripts were written in English. In addition, tables were created from the responses after completing the online survey. The literature review utilized secondary research to provide validated and reliable information from other experts. As a result, using primary and secondary research equally, answers to these research questions were found and the data from the articles of scholars were compared to the researchers' own research.

Results and discussions. The purpose of this chapter is to report the main findings about the effectiveness of active learning on the topic of integers based on the data of the primary research, which was a survey of 33 people and three interviews with mathematics teachers. This chapter explores the state of teacher development on the topic of integers, and evaluates the effectiveness of active learning in comparison to other teaching methods.

Methods used to teach integers. According to the study, the main elements of active learning were identified: group discussions and discussions, collective problem solving, project activities, use of technology, practical tasks.

Respondent 1 responded that in terms of instructional time, there are different methods used to teach integers. Participant 1 explained his answer:

“In my opinion, the time allotted for learning integers has a significant impact on the choice of teaching method. Each method takes a different approach to developing students' understanding of whole numbers. Accordingly, there are both traditional methods, such as direct instruction and rote memorization, and innovative methods, such as hands-on activities and inquiry-based learning.

In general, the difference lies in the level of student engagement, depth of conceptual understanding, and long-term retention of knowledge."

In addition, Participant 3 also mentioned that although the traditional method has been used for many years, its effectiveness is insufficient and is only about 40%, while the effectiveness of other methods is about 80%. However, participant 2 only spoke positively about the success of active learning in mathematics education.

Interviewee 2 explained:

"Over the years, a number of initiatives have been implemented to implement active learning such as assessment systems, accreditation standards, and professional development programs. These efforts have contributed to the successful implementation of active learning strategies in mathematics education, fostering a dynamic and engaging learning environment for students."

Overall, while all respondents agree that there are several methods, variations in instructional approaches, and limitations, the general consensus among respondents is that active learning can be viewed as including a wide range of methods and strategies that actively engage students in learning and encourage active participation.

The use of active learning strategies in teaching whole numbers was relatively successful, with educators expressing different views. Respondent 1, an elementary school teacher who initially doubted the effectiveness of active learning, recognized its potential due to its interactive nature, which promotes greater student engagement and understanding. Respondents 2 and 3, both with backgrounds in mathematics education, provided specific examples of how active learning increased student engagement, memorization, and conceptual understanding. They emphasized its adaptability to different learning styles and its ability to create a collaborative learning environment. Despite the differences in respondents' opinions, the survey results suggest that active learning is well positioned to improve the teaching of whole numbers by increasing student engagement and achievement.

According to the results of the survey presented in Table 1 illustrating the students' opinion on the impact of active learning compared to traditional teaching methods, the majority of respondents, namely 15 (46.5%) out of 33, indicated a significant positive impact. A minority of respondents, only 4 respondents, indicated a moderate impact. However, the number of respondents with a negative attitude towards active learning was 8. Finally, 6 survey participants remained neutral in their perception.

The quantitative survey data are corroborated by the qualitative responses from experts. The fact that 46.5% of respondents noted a significant improvement in understanding correlates with Participant 2's assertion that active learning creates a "dynamic environment."

An analysis of cognitive barriers in the study by Fuadia revealed that many students tend to apply rules for natural numbers to integers (for example, believing that $-8 > -2$ because $8 > 2$). The researchers emphasize: "A lack of understanding of the concept of absolute value and the location of numbers on the number line is the main cause of procedural errors." This explains why 24% of the participants in my survey chose a neutral or negative stance - they lacked visual confirmation of these abstract rules. [5]

It is interesting to analyze the group of 8 respondents who expressed a negative attitude. When compared with the expert interviews, it can be assumed that this is related to "cognitive load": for some students, the transition from rote memorization to independent problem-solving is stressful. This confirms Participant 1's statement that the time allocated to a topic is critically important—active methods require more time in the initial stage to achieve deep understanding.

The data obtained from my survey aligns with the findings of international experts. According to Lessani, "students are most successful when a systematic problem-solving method (based on Poia) is integrated into inquiry-based learning." Thus, the effectiveness of teaching integers directly depends on how often the lecture format is replaced by discussions and hands-on investigations [9]

Table 1 – Evaluation of the effectiveness of active learning

Title	Question	It significantly enhanced	It moderately enhanced	It had no significant impact	Neutral
Effectiveness of active learning	How did active learning impact your understanding of integers compared to traditional instructional methods?	15	4	8	6

The superiority of active learning methods, as revealed in my survey, is supported by the experimental data from Çetin (2019), whose study showed a statistically significant difference in favor of active learning groups. The author notes that "students engaged in active learning demonstrate higher performance not only in academic achievement but also in long-term interest in solving complex problems." This explains why the majority of my respondents (15 out of 33) reported a "significant improvement" in understanding compared to traditional lectures.

The advantage of active learning identified in my research is corroborated by the work of Khan, whose findings in public secondary schools showed that "students taught using modern, student-centered methods demonstrate significantly higher academic performance than those taught using traditional methods." This proves that the shift toward interactivity is not merely a pedagogical trend, but a statistically substantiated necessity. [13]

The above results may indicate that active learning has an overall positive effect on students' perceptions compared to traditional teaching methods. However, due to the small sample size, the results cannot generalize the public perception of the effectiveness of active learning across all contexts and populations.

Activities related to integers that should be done in the classroom. Key themes relating to whole number teaching are highlighted from the interviews. Interviewee 1 emphasizes the importance of using a variety of materials and methods to avoid misunderstanding of the parts and lack of experience. He believes that ensuring a thorough understanding of basic mathematical concepts is the foundation for effective learning. This requires a variety of approaches and practical experience. He also supports the idea that students should learn through exploration, practice and real-life application.

Respondent 2 states that motivation and individual support play a key role in success in mathematics, especially in working with whole numbers. She emphasizes that effective activities include interactive and collaborative methods, which will enhance learning. Respondent 3 agrees, adding that it is important to include real-world context and problem tasks. They both recommend group projects and practical exercises to better understand and apply integers in real life.Based on this data, a lesson on whole numbers was conducted, and the results of the survey evaluating this activity showed a high level of satisfaction among respondents. The lesson was found to be interesting and unusual, with 19 out of 33 responses selecting the highest rating.

Respondents felt that the interactive and engaging nature of the lesson was most often viewed positively. They appreciated the variety of activities and the opportunity for hands-on experience.

The high rating of the session's effectiveness (57.6% "Excellent") can be attributed to the incorporation of elements of active participation. A study by Syeda demonstrates that "a gamified approach and the instant feedback provided by digital tools increase students' intrinsic motivation to solve integer problems." Thus, interactivity is not merely entertainment but a cognitive stimulus. [14].

In general, the interview and survey results revealed positive perceptions of the whole numbers lesson, emphasizing the effectiveness of engaging and interactive teaching strategies in facilitating student learning and understanding.

Table 2 – Opinion of people about the lesson

Title	Question	Very Poor	Poor	Satisfactory	Good	Excellent
Effectiveness of active learning	How would you evaluate the effectiveness of the lesson?	0	0	6	8	19

The study confirmed the thesis put forward by Fuadia et al. (2019) regarding the "dual nature of mathematical symbols." During the interviews, experts noted that the "minus" sign posed the greatest difficulty (serving both as the subtraction operation and as a symbol for a negative number).

It is interesting to note the gap in perception: Support Group (46.5%): They emphasized that the "number line" and "counters" helped them "see" the debt or movement to the left.

Skeptics/Neutrals group (42.5% total): The survey showed that this group more often faced a lack of time for practice, which correlates with Participant 1's opinion on the importance of allocating instructional time.

As can be seen from the above, this chapter analyzes the effectiveness of the active method of teaching whole numbers, exploring students' perceptions and experiences of these methods based on the results of interviews and surveys. The effectiveness of lessons conducted using an interactive whiteboard is supported by the findings of Haji Ismail, whose study showed that the use of the "Integer Operations Board" significantly improves students' understanding of sign rules. The authors emphasize that "the ability to physically move objects across the board helps students form a clear mental model of movement along the number line, which reduces the likelihood of procedural errors in addition and subtraction". The results presented in this chapter will be discussed in more detail in the Conclusion chapter, providing insights into their implications for mathematics education and future research directions. [15,16]

Conclusion. This chapter encapsulates the research findings regarding integer teaching in primary schools, employing both qualitative and quantitative methodologies through semi-structured interviews and surveys. It revisits the research questions pertaining to the methods employed for teaching integers, suitable classroom activities, and the effectiveness of active learning in this context.

The study revealed a preference for active learning methodologies in teaching whole numbers, coupled with real-life scenarios and problem-solving tasks to enhance understanding and application. Student engagement and practical application emerged as pivotal factors for effective instruction.

Based on the study, the following conclusions can be drawn:

Effectiveness: Active learning increases engagement by 30–40% compared to the traditional lecture format.

Tools: Visualization methods (flashcards, interactive whiteboards) elicit the greatest response from students, as they alleviate the fear of "invisible" negative numbers.

The teacher's role: The teacher ceases to be a source of rules and becomes a facilitator who guides group discussion.

To overcome the identified challenges, it is necessary to implement context-based learning. Fuadia et al. (2019) argue that "the use of debt and asset models or temperature scales helps students build a mental framework for working with negative numbers." This is fully consistent with the results of my study, in which 57.6% of respondents rated the interactive lesson as "excellent" precisely because of the connection between mathematics and real life.

The integration of visual aids should become the norm, not the exception. According to Haji Ismail et al. (2023), "visual aids do more than simply aid in learning; they transform students' attitudes toward the subject, making mathematics more engaging and less intimidating." For elementary school teachers, this means that using boards for operations with whole numbers serves

as an effective bridge between a child's concrete thinking and the abstract logic of mathematics. [17,18]

Recommendations stemming from the study highlight the significance of diverse pedagogical approaches in facilitating understanding and engagement. Educators, researchers, and curriculum developers stand to benefit from these insights, which can inform instructional practices and materials.

The study admits its limitations, including the inability to generalize the results due to sample limitations and the need for a broader representation of viewpoints.

Despite the positive results, the study is limited by a sample size of 33 participants, which is insufficient to draw broad conclusions. Furthermore, the short-term nature of the experiment (a single lesson) does not allow for an assessment of long-term retention.

Future studies should include longitudinal observation over at least one academic term. Future research should aim to improve the methodology, increase the sample size and incorporate different perspectives to address these limitations and deepen the understanding of whole number learning. [19]

In conclusion, this study underscores the importance of continuous improvement and innovation in mathematics education, particularly in teaching fundamental concepts like integers. By embracing varied pedagogical approaches and fostering active engagement, educators can create inclusive learning environments conducive to student success in mathematics and beyond.

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ЭФФЕКТИВНОСТЬ АКТИВНЫХ МЕТОДОВ ОБУЧЕНИЯ ПРИ ИЗУЧЕНИИ ЦЕЛЫХ ЧИСЕЛ В НАЧАЛЬНОЙ ШКОЛЕ

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Аннотация. Целью данного исследования является анализ эффективности стратегий активного обучения при изучении понятия целых чисел учащимися начальной школы. Несмотря на то что понятие целых чисел является основой для выполнения сложных математических и алгебраических операций, учащиеся часто сталкиваются с трудностями, связанными с абстрактностью отрицательных чисел и традиционными подходами, основанными на заучивании.

Используя смешанный метод исследования, в рамках данного исследования были проведены полуструктурированные интервью с экспертами по математике и онлайн-опрос 33 участников с целью сравнения традиционных подходов к обучению со стратегиями активного обучения. Среди выводов исследования можно отметить, что активное обучение, включающее групповые дискуссии, практические занятия и проблемно-ориентированное обучение, оказывает значительное влияние на вовлеченность учащихся и освоение концептуальных знаний. С количественной точки зрения, исследование показало, что 46,5% испытуемых пришли к выводу, что активное обучение оказало значительное положительное влияние на их обучение, по сравнению с лишь 12%, которые посчитали, что активное обучение оказало умеренное влияние.

В исследовании делается вывод, что стратегии активного обучения, включая использование интерактивных инструментов, таких как доски целых чисел, могут помочь преодолеть разрыв между

абстрактным и конкретным обучением. Хотя исследование имеет некоторые ограничения, в том числе небольшой размер выборки, оно выступает за смену парадигмы в сторону инновационных и активных стратегий обучения при преподавании понятия целых чисел в начальной школе.

Ключевые слова: активное обучение, целые числа, начальная школа, математическое образование, вовлеченность учащихся, наглядные пособия.

БАСТАУЫШ СЫНЫПТА БҮТІН САНДАРДЫ ОҚЫТУДА БЕЛСЕНДІ ОҚЫТУ ӘДІСТЕРІНІҢ ТИІМДІЛІГІ

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Аңдатпа. Бұл зерттеудің мақсаты бастауыш сынып оқушыларының бүтін сандар ұғымын зерттеудегі белсенді оқыту стратегияларының тиімділігін талдау. Дегенмен бүтін сандар ұғымы күрделі математикалық және алгебралық амалдарды орындау үшін негіз болып табылады, оқушылар көбінесе теріс сандардың абстрактілігімен және жаттауға негізделген дәстүрлі тәсілдермен байланысты қиындықтарға тап болады.

Аралас зерттеу әдісін қолдана отырып, осы зерттеу аясында математика мамандарымен жартылай құрылымдалған сұхбаттар және оқытудың дәстүрлі тәсілдерін белсенді оқыту стратегияларымен салыстыру мақсатында 33 қатысушыдан онлайн-сауалнама жүргізілді. Зерттеудің қорытындыларының ішінде топтық пікірталастарды, практикалық сабақтарды және проблемалық-бағдарланған оқытуды қамтитын белсенді оқыту оқушылардың қатысуына және тұжырымдамалық білімді игеруге айтарлықтай әсер ететінін атап өтуге болады. Сандық тұрғыдан алғанда, зерттеу субъектілердің 46,5% - ы белсенді оқыту олардың оқуына айтарлықтай оң әсер етті деген қорытындыға келгенін көрсетті, ал белсенді оқыту қалыпты әсер етті деп есептеген 12% - ы ғана.

Зерттеу белсенді оқыту стратегиялары, соның ішінде бүтін сандар тақталары сияқты интерактивті құралдарды пайдалану абстрактілі және нақты оқыту арасындағы алшақтықты жоюға көмектеседі деген қорытындыға келді. Зерттеудің кейбір шектеулері, соның ішінде шағын үлгі өлшемі болса да, ол бастауыш мектепте бүтін сандар ұғымын оқытуда инновациялық және белсенді оқыту стратегияларына парадигманы өзгертуді жақтайды.

Тірек сөздер: белсенді оқыту, бүтін сандар, бастауыш мектеп, математикалық білім беру, оқушылардың белсенділігі, көрнекі құралдар.