

Innovative Strategies for Teaching Integers: A Systematic Literature Review

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ABSTRACT

The instruction of integer has been one of the difficult mathematics education topics because of the current misconceptions and teaching gaps. This is a systematic literature review of research trends, pedagogical strategies, impact, limitations, and future directions of teaching integer operations that includes studies published after 2015. Twenty-one peer-reviewed articles were analysed with the help of the PRISMA model, and the usage of various innovative approaches, such as manipulative-based, contextual, model-based, technology-enhanced, and student-centred, was identified. These results prove that the number lines, manipulatives, and virtual tools are effective strategies to promote the conceptual learning and interest among students. Real life analogies and cultural elements provided contextual approaches that helped learners make learning relatable and the use of embodied learning and problem-posing activities enabled flexibility in reasoning. But problems like excessive use of tools, low sample sizes, little attention to multiplication and division, and teacher knowledge gaps were detected. Also, the ability to get students out of concrete thinking to abstract thinking is a critical challenge. This review highlights that there is a need to fill these gaps in future research that covers wider populations, longitudinal research, and teacher professional development. These points are consistent with the priorities of global education reform, which provides practical advice to educators, curriculum developers and policymakers on how to enhance the teaching of integers and help students develop mathematically.

Contribution/Originality: This study contributes to the existing literature by offering a comprehensive synthesis of recent innovations in teaching integer operations. The paper's primary contribution lies in identifying how manipulative-based, contextual, and technology-enhanced strategies foster deeper conceptual understanding. It is among the few systematic reviews exploring pedagogical trends from 2015 to 2025.

1. Introduction

The instruction of integer numbers such as positive and negative numbers, is a longstanding challenge in the mathematics classrooms. Learning of integers is significant as it sets the students up to higher levels of study like algebra, number theory and applied mathematics. According to [Lin \(2022\)](#), many of them continue to struggle, frequently with the application of the whole number rules to signed numbers, or mistaken interpretation of direction. These challenges are found in various contexts, and it proves that the subject is conceptually challenging and not simple to learn.

The issue is also carried over to the individuals who are on the verge of becoming educators. According to the study conducted by [Rosyidah et al. \(2021\)](#), over fifty percent of pre-service elementary teachers committed mistakes when performing simple arithmetic operations that used Integers like the process of subtracting the negative numbers. This observation shows the extent to which these misconceptions are entrenched, and this raises the question of the impact that they are likely to have on future teaching practices.

Within the past years, teachers have been trying out novel methods of teaching integers. The Integer Operations Board was introduced by [Annisa \(2024\)](#), and it was created with the help of Thiagarajan 4D model. The instrument involved a metaphor of debt and asset and enabled the primary school students to exhibit improved pre and post-tests. The other new technique was the implementation of a floor number line, in which students literally walked through integer operations. This practical approach helped learners to be active and at least develop a better picture of addition and subtraction involving negative numbers. The use of technology has also become an important portion of the solution. Online learning resources are digital manipulatives, the online counterparts of physical teaching aids, and they provide students with an opportunity to interactively and flexibly explore mathematical concepts. Year 9 students in Brunei had better achievement and confidence according to findings by [Ismail et al. \(2023\)](#), who made an improvement in learning integers using a Gizmos-based digital lesson. These kinds of environments also enabled students to visualise their reasoning and deal with dynamic representations that facilitated a better understanding of concepts.

The available results of these studies indicate that hands-on and technology-based approaches may aid students in getting rid of the widespread mistakes in carrying out integer operations. Nevertheless, studies on this topic are still disjointed. Various studies target various purposes, e.g. procedural accuracy, conceptual understanding, or attitudes of the learner, so it is hard to create a satisfactory picture.

Past reviews in mathematics education have largely referred to larger subjects like number sense, rational numbers or algebraic readiness. In these works, integers tended to be a minor side subject. So far no specific systematic review has been done in respect of the teaching of integers. This gap is particularly remarkable considering the quick development of digital technologies, learning based on games, and inquiry-based approaches over the last ten years, particularly in the COVID-19 era when most of classes were transitioned to blended and internet-based courses.

These reasons are why a systematic review of the latest innovations in the field of teaching integer is necessary and timely. This is in line with the contemporary global priorities in education that emphasize reasoning, representation, and digital literacy. It

also provides a helpful advice on how teachers, curriculum developers and policymakers can find a more effective approach to helping students master this mathematical concept that must be taught to them.

1.1. Objectives

- i. To analyse research trends on innovative strategies for teaching integer, focusing on studies conducted between 2015 and 2025.
- ii. To identify the scope of research related to pedagogical strategies for teaching integer operations.
- iii. To identify the impact, limitations, and potential directions for future research in the teaching of integer operations.

2. Methodology

This study developed a systematic literature review (SLR) to address not only the recent trends in pedagogical strategies on how integer can be taught, but also on potential future research directions.

The review process started by formulating articulate research questions, which were used as the basis of identifying, selecting, and analysing pertinent studies. This was led by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework that gives a systematic route to follow four steps: identification, screening, eligibility, and inclusion as illustrated in [Figure 1](#). This study adopted the PRISMA model as an analytical framework, as it provides a structured and systematic approach for evaluating research quality and analysing relevant records and articles in sequential stages ([Ng & Rosli, 2023](#)).

The primary source of data was two major databases Scopus and Web of Science (WoS). To retrieve articles that satisfied the research aims of the review, a combination of keywords such as “integer,” “pedagogical strategies,” and “teaching integers” was employed to capture studies relevant to the review objectives. To embrace the current views, the year limit was set to between January 2015 and June 2025. The detailed search strings used for each database are presented in [Table 1](#), which outlines the specific keywords and parameters applied during the systematic review process. Peer-reviewed journal articles only were used to be able to be of academic quality. Duplicated records were eliminated during the screening process and further requirements like level of education and scope of study were incorporated. Title, abstracts and full texts were previewed at the eligibility level to ascertain suitability. Lastly, the ones that met all the criterion were incorporated in the comprehensive analysis.

Two major databases, Scopus and Web of Science (WoS), were used as the primary sources of data. A combination of keywords such as “integer”, “pedagogical strategies,” and “teaching integers” was employed to capture studies relevant to the review objectives. The search strategy was carefully designed to maximise coverage while maintaining focus on the core topic.

To capture the modern point of view, the publication year was restricted between January 2015 and June 2025. Peer-reviewed journal articles were only incorporated to make sure it was of academic quality. During the screening stage, duplicate records were eliminated, and other criteria were used like education level and scope of study.

Abstracts, full texts and titles were reviewed at the eligibility stage to identify suitability. Lastly, only those studies that met the criteria were put under the detailed analysis.

Figure 1: PRISMA Model

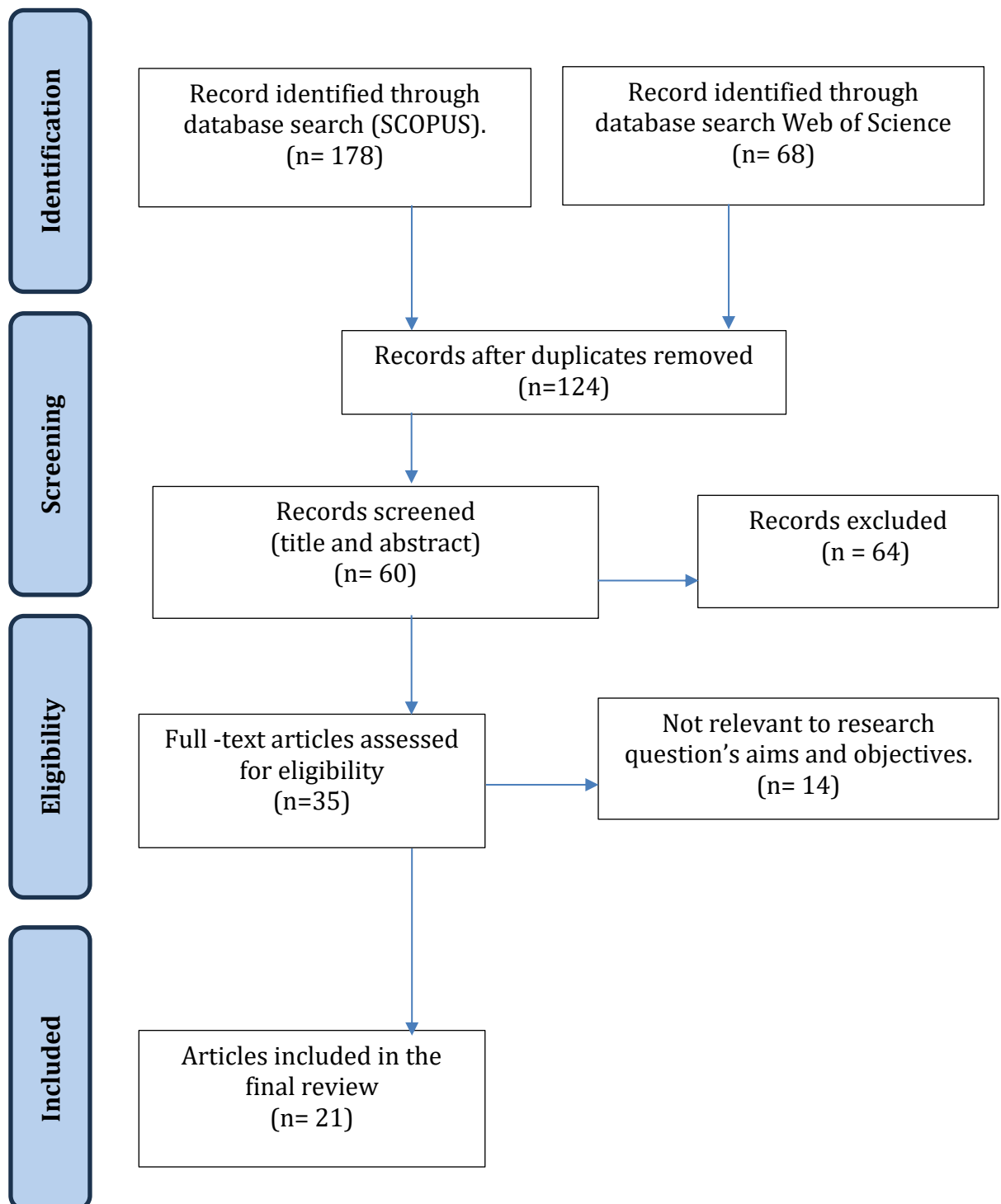


Table 1: Search string for systematic literature review

Data base	Key Word
Scopus	TITLE-ABS-KEY("integer*" OR "whole number*" OR "negative number*" OR "signed number*") AND ("integer arithmetic operations,") AND ("teaching integers " OR "instruction*" OR " pedagogical strategies *" OR "didactic*" OR "classroom practice*" OR "learning strategy*") AND PUBYEAR > 2015
World of Science	TS=(" teaching integers *" OR "whole number*" OR "signed number*") AND ("teaching method*" OR "instructional strategy*" OR "pedagogical approach*" OR "teaching practice*") AND ("school*" OR "secondary education" OR "classroom") AND PY=(2015-2025)

The data analysis technique employed in this study is based on the Interactive Model of Miles & Huberman (Suciati, 2022), which involves: (1) data collection, (2) organization of the data according to the established criteria and themes, (3) presentation of data using tables and graphical representations, and (4) comprehensive analysis of findings leading to informed conclusions. By following this systematic process, the review ensures a comprehensive and credible synthesis of current evidence on effective strategies for teaching integer.

3. Results

A total of 246 articles matching the keywords of this study were found. Nevertheless, among the articles that underwent the screening process, only 21 articles were found to meet the criteria of the study and were thus included in the analysis of this study. In answering the first research question, descriptive analysis approach was applied to analyse these articles. In this analysis, the year the studies were published, country, sample, education level and research method were analysed as presented in Table 2. The articles were next analysed according to the pedagogical approaches and scope of study in order to respond to the second research question.

Table 2: Thematics analysis based on reviewed article

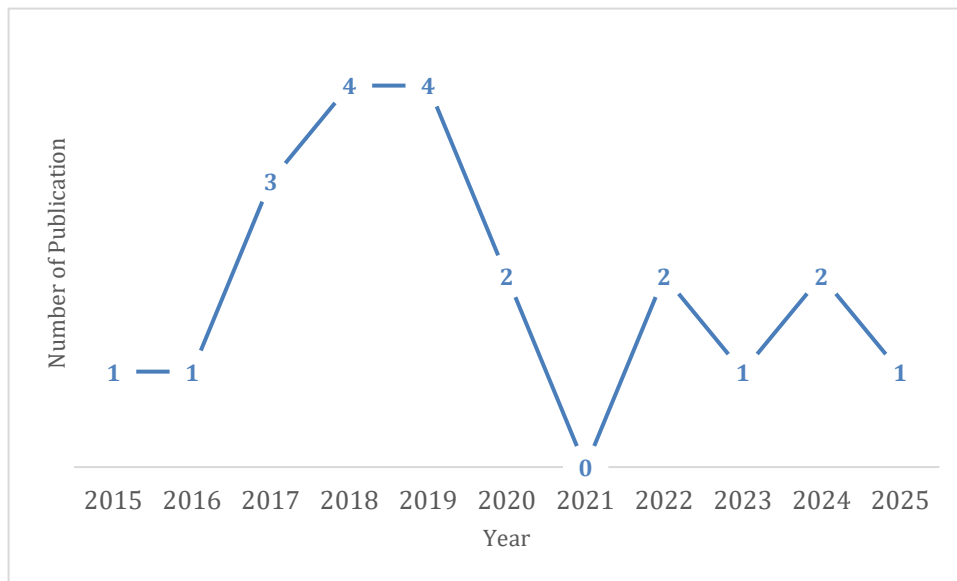
Article No.	Sources	Country	Sample Types	Education Level	Research Approach
1	Bofferding & Kloser (2015)	United States	Student	Upper Secondary	Mixed Methods
2	Makonye & Fakude (2016)	South Africa	Non-empirical	Lower Secondary	Qualitative
3	Bofferding & Wessman-Enzinger (2017)	United States	Non-empirical	Upper Primary	Qualitative
4	Fuadiah et al. (2017)	Indonesia	Student	Upper Primary	Qualitative
5	Whitacre et al. (2017)	United States	Student	Lower Primary, Lower	Qualitative

				Secondary, Upper Secondary Upper Primary,	Mixed methods
6	Verzosa et al. (2018)	Philippines	Student	Primary,	Mixed methods
7	Fuadiah et al. (2018)	Indonesia	Student	Lower Secondary	Qualitative
8	Ozdemir & Shal (2018)	Turkey	Student	Lower Secondary	Mixed methods
9	Sahat et al. (2018)	Brunei Darussalam	Student	Lower secondary	Quantitative
10	Fouryza et al. (2019)	Indonesia	Non- empirical	Upper Primary	Other
11	Cetin (2019)	Turkey	Non- empirical	Upper Primary	Quantitative
12	Wessman-Enzinger (2019)	United states	Student	Upper Secondary	Qualitative
13	Faudiah et al. (2019)	Indonesia	Student, Teacher	Lower Secondary	Qualitative
14	Muslimin et al. (2020)	Indonesia	Non- empirical	Lower Secondary	Qualitative
15	Sari et al. (2020)	Indonesia	Student	Upper Primary	Qualitative
16	Nur et al. (2022)	Indonesia	Student	Upper secondary	Qualitative
17	Nurnberger-Haag (2022)	United States	Student	Lower Primary	Quantitative
18	Lamb et al. (2023)	United States	Student	Lower Primary, Lower Secondary, Upper Secondary	Mixed Methods
19	Vallejo-Vargas & Reid (2024)	Germany	Student	Upper Primary	Qualitative
20	Canogullari & Isiksal-Bostan (2024)	Turkey	Teacher	Lower Secondary,	Qualitative
21	Anton & Abrahamson (2025)	United States	Student	Lower Secondary	Qualitative

3.1. Year Of Publication

Figure 2 shows the distribution of those published articles on innovative strategies of teaching integers in the recent years (2015-2025). The general pattern indicates that there is a changing trend of the academic output. The greatest density of publications was in 2018 and 2019, with four publications in each of the years, as there was increased academic interest at the time. Conversely, 2021 had the lowest number of studies registered, which was the lowest in the dataset. This was the case in 2015, 2016, 2023, and 2025 with just a single study being published in those years. In the meantime, in 2020, 2022 and 2024 there was moderate publication activity, with two studies being reported in each of these years.

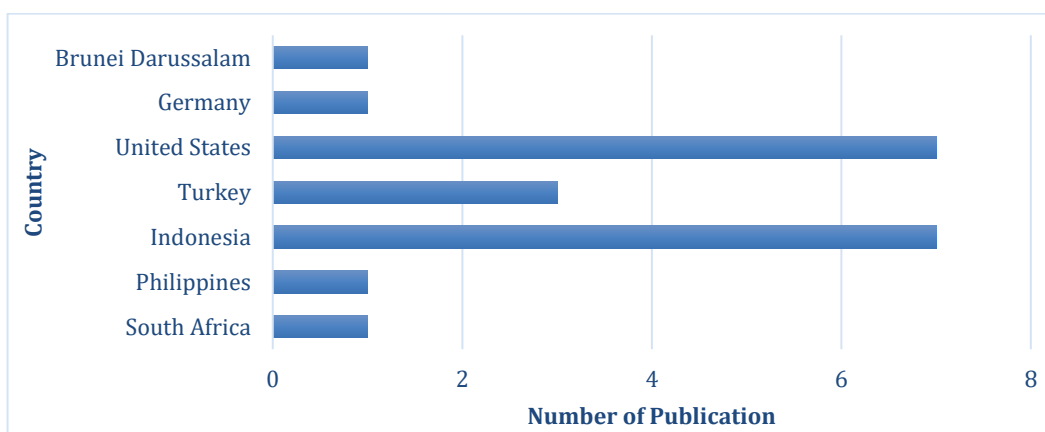
Figure 2: Year of Publication



3.2. Country of Publication

The distribution of the publications in seven countries participating in the study of the innovative strategies of teaching integers is shown in the Figure 3.

Figure 3: Country of Publication

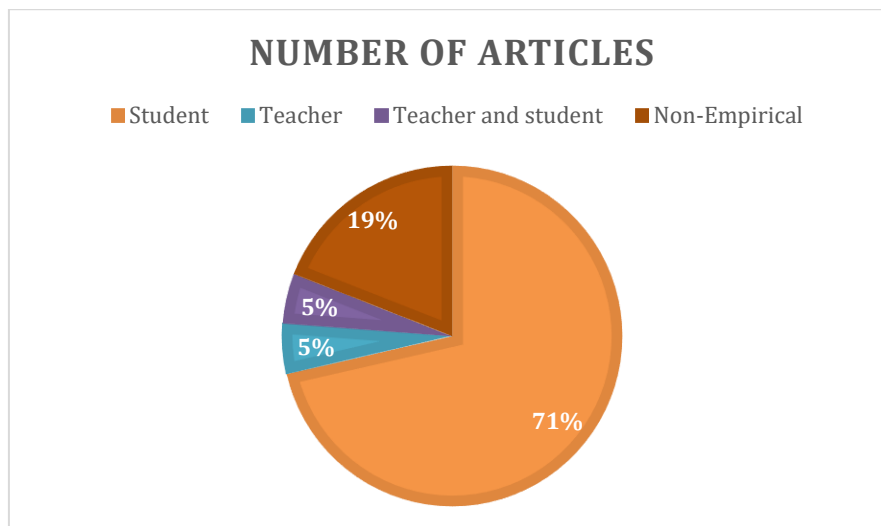


The United States and Indonesia were the most prolific in terms of the number of publications, seven publications each. This was then followed by Turkey with three studies. The rest of the countries made lesser contributions as there was only one publication each.

3.3. Samples Types

Figure 4 shows that out of 21 articles analysed, the types of samples used in the study could be divided into three categories: students, teachers, and non-empirical. The results of this research show that there is a tendency to study more of the student samples with 15 studies with student samples, one study with teacher samples, one study with teacher and student samples and 4 studies with non-empirical data. This implies that the target population of most of the researches featured in this review revolves around students. This is because most of the studies mainly concentrate on the effect of innovative methods of teaching integers to students in the aspects of learning and performance.

Figure 4: Type of Sample

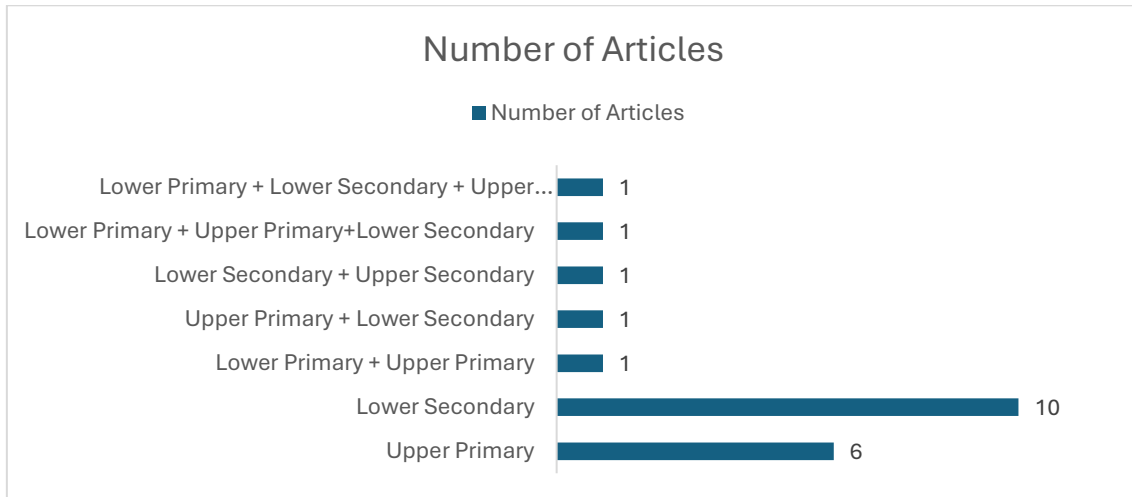


3.4. Education Level

Figure 5 shows the distribution of education levels among the reviewed studies, which shows specific patterns in the focus of research. Majority of the studies concentrated on single level groups with ten studies considering the lower secondary level, which is the most studied level, followed by six studies at the upper primary level.

The percentage of studies with mixed-level samples was smaller. In general, the results indicate that the literature has focused mainly on lower secondary and upper primary students, with relatively few studies focusing on upper secondary students and educators.

Figure 5: Distribution of Education Level



3.5. Scope of Study

Table 3 gives an overview of the researches on integer operations as written in a chronological order by the number of the article, year and area of focus, to illustrate how the area of study has advanced since 2015 to 2025. The papers regularly present their attempts to eliminate the misconceptions and negative number difficulties of students (Bofferding & Kloser, 2015; Fuadiah et al., 2017; Sari et al., 2020) and discuss the relationship between whole number reasoning and integer operations (Bofferding & Wessman-Enfinger, 2017; Nurnberger-Haag et al., 2022). The effectiveness of teaching strategies and models, including the opposite model (Fuadiah et al., 2018) and the neutralization model (Cetin, 2019), as well as the use of technology, including mobile apps (Verzosa et al., 2018) and virtual manipulatives (Vallejo-Vargas & Reid, 2024), are studied by many studies. The focus on the development of reasoning and argumentation in the students is also high (Whitacre et al., 2017; Lamb et al., 2023; Anton and Abrahamson, 2025). The present research also uses the different methodologies such as traditional games (Muslimin et al., 2020), didactical designs (Ozdemir & Sahal, 2018), and assessment tools (Nur et al., 2022), which proves the variety of approaches in this context. Nevertheless, gaps still exist, especially when it comes to the investigation of the behavior of integer division (Canogullari & Isiksal-Bostan, 2024) and the long-term effect of the approach to teaching and technology-based interventions. These limitations provide a possibility of future research. In general, the analysis reveals the increasing attention to the enhancement of the student learning and comprehension of integers.

Table 3: Scope of study based on reviewed article

Article No.	Sources	Scope of Study
1	Bofferding & Kloser (2015)	Errors and misconceptions in learning directed numbers
2	Makonye & Fakude (2016)	Impact of usage of models and real-life contexts
3	Bofferding & Wessman-Enfinger	Connections between whole number reasoning and integer subtraction

	(2017)	
4	Fuadiah et al. (2017)	Difficulties in understanding negative numbers
5	Whitacre et al. (2017)	Integer comparisons across grades and reasoning strategies
6	Verzosa et al. (2018)	Impact of mobile app usage on integer operations
7	Fuadiah et al. (2018)	Effectiveness of the opposite model for teaching integers
8	Ozdemir & Shal (2018)	Institutionalization of integer operations through didactical design
9	Sahat et al. (2018)	Impact on students' academic achievement and attitudes
10	Fouryza et al. (2019)	Developmental progression in learner-generated drawings for integer operations
11	Cetin (2019)	Effectiveness of the Neutralization on an Empty Number Line model
12	Wessman-Enzinger (2019)	Impact of manipulatives on integer operations performance
13	Faudiah et al. (2019)	Impact of teaching strategies on student misunderstandings of negative integers
14	Muslimin et al. (2020)	Learning trajectories for solving integer word problems using traditional games
15	Sari et al. (2020)	Impact of classroom teaching activities on student misunderstandings
16	Nur et al. (2022)	Validation of assessment tools for integer arithmetic
17	Nurnberger-Haag (2022)	Connections between whole number reasoning and integer subtraction concepts
18	Lamb et al. (2023)	Flexibility in reasoning about integer addition and subtraction
19	Vallejo-Vargas & Reid (2024)	Impact of virtual manipulatives on argumentation about integers
20	Canogullari & Isiksal-Bostan (2024)	Teachers' knowledge and use of models for integer division
21	Anton & Abrahamson (2025)	Students' reasoning and justifications for integer comparisons across grades

3.6. Pedagogical Strategy

Table 4 reveals that one of the most applied strategies in the pedagogy of teaching integer is the number line that was used in eight out of the reviewed studies. It was applied in many ways, e.g. physical number lines, virtual number lines and embodied learning techniques, to enable students to visualise and learn about integer relationships. As an example, it was applied in models such as the Neutralization on an

Empty Number Line (NNL) model, body-scale number lines (BNL) and desk-scale number lines (SNL). These applications were meant to make abstract ideas such as negative numbers and subtraction easy. In the other studies though, using number lines was substituted by other types of strategies namely manipulatives (counter), contextual learning (real-life analogy) and technology-based tools (mobile apps). This emphasizes the flexibility of the number line as a pedagogical resource and demonstrates the variety of ways of addressing the challenges of teaching integers.

Table 4: Categorization of Pedagogical Strategies for Teaching Integer Operations

Category	Pedagogical Strategies	Article No.
Manipulative-Based Strategies	Coloured counters, jars, candies; Integer Tiles Theory with virtual manipulatives; Neutralization on an Empty Number Line	7,9,11.
Contextual and Real-Life Approaches	Real-life contexts (e.g., loans, diving, thermometers); Islamic value-based contexts; Traditional games (e.g., marbles, rubber bands)	4,13,14,16
Model-Based Strategies	Number line models; Opposite model for subtraction	3,11,15,20
Technology-Enhanced Strategies	Mobile apps (e.g., AlgeOps); Virtual manipulatives	6, 19
Embodied Cognition Strategies	Body-scale number line (BNL); Desk-scale number line (SNL)	7, 21
Problem Posing and Student-Centred Approaches	Problem posing activities; Learner-generated drawings	8,13
Assessment and Validation Strategies	Integer Test of Primary Operations (ITPO)	17
Didactical Design Research (DDR)	Identifying learning obstacles and designing interventions	4, 7, 13
Flexibility and Reasoning Development	Encouraging multiple Ways of Reasoning (WoRs)	3,4,18

4. Discussion

4.1. Impact of Studies on Integer Learning and Teaching

The effect of the studies on the area of the learning and teaching of integers. The studies as a whole are pointing at high progress in learning about how students learn about integers and how they can be instructed to improve the process in accordance with the constructivist principles of the teaching and learning processes. Concrete models (number lines, manipulatives, interactive applications) described in a number of studies (Bofferding et al., 2017; Verzosa et al., 2018; Ozdemir & Sahal, 2018; Fouryza et al., 2019) are a compromise between abstract mathematical ideas and real life. This practice is close to the constructivist focus on learners actively building knowledge through interaction with the environment and relating new concepts to knowledge gained previously, thus, promoting deeper understanding and interest.

In addition, considering cultural and contextual factors in the process of learning integer, as emphasized by Muslimin et al. (2020) and Nur et al. (2022) is a reflection of the philosophy of constructivism, where the learner takes centre stage, and his or her viewpoints, cultural backgrounds, and experiences are considered. Incorporating

traditional games and culturally valuable problem-posing exercises will help the students to participate in meaningful learning processes that develop creativity, collaboration, and positive attitude as Dewey suggested education to be based on real-life activities and social interaction.

The focus on considering misconceptions, including the problems with the minus sign and the generalization of whole number logical reasoning, is also consistent with constructivist views of active knowledge building and meaning making. Earlier research demonstrated that learners have a tendency to use whole number logic when operating with integers, which might result in long-term errors and conceptual misconceptions (Bofferding & Wessman-Enzinger, 2017; Makonye & Fakude, 2016; Rosyidah et al., 2021). In order to resolve such challenges, it is important to involve instructional practices that foster reflection, enhancement of mental models, and the formation of flexible thinking. In this way, the students are able to develop more advanced perspectives of integer operations by having a guided approach to problem-solving and critical thinking (Lamb et al., 2023).

Different instructional practices have been used in the constructivist learning settings to promote meaningful learning integers. Abstract concepts have been made more tangible and reachable with the help of manipulatives (Annisa, 2024; Sahat et al., 2018). Mobile applications or virtual manipulatives are also technology-based strategies that have proven to be more engaging and help understand the concept better (Verzosa et al., 2018; Ismail et al., 2023). Moreover, embodied learning could include walking through a number line body-sized or neutralizing an empty number line, which encourages exploration and visualization of the idea of integers (Anton & Abrahamson, 2025; Sari et al., 2020). The strategies are reflective of a constructivist orientation whereby teachers are facilitators of knowledge instead of information carriers (Muslimin et al., 2020; Nur et al., 2022). Such practical and meaningful experiences can also put students in a better position to build, experiment, and practice their mathematical reasoning, therefore, gaining greater conceptual mastery (Canogullari & Isiksal-Bostan, 2024; Fuadiah et al., 2017).

Finally, the constructivist principle that knowledge and its assessment require being placed in real and pertinent contexts which is indicative of the experiences of learners is validated by using assessment tools that can be customized to specific contexts as proposed by Nur et al. (2022). The practice not only guarantees meaningful learning, but also equitable evaluation depending on the developmental level of the learners and their culture.

Overall, these articles all highlight the significance of a student-centered, culturally responsive and interactive method to instruction in integers, which is aligned with constructivist theory. Successful teaching means helping students to construct their knowledge actively by using real-life problems solving, contextual cultural situations, and adaptable reasoning style to develop further knowledge and positive attitude towards mathematics.

4.2. Gaps and Limitations of Current Approaches

Although there has been a significant improvement, there are a few critical gaps and issues to the teaching and learning of integers. A frequent weakness is that in numerous cases, studies have been carried out with a relatively small or local sample, as in the

study by [Makonye and Fakude \(2016\)](#), [Fuadiah et al. \(2017\)](#) and [Fuadiah et al. \(2018\)](#). Although these studies are insightful, the scope of their studies is also limited making it difficult to generalize the findings to various educational environments with varying socio-cultural considerations.

The other weakness is the area of content covered. A lot of the available literature is too centered on addition and subtraction of integers ([Fuadiah et al., 2017](#); [Ozdemir & Sahal, 2018](#); [Fuadiah et al., 2019](#)), whereas comparatively little information is available on multiplication and division by negative numbers. Such an imbalance is a problem, because of multiplication and division, different conceptual problems are significant on the way to the full perception of integers. Failure to cover these areas results in both research and practice having serious blind spots.

There are also the possible dangers of overdependence on manipulatives and concrete instructional tools, which the literature is also talking about. According to studies by [Fuadiah et al. \(2018\)](#), [Sari et al. \(2020\)](#) and [Nur et al. \(2022\)](#), although these tools have the potential to simplify abstract concepts, overuse or over time can result in students being unable to make the transition to more abstract thinking. This implies that there should be instructional designs to bring the students up slowly but surely out of tangible models to abstract generalization.

The situation is only worsened by issues relating to teachers. It has been revealed that most educators may have difficulties using the operation involving division with negative numbers or modeling real life situations accurately reflecting such concepts ([Fuadiah et al., 2019](#); [Vallejo-Vargas & Reid, 2024](#)). These loopholes indicate the need to have a more general need to offer such professional development opportunities that enhance teacher pedagogical content knowledge in the teaching of complex operations with integers.

On the student side, problems continue to exist in subtraction using negative numbers and with the use of representational aids like number lines. Researchers can explain these predicaments by a restrictive focus on procedural learning at the cost of conceptual knowledge ([Ozdemir & Sahal, 2018](#); [Sari et al., 2020](#); [Anton & Abrahamson, 2025](#)). Misconceptions could be held when the students are taught methods focused mainly on the rote technique and therefore fail to apply the concept of integers in flexible ways in various situations.

Even with a good attitude, teacher-centered methods may occasionally support the misconceptions. As an example, explicit analogy like borrowing in finance or thermometer scale, sometimes causes more confusion than clarity to use with negative numbers ([Fuadiah et al., 2019](#)). This implies that analogies should be formulated thoughtfully and should be applied in a manner that supports and not distorts mathematical meaning.

To their credit, there have been some teaching advancements that have been promising. As an example, the Neutralization on an Empty Number Line (NNL) model investigated by [Sari et al. \(2020\)](#) has been shown to be helpful in facilitating the conceptual learning of students. The findings of such studies make it important to continue to discuss and improve the teaching tools that are balanced in terms of clarity, accessibility, and transferability.

Lastly, there is still a limitation of small sample sizes in most research, such as the ones by [Fuadiah et al. \(2018\)](#), [Wessman-Enzinger \(2019\)](#), and [Canogullari and Isiksal-Bostan \(2024\)](#). In the future, bigger and more varied samples, and longitudinal research designs will be needed to produce results that are more solid and can be applied globally.

In brief, although there is a lot of improvement that has been achieved in the areas of how students learn the integers and how they can be taught effectively, there are still gaps that persist. Meeting the neglected operations, enhancing teacher preparation and conceptually oriented instructions are important next steps in advancing research and practice in this significant area of mathematics education.

4.3. Future Research Directions

The current review has revealed that there are some major gaps in integer pedagogy that need to be addressed. In order to enhance the applicability of the results to other educational settings, research with bigger and more heterogeneous samples is required ([Makonye & Fakude, 2016](#); [Fuadiah et al., 2017](#); [Fuadiah et al., 2018](#)). It is still under-researched, even though the conceptual complexity and significance of multiplication and division with integers, especially the application of negative numbers are significant and difficult to comprehend ([Fuadiah et al., 2017](#); [Ozdemir & Sahal, 2018](#); [Vallejo-Vargas & Reid, 2024](#)).

The longitudinal research designs will be required to give information on the retention and long-term effect of instructional interventions ([Nur et al., 2022](#); [Canogullari & Isiksal-Bostan, 2024](#)). The restrictions of traditional procedural methods should be addressed by creating innovative instructional techniques that involve virtual manipulatives, embodied learning, and virtual reality and empirically validate them ([Cetin, 2019](#); [Canogullari & Isiksal-Bostan, 2024](#); [Anton & Abrahamson, 2025](#)).

The professional development of teachers is necessary to enhance the ability of teachers to master more difficult integer operations such as division and contextual modelling ([Vallejo-Vargas & Reid, 2024](#)). A more balanced and culturally and linguistically appropriate teaching plan can be achieved through research taking into account cultural and linguistic aspects of instructional frameworks ([Makonye & Fakude, 2016](#); [Muslimin et al., 2020](#)). The relationship between integer knowledge and performance in STEM subjects is also one of the key areas of interdisciplinary curriculum development ([Nurnberger-Haag et al., 2022](#)). Learner agency and the use of flexible reasoning strategies can facilitate mathematical reasoning and help learners to develop favorable mathematical identities in student-centered environments ([Fuadiah et al., 2019](#); [Lamb et al., 2023](#)).

5. Conclusion

This review shows that the investigation of integer pedagogy needs to be extended and diversified in the context of sample groups, object of study, and methodology. The gaps need to be filled using longitudinal studies, technology-based instruction techniques, teacher professional growth and culturally responsive frameworks. Such actions will help to build stronger evidence-based practices and contribute more to supporting mathematical achievement of learners in any educational setting.

Ethics Approval and Consent to Participate

As this research is based on secondary data and document analysis, no ethical approval or consent to participate was required.

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Conflict of Interests

The authors indicate that they do not have any conflict of interests in terms of this study, or the publication.

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