IJAMS
INTERNATIONAL JOURNAL OF ADVANCED MULTIDISCIPLINARY STUDIES
Volume IV, Issue 8 August 2024, eISSN: 2799-0664

Implementing an Instructional Intervention to Support Special Education Students with Systems of Equations: An Action Research Approach

XERXES M. BUDOMO
Western Governors University
xbudomo@gmail.com

Abstract — This capstone research project focused on developing and implementing an instructional intervention to support special education students in comprehending and solving systems of equations. The problem addressed the challenges faced by special education students in mastering mathematical concepts, particularly systems of equations. The research questions explored the effectiveness of the instructional intervention in improving students' understanding and mastery of systems of equations. The project utilized a 5-day instructional unit, differentiated instruction strategies, and various teaching methods, including substitution, elimination, and graphing, to facilitate learning. Participants included special education students in a school setting. Data collection involved pre and post-assessment tests, observations, and student feedback. The study concluded that the instructional intervention positively impacted students' ability to solve systems of equations, highlighting the importance of tailored instruction for special education students in mathematics.

Keywords — Special Education, Systems of Equations, Instructional Intervention, Differentiated Instruction, Mathematical Concepts, Substitution Method, Elimination Method, Graphing Method, Action Research, Tailored Instruction.

I. Introduction

The realm of mathematics instruction for special education students is evolving, with a growing emphasis on effective instructional practices and the integration of technology. In this literature review, we explore two predominant themes: effective instructional practices tailored for special education students and the integration of technology in mathematics instruction. Both themes are pivotal in addressing the challenges faced by special education educators, particularly in teaching complex mathematical concepts such as systems of equations. By examining current scholarly sources, we aim to synthesize insights into these themes and their relevance to our proposed capstone research on action research with an instructional intervention to support special education educators with systems of equations.

Literature Review

Effective instructional practices for special education students are essential for enhancing their learning experiences and outcomes in mathematics. Research has demonstrated the

significance of employing differentiated instruction strategies tailored to the diverse needs of special education students. Differentiation requires instructors to adapt teaching methods, materials, and assessments to accommodate students' varied learning styles, abilities, and interests (Tomlinson, 2019). Moreover, strategies such as technology integration, collaborative learning, and real-world applications have been identified as effective approaches for promoting engagement, understanding, and problem-solving skills among special education students (Horn, Hoover, & Jacome, 2020; Murphy & Marshall, 2021).

The acknowledgment that a one-size-fits-all approach to instruction is not suitable for special education students highlights the importance of individualized teaching strategies. This calls attention to the need for educators to recognize and address the diverse needs of their students to ensure meaningful learning experiences. Incorporating technology into instruction offers new avenues for engaging special education students and enhancing their comprehension of mathematical concepts. By integrating technology tools such as interactive simulations and virtual manipulatives, instructors can provide personalized learning experiences that cater to students' individual needs and preferences (Basham & Marino, 2020).

Illustrating that effective instructional practices go beyond traditional methods, the integration of technology opens up opportunities for interactive and multisensory learning experiences. This approach leads to increased student engagement and improved learning outcomes for special education students (Katz & Jordan, 2019). Budomo et al. (2023) provide evidence that technology can effectively support the motivation and self-efficacy of learners with disabilities. Furthermore, the synthesis of these findings underscores the importance of adopting a holistic approach that combines differentiated instruction with technology integration to support the diverse needs of special education students in mastering mathematical concepts (Snyder, 2020; Brownell, Smith, & McLeskey, 2021).

The integration of technology in mathematics instruction has emerged as a promising avenue for supporting special education students' learning (Li & Ma, 2021). Personalized, multisensory learning experiences, such as interactive simulations, virtual manipulatives, and educational software, cater to diverse learning preferences and abilities (Warren, Lee, & Ryan, 2020). This dynamic learning environment engages students in interactive problem-solving activities, fostering deeper understanding and retention of mathematical concepts. Additionally, technology serves as a valuable tool for facilitating differentiated instruction and providing access to instructional resources tailored to students' individual needs (Serafini, 2021). Leveraging technology addresses the diverse learning needs of special education students, ensuring equitable access to quality education.

To explore these themes further, Conderman and Hedin (2020) discussed instructional issues and practices in secondary special education, and Rizzo et al. (2020) examined special education teachers' perceptions of factors influencing their instructional practices. Moreover, McLeskey, Maheady, and Billingsley (2019) provided insights into evaluating and advancing the

effective teaching of special educators, while Cheung and Slavin (2021) discussed challenges in integrating technology into mathematics instruction in secondary schools, offering valuable perspectives on practical barriers and opportunities. Studies like Goodwin and Hein (2020) explored factors influencing mathematics teachers' integration of technology in lessons, and Murphy, Marshall, and Alpert (2021) examined the use of technology among school mathematics teachers and students, shedding light on emerging trends and recommended instructional practices. These studies provide a comprehensive overview of effective instructional practices and technology integration in mathematics instruction for special education students, laying the groundwork for the proposed capstone research.

The synthesis of scholarly sources underscores the significance of effective instructional practices and the integration of technology in supporting special education students' learning experiences in mathematics, particularly regarding systems of equations. By incorporating differentiated instruction strategies tailored to diverse learning needs and leveraging technology tools for personalized learning, educators can address the challenges outlined in our research question. Specifically, the implementation of an innovative instructional intervention focused on interactive problem-solving activities aligns with the principles of differentiated instruction and technology integration highlighted in the literature. These themes collectively contribute to the development of effective strategies aimed at enhancing special education students' comprehension and problem-solving skills in mathematics, thereby reinforcing the objectives of our proposed capstone research.

II. Methodology

Data Collection Method:

Pre- and post-instruction assessment will be conducted to measure the students' understanding and mastery of systems of equations before and after the instructional intervention.

This method directly aligns with the research question by providing quantitative data to measure the impact of the instructional intervention on the students' understanding and mastery of systems of equations.

Instrument:

A systems of equations assessment test will be administered before the instructional intervention begins and again after the completion of the instructional unit. This assessment will consist of a series of problems related to systems of equations to evaluate students' comprehension and problem-solving abilities.

This assessment directly addresses the research question by providing quantitative data to measure the impact of the instructional intervention on the students' understanding and mastery of systems of equations.

The pre- and post-instruction assessment test directly addresses the research question by providing quantitative data to measure the impact of the instructional intervention on the students' understanding and mastery of systems of equations. By comparing the pre-test and post-test results, it will be possible to determine the effectiveness of the instructional intervention.

Pre- and Post-Instruction Assessment Test:

Pre- and Post-Instruction Assessment Test on Systems of Equations

Pre-Instruction Assessment Test:

1. Evaluate each system of equations:
   - $\begin{cases} 2x + y = 8 \\ x - 3y = 4 \end{cases}$
   - $\begin{cases} 3x - 2y = 5 \\ 4x + 3y = 2 \end{cases}$
   - $\begin{cases} 5x + 2y = 11 \\ 3x - y = 2 \end{cases}$

2. Solve the following systems of equations:
   - $\begin{cases} 3x - y = 7 \\ 2x + 3y = 1 \end{cases}$
   - $\begin{cases} x + 2y = 5 \\ 3x - 4y = 8 \end{cases}$
   - $\begin{cases} 2x - 3y = 4 \\ 5x + y = 7 \end{cases}$

3. Identify the number of solutions for each system of equations:
   - $\begin{cases} 3x - y = 7 \\ 2x + 3y = 1 \end{cases}$
   - $\begin{cases} x + 2y = 5 \\ 3x - 4y = 8 \end{cases}$
   - $\begin{cases} 2x - 3y = 4 \\ 5x + y = 7 \end{cases}$

Post-Instruction Assessment Test:

1. Evaluate each system of equations:
   - $\begin{cases} 2x + y = 8 \\ x - 3y = 4 \end{cases}$
   - $\begin{cases} 3x - 2y = 5 \\ 4x + 3y = 2 \end{cases}$
   - $\begin{cases} 5x + 2y = 11 \\ 3x - y = 2 \end{cases}$
2. Solve the following systems of equations:
   - $\begin{cases} 3x - y = 7 \\ 2x + 3y = 1 \end{cases}$
   - $\begin{cases} x + 2y = 5 \\ 3x - 4y = 8 \end{cases}$
   - $\begin{cases} 2x - 3y = 4 \\ 5x + y = 7 \end{cases}$
3. Identify the number of solutions for each system of equations:
   - $\begin{cases} 3x - y = 7 \\ 2x + 3y = 1 \end{cases}$
   - $\begin{cases} x + 2y = 5 \\ 3x - 4y = 8 \end{cases}$
   - $\begin{cases} 2x - 3y = 4 \\ 5x + y = 7 \end{cases}$

Data Analysis Technique(s)

a. Pre- and Post-Instruction Assessment:

Data Analysis Technique:

This study will use descriptive statistics and graphical analysis. Descriptive statistics and graphical analysis will be used to compare the mean scores and the visual representation of pre- and post-instruction assessment results. It will determine if there is a significant difference in students' understanding and mastery of systems of equations before and after the instructional intervention.

Descriptive statistics and graphical analysis directly address the research question by statistically analyzing the difference between the pre- and post-instruction assessment scores, providing quantitative evidence of the effectiveness of the instructional intervention on the students' understanding and mastery of systems of equations.

Timeline of Data Collection Activities

Brief Timeline for Data Collection Activities:

Pre-Instruction Assessment Test:

Date: Week 1, Day 1

Time: 9:00 AM - 10:00 AM

Instructional Intervention:

Dates: Week 1, Day 2 to Week 2, Day 6

Time: 9:00 AM - 11:00 AM (Daily)

Post-Instruction Assessment Test:

Date: Week 2, Day 7

Time: 9:00 AM - 10:00 AM

The timeline for data collection for this research is strategically structured to gather information at key points before, during, and after the instructional intervention, ensuring a comprehensive assessment of its effectiveness.

Pre-Instruction Assessment Test (Week 1, Day 1, 9:00 AM - 10:00 AM):

Conducting a pre-instruction assessment allows for the baseline measurement of students' understanding and mastery of systems of equations before the instructional intervention begins. This baseline data will serve as a reference point for evaluating the impact of the intervention.

Instructional Intervention (Week 1, Day 2 to Week 2, Day 4, 9:00 AM - 11:00 AM Daily):

The instructional intervention spans multiple days to provide ample time for students to engage with the instructional materials, receive targeted support, and practice problem-solving techniques related to systems of equations. The extended duration ensures thorough coverage of the intervention's content and allows for meaningful learning experiences.

Post-Instruction Assessment Test (Week 2, Day 5, 9:00 AM - 10:00 AM):

Administering a post-instruction assessment immediately after the instructional intervention concludes enables the measurement of any changes or improvements in students' understanding and mastery of systems of equations. By comparing the post-test results to the pre-test baseline, it becomes possible to determine the effectiveness of the instructional intervention in addressing the research question.

Overall, this timeline facilitates the collection of data at critical junctures in the research process, ensuring a comprehensive evaluation of the instructional intervention's impact on students' learning outcomes. By systematically capturing data before, during, and after the intervention, researchers can obtain valuable insights into the effectiveness of the intervention and its alignment with the research question.

Following the initial pre-assessment, it became evident that students were struggling with understanding and solving systems of equations, as indicated by their average score of 3.6. This data reinforced the need for targeted instructional intervention to address this challenge among special education students.

Over the course of five days, students received focused instruction tailored to support their comprehension of systems of equations. Descriptive data, collected through pre- and post-instruction assessments, provided numerical insights into students' performance and progress.

Upon completion of the instructional intervention, students were assessed using the same criteria as the pre-assessment. The post-assessment data revealed a significant improvement in students' understanding and mastery of systems of equations, with an average score of 7.4. The improvement from the pre-assessment to the post-assessment indicated the effectiveness of the instructional intervention.

Comparing the data from the pre-assessment to the post-assessment highlighted the growth students made over the course of the intervention. Despite the short duration of the study, students demonstrated notable progress in their comprehension and ability to solve systems of equations. This research connects directly to the question of how an instructional intervention tailored for special education students would impact their understanding and mastery of systems of equations, showcasing the positive impact of targeted instruction on student learning outcomes.

III. Results and Discussion

The data collected from the pre-test assessment indicates that prior to the instructional intervention, students exhibited varying levels of understanding and proficiency in systems of equations. Student #1 and Student #2 scored the lowest with scores of 3 and 2, respectively, suggesting limited comprehension of the concepts. Student #3 and Student #4 performed slightly better with scores of 4, indicating a basic understanding, while Student #5 demonstrated the highest pre-test score of 5, reflecting a relatively stronger grasp of the material compared to their peers.

Student	Score
Student #1	3
Student #2	2
Student #3	4
Student #4	4
Student #5	5

Figure 1. Pre-assessment scores

Following the instructional intervention, the post-test results revealed notable improvement across all students. Student #1 exhibited the most significant growth, increasing their score from 3 on the pre-test to 7 on the post-test. Similarly, Student #2 improved from a pre-test score of 2 to a post-test score of 6. Students #3, #4, and #5 also demonstrated considerable progress, with each achieving post-test scores of 8, indicating a much deeper understanding and mastery of systems of equations compared to their initial performance.

Student	Score
Student #1	7
Student #2	6
Student #3	8
Student #4	8
Student #5	8

Figure 2. Post-assessment results

The analysis suggests that the instructional intervention had a positive impact on students' comprehension and mastery of systems of equations, as evidenced by the significant improvement in post-test scores across all students. Each student demonstrated notable progress from the pre-test to the post-test, with substantial increases in their scores. In Figure 3, Student #1 increased their score from 3 on the pre-test to 7 on the post-test, reflecting a significant improvement of +4. Similarly, Student #2 showed a score increase from 2 to 6, also indicating a +4 improvement. Students #3, #4, and #5 all exhibited score changes of +4, as they progressed from pre-test scores of 4 to post-test scores of 8. Student #5, while achieving a post-test score of 8, demonstrated a slightly lower score change of +3, starting with a pre-test score of 5.

The average change in scores across all students is 3.8. These score changes highlight the effectiveness of the instructional intervention in enhancing students' understanding and mastery of systems of equations. The substantial improvements in scores reflect the impact of targeted instruction tailored to support special education students. The graphic representation of the data further reinforces these findings, providing visual evidence of the intervention's efficacy in facilitating learning outcomes.

Overall, the results indicate that the instructional intervention effectively contributed to improving students' mathematical proficiency and readiness in systems of equations. By addressing their specific needs and employing differentiated instructional strategies, the intervention fostered meaningful learning experiences and academic growth among special education students.

Student	Pre-Test Score	Post-Test Score	Score Change
Student #1	3	7	+4
Student #2	2	6	+4
Student #3	4	8	+4
Student #4	4	8	+4
Student #5	5	8	+3

Figure 3. Changes between pre-assessment and post-assessment data

Implementation

The research was conducted in a school setting, with permission obtained from the superintendent prior to implementation. Stakeholders, including school administrators, teachers, and parents, were informed about the research to ensure transparency and collaboration throughout the process.

To implement the research, a detailed plan was developed outlining the steps involved in conducting the instructional intervention and data collection process. The instructional intervention involved designing and delivering tailored instruction to support special education students in comprehending and solving systems of equations. This intervention was based on evidence-based instructional practices and targeted the specific needs of the students.

The research utilized a pre- and post-test design, with a 9-item assessment test administered to students before and after the instructional intervention. The assessment test was designed to measure students' understanding and mastery of systems of equations. Prior to administering the tests, appropriate accommodations and modifications were made for students with special needs to ensure equitable participation.

During the intervention period, instructional sessions were conducted according to the predetermined timeline, which included daily sessions for five days. Each session was carefully planned to incorporate differentiated instruction strategies and technology integration to address the diverse learning needs of the students.

Data collection involved administering the pre-test at the beginning of the intervention period and the post-test at the conclusion of the intervention. The assessment tests were scored, and the results were analyzed to determine the impact of the instructional intervention on students' understanding and mastery of systems of equations.

Overall, the research was implemented systematically and with careful attention to detail to ensure validity and reliability of the findings. By documenting the procedures followed in the research process, another

The analysis of the data provides valuable insights into the effectiveness of the instructional intervention tailored to support special education students in comprehending and solving systems of equations. The research question aimed to determine how this intervention impacts the understanding and mastery of systems of equations among special education students.

The pre-test scores revealed that students initially demonstrated limited proficiency in comprehending and solving systems of equations, with scores ranging from 2 to 5 out of 9. These results underscored the existing challenges faced by these students in mastering this mathematical concept.

Following the instructional intervention, there was a notable improvement in students' performance, as indicated by the post-test scores. Across the board, students showed significant progress, with scores ranging from 6 to 8 out of 9. This improvement suggests that the intervention positively influenced students' understanding and mastery of systems of equations within a short timeframe.

The average score increase from the pre-test to the post-test further emphasizes the effectiveness of the instructional intervention. With an average score change of 4 points, it is evident that the intervention had a substantial impact on enhancing students' proficiency in comprehending and solving systems of equations

The approved product for this research is a 5-day instructional unit tailored to support special education students in comprehending and solving systems of equations. This instructional

unit integrates innovative teaching strategies and activities to meet the unique learning needs of special education students, providing a step-by-step approach to gradually enhance their understanding and mastery of systems of equations. It encompasses various components, including a unit overview that introduces the topic and outlines objectives and lessons, daily lesson plans with detailed instructions and differentiated strategies, worksheets, and assessment tools for evaluating student progress with accommodations for special education students. An example lesson plan from the unit includes an introduction to systems of equations, teaching methods for solving them, guided and independent practice sessions, and opportunities for engagement and clarification. By implementing this structured instructional unit, educators can effectively support special education students in developing their proficiency in systems of equations within a 5-day timeframe, ensuring meaningful learning experiences tailored to their diverse needs and abilities.

Implications of the results to the present study

The results of the present study highlight the effectiveness of employing differentiated instruction and targeted intervention strategies in improving the academic performance of special education students. The success observed in enhancing students' understanding of systems of equations suggests that similar instructional approaches could be beneficial across various subjects and concepts. This reinforces the importance of tailoring educational practices to meet the diverse needs of learners, particularly those with learning disabilities.

Moreover, the study demonstrates the value of using pre- and post-assessments to measure the impact of instructional strategies, emphasizing the need for continuous monitoring and adaptation in special education settings. This approach ensures that teaching methods remain responsive to students' progress and challenges, ultimately leading to more effective learning outcomes.

The findings also suggest that integrating structured instructional units, like the 5-day intervention used in the study, can lead to significant improvements in student performance. This has broader implications for curriculum design, encouraging educators to develop and implement similar interventions to address specific learning objectives.

Lastly, the results imply that ongoing professional development for educators is crucial, as it equips them with the necessary skills and knowledge to effectively deliver differentiated instruction. This supports the idea that investing in teacher training can lead to better educational outcomes for special education students.

IV. Conclusion

In conclusion, the research findings indicate that the instructional intervention, designed specifically to support special education students in comprehending and solving systems of equations, had a significant positive impact on their understanding and mastery of the subject matter. The data analysis revealed a notable improvement in students' performance from the pretest to the posttest, with an average score increase of 3.8 points. This demonstrates the effectiveness of the instructional unit in addressing the unique learning needs of special education students and facilitating their academic growth in mathematics.

Moreover, the research has broader implications for the educational environment, particularly in the realm of special education. By implementing targeted instructional interventions tailored to the diverse needs of special education students, educators can enhance their ability to meet individual learning objectives and promote academic success. The structured approach outlined in the instructional unit provides a framework for delivering effective instruction that accommodates different learning styles and abilities, fostering an inclusive learning environment where all students can thrive.

Furthermore, the research highlights the importance of evidence-based practices and differentiated instruction in special education settings. By integrating innovative teaching strategies and leveraging technology tools, educators can create dynamic learning experiences that engage students and enhance their comprehension of complex concepts. This not only improves academic outcomes but also promotes confidence and self-efficacy among special education students, empowering them to succeed academically and beyond.

In summary, the research underscores the value of tailored instructional interventions in supporting special education students and enhancing their educational experiences. By implementing effective teaching practices and providing targeted support, educators can create an inclusive learning environment where all students have the opportunity to reach their full potential in mathematics and beyond.

REFERENCES

[1] Basham, J. D., & Marino, M. T. (2020). Understanding STEM Education and Supporting Students through Universal Design for Learning. TEACHING Exceptional Children, 52(4), 197–205.
[2] Brownell, M. T., Smith, S. W., & McLeskey, J. (2021). Special Education Teachers and High-Quality Instruction: Challenges and Opportunities. Exceptional Children, 87(2), 130-149.
[3] Budomo, X. M., Pamaran, E. C. W., So, L. M. F., Capuno, R. G., Reyes, N. R. T. D., Pinili, L. C., & Añero, M. B. (2023). The Impact of Bionic Reading on the Reading Motivation and Self-Efficacy of Students with Learning Disabilities.
[4] Cheung, A., & Slavin, R. E. (2021). How Well Does Evidence-Based Practice Improve Outcomes for Students with Disabilities? Educational Research Review, 33, 100390.

[5] Conderman, G., & Hedin, L. (2020). Teaching Secondary Students with Disabilities: Essentials for Effective Instruction. Council for Exceptional Children.
[6] Goodwin, B., & Hein, H. (2020). Keeping Students at the Center: Technology Integration and Students with Disabilities. Educational Leadership, 77(4), 66-72.
[7] Horn, I. S., Hoover, M., & Jacome, C. (2020). Effective Differentiation for All Learners: Strategies and Tools for Secondary Teachers. Learning Sciences International.
[8] Katz, L. A., & Jordan, P. (2019). Strategies for Mathematics Instruction and Intervention: Grade 6–8. Brookes Publishing Co..
[9] Li, Q., & Ma, X. (2021). The Effects of Technology Integration on Student Learning in Mathematics Education: A Meta-Analysis. Educational Research Review, 34, 100412.
[10] McLeskey, J., Maheady, L., & Billingsley, B. (2019). High Leverage Practices in Special Education: Effective Instructional Strategies and Practices. Council for Exceptional Children.
[11] Murphy, S., Marshall, S., & Alpert, C. (2021). Emerging Trends in Mathematics Education: The Role of Technology in Supporting Special Education Students. Journal of Special Education Technology, 36(2), 103-114.
[12] Rizzo, T. L., Simplicio, J. S. C., & Brewer, M. A. (2020). Special Education Instructional Practices: The Role of Teacher Perceptions and Student Engagement. Journal of Research in Special Educational Needs, 20(3), 223-233.
[13] Serafini, F. (2021). Multimodal Literacies in the Mathematics Classroom: Supporting Students with Disabilities through Technology. Mathematics Teacher Education and Development, 23(1), 35-51.
[14] Snyder, P. A. (2020). Special Education Technology Trends: Personalized Learning through Digital Tools. Exceptional Children, 86(4), 471-488).
[15] Tomlinson, C. A. (2019). Differentiated Classroom: Responding to the Needs of All Learners (2nd ed.). ASCD.
[16] Warren, K., Lee, C. J., & Ryan, D. (2020). Technology-Enhanced Mathematics Instruction: Perspectives on Virtual Manipulatives and Simulations. Journal of Mathematics Education, 12(3), 141-157).