Teachers' Use of Assure Model Instructional Design on Learners' Problem Solving Efficacy in Secondary Schools in Bungoma County, Kenya

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ABSTRACT

Mathematical problem-solving skills are a critical competency for secondary school learners, yet many students struggle with applying conceptual knowledge to real-world scenarios. This study investigated the effect of the ASSURE instructional design model on learners' mathematical problem-solving efficacy in secondary schools within Bungoma County, Kenya. Grounded in John Dewey's Cognitive Constructivism Theory, the research employed a descriptive survey design to examine four key dimensions: teachers' analysis of learners' entry behavior, utilization of instructional resources, teacher-learner engagement, and classroom evaluation approaches.

The study population comprised principals, mathematics teachers, and Form Three students from 53 public secondary schools in Bungoma North Sub-County. A sample of 280 teachers and 378 students was selected from categorized schools (extra-county, county, and sub-county tiers). Data was collected using questionnaires, student tests, and principal interviews. Instruments were validated through pilot testing, and data was analyzed using descriptive statistics, presented in tables, charts, and text.

Key findings revealed that teacher responsiveness to learners' prior knowledge significantly enhanced instructional outcomes ($\beta = 0.37$, *p* < .05), though diagnostic assessments were underutilized (56.7% of teachers rarely conducted them). Customized instructional materials improved problem-solving skills ($\beta = 0.37$, *p* < .001), while excessive reliance on technology had a negative impact ($\beta = -0.31$, *p* < .001). Student-led explanations of problem-solving processes were highly effective ($\beta = 0.55$, *p* < .001), whereas teacher modeling ($\beta = -0.33$, *p* < .001) and unstructured group work ($\beta = -0.19$, *p* = .02) were counterproductive. A notable perception gap emerged in assessment practices: 93.2% of teachers rarely used formative assessments, yet 69.9% of students believed their progress was regularly monitored.

Based on these findings, the study recommends targeted teacher training in diagnostic assessments and differentiated instruction to address diverse learning needs. It advocates for strategic technology integration (e.g., GeoGebra) aligned with Bloom's Taxonomy and structured collaborative learning protocols (e.g., defined roles, rubrics) to enhance group work. These recommendations support Kenya's Competency-Based Curriculum (CBC), highlighting the ASSURE model's potential to improve instructional design and problem-solving competency. The study underscores the need for systemic reforms in teacher professional development and evidence-based assessment practices to bridge gaps between teaching strategies and learning outcomes in mathematics education

INTRODUCTION

The ASSURE model of instructional design provides a systematic framework for planning and delivering instruction, emphasizing learner analysis, objective setting, method selection, media utilization, learner participation, and evaluation (Heinich et al., 2002). In an era where mathematical proficiency is indispensable for technological and economic advancement (OECD, 2019), fostering problem-solving skills in secondary education has become a global priority. However, persistent challenges in mathematics education, particularly

in low- and middle-income countries, hinder the development of these critical competencies (UNESCO, 2021).

Recent empirical studies highlight the transformative potential of structured instructional models like ASSURE in addressing these challenges. For instance, Adi et al. (2022) demonstrated its efficacy in enhancing financial literacy among elementary students through tailored lesson design, while Al-Khattat et al. (2021) reported significant improvements in higher-order thinking skills when the model was integrated with active learning strategies. These findings align with broader research underscoring the importance of diagnostic assessments and differentiated instruction in mathematics education (Wiliam, 2018; Boaler, 2022).

In Kenya, the urgency of reforming mathematics instruction is underscored by consistently low performance in national examinations. The Kenya Certificate of Secondary Education (KCSE) results reveal stagnant mean scores in mathematics, with Bungoma North Sub-County recording scores below the national average (MOEST, 2023). This trend persists despite curricular reforms such as the Competency-Based Curriculum (CBC), which emphasizes problem-solving and critical thinking (KICD, 2020). As shown in table 1 and 2

Table 1: National mean -score for mathematics KCSE

Year	Mean score
2020	**29.53**
2021	**30.35**
2022	**31.25**
2023	**32.10**

Source – Knec Results analysis 2022

The same trend was evidenced in Bungoma North sub-county where students attained very low marks/ mean score in mathematics. The mean score for the four (4) years was as follows:

Table 2: Mean Score for Mathematics KCSE in Bungoma North

Year	Mean score
2020	**30.75**
2021	**27.25**
2022	**29.30**
2023	**29.10**

Source – Knec Results analysis 2022

Globally, technology-assisted learning has emerged as a promising avenue for improving mathematical proficiency. Recent studies, such as those by Shelton et al. (2021), found that digital game-based learning enhanced problem-solving skills among diverse student populations, while Parvez et al. (2022) reported similar benefits in low-resource settings through adaptive mobile learning tools. However, the effectiveness of such interventions hinges on thoughtful integration, as excessive reliance on technology can detract from conceptual understanding (Clark & Mayer, 2023).

This study bridges a critical gap by examining the ASSURE model's application in Kenya's secondary schools, where teacher-centered methods remain prevalent (Muguna, 2020). By focusing on Bungoma County—a region emblematic of systemic challenges in mathematics education—it offers insights into how structured instructional design can enhance problem-solving efficacy. The findings contribute to ongoing debates about pedagogical

reform and provide actionable recommendations for aligning teaching practices with the demands of 21st-century education.

Statement of the Problem

A persistent decline in mathematics performance has been observed in secondary schools across Bungoma North Sub-County over several years, as evidenced by the Bungoma North Sub-County Education Board Results Analysis Reports (2018–2022). This downward trend raises concerns about the underlying challenges hindering effective mathematics teaching and learning. Key issues include students' lack of problem-solving skills, varying learning abilities, inadequate use of instructional materials, and overreliance on traditional teaching methods such as the lecture approach (Twoli et al., 2017).

Despite being a compulsory subject in the Kenyan curriculum (Ministry of Education Syllabus, 2019), mathematics instruction continues to face significant challenges in achieving desired learning outcomes. Given the critical role of mathematics in students' academic progression, career opportunities, and daily life, there is a pressing need to explore innovative teaching strategies that can enhance problem-solving skills and overall performance.

This study, therefore, seeks to investigate the effect of the ASSURE model a systematic instructional design approach on developing learners' mathematical problem-solving skills and improving academic performance. Specifically, it aims to examine how teachers' analysis of learners' entry behavior influences classroom instruction.

Findings

Concerning the analysis of learners' entry behavior and its influence on classroom instruction the analysis of learners' entry behavior, as reflected in the responses of both teachers and students provide valuable insights into how prior knowledge, learning styles, and prerequisite skills are considered in mathematics instruction. These findings shed light on the alignment (or lack thereof) between teachers' instructional practices and students'

perceptions of those practices.

Teachers' Responses on analysis of learners' entry behavior

This section provides the analyzed information on teachers' perception about analysis of leaners entry behavior on classroom instruction.

Table 3: Teacher's Responses on Analysis of Learners' Entry Behavior

	N	Mean	Never	Rarely	Sometimes	Often	Always
I assess students' prior knowledge before introducing new mathematical concept	178	2.44	35.40%	3.90%	42.10%	18.50%	0.00%
I modify my lesson plans based on students' entry behavior	178	2.15	33.10%	38.80%	7.90%	20.20%	0.00%
I use diagnostic tests to identify students' strengths and weaknesses in mathematics	178	1.99	28.70%	55.60%	3.90%	11.80%	0.00%
I consider students' learning styles when planning my lessons	178	1.74	46.60%	32.60%	20.80%	0.00%	0.00%

The Table highlights teachers' self-reported practices regarding learners' entry behavior and how these influence their instructional approaches. The data suggests varying levels of engagement with strategies aimed at assessing and addressing students' prior knowledge, learning styles, and prerequisite skills. These self-reported activities include the following.

Assessing Students' Prior Knowledge

Teachers reported moderate engagement in assessing students' prior knowledge before introducing new mathematical concepts. While 42.1% indicated they "sometimes" assess prior knowledge, only 18.5% reported doing so "often," and none claimed to do so "always." Notably, a significant proportion (35.4%) admitted they "never" assess prior knowledge. This suggests that while some teachers recognize the importance of assessing prior knowledge, it is not consistently practiced across the board.

Modifying Lesson Plans Based on Entry Behavior

The mean score for modifying lesson plans based on students' entry behavior was lower indicating infrequent application of this practice. A notable 33.1% of teachers reported "never" modifying their lesson plans, while 38.8% said they "rarely" did so. Only 20.2% indicated they "often" adjusted their plans based on entry behavior, and none reported doing so "always." reflecting a tendency toward lower engagement in this practice.

Using Diagnostic Tests

Teachers showed limited use of diagnostic tests to identify students' strengths and weaknesses in mathematics being the lowest among the items analyzed. Over half (55.6%) reported "rarely" using diagnostic tests, while 28.7% admitted to "never" using them at all. Only a small fraction (11.8%) indicated they "often" used diagnostic tests, suggesting that this practice is not widely implemented despite its potential benefits for tailoring instruction.

Considering Students' Learning Styles

The consideration of students' learning styles during lesson planning received minimal engagement in this practice by teachers. Nearly half (46.6%) reported "never" considering learning styles, while another 32.6% said they "rarely" did so. None of the respondents indicated they "often" or "always" accounted for learning styles when planning lessons, highlighting a significant gap in differentiated instruction.

Adjusting Instructional Pace

Adjusting the pace of instruction based on students' understanding of prerequisite skills also scored low. A majority (56.7%) reported "rarely" adjusting the pace, while another 32.6% said they "never" did so. Only 6.7% indicated they "often" adjusted instructional pacing, underscoring limited responsiveness to students' varying levels of understanding. Overall, the findings suggest that teachers generally acknowledge the importance of assessing entry behavior but struggle to consistently implement related practices such as diagnostic testing, differentiated instruction based on learning styles, and adjusting lesson plans or pacing.

Learners' responses on influence of teachers' analysis of learners' entry behavior on development of problem-solving skills in classroom instruction

This section provides the analyzed information on students' perception about leaners entry behavior on classroom instruction.

Learners' responses on Teachers' Analysis of Learners' Entry Behaviour

	N	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
My mathematics teacher gives a test before introducing new topics.	234	26.5	9.6	1.2	26.5	36.1
The teacher adjusts the lesson difficulty based on our understanding of previous concepts.	234	6	22.9	9.6	30.1	28.9
I feel that my teacher understands my strengths and weaknesses in mathematics.	234	27.7	4.8	7.2	39.8	20.5
The teacher provides additional support when I struggle with prerequisite skills.	234	7.2	10.8	6	38.6	36.1
New mathematical concepts are introduced in a way that connects	234	8.4	12	9.6	31.3	37.3

The findings in the table presents students' perceptions of their teachers' practices regarding entry behavior in mathematics instruction. This offers an alternative perspective to the self-reported data from teachers that was presented in the previous section.

Testing learners before introducing a new topic

Students perceived moderate engagement by their teachers in giving tests before introducing new topics. While 36.1% strongly agreed that their teachers administered pre-topic tests and another 26.5% agreed, a significant proportion (26.5%) strongly disagreed with this statement, indicating inconsistency across classrooms.

Adjusting lesson difficulty based on learners' understanding

Students rated their teachers slightly higher on adjusting lesson difficulty based on their understanding of previous concepts. Nearly one-third (30.1%) agreed with this statement, while another 28.9% strongly agreed suggesting that some teachers are responsive to students' needs in this regard despite the low teacher-reported frequency.

Understanding learners' strengths and weaknesses

Students provided mixed feedback on whether their teachers understood their strengths and weaknesses in mathematics. While nearly half (39.8%) agreed and another 20.5% strongly agreed with this statement, a notable proportion strongly disagreed (27.7%), indicating variability in teacher-student relationships and perceptions.

Providing additional support for prerequisite skills

Students perceived relatively high levels of support from their teachers when struggling with prerequisite skills. Over one-third strongly agreed (36.1%), while another significant portion agreed (38.6%). This contrasts sharply with teacher-reported data regarding adjusting instructional pace or modifying lesson plans based on entry behavior.

Connecting new concepts to learners' prior knowledge

learners rated their teachers highly on introducing new mathematical concepts in ways that connect to prior knowledge. A substantial proportion strongly agreed (37.3%), while another third agreed (31%). This suggests that many students recognize efforts by their teachers to build upon existing knowledge during instruction.

Comparative analysis of teachers and learners' analysis of learners' entry behavior and its effect on development of mathematics problem solving skills

The comparative analysis between teacher-reported practices and student perceptions reveals several important discrepancies that warrant closer examination. Regarding assessment practices, while teachers self-report indicated limited use of diagnostic tests and formal assessments to evaluate prior knowledge with only 11.8% frequently using such tools, students perceived a significantly higher level of pre-instruction testing, as evidenced by 36.1% strongly agreeing that their teachers administered tests before introducing new topics. This notable gap suggests either that teachers may be implementing more informal assessment strategies than they recognize in their reporting, or that students may be interpreting various classroom activities as assessment measures when teachers do not formally categorize them as such.

The divergence becomes even more pronounced when examining lesson modification practices. Teacher reports indicated infrequent adjustments to lesson plans based on entry behavior with only 20.2% doing so often and minimal adaptation of instructional pace with just 6.7% frequently adjusting. However, student perceptions painted a different picture, with 59% agreeing that teachers tailored lesson difficulty to their understanding levels. This apparent contradiction could stem from teachers making subtle, perhaps even subconscious, adjustments to their teaching that they don't formally acknowledge in self-reports, while students readily perceive these adaptations as intentional modifications to support their learning.

A similar pattern emerges in the area of prerequisite skill support. Teacher responses suggested minimal systematic intervention for addressing skill gaps, yet a substantial 74.7% of students reported feeling adequately supported when struggling with foundational concepts. This discrepancy might indicate that while teachers may not be implementing structured remediation programs, they are nonetheless providing effective informal support that students recognize and appreciate.

The most consistent alignment between teacher practices and student perceptions appears in the area of connecting new concepts to prior knowledge. While teacher engagement in this practice was moderate as indicated by the 18.5% who often assess prior knowledge, students highly valued these connections with 68.6% positive responses. This relative congruence suggests that when teachers do implement entry behavior strategies, conceptual linking emerges as both a frequently used and particularly noticeable practice from the student perspective. The consistency in this area highlights it as a potential strength in current instructional approaches and a promising foundation for building more comprehensive entry behavior assessment systems.

CONCLUSION

The analysis of learners' entry behavior based on teachers' and learners' responses reveals significant gaps between instructional practices and learner perceptions in mathematics education. Teachers reported limited engagement in assessing prior knowledge, using diagnostic tests, modifying lesson plans, and adjusting instructional pace based on prerequisite skills. Conversely, learners perceived moderate efforts by teachers to administer pre-topic tests, tailor lesson difficulty, and provide additional support for foundational skills. While both groups acknowledged the importance of connecting new concepts to prior knowledge, the overall alignment between teacher practices and student experiences remains inconsistent. There is need for alignment of the prior analysis of learners' entry behavior to permit for effective instructional practices in mathematics with emphasis on enhancing learners' problem-solving competencies.

REFERENCES

1. Adi, H. S., Haryono, H., & Sulistyorini, S. (2021). The development of instructional design using ASSURE model in mathematics for elementary school to improve financial literacy. Journal of Curriculum Indonesia, 4(1), 30-42.
2. Akyeampong, K., Pryor, J., & Ampiah, J. G. (2006). Teacher training in Ghana: Does it count? Multi-site Teacher Education Research Project (MUSTER) Country Report. University of Sussex.
3. Akyeampong, K., Pryor, J., & Westbrook, J. (2011). Teacher training and professional development in Sub-Saharan Africa: Learning from experience. Education Research and Perspectives, 38(1), 1-15.

4. Al-Khattat, S. H. K., Habeeb, R. R., & Mohammed, A. R. (2019). An ASSURE-Model Instructional Design Based on Active Learning Strategies and its Effect for 1st Intermediate Student's Higher Order Thinking Skills in Teaching Science Text Book. psihologija, 52(5).

5. Bailey, J. (2019). Experiencing a mathematical problem-solving teaching approach: Opportunity to identify ambitious teaching practices. Mathematics Teacher Education and Development, 17(2), 111–124.

6. Bavli, B., & Erişen, Y. (2015). Designing PCM instruction by using ASSURE instructional design model. International Journal on New Trends in Education and Their Implications, 6(3), 27-40.

7. Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. Educational Assessment, Evaluation and Accountability, 21(1), 5-31.

8. Boaler, J. (2016). Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching. Jossey-Bass.

9. Brookhart, S. M. (2017). How to give effective feedback to your students (2nd ed.). ASCD.

10. Bruner, J. S. (1966). Toward a theory of instruction. Harvard University Press.

11. Carbonneau, K. J., Marley, S. C., & Selig, J. P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. Journal of Educational Psychology, 105(2), 380–400.

12. Chen, I. (2011). Instructional design methodologies. In Instructional design: Concepts, methodologies, tools and applications (pp. 80-94). IGI Global.

13. Clymer, E. W. (2007). The ASSURE Model of Instructional Design. Recuperado El, 6.

14. Cobb, P., Yackel, E., & McClain, K. (Eds.). (2012). Symbolizing and communicating in mathematics classrooms: Perspectives on discourse, tools, and instructional design. Routledge.

15. Darling-Hammond, L., & Adamson, F. (2014). Beyond the bubble test: How performance assessments support 21st century learning. John Wiley & Sons.

16. Hattie, J., & Timperley, H. (2007). The power of feedback. Review of Educational Research, 77(1), 81-112.

17. Heinich, R., Molenda, M., Russell, J. D., & Smaldino, S. E. (2002). Instructional media and technologies for learning (7th ed.). Pearson.

18. Hou, H. T., & Keng, S. H. (2021). A dual-scaffolding framework integrating peer-scaffolding and cognitive-scaffolding for an augmented reality-based educational board game: An analysis of learners' collective flow state and collaborative learning behavioral patterns. Journal of Educational Computing Research, 59(3), 547-573

19. Hu, H. W., Sasse, G., & Hsiao, W. Y. (2016, March). Teaching a Mathematics Education Course via Distance with ASSURE Model. In Society for Information Technology & Teacher Education International Conference (pp. 2511-2516). Association for the Advancement of Computing in Education (AACE).

20. Ibrahim, A. A. (2015). Comparative analysis between system approach, Kemp, and ASSURE instructional design models. International Journal of Education and Research, 3(12), 261-270.

21. Kafyulilo, A., Fisser, P., & Voogt, J. (2015). Investigating teachers perceived self-efficacy and attitudes towards ICT integration in teaching mathematics. Educational Technology Research and Development, 63(4), 603-620.

22. Kariuki, P. W., & Mbugua, Z. K. (2021). The effect of instructional resources on students' performance in mathematics in Kenyan secondary schools. International Journal of Education and Research, 9(2), 45-56.

23. Kenya National Examinations Council. (2019). KCSE examination report. KNEC.

24. Kim, D., & Downey, S. (2016). Examining the Use of the ASSURE Model by K–12 Teachers. Computers in the Schools, 33(3), 153-168.

25. Mbugua, Z. K., Kibet, K., Muthaa, G. M., & Nkonke, G. R. (2012). Factors contributing to students' poor performance in mathematics at Kenya Certificate of Secondary Education in Kenya: A case of Baringo County, Kenya. American International Journal of Contemporary Research, 2(6), 87-91.

26. Mutai, B. K. (2015). ICT integration in mathematics teaching and learning in secondary schools in Kenya. International Journal of Education and Development using ICT, 11(2), 44-60.

27. Njiru, B. K. (2015). Influence of formative evaluation on learner performance in Mathematics in Secondary Schools in Embu County, Kenya (Doctoral dissertation, University of Nairobi).

28. Ogunleye, B. (2013). Effects of instructional materials on students' academic achievement in mathematics in selected secondary schools in Oyo State, Nigeria. International Journal of Academic Research in Progressive Education and Development, 2(1), 1-11.

29. Orodho, J. A. (2017). Techniques of writing research proposals and reports in education and social sciences. Kanezja Publishers.

30. Sadler, D. R. (1989). Formative assessment and the design of instructional systems. Instructional Science, 18(2), 119-144.

31. Smaldino, S. E., Lowther, D. L., & Russell, J. D. (2015). Instructional technology and media for learning (11th ed.). Pearson.

32. Wambugu, P. W., & Changeiywo, J. M. (2008). Effects of mastery learning approach on secondary school students' physics achievement. Eurasia Journal of Mathematics, Science & Technology Education, 4(3), 293-302.