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Computer-Supported Collaborative Learning in Minimising Integer Operation Errors

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***Abstract*— The study investigated the impact of Computer-Supported Collaborative Learning (CSCL) on reducing integer operation errors among junior high school students. It involved 44 Grade 7 students from Sara National High School, divided into experimental and control groups. The results showed that CSCL significantly improved performance, while the control group showed only slight gains. Post-test comparisons confirmed the effectiveness of CSCL in reducing errors, with the experimental group showing a higher improvement. CSCL also enhanced students' engagement, motivation, and confidence in mathematics, fostering collaboration and conceptual understanding. The interactive learning environment reduced math anxiety, highlighting CSCL's role in improving computational accuracy and creating a more engaging and supportive learning experience.**

***Index Terms:* Computer-Supported Collaborative Learning (CSCL), Integer Operations, Mathematics Performance, Learning Experiences.**

I. INTRODUCTION

Computer-Supported Collaborative Learning (CSCL) has emerged as a promising educational strategy, particularly effective in addressing learning challenges in mathematics. Research has shown that CSCL positively impacts student engagement, attitudes, and academic performance by integrating technology with structured peer collaboration (Chen & Liu, 2019). Collaboration scripts and mobile technologies enable flexible, interactive learning environments that foster meaningful communication and teamwork (Dillenbourg et al., 1996; Lin, 2017).

In mathematics education, CSCL has been found to improve conceptual understanding and problem-solving skills, particularly when supported by synchronous digital tools (Bringula & Atienza, 2023). However, issues of device unfamiliarity and usability concerns may hinder its implementation. Despite these challenges, CSCL approaches, using platforms like GeoGebra, have successfully improved performance in complex mathematical topics and developed students' logical thinking (Birgin & Acar, 2020; Ramirez & Monterola, 2022).

While CSCL's benefits are recognised and well-documented, there is limited research on its effectiveness in specific circumstances at Sara National High School. Students in this area continue to struggle with integer operations, a fundamental yet often misunderstood component of mathematics. This study aimed to fill that gap by investigating how CSCL, facilitated through social media, can minimise errors in integer operations among Grade 7 students in Sara. The goal is to improve their mathematical proficiency and contribute valuable insights to educational practice and policy.

II. LITERATURE REVIEW

A. Computer-Supported Collaborative Learning in Mathematics

Computer-Supported Collaborative Learning (CSCL) is a transformative approach in education, especially in mathematics, as it integrates Information and Communication Technology (ICT) to foster collaborative and interactive learning. By utilising digital platforms like emails, blogs, and social networking sites, CSCL encourages peer interaction, idea-sharing, and co-creation of knowledge. This collaboration promotes exploratory talk and structured problem-solving, which enhances students' cognitive development and understanding (Merculio, 2023).

Research shows that CSCL significantly improves academic performance, especially in STEM subjects (Wang & Shen, 2023). Tools like GeoGebra have effectively enhanced students' understanding of complex topics like exponential and logarithmic functions (Birgin & Acar). Studies such as those by Jeong et al. (2019) and Talan (2021) found that students in CSCL environments showed greater interest and better post-test scores. CSCL also fosters self-directed learning, where students actively seek support from peers and educators, further promoting a collaborative learning culture.

However, CSCL also faces challenges, such as distractions, technical difficulties, and unequal participation, which can hinder engagement if not correctly managed (Noroozi & Hatami, 2018). Structured activities, clear expectations, and teacher guidance are essential for effective implementation. Overall, CSCL represents a significant shift in mathematics education, creating dynamic, student-centred environments that cater to the needs of 21st-century learners and support both academic achievement and personal growth

(Jeong et al., 2014).

B. Errors in Integers of Students

Mathematics involves cognitive skills like number sense, symbol decoding, and logical reasoning. Learning difficulties in math can arise from neurological or environmental factors and often begin in early education, affecting long-term success (Clisens et al., 2009; Lubinski et al., 2014). Students with math disabilities struggle with fundamental concepts like grouping, place value, memory, and problem-solving (Soares et al., 2018; Jamaris, 2014). Errors in integer operations are common, often due to weak foundational knowledge, rule confusion, and lack of conceptual understanding (Khalid & Embong, 2019). This error includes mistakes with signs, misapplication of rules, and careless errors (Aygün, 2021; Altiparmak & Özdoğan, 2010).

Technology tools like Quizizz can enhance student engagement and help those with learning difficulties (Morata, 2024). However, negative attitudes and low self-efficacy still hinder performance (Akyuz, 2014). Integer operations, particularly with negative numbers, are especially challenging, leading to errors in both conceptual understanding and procedures (Chen & Liu, 2019; Ramirez & Monterola, 2022). Tools like the Integer Test of Primary Operations (ITPO) help assess student understanding and identify problem areas, such as division by -1 (Nurnberger-Haag et al., 2022).

Errors also arise in operations with algebraic expressions and fraction division, often due to overgeneralised rules and conceptual misunderstandings (Aydin-Güç & Aygün, 2021; Uzel, 2018). Strategies like Realistic Mathematics Education (RME) and context-based approaches have been shown to improve student achievement and attitudes (Gübbük & Uygun, 2023). Young students intuitively understand integers, which can be nurtured through real-life examples and instruction focusing on cardinal and ordinal meanings (Cengiz et al., 2018).

C. Students' Performance and Achievement in Integer Operations

The persistent poor performance of students in mathematics, especially in understanding integers, remains a significant concern. A key issue is students' confusion with signs and operations, which is often worsened by traditional teaching methods like the number line, leading to misinterpretations. Rote memorisation and reliance on algorithms without conceptual understanding have also proven ineffective (Gningue et al., 2018). Research has shown that strategies like Realistic Mathematics Education (RME), which uses real-life contexts and reflective practices, can improve student achievement and attitudes (Gübbük & Uygun, 2023). Professional development programs for teachers, such as the Cognitively Guided Instruction 3-5 program, have also been shown to positively impact student performance in number operations and algebraic thinking (Schoen et al., 2024).

However, many elementary teachers still lack a strong conceptual foundation and rely on procedural knowledge from traditional, teacher-centred instruction (Ball, 1990; Utley & Reeder, 2012). To address these challenges, innovative pedagogical approaches are needed. Methods like reasoned arithmetic, mathematics games, and strategies based on cognitive load theory (such as visual aids and spatial tools) can enhance engagement and understanding. RME principles, when applied effectively, help students progress from concrete experiences to abstract reasoning, using relatable contexts like finances or temperature to introduce complex concepts like integer operations (Stephan & Akyüz, 2012). Effective instruction should address misconceptions, build on prior knowledge, offer varied representations, and foster a supportive learning environment.

D. Integer Teaching Strategy

The teaching and learning of integers are essential in middle school mathematics as it transitions students from concrete to abstract thinking (Lamb & Thanheiser, 2006). Several instructional models, such as number lines, money, and two-colour tiles, have been developed to aid in understanding these concepts (Cemen, 1993). Research by Harun et al. (2024) found that misconceptions, especially in Subtraction and negative numbers, persisted while students showed average mastery in integer operations. Puzzle-based methods, like the KenKen puzzle (Molina & Ibañez, 2024), improved performance and attitudes, encouraging creativity and critical thinking. Lopez (2024) evaluated a mobile game for numeracy, which showed promise but suggested improvements in its user interface.

Other studies, such as Campanilla (2024), indicated that methods like SIGNS helped improve students' skills with positive and negative signs. Project MathSagip (Rosanes et al., 2024) showed significant improvements through peer tutoring. Traditional models, particularly the number line, were also advocated by Cemen (1993) as effective for teaching integer operations. Epstein (2007) highlighted the importance of intentional teaching, setting clear goals, and using targeted strategies to enhance learning outcomes. For students with learning disabilities, the CRA sequence and STAR method (Maccini & Ruhl, 2000) using concrete tools effectively improved problem-solving skills with integers.

Moreover, real-life contexts help make integer concepts more relatable and understandable (Akyüz, Dixon & Stephan, 2012). Combining intentional instruction, effective models, manipulatives, and real-world applications offers a comprehensive approach to improving students' understanding and mastery of integers.

III. PURPOSE OF THE STUDY

This study was conducted to determine the effects of computer-supported collaborative learning on minimising

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integer operation errors among junior high school students. This research study aimed to answer the following research questions:

1. What are the common errors in integer operations among junior high school students?
2. What is the pre and post-test performance in minimising integer operations errors of junior high school students exposed to Computer-Supported Collaborative Learning?
3. What is the pre and post-test performance in minimising integer operations errors of junior high school students not exposed to Computer-Supported Collaborative Learning?
4. Is there a significant difference in the pre-test and post-test performance in minimising integer operations errors of junior high school students exposed to Computer-Supported Collaborative Learning?
5. Is there a significant difference in the pre and post-test performance in minimising integer operations errors of junior school students not exposed to Computer-Supported Collaborative Learning?
6. Is there a significant difference in the pre-test performance in minimising integer operations errors of junior high school students exposed and not exposed to Computer-Supported Collaborative Learning?
7. Is there a significant difference in the post-test performance in minimising integer operations errors of junior high school students exposed and not exposed to Computer-Supported Collaborative Learning?
8. How do the experiences of junior high school students toward learning mathematics change after participating in CSCL?

IV. THEORETICAL AND CONCEPTUAL FRAMEWORK

This study is anchored on Merculio's (2023) work on Computer-Supported Collaborative Learning (CSCL), which uses technology to create collaborative learning environments that enhance peer interaction and knowledge building, particularly in mathematics. CSCL integrates tools like email, blogs, and social media to encourage students to collaborate and solve problems, fostering deep understanding. It also includes face-to-face activities supported by digital resources, making it adaptable to different learning styles.

The study applies Merculio's CSCL framework to examine its effect on minimising errors in integer operations among junior high students. Using social media for collaborative learning, students discuss math problems, share strategies, and reflect on their thinking. The study aimed to show that CSCL improves understanding, minimises errors, and promotes active learning, helping students master mathematical concepts and develop teamwork skills.

In addition to CSCL, this study is also anchored on the Cognitive Information Processing (CIP) Model, which describes learning as a series of cognitive stages: sensory input, attention, perception, and memory (Siegler & Alibali, 2004; Atkinson & Shiffrin, 1968). As students develop, they enhance their ability to focus attention, retain information, and use metacognitive strategies to regulate their learning (Solso et al., 2005; Klahr & MacWhinney, 1998). In the context of this study, the CIP Model provides insights into how students process information related to integer operations through CSCL, where digital content and peer interaction act as cognitive stimuli.

Furthermore, this study also incorporates Lev Vygotsky's Social Constructivism Learning Theory, which highlights the social nature of learning. Vygotsky (1978) asserted that meaningful learning occurs through peer interaction and that individual learning is closely tied to collaborative success. Teachers play a vital role in structuring and guiding these interactions through scaffolding and mediation. In the context of this study, social media platforms are used to foster collaborative engagement among students. Through guided online discussions and problem-solving tasks, students co-construct knowledge related to integer operations while teachers prompt deeper thinking through questions, clarifications, and feedback.

This model reinforces the idea that collaborative learning is not incidental but intentional and structured, which aligns well with Merculio's vision of CSCL as a cognitive and social development vehicle.

Overall, this study is anchored on Merculio's (2023) framework of Computer-Supported Collaborative Learning, supported by the Cognitive Information Processing Model and Vygotsky's Social Constructivism Learning Theory. Together, these theoretical frameworks provide a comprehensive foundation for exploring how digital collaboration tools can improve junior high school student's performance in integer operations. Emphasising collaborative problem-solving, cognitive engagement, and teacher mediation, the study aimed to demonstrate how CSCL can serve as an effective intervention in mathematics education.

V. CONCEPTUAL FRAMEWORK

The study paradigm presented the relationships among variables when investigating the effect of Computer-Supported Collaborative Learning (CSCL) on minimising errors in integer operations made by junior high school students. The independent variable was the group of students assigned: the experimental group experienced Computer-Supported Collaborative Learning, while the control group did not. The intervening or moderating variable was the CSCL strategy, which served as the mode of instruction delivered to the experimental group. The dependent variable was the errors made by students while performing operations on integers.

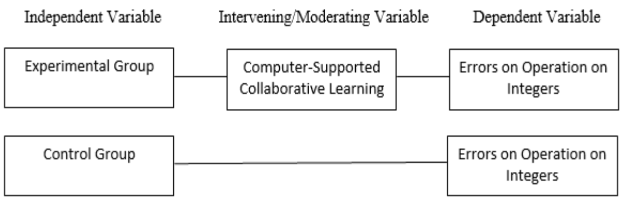

Figure 1. Computer-Supported Collaboration Learning Integers Operation

VI. METHODOLOGY

A. Research Design

This study used a quasi-experimental research approach, specifically a non-equivalent control group pre-test and post-test design. Quasi-experimental studies that aim to evaluate interventions but do not use randomisation. Instead, they use other techniques to control confounding variables, such as matching or statistical adjustments" (Cook & Campbell, 1979).

B. Participants

The participants were Grade 7 students from Sara National High School in Sara, Iloilo, during the S.Y. 2024-2025. A total of 44 Grade 7 students took part, with 22 assigned to the experimental group and 22 to the control group. The experimental group used Computer-Supported Collaborative Learning (CSCL) by working on worksheets posted on a Facebook Page for this study, while the control group continued with traditional classroom learning.

C. Research Instrument

This study utilised three instruments. The first instrument was a researcher-made questionnaire containing an Objective Type of Test in integers. This test assessed the types of errors that students made in integer operations. The perfect score for the test was 40 points. The second instrument was a researcher-made rubric to evaluate students' performance in solving integer problems. The third instrument was an interview questionnaire that explored the learning experiences of the Grade 7 students in using Computer-Supported Collaborative Learning (CSCL). A panel of experts validated all instruments to ensure they were appropriate and easy for students to understand.

D. Data Gathering Procedure

Permission to conduct the study was secured from the Schools Division Superintendent of the Schools Division of Iloilo. A copy of the approved letter was furnished to the school Principal of Sara National High School, Sara, Iloilo. Afterwards, the researcher sought permission from the school principal to conduct the study. Students were assured that their responses would be treated confidentially. The data collection involved several stages.

First, the researcher prepared a pre-test on integer operations to validate its content and ensure accuracy. Following this, the pre-test was administered to Grade 7 students. Based on the results, the researcher created a Facebook group page entitled "CSCL Operation on Integers (Lotus)" to serve as the platform for implementing Computer-Supported Collaborative Learning (CSCL) among the experimental group. The researcher implemented a structured and sequential approach to introducing and assessing fundamental arithmetic operations using a combination of instructional videos and worksheets shared on the Facebook platform. The CSCL approach was not implemented daily. Instead, the researcher focused on specific concepts within a defined timeframe, allowing students to engage with the materials and complete worksheets at their own pace. The process spanned six weeks, each focusing on a specific mathematical concept through instructional materials and assessments.

The CSCL implementation for the experimental group involved introducing key concepts in integer operations through instructional videos and worksheets. The researcher introduced addition, utilising videos that provided step-by-step explanations, real-life applications, and problem-solving strategies. Worksheets were designed to offer varied addition problems, ranging from simple single-digit exercises to more complex multi-digit tasks. At the end of the learning period, a short formative assessment was administered to evaluate students' comprehension and identify areas needing reinforcement.

Subtraction was introduced to build upon this foundation. Videos demonstrated subtraction methods, including regrouping when necessary, and emphasised their practical applications. Worksheets gradually increased in difficulty to guide students from basic to more advanced problems. A formative assessment was again given to check students' understanding of Subtraction and their ability to distinguish it from addition.

Engaging instructional videos introduced multiplication, explaining repeated addition, the use of arrays, and its relevance in everyday life. Worksheets included exercises focusing on mastering multiplication facts and solving single- and multi-digit multiplication problems. Students' proficiency was measured through a short assessment.

Following multiplication, the concept of division was presented, emphasising its relationship to multiplication. The videos and guided examples supported students in understanding division through simple to complex tasks, while worksheets allowed for practice in basic division facts and multi-digit division. Another formative assessment measured students' proficiency in this area.

After introducing the four fundamental operations, the researcher integrated these concepts through word problems that required students to apply addition, Subtraction,

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multiplication, and division in real-world scenarios. Instructional videos guided students through breaking down and solving complex word problems, while worksheets provided additional practice.

In the final phase of the intervention, participants completed a comprehensive assessment covering all previously taught arithmetic operations. This summative evaluation included computational and word problems to measure overall proficiency. Data from all worksheets, assessments, and participant feedback were analysed to determine individual progress, standard errors, and areas that need further improvement.

Throughout the intervention, teaching aids such as videos and worksheets were posted periodically on the Facebook group. The total intervention lasted for six weeks. Conversely, the control group continued with their regular class without the Facebook platform or CSCL strategies. Their instruction followed the traditional face-to-face method, where the teacher lectures, provides textbook exercises and provides direct instruction. Students in the control group received printed worksheets and participated in teacher-led discussions, which were predominantly teacher-centred and lacked online collaboration.

After six weeks, a post-test was administered to the experimental and control groups. The results from the pre-test and post-test were compared to determine the effectiveness of the CSCL intervention. Additionally, to gain deeper insight into the students' experiences in the experimental group, interviews were conducted to explore their perceptions, challenges, and overall engagement with collaborative learning through the Facebook platform.

E. Data Analysis

After the experiment, the data gathered for this study were subjected to appropriate computer-processed statistics employing the Statistics Package for Social Sciences (SPSS) software. The level of significance was 0.05. Frequency means, standard deviations, and t-tests were used for quantitative data, and thematic analysis was used for qualitative data.

F. Ethical Considerations

Rani & Sharma (2012) and Govil (2013) stress the crucial importance of researchers prioritising participant welfare and following ethical guidelines. The study's goals are knowledge advancement, data confidentiality, transparency, equity, and respect. Official correspondence, anonymity, and voluntary engagement all contribute to participant welfare.

VII. RESULTS AND DISCUSSION

This section presents the findings of this study.

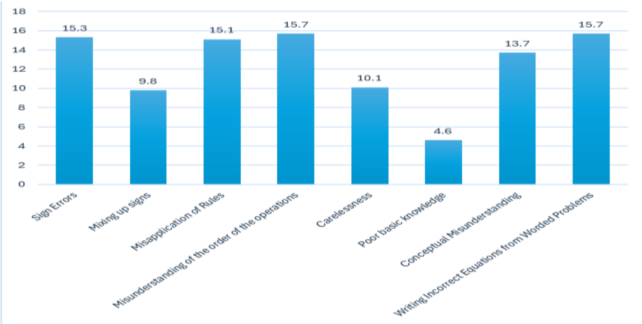

Figure 2. Common Errors in Integer Operations of Junior High School Students

Figure 2 shows that the most prevalent errors, each with a frequency of 15.7%, are misunderstanding the order of operations and writing incorrect equations from worded problems. These findings underscore the critical need to strengthen students' procedural knowledge and ability to translate verbal problems into mathematical expressions accurately. Sign errors (15.3%) and misapplication of rules (15.1%) also exhibit high frequencies, indicating significant challenges in applying operational rules, particularly in handling positive and negative integers. Conceptual misunderstanding accounts for 13.7% of the errors, suggesting persistent difficulties in internalising the principles underlying integer operations. Carelessness (10.1%) and mixing up signs (9.8%) are moderately common, likely reflecting issues related to students' attentiveness and precision during problem-solving activities. Notably, poor basic knowledge was the least frequently occurring error at 4.6%, implying that while most students possess fundamental competencies, they encounter obstacles in correctly applying their knowledge.

Table I: Pre-Test and Post-Test Performance of Junior High School Students Exposed to CSCL

Test	Mean Score	Standard Deviation	Performance Level
Pre-Test	8.31	3.59	Poor
Post-Test	16.50	6.45	Fair

Note: Excellent (31-40)
Good (21-30)
Fair (11-20)
Poor (0-10)

The findings showed that the pre-test performance of junior high school students in minimising integer operation errors was "poor" (M=8.31, SD=3.59), and the post-test performance of junior high school students exposed to CSCL was "fair" (M=16.50, SD=6.45). This result means that the post-test result is higher than the pre-test result. Using CSCL helps improve their performance by minimising integer operation errors. This outcome implies that Computer-Supported Collaborative Learning (CSCL) effectively enhanced students' mathematical proficiency, particularly in minimising integer operation errors. The notable improvement in post-test scores implies that CSCL provided an engaging and interactive learning environment that fostered conceptual understanding, peer collaboration, and active learning.

Table II: Pre-Test and Post-Test Performance of Junior High School Students Not Exposed to CSCL

Test	Mean Score	Standard Deviation	Performance Level
Pre-Test	6.68	1.86	Poor
Post-Test	8.68	1.46	Poor

Note: Excellent (31-40)
Good (21-30)
Fair (11-20)
Poor (0-10)

The findings showed that the pre-test performance of junior high school students in minimising integer operation errors was "poor" (M=6.68, SD=1.86). At the same time, there was a minor improvement in the post-test scores (M=8.68, SD=1.46), the students' performance remained within the "poor" category, indicating that conventional teaching methods may not provide sufficient engagement, interaction, or reinforcement for mastering integer operations. The results suggest that while traditional instruction provides some improvement, it is not as effective as CSCL in minimising integer operation errors. The results corroborate with Aygun (2021), who states that students frequently struggle with integer operations due to misconceptions and procedural errors. Similarly, Altiparmak and Özdoğan (2010) identified common mistakes in integer operations, including incorrect equation formulation and conceptual misunderstandings, leading to computational errors (Altiparmak & Özdoğan, 2010).

Table III: Comparability of Pre-Test Results of Experimental and Control Groups

Groups	Means	Significance
Experimental	8.31	
		0.065
Control	6.68	

P>.05siginificant

The findings revealed that the Control Group obtained a mean pre-test score of 6.68, while the Experimental Group achieved a higher mean score of 8.31. The statistical analysis showed a p-value of 0.065, greater than the significance level ($\alpha = 0.05$). This result indicates that there is no significant difference between the pre-test scores of the two groups.

Table IV: T-test result of the difference in the pre-test and post-test performance in minimising integer operation errors of junior high school students exposed to CSCL

Groups	Mean	t-value	df	Sig
Pre-Test	8.31			
		7.450	21	0.000
Post-Test	16.50			

P<.05siginificant

The findings revealed that there is a significant difference in the pre-test and post-test performance in minimising integer operation errors of junior high school students exposed to CSCL (p=.000). This confirms that CSCL positively impacted students' ability to minimise integer operation errors, as their post-test scores (M = 16.50) were significantly higher than their pre-test scores (M = 8.31). This result means that the significant improvement in students' post-test scores suggests that CSCL fosters a deeper understanding of integer operations, enabling learners to correct misconceptions and apply more accurate problem-solving strategies. This finding highlights the importance of conceptual and procedural knowledge in minimising computational errors, both enhanced through interactive and collaborative learning.

Table V: T-test result of the difference in the pre-test and post-test performance in minimising integer operation errors of junior high school students not exposed to CSCL

Groups	Mean	t-value	df	Sig
Pre-Test	6.68			
		5.850	21	0.000
Post-Test	8.68			

P<.05 significant

The findings revealed a significant difference in the pre-test and post-test performance in minimising integer operation errors of junior high school students not exposed to CSCL (p=.000). Traditional instruction alone led to some improvement in minimising integer operation errors. However, it is essential to note that, despite statistical significance, the actual improvement in mean scores was marginal, increasing from 6.68 (poor) to 8.68 (still poor). Although the pre-test and post-test performance of students not exposed to CSCL showed statistical significance, the improvement remained minimal, and students struggled with integer operation errors.

Numerous studies support the effectiveness of CSCL in improving mathematical proficiency. Talan (2021) conducted a meta-analysis of 40 studies and concluded that CSCL significantly enhances students' academic achievement by fostering interactive and engaging learning environments (Talan, 2021). Furthermore, Jeong, Hmelo-Silver, and Yu (2019) reviewed ten years of research on CSCL and found that it promotes deeper conceptual understanding and problem-solving skills in STEM education (Jeong et al., 2019).

Table VI: T-test result of the difference in the pre-test in minimising integer operation errors of junior high school students exposed and not exposed to CSCL

Groups	Mean	t-value	df	Sig
Pre-Test	8.31			
		1.898	42	0.065
Post-Test	6.68			

P>.05 significant

The findings reveal that there was no significant difference in the pre-test performance of students exposed and not exposed to CSCL (p = .065). Although the pre-test means score (M = 8.31) of the CSCL group is slightly higher than that of the non-CSCL group (M = 6.68), this difference was insignificant. This result indicates that the two groups were relatively comparable at the start of the study, ensuring a fair basis for assessing the effectiveness of CSCL in the subsequent intervention. It also highlights the need for targeted interventions, differentiated instruction, and enhanced teaching methodologies to address foundational gaps in integer operations. The study also reinforces the potential of CSCL in providing a more structured, engaging, and interactive approach to improving mathematical skills among junior high school students.

Table VII: T-test result of the difference in the post-test performance in minimising integer operation errors of junior high school students exposed and not exposed to CSCL

Groups	Mean	t-value	df	Sig
Pre-Test	16.50			
		5.483	21	0.000
Post-Test	8.68			

P<.05 significant

The findings reveal a significant difference in the post-test performance of students exposed to CSCL compared to those not exposed (p = .000). The higher mean score (M = 16.50) of students who used CSCL indicates that CSCL had a substantial positive impact on minimising integer operation errors. In comparison, students not exposed to CSCL had a lower post-test mean score (M = 8.68), which remained in the poor performance category. This finding indicates that traditional instruction alone was insufficient in helping students effectively minimise integer operation errors. Hence, the significant difference in post-test scores between students exposed and not exposed to CSCL confirms that CSCL is a highly effective method for minimising integer operation errors. Compared to traditional instruction alone, CSCL significantly enhances students' mathematical performance.

Table VIII: Mean Gain Result of Post-Test of Experimental and Control Group

Group	N	Mean Gain	SD
Experimental	22	8.18	5.15
Control	22	2.00	1.60

The findings revealed that the Experimental Group (N = 22) had a mean gain score of 8.18 with a standard deviation of 5.15, while the Control Group (N = 22) had a lower mean gain score of 2.00 and a standard deviation of 1.60.

The higher mean gain in the experimental group suggests that the intervention or strategy applied to this group enhanced their knowledge or skills more effectively. The higher standard deviation in the experimental group suggests varied responses to the intervention, with some participants achieving substantial improvement while others showed minimal gains. Meanwhile, the control group's lower mean gain reflects limited improvement, likely due to the absence of the intervention. These results imply that the intervention positively impacted the experimental group, leading to better post-test performance than the control group. The results supported by Jeong et al. (2019) showed that students in CSCL environments performed significantly better than those taught through conventional methods due to increased engagement and interactivity. Traditional teaching, which often relies on rote memorisation, may be less effective in reinforcing mathematical concepts.

Moreover, the statistical significance of CSCL's impact on student learning has been widely documented. Talan (2021) found that CSCL interventions produce significant gains in student performance, as indicated by higher post-test scores across various subjects (Talan, 2021). These findings reinforce that interactive and technology-supported learning strategies can minimise mathematical errors and improve retention.

The study examined the experiences of junior high school students in learning mathematics after participating in Computer-Supported Collaborative Learning (CSCL). By analysing their responses, key themes emerged regarding their learning experiences, engagement, challenges, and the impact of CSCL on their mathematical understanding and confidence.

Improved Confidence and Problem-Solving Skills. Many students reported increased confidence in mathematics after participating in CSCL. The collaborative learning environment enabled them to approach problem-solving with greater assurance, seek peer support without hesitation, and persevere in tackling mathematical challenges. It highlights how CSCL fosters self-efficacy by encouraging students to engage in mathematical discussions, explore different problem-solving techniques, and support each other in understanding concepts.

Increased Interest and Motivation. Students expressed that CSCL made learning mathematics more engaging.

Collaborative problem-solving and interactive learning environments were seen as more enjoyable compared to traditional instruction, making math less intimidating and more appealing. The insights suggest that working with peers alleviates anxiety and enhances motivation, making mathematics a more enjoyable subject for students.

Distractions and Online Learning Difficulties. A few students found it challenging to stay focused due to distractions and technical difficulties during CSCL sessions. These challenges highlight the need for structured activities and clear guidelines to maintain engagement. These concerns suggest creating a more structured and well-facilitated online learning environment to minimise distractions and ensure active participation.

The results corroborate Norrozi and Hatami (2018), who state that distractions and technical issues are common challenges in CSCL and affect student engagement and participation. The authors emphasise the need for structured activities and teacher guidance to maintain focus. Another is Wang & Huang (2021) stated that some students contribute less in CSCL environments, leading to frustration among peers. The authors recommend setting clear expectations and accountability measures to enhance equal participation.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings gathered and observations, the following conclusions were drawn.

Junior high school students often struggle with integer operations due to common errors like sign errors, rule misapplication, and conceptual misunderstandings. The findings revealed that students exposed to Computer-Supported Collaborative Learning (CSCL) showed significant improvement, moving from "poor" to "fair" performance in post-tests. In contrast, students taught through traditional methods showed minimal gains, remaining in the "poor" category.

The CSCL group demonstrated better engagement, critical thinking, and peer-assisted learning, leading to fewer computational errors and improved confidence. Both groups started with comparable pre-test scores, affirming the effectiveness of CSCL as an instructional method. This finding supports the integration of CSCL strategies in math education, leveraging technology and collaboration to enhance conceptual understanding and problem-solving skills in integer operations. The findings of this study reinforce the importance of modern teaching approaches that incorporate collaboration and technology to address learning challenges in mathematics.

Based on the study's findings, several recommendations can be made to enhance the mathematics performance of junior high school students.

Computer-Supported Collaborative Learning (CSCL) can be incorporated into teaching mathematics. Teachers are encouraged to use interactive tools and foster peer collaboration to address common learning errors. Students should actively engage in CSCL by collaborating with peers, practising regularly, and using digital resources to strengthen their skills. School principals play a key role by supporting teachers through continuous professional development and providing necessary digital tools that encourage collaboration and innovation in mathematics education. Policymakers should incorporate CSCL into educational frameworks and fund-related initiatives. Lastly, future research should examine CSCL's broader impact on learning outcomes, motivation, and long-term effectiveness across different mathematical areas.

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