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Enhancing Grade 8 Proficiency in Analyzing Ohm's Law Concepts through the GameMapPro Method

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Abstract. Ohm's Law remains a complex topic for many Grade 8 students due to its abstract nature, making effective instructional strategies crucial for improving conceptual understanding. This action research aimed to address this challenge by implementing the GameMapPro method—an instructional strategy that combines game-based learning, concept mapping, and teacher-guided worksheets—in a public high school. A total of 28 participants were involved to improve their class proficiency level (CPL) in Ohm's Law. To assess progress, pre-tests were administered before the intervention, and post-tests were given after each of the three instructional sessions using GameMapPro. Data triangulation, using scores, observations, and interviews, strengthened the validity and reliability of the results. CPLs improved significantly, rising from 14.29% to over 85% across the three sessions, while mean scores increased notably in each session. Observations and interviews further revealed increased student engagement and independent application of concepts. The findings indicate that GameMapPro is a practical approach for enhancing students' understanding of Ohm's Law. However, limitations such as the small sample size and the localized context must be taken into account. This study suggests that interactive and integrative methods, such as GameMapPro, can enrich science education when adapted thoughtfully to specific classroom environments.

Keywords: Concept mapping; Conceptual understanding; Game-based learning; Guided worksheet; Interactive learning environment.

1.0 Introduction

Ohm's Law is a cornerstone of electrical theory, providing a fundamental understanding of how electricity behaves within circuits by defining the interrelationship between voltage (V), current (I), and resistance (R). Represented mathematically as $V = IR$, this equation highlights that the voltage across a conductor is directly proportional to the current flowing through it, provided the resistance remains constant (Bird, 2021). More than a theoretical concept, Ohm's Law is a practical tool for analyzing and solving electrical circuit problems, enabling the calculation of missing values and troubleshooting issues by examining the interplay of these three quantities (Popat, 2021). Ohm's Law has long been a cornerstone of electrical engineering, providing a fundamental relationship between voltage, current, and resistance that has underpinned modern circuit analysis (Kimuya, 2023). The utility of the principle spans many applications, including designing efficient circuits and diagnosing faults in electrical systems, making it indispensable for professionals in the field.

Numerous studies have highlighted the effectiveness of different educational methods in improving student learning outcomes (Tomkelski et al., 2023). Game-based learning has emerged as a strong method, demonstrating its positive effect on student performance (Leaño & Belgica, 2023). Their study revealed enhancements in post-test scores following the implementation of game-based lessons. Similarly, integrating concept mapping has proven beneficial in cultivating a deeper understanding of science education (Marcelo & Baptista, 2023). This method aligns with cognitive and constructivist theories, encouraging students to connect new knowledge with existing concepts, thereby nurturing critical thinking skills (Piaget, 1950; Vygotsky, 1978). Furthermore, pro-guided worksheets have significantly improved students' comprehension of physics concepts and higher-order thinking abilities. Learners' mastery levels increased substantially following the use of pro-guided worksheets, as evidenced by improved results on both pre- and post-tests. Therefore, these studies demonstrate the importance of employing innovative teaching strategies to enhance student learning, encompassing game-based learning, concept mapping, and project-guided worksheets, in fostering inclusive and learner-centered environments.

To address the need for diverse, student-centered strategies, this study adopted an integrated instructional method called the GameMapPro method—a combination of game-based learning, concept mapping, and pro-guided worksheets. This approach aims to enhance conceptual understanding and improve proficiency in complex topics, such as Ohm's Law. The implementation of DepEd Order 34, s. 2022 marked a shift in education. While the return to in-person classes offered opportunities for enhanced learning, it also presented challenges. Despite efforts to adapt to the new normal, Grade 8 students struggled to understand Ohm's Law concepts, as evidenced by their low CPL and the issues identified in the problem tree analysis (Figure 1).

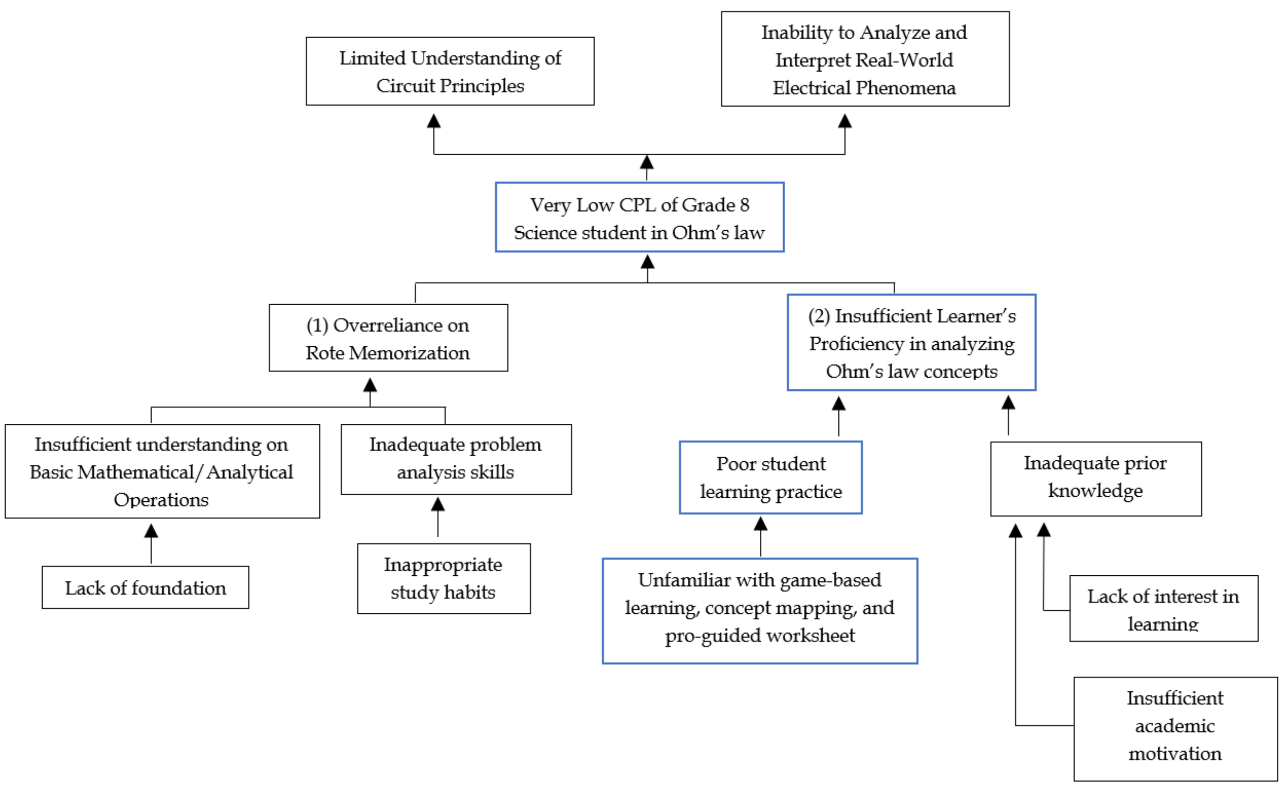

Figure 1. *Problem Tree Analysis*

Figure 1 shows the underlying causes of the low CPL of Grade 8 Science students in Ohm's Law. At the root of the issue is insufficient learner proficiency in analyzing key concepts, which leads to inadequate problem-solving skills, poor learning practices, and a lack of interest in the topic. Addressing this issue requires shifting the focus from rote memorization to a deeper conceptual understanding through various teaching strategies (Heilporn et al., 2021). Furthermore, inadequacies in instructional methods, as shown in Figure 1, indicate the limited use of game-based learning activities, concept mapping, and pro-guided worksheets, often attributed to factors such as time constraints, a lack of resources, and insufficient teacher training.

Effective integration of game-based learning can enhance student engagement and learning outcomes (Pacheco-Velazquez et al., 2024). Concept mapping is a valuable tool for promoting meaningful learning and conceptual understanding, and pro-guided worksheets can be used as an alternative teaching material (Hastuti et al., 2020). These gaps in the learning environment contribute to the struggles of Grade 8 learners in comprehending the abstract principles of Ohm's law. The need for a targeted and interactive intervention becomes apparent as traditional teaching methods fall short in addressing the diverse and systematic nature of science education.

Grade 8 learners should have developed a deep understanding of fundamental scientific concepts, enabling them to apply their knowledge to real-world problem-solving (Lansangan & Orleans, 2024). Inclusive and engaging science learning environments that promote active participation, critical thinking, and long-term knowledge retention are essential for effective STEM education for all students, regardless of background (O'Leary et al., 2020). This study emphasizes the crucial role of inclusive classrooms in achieving equitable learning outcomes for all students, regardless of their background (Ainscow & Messiou, 2021).

Moreover, engaging learning environments are crucial for fostering student motivation, deep learning, and positive learning outcomes, including the choice of effective learning strategies (Acera, 2022) and higher levels of student engagement (Cayubit, 2021). This suggests that incorporating diverse, student-centered teaching strategies and innovative instructional methods could enhance student learning and prepare them for future success, addressing identified gaps in student engagement, digital literacy, and pedagogical innovation within 21st-century teaching practices. As mandated by DepEd Order No. 34, Series of 2022, the transition to face-to-face learning provided an opportunity to optimize the educational process and elevate students' proficiency in science.

The GameMapPro method was implemented to bridge the gap in understanding and elevate proficiency levels. This action research contributes to the teaching and learning theme of the DepEd's basic education research agenda, which examines strategies, best practices, and facilitating instruction. The study tailored an integrated intervention into the lesson plan and created instructional materials to address the students' needs. While the specific challenges these students face may be localized, the findings and effects of the intervention have broader implications for Philippine education. The implemented GameMapPro method addressed these challenges and contributed to the improvement of science education. By leveraging innovative, student-centered approaches, the study empowered Grade 8 learners with a stronger conceptual understanding of Ohm's Law and enhanced their learning experience.

2.0 Methodology

2.1 Research Design

The study employed a participatory action research design (PAR) aimed at enhancing the proficiency of Grade 8 students in analyzing Ohm's Law concepts by implementing a holistic teaching method, "GameMapPro." This research involved active participation from students and teachers to collaboratively identify challenges in understanding Ohm's Law, develop the GameMapPro method, implement it in the classroom, and evaluate its effectiveness. Recognizing the need to cater to diverse learning styles and cultivate critical thinking skills in science education, this study developed an integrated instructional approach by incorporating the 'GameMapPro Method' into the well-established 7Es (Elicit, Engage, Explore, Explain, Elaborate, Extend, and Evaluate) lesson plan (see Figure 2). This integration aimed to provide a more engaging and interactive learning experience, enhancing student understanding and applying scientific concepts.

2.2 Research Locale

This study was carried out in a specific Grade 8 section at Baybay National High School (BNHS) in Baybay City, Leyte, Philippines. This section was chosen because students demonstrated significantly lower proficiency levels in Ohm's Law.

2.3 Research Participants

The participants in this study were the 28 students in Section Lily, a Grade 8 class at BNHS. The process of selecting participants for this participatory action research involves assessing their CPL (which garnered 25% during the pre-implementation phase), researchers' observations, and the initial interview. Considering the previous CPL scores, initial interviews, and researchers' observations, a pre-test was administered as part of the process; students who exhibited low scores or showed noticeable challenges in understanding Ohm's Law-related concepts were identified as eligible participants for the action research. This approach ensures that students who may benefit the most from the research interventions are included, allowing for a comprehensive examination of their progress and the effectiveness of the proposed solutions. The research team aims to create a sample group that accurately represents students facing difficulties in understanding Ohm's Law, enabling targeted interventions to be developed accordingly.

I. OBJECTIVES	Infer the relationship between current and voltage **(S8FE-1h-30)** 1.1 Apply Ohm's law (V=IR) 1.2 Solve numerical problems involving current, voltage, and resistance relationships
II. CONTENT	Basic Electricity: Ohm's Law
III. PROCEDURE ACTIVITY	
ELICIT/ENGAGE	The model teacher will use Kahoot! to conduct a game-based review and pre-test, to allow students to recall prior knowledge on electricity and gauge their initial understanding of Ohm's Law.
EXPLORE	The class will be divided into six groups, with all members of the Action Research team serving as facilitators for each group. Using the guided worksheet, each problem must be solved within a ten-minute time frame. The differentiated activities of each group are as follows: **Groups 1–2: Current–Voltage Graph** Groups 1 and 2 will plot and interpret a current-voltage graph to visualize the direct relationship between current and voltage based on Ohm's Law. **Groups 3–4: Problem Analysis** Groups 3 and 4 will analyze a word problem with constant voltage to infer how current behaves, enhancing their understanding of electric circuits. **Groups 5–6: Table Analysis** Groups 5 and 6 will examine a table with constant voltage and varying resistance to determine how current changes, highlighting the inverse relationship between current and resistance.
EXPLAIN	Each group will present their outputs using a concept map to explain the relationship among current, voltage, and resistance. They will briefly discuss how their activity supports Ohm's Law.
ELABORATE	The model teacher will lead a brief discussion to clarify key points, reinforce Ohm's Law concepts, and address misconceptions by introducing the formulas properly and providing real-life examples.
IV. EVALUATION	The students will answer a short 5-item multiple-choice test to assess their understanding of Ohm's Law and its related concepts.
V. EXTEND	As homework, students will write a short reflection in no less than a paragraph in their notebooks explaining Ohm's Law and describing the relationship among current, voltage, and resistance.

Figure 2. *Abridged 7Es Lesson Plan for Science 8*

2.4 Research Instrument

The study used pre-test and post-test assessment tools consisting of a 10-item multiple-choice test on Ohm's Law, administered to measure students' knowledge and understanding of the topic. The Cronbach's alpha reliability coefficient of the assessment was .72, indicating acceptable reliability. An observational checklist was employed to systematically record and analyze participants' behaviors and actions during specific activities or tasks. Semi-structured interviews were conducted using a validated questionnaire to gain deeper insights into students' learning experiences and perceptions. This provided valuable qualitative data on engagement, problem-solving abilities, and application of knowledge. Additionally, focus group discussions were conducted with participants to gather in-depth insights into their experiences and perceptions of the GameMapPro method. By combining these three research instruments, the study aimed to gain a comprehensive understanding of the intervention's effect on participants' learning and overall development.

2.5 Data Gathering Procedure

During the pre-implementation phase, the researchers introduced the GameMapPro method to participants to facilitate its integration. The pre-test was administered. The intervention was implemented using the 7Es lesson plan (refer to Figure 2). To gather more in-depth data, an observational checklist was utilized during the discussion to document participants' engagement and real-time reactions to the intervention. In the post-implementation, a post-test was administered. Finally, focus group discussions were conducted with both high- and low-scoring groups of participants to further explore the results. This provided valuable insights into observable behaviors that might correlate with their assessment performance and their feedback during the focus group discussions. The transcripts from these discussions were thematically analyzed using Saldaña's (2013) guidelines, which emphasize a two-cycle coding process: the first involves initial coding to break down qualitative data into discrete parts, and the second involves pattern coding to group these parts into emerging themes. To ensure reliability and validity, codes were reviewed by a co-researcher and cross-checked against the raw data.

Triangulation of data was employed using three distinct methods. First, the CPL method, as outlined in DepEd Order No. 31, s. 2012 was utilized to assess individual student performance based on daily assessment scores. This quantitative measure provided insights into proficiency levels. Pre- and post-test scores were collected and analyzed to calculate CPL. The checklist method was utilized in direct observation, where specific behaviors and actions are noted and analyzed. The narrative response technique involves group consultation through focus group discussion (FGD), creating a qualitative understanding by collecting insights, opinions, and perspectives within a group setting. This sequential approach enables a comprehensive evaluation, combining quantitative and qualitative data to provide a multifaceted perspective on using GameMapPro.

2.6 Ethical Considerations

To ensure the ethical conduct of this research, several measures were implemented to ensure the ethical conduct of this research. Informed consent was obtained from all participants or their legal guardians, as applicable, providing clear information about the study's purpose, procedures, potential risks, and benefits. To protect participant privacy, all data were anonymized, and confidentiality was maintained throughout the research process. In accordance with the Philippine Data Privacy Act of 2012, the researchers took necessary steps to safeguard personal information and ensure its secure handling. The intervention was designed to be engaging and beneficial, minimizing potential harm to participants. Additionally, participants were allowed to withdraw from the study at any time. Efforts were made to ensure fairness and equity in the selection of participants and the conduct of the research. Rigorous data collection and analysis procedures were followed to maintain data integrity and reliability. By adhering to these ethical principles, the researchers aimed to uphold the highest standards of research ethics and protect the well-being of all participants.

3.0 Results and Discussion

3.1 Analytical Results of Score Data

Table 1 presents descriptive statistics for the three phases of the study: Day 0 (Pre-implementation/diagnostic phase), Days 1 and 2 (Implementation phase), and Day 3 (Post-implementation phase), revealing key patterns in student performance. During the pre-implementation phase (Day 0), students took a diagnostic pre-test to assess their baseline understanding of Ohm's Law. The implementation phase (Days 1 and 2) involved integrating the GameMapPro Method into classroom instruction, with pre-tests and post-tests administered on each day to measure learning gains from the intervention. The post-implementation phase (Day 3) featured a final formative post-test to evaluate retention and sustained understanding. During the implementation phase (Days 1 and 2), the mean scores on the post-tests were consistently higher than those on the pre-tests, indicating that the GameMapPro Method had a positive impact on student learning. The CPL values also increased, indicating an improvement in students' competency levels throughout the study phases.

Table 1. *Descriptive Statistics of Pre, During, and Post Implementation Phases*

Descriptive Statistics	Pre-Implementation Phase (Diagnostic)	During the Implementation Phase				Post Implementation Phase (Post Quiz)
	Day 0	Day 1		Day 2		Day 3
	Pre-test (Diagnostic)	Pre-test	Post Test	Pre-test	Post Test	Post Test (Formative)
Mean	5.36	3.14	9.14	4.93	9.57	8.82
Std. dev.	2.45	2.29	1.27	2.18	0.84	0.9
CPL	25%	14.29%	86%	14.29%	92.86%	89.29%
Minimum	-	1	6	1	6	7
Maximum	-	8	10	8	10	10

During the implementation phase, pre-test scores were consistently lower than post-test scores on Days 1 and 2, supporting the positive effect of the GameMapPro Method. Notably, the highest CPL increase occurred on Day 2. Although a slight decline was observed in the post-test mean score on Day 3 compared to Day 2, the value remained significantly above pre-implementation levels. This decline was not statistically significant, suggesting that learning gains were sustained. The CPL also remained high, further supporting this trend. These outcomes suggest the method's effectiveness in fostering conceptual mastery and align with differentiated instruction strategies, which support diverse learning needs in inclusive classrooms (Nuñez & Rosales, 2021).

Table 2 presents the results of a paired-samples t-test comparing pre-test and post-test scores for students who participated in the GameMapPro Method intervention. A strong positive correlation was observed between pre-test scores ($M = 5.36$, $SD = 2.45$) and post-test scores ($M = 8.82$, $SD = 0.90$), $r = .90$, $p < .001$, indicating that the intervention consistently contributed to improved student learning outcomes. (See Table 1 for descriptive statistics.)

Table 2. *Statistical Paired t-test for the Implementation Phase of Pre-Test and Post-Test Scores*

Day	Variables	n	df	r	t	p-value
1	Pre-test vs Post-test Test	28	27	0.53	-16.33	0.004
2	Pre-test vs Post-Test	28	27	0.72	-14.6	<0.001
3	Pre-test vs Post-test Test	28	27	0.9	-10.86	<0.001

*Note: *significant at 5%, Null Hypothesis: GameMapPro Method intervention does not have any effect on altering student performance*

Specifically, the paired-samples t-test on Day 1 revealed a statistically significant performance improvement, $t(27) = -16.33$, $p < .001$, with a correlation of $r = .53$. Day 2 results showed a stronger correlation, $r = .72$, and continued significant improvement, $t(27) = -14.60$, $p < .001$, confirming the consistency of the method's effectiveness. By Day 3, the paired-samples t-test further validated the sustained impact of the intervention, $t(27) = -10.86$, $p < .001$.

Although a slight, non-significant decrease in post-test mean scores was observed on Day 3 compared to Day 2, performance gains were generally maintained. This minor decline may be attributed to factors such as student fatigue, reduced novelty effect of the intervention, or external distractions. Focus group discussions also revealed that some students experienced difficulty maintaining concentration during later sessions due to unstable internet connections or repetitive task structures, which may have influenced their performance. The degrees of freedom ($df = 27$) correspond to the 28 matched pairs of students involved in each testing phase. These findings provide robust evidence that the GameMapPro Method significantly enhanced student proficiency in understanding Ohm's Law.

These findings support that the GameMapPro Method can enhance the CPL of Grade 8 students. As evidenced by the observational checklist in Figure 5, students actively engaged with pro-guided worksheets and independently applied prior knowledge, indicating a deeper understanding of the concepts (Anbiya et al., 2023). These results align with research suggesting that engaging, relevant, and learner-centered strategies can enhance science instruction (Rogayan & Bautista, 2019). The GameMapPro Method addresses diverse learning styles and has the potential to enhance student motivation and active participation. Furthermore, using digital tools and integrating interactive activities helps improve learners' motivation and engagement, as learners are more likely to invest effort in enjoyable and challenging activities (Mitchell & Co., 2024).

3.2 Monitoring of Participants' Observations Using Checklist

To contextualize these statistical outcomes, observational data from Figures 3, 4, and 5 provide additional insight into students' behaviors during the intervention. Figure 3 reveals consistently high scores among students engaged in game-based learning activities, reflecting heightened motivation, active participation, and enjoyment. This is further supported by observations of students' responsiveness to interactive elements such as Kahoot and group challenges. However, sporadic competitiveness was noted, suggesting a need to balance individual achievement with collaborative efforts (Cagatan & Quirap, 2024), aligning with the importance of integrating both individual and social learning skills (Hank & Huber, 2024).

Figure 4 highlights a learner's engagement through active feedback-seeking and concept integration, which indicates a high level of self-regulated learning. This behavior aligns with Frondozo and Yang's (2023) findings, which emphasize the importance of feedback literacy in promoting meaningful academic experiences. Additionally, the creative and autonomous application of prior knowledge is visible in Figure 5, where students interact enthusiastically with pro-guided worksheets. This self-directed learning strategy demonstrates the effectiveness of structured guidance tools in deepening understanding, as also supported by Anbiya et al. (2023). When taken together, these observations highlight the GameMapPro Method's ability to foster motivation, facilitate active learning, and promote cognitive engagement through multimodal, student-centered tasks.

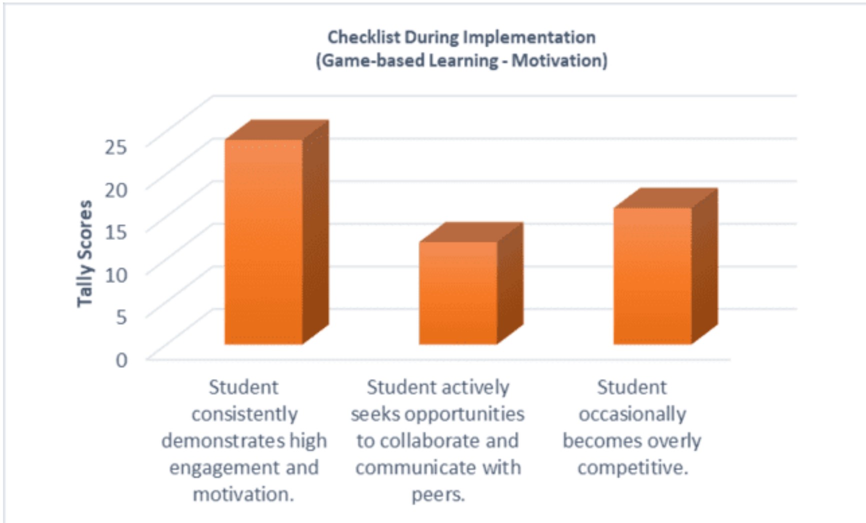

Figure 3. *Observational Checklist During Implementation of GameMapPro Method (Game-based Learning-Motivation)*

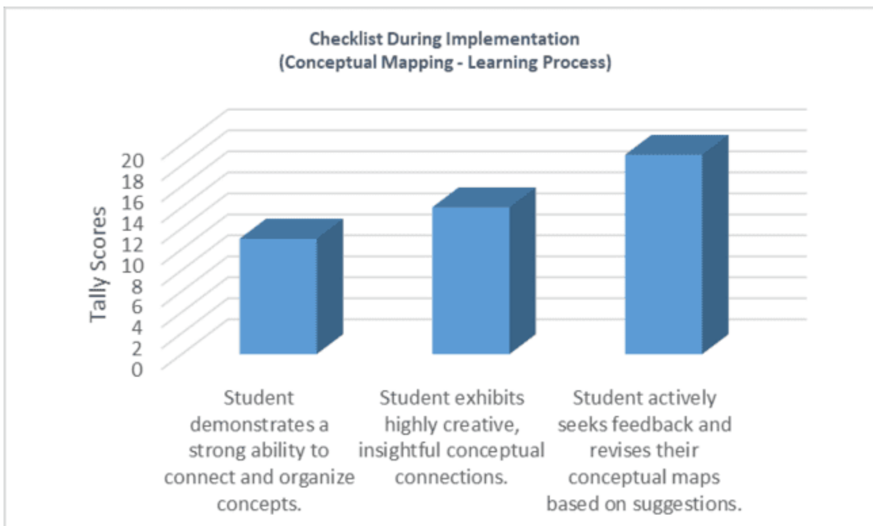

Figure 4. *Observational Checklist During Implementation of GameMapPro Method (Conceptual Mapping-Learning Process)*

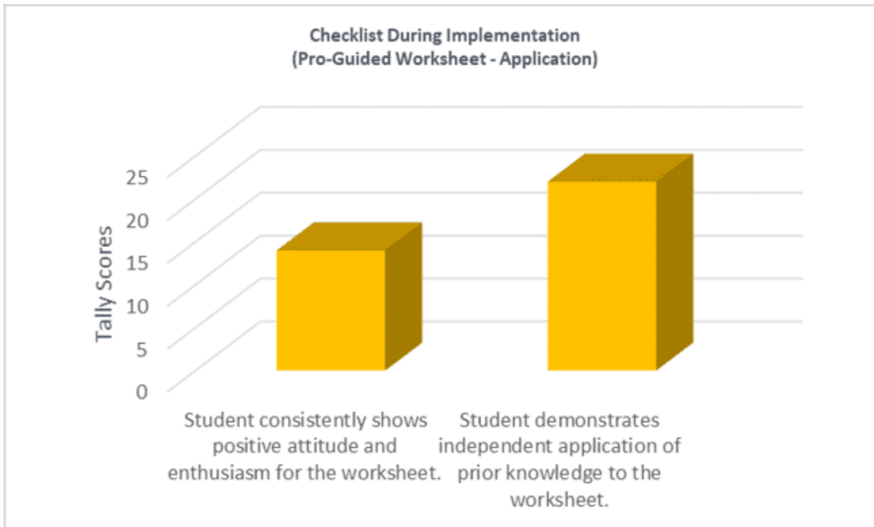

Figure 5. *Observational Checklist During Implementation of GameMapPro Method (Pro-Guided Worksheet-Application)*

3.3 Identifying Key Themes in Interview Feedback

To further support the findings from scores and observations, interview responses highlighted students' perceptions of the method's effectiveness. Table 3 presents the thematic analysis of integrating GameMapPro into the learning process for understanding Ohm's Law. The table outlines two primary themes: "Integration of different teaching tools" and "GameMapPro Effectiveness in Ohm's Law," each with corresponding subthemes. The sub-themes examine comparisons to traditional methods, active learning, tool integration and impact, learning tool efficacy, immediate feedback, and student engagement, supported by interview transcripts. This aligns with Esparcia et al.'s (2024) study, which found that scaffolding techniques, such as peer tutoring and teacher demonstrations, relate to academic performance and may offer broader academic benefits across various subjects. By considering students' prior knowledge and experiences, the platform provides the right level of challenge and support through relevant and engaging learning tasks, thereby contributing to the development of their cognitive skills and the role of prior knowledge in knowledge construction (Anbiya et al., 2023).

Table 3. *Effectiveness and Integration of Teaching Tools "GameMapPro Method" in Analyzing Ohm's Law*

Themes	Sub Themes
Integration of different teaching tools	Comparison to Traditional Methods
	Motivation and Active Learning Engagement
	Tool Integration and Impact
GameMapPro Effectiveness in Ohm's Law	Learning Tool Efficacy
	Immediate Feedback Impact
	Student Engagement

Moreover, Table 3 suggests that the GameMapPro method fosters a more active and engaging learning environment, which may enhance student understanding. This aligns with findings that indicate a significant relationship between teachers' active learning approaches (including learning environment organization) and students' academic interest (Ramteke & Tripathi, 2024). The observations in Figure 3, specifically in game-based learning, highlight the students' high motivation and active participation, with occasional over-competitiveness earning the highest tally scores. This also aligns with the positive impact mentioned by student 12, who responded "*…. I prefer participating if there are those three elements rather than none or the traditional lecture style*" (P12), who also found the integration facilitated a more efficient learning process compared to the traditional setting. The observed motivation and active learning engagement suggest the method's potential effectiveness, as indicated by the increase in their mean scores from Day 1 to Day 3 (see Table 1). A student found the method enjoyable but was frustrated due to slow Wi-Fi connectivity. This issue aligns with findings by Celeste and Osias (2024) in their study, which highlights that inadequate infrastructure, such as unreliable internet access, is a barrier to effective technology integration in educational settings. However, they acknowledged that this was a minor issue and their motivation remained unaffected. Despite this minor setback, the method proved to be a valuable tool that significantly enhanced student motivation, active engagement, and teamwork (Hartt et al., 2020).

Furthermore, the interactive nature of the GameMapPro method enhanced the learning experience of Grade 8 students, particularly in understanding the fundamental concepts of Ohm's Law. As evidenced by student 3's response:

"*I tend to participate more when all three elements are present because if the pro-guided worksheet is available, I understand how to answer, and with the concept map, I like it because it provides a continuous flow of ideas…*" (P3)

Students demonstrated improved performance when exposed to problems that required the use of multiple strategies, with increased motivation and participation observed. Student 6 stated, "*It was helpful, especially with the guided worksheet; it encourages participation*" (P6), indicating that the pro-guided worksheet fostered engagement. Student 2 added, "*Yes, because in the guided worksheet area, you can participate and there is engagement involved…*" (P2), further emphasizing the interactive nature of this method. The collaborative aspect also played a role, as Student 5 explained:

"*We created a collaboration, ma'am. We can ask our classmates questions about the topic, and it is easier for us to understand. Especially with concept mapping, which is easily comprehensible…*" (P5)

Additionally, Student 4 found the experience enjoyable and motivating, stating," *It is enjoyable and also motivating.*" (P4). These elements of collaboration, including clear learning tools such as GBL, concept mapping, and pro-guided worksheets, fostered active participation and promoted learner-centeredness.

The positive effect of the method is reflected in the increasing mean scores (see Table 1). The participants' commitment to learning and imaginative thinking contributes to the effectiveness of concept mapping in analyzing Ohm's Law concepts (Dela Cruz & Castillo, 2024). Moreover, participants' positive attitude and enthusiasm while working on pro-guided worksheets, as shown in Figure 5, correspond with an increase in CPL (see Table 1). The data demonstrates a clear relationship between student competence and engagement with the GameMapPro method.

The interconnectedness of game-based learning, concept mapping, and guided worksheets in promoting an active, learner-centered educational experience is highlighted in student 3's response. This integrated teaching method, employing multiple strategies, caters to diverse learners and fosters deeper comprehension by creating learner-centered environments that encourage active participation. Student 2 noted, "*With the concept map, you can generate your ideas*" (P2), highlighting how specific strategies empower students. Student 12 expressed, "*I enjoy participating because there are ideas present...I also like Kahoot because it is enjoyable...*" (P12), indicating that engaging activities motivate involvement. This approach, through elements that provide ideas and enjoyment, facilitates robust knowledge construction, boosts involvement, and cultivates a more profound understanding of the subject matter. Students 4 and 5 further emphasized the motivating and engaging nature of the integrated method in learning physics. Student 4 highlighted the combined effect of the tools, while student five specifically mentioned the visual and interactive aspects of the method, which resonated with their learning style. These responses underscore the importance of tailoring instruction to meet the diverse needs and preferences of learners.

Furthermore, this indicates that combining approaches can enhance the learner's learning experience. This is further highlighted by Student 5, who notes, "All three methods helped earlier, especially in solving the problem" (P5), emphasizing the practical benefits of these integrated tools. Student 5 described how all three tools helped solve problems and aligned with the positive effect. The mention of enjoyment and motivation further supports the idea that this intervention enhances learning (Cayubit, 2021). Integrating various educational tools aligns with Vygotsky's socio-cultural theory, emphasizing the importance of social interaction and collaboration in learning.
The second theme, "GameMapPro Effectiveness in Ohm's Law," explores the tool's specific effect on student learning. Student feedback indicates that the GameMapPro method offers a comprehensive approach to enhancing understanding of Ohm's Law. A similar study revealed that continuous interaction and timely feedback helped students improve their mastery of physics content and motivation to learn (Alcantara & Roleda, 2016). Student 9 found the tool effective in visualizing complex concepts, particularly through interactive simulations that helped concretize the relationship between resistance, voltage, and current (Dioson et al., 2020). Student 7 highlighted the importance of immediate feedback in the learning process, stating:

"*The immediate feedback helped me identify my mistakes and correct them right away. This truly shows that the method was effective about my needs.*" (P7).

This underscores the value of timely and specific feedback in promoting effective learning, as also supported by research (Hadijah et al., 2022).

Thus, results suggested that the GameMapPro method catered to the diverse needs of students in an inclusive classroom by enhancing understanding through various means. It also highlighted potential limitations regarding student independence and guidance, as evidenced by the scores in Table 1. Student 9 emphasized the tool's effectiveness in visualizing complex concepts, stating:

"*The method helped me understand how resistance, voltage, and current are related, allowing me to see how changes in one variable directly impacted the others. For example, I could observe how increasing resistance while keeping voltage constant resulted in a decrease in current flow.*" (P9)

The elements of the GameMapPro method captivated students' attention and motivated them to engage actively with the material. Student 6 expressed enthusiasm for the interactive tool, its challenges, and rewards, which stimulated their curiosity and desire to learn. This method enhanced students' comprehension of Ohm's Law by providing an interactive, engaging, and supportive learning environment that fostered a deeper understanding and improved learning outcomes.

4.0 Conclusion

The implementation of the GameMapPro Method, a holistic intervention that integrates game-based learning, conceptual mapping, and pro-guided worksheets within a 7E lesson plan, provides evidence to enhance Grade 8 students' proficiency in analyzing Ohm's Law. The significant increase in mean scores and CPL underscores the method's value in promoting formative assessment practices, allowing teachers to monitor conceptual growth and adjust instruction accordingly in science education. Additionally, the observational checklist data corroborated these findings. The checklist revealed that students exhibited increased motivation levels, active participation, and enhanced engagement. The themes emphasized the method's potential not only to foster active learning, enhance motivation, and provide immediate feedback, but also to inform evidence-based curriculum design and advocate for learner-centered policy initiatives focused on improving engagement in science classrooms. In light of these findings, integrating the GameMapPro Method into teacher professional development programs and national science curriculum frameworks could equip educators with adaptable tools that support differentiated and interactive instruction.

This study addresses a pedagogical gap in integrating diverse, student-centered strategies in secondary physics education by offering a replicable model that combines game-based learning, conceptual mapping, and structured guidance. It also builds on the works of Marcelo and Baptista (2023) on concept maps, Leaño and Belgica (2023) on the effectiveness of game-based learning, and Anbiya et al. (2023) on pro-guided worksheets, situating this intervention within the growing body of literature advocating for multimodal, interactive instructional approaches. By demonstrating the effectiveness of an integrated approach combining game-based learning, concept mapping, and guided worksheets within a 7E's lesson plan framework, this study strengthens the discourse on adaptive, interactive science instruction tailored to diverse learners.

Action research is a valuable tool for teachers to investigate and enhance their practice; however, it carries inherent limitations when used to evaluate complex and multifaceted teaching strategies. Its focus on specific, localized contexts restricts the generalizability of findings, while the potential for researcher bias may compromise the study's rigor and objectivity. When applied to a comprehensive intervention that integrates game-based learning, concept mapping, and pro-guided worksheets within a 7E's lesson plan, these limitations are compounded by challenges in isolating the effects of individual components, measuring varied outcomes, and assessing the intervention's overall impact. Time constraints related to implementation and data analysis, along with the critical consideration of students' cognitive load, further hinder the depth and scope of action research in such contexts.

Despite these challenges, action research remains a valuable approach for the initial exploration and refinement of integrated instructional interventions. Collaboration with fellow educators can enhance the credibility and depth of findings, while the strategic use of formative assessments offers ongoing feedback for instructional adjustment. Still, researchers must remain mindful of the context-specific nature of results and avoid overgeneralizing beyond the study environment. Consideration of available time, resource availability, and students' cognitive demands is essential to ensure meaningful and sustainable learning experiences. To further promote its classroom applicability, future efforts should explore the incorporation of GameMapPro into institutional training modules and science teaching manuals, thereby fostering scalable models of best practices. To strengthen the evidence base, future studies should pursue broader implementations of the intervention across varied educational contexts and utilize more rigorous methodologies such as quasi-experimental or longitudinal designs. These approaches can provide deeper insights into the replicability, scalability, and long-term impact of integrated strategies, such as the GameMapPro method. Ultimately, while action research is well-suited for localized, iterative improvement, more rigorous research designs are recommended to validate its findings on a broader scale.

5.0 Contributions of Authors

The authors declare equal contribution to all sections of this work and have reviewed and approved the final version.

6.0 Funding

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7.0 Conflict of Interests

The authors declared no conflicts of interest.

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