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Educational Narratives of a Media-Supported ASSURE–SPUR Design for Systematic and Multidimensional Fraction Learning in Grade V Elementary School

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ABSTRACT

Background. Fraction learning in elementary school often remains centred on computational procedures, while conceptual understanding, real-world use, and visual representation receive less systematic attention.

Purpose. This study aimed to develop and evaluate a media-supported ASSURE–SPUR learning design for fraction multiplication in Grade V elementary school.

Method. The study used a design-based research approach consisting of needs analysis, design planning, expert validation, limited classroom implementation, revision, and evaluation. Data were collected through teacher interviews, curriculum document analysis, expert validation sheets, classroom observations, student worksheets, student and teacher response questionnaires, and analysis of students' work.

Results. The needs analysis showed that students could often follow computational steps but struggled to explain the meaning of fraction operations, connect symbolic forms with visual models, and apply fractions in contextual situations. The developed design integrated the instructional stages of ASSURE with the SPUR dimensions of mathematical understanding: Skills, Properties, Uses, and Representations. The learning tools included lesson plans, student worksheets, contextual videos accessed through QR codes, Mathigon, Quizizz, manual representations, and SPUR-based tasks. Expert validation produced an average score of 4.46 out of 5, indicating that the design was highly valid.

Conclusion. The media-supported ASSURE–SPUR design is feasible, preliminarily practical, and pedagogically promising for supporting more systematic and multidimensional fraction learning.

KEYWORDS

Elementary School, Fraction Multiplication, Learning Design

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INTRODUCTION

Numeracy at the elementary school level should not be narrowly understood as the ability to perform arithmetic operations. In mathematics learning, particularly within the domain of numbers, numeracy includes the ability to understand numerical meanings, recognize relationships among numbers, use numbers in real-life contexts, and construct appropriate mathematical representations (Sara, 2025). These abilities are essential because number learning provides the foundation for problem solving, propotional reasoning, and students readiness to engage with more abstract mathematical concepts. Studies on number sense also indicate that numeracy development is multidimensional and is influenced by the quality of learning experiences, representational support, and the instructional designs implemented in the classroom (Haun, 2025; Siciliano, 2025).

Fractions are one number-related topic that often becomes a persistent challenge in elementary mathematics learning. Fractions require students to understand part–whole relationships, relative magnitude, equivalence, operations, and their use in real-life situations (Belcher, 2025; Khadse, 2025). However, in classroom practice, fractions are still frequently taught as procedural rules. Students may be able to follow solution steps, but they do not always understand why those steps work or how the results of fraction operations should be interpreted. Studies on fraction learning show that procedural fluency does not necessarily indicate conceptual understanding; reliance on algorithms can also create difficulties when fractions are applied to word problems, visual models, or everyday contexts (Ahlin, 2025). The preliminary analysis in this study revealed a similar pattern: teachers reported that Grade V students could perform basic fraction calculations but still struggled to explain the meaning of operations, connect symbols with visual representations, and use fractions in contextual situations.

These issues suggest that fraction learning requires more than simply increasing the number of practice exercises. Based on the 2022 Programme for International Student Assessment (PISA) results, Indonesian students' numeracy skills in number content remain relatively low, as most students scored below Level 2 with scores under 366 points. This condition indicates that many students have not yet achieved the basic mathematical competence required to solve numeracy problems in everyday life. At this lower level, students are generally only able to recognize simple integers or basic fractions when instructions are stated explicitly. However, when numbers and fractions are presented in the form of word problems, graphs, tables, or real-life contexts, most students experience difficulties in understanding information, determining solution strategies, and connecting mathematical concepts to the given situations. PISA 2022 data revealed that only around 18% of Indonesian students were able to solve mathematics problems at Level 2 or above.

These low numeracy skills are influenced by several factors, including learning approaches that still emphasize procedural memorization, limited contextual problem-solving practice, and students' low reading literacy skills. Therefore, mathematics learning should become more contextual, interactive, and oriented toward developing critical thinking skills so that students can better understand and apply numerical concepts in daily life (Chouhan, 2025). Instruction needs to be designed so that students have opportunities to reason, model, represent, and connect fraction concepts with real-life experiences. Previous studies have shown that multiple representations, digital manipulatives, technology-based visualizations, and realistic contexts can support more meaningful fraction understanding (Kistler, 2026). However, media do not automatically lead to conceptual learning when they are not embedded within a clear pedagogical design. Videos, visualization tools, worksheets, and interactive quizzes become meaningful only when they are selected based on learners' characteristics, aligned with learning objectives, used within active learning activities, and evaluated continuously.

In this context, the ASSURE model is relevant because it provides a systematic framework for instructional design, including learner analysis, objective formulation, media selection, learner participation, and evaluation revision processes (Alotaibi, 2026). Recent studies also indicate that ASSURE can help teachers organize media-based learning, although the learner analysis stage is often not used deeply enough in classroom practice (Ferreira-Santos, 2025). Nevertheless, ASSURE primarily addresses how instruction is designed and implemented. For fraction learning, teachers also need a framework that clarifies the quality of mathematical understanding to be developed. Therefore, this study integrates ASSURE with the SPUR framework Skills, Properties, Uses, and Representations so that instruction does not only target computational skills, but also mathematical properties, contextual use, and visual or symbolic representations (Cakir, 2025).

The main research gap addressed in this study is the absence of an operational learning design that connects a systematic instructional process with multidimensional mathematical understanding in fraction multiplication. Existing fraction learning practices often separate procedural fluency from conceptual understanding, while available instructional designs do not always organize media selection, student engagement, and multidimensional assessment within a single coherent framework. The novelty of this study lies in developing an ASSURE–SPUR learning design that positions ASSURE as the instructional design process and SPUR as the framework for the quality of mathematical understanding. This study aims to develop, validate, implement, and evaluate an ASSURE–SPUR learning design for fraction multiplication in Grade V elementary school. Since the study adopts a design-based research (DBR) approach, its focus is not to claim long-term experimental effectiveness, but to examine the development process, expert validation, limited implementation, design revision, student and teacher responses, and the pedagogical potential of the learning design (Su, 2025; Watanabe, 2025).

RESEARCH METHODOLOGY

This study employed a design-based research (DBR) approach to develop an ASSURE–SPUR learning design for fraction multiplication in Grade V elementary school. DBR was selected because the study focused on designing learning tools, validating them through expert judgment, implementing them in limited classroom trials, and revising the design based on field findings. Following Plomp's educational design research model, the study was organized into five stages: needs analysis, design planning, development and validation, limited implementation, and evaluation (Saifan, 2025). The study was not designed as a comparative experiment; therefore, the claims are limited to design validity, implementation feasibility, preliminary practicality, user responses, and pedagogical potential rather than long-term learning effectiveness.

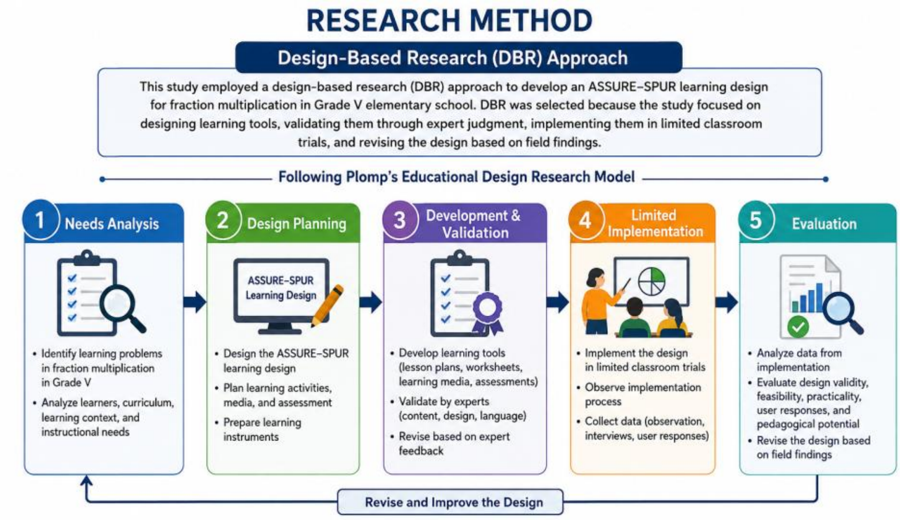

Figure 1. Design-based research (dbr) framework for developing the assure spur learning design in fraction multiplication

Design-Based Research (DBR) framework adopted in this study to develop the ASSURE–SPUR learning design for teaching fraction multiplication in Grade V elementary school. Following

Plomp's educational design research model, the process consisted of five interconnected stages: needs analysis, design planning, development and validation, limited implementation, and evaluation. The study began by identifying instructional needs and learning challenges related to fraction multiplication, followed by the design of learning tools and instructional strategies. The developed materials were then validated by experts and revised based on their feedback. Subsequently, the learning design was implemented in a limited classroom setting to examine its feasibility and practicality. Finally, evaluation was conducted to assess design validity, implementation feasibility, user responses, and pedagogical potential, leading to further refinement of the learning design. As a design-oriented study, the findings emphasize the quality and practicality of the developed instructional model rather than measuring long-term learning effectiveness through experimental comparison.

The study was conducted in Grade V mathematics classes at two elementary schools: SDN Mancogeh and SDN 2 Sukamaju. The first limited trial involved 21 Grade V students at SDN Mancogeh, while the second trial involved 28 Grade V students at SDN 2 Sukamaju after the learning tools had been revised. The study also involved Grade V classroom teachers and three expert validators: a mathematics education expert, an instructional technology/media expert, and an elementary school teacher practitioner. The validators assessed the learning tools in terms of content, media, pedagogy, language, readability, and suitability for elementary students.

The development procedure consisted of five DBR stages. The needs analysis stage identified problems in fraction learning through teacher interviews and curriculum document analysis. The design planning stage produced the initial ASSURE–SPUR learning tools, including lesson plans/teaching modules, student worksheets, QR Code-based contextual videos, Mathigon, Quizizz, and SPUR-based tasks. The development stage involved expert validation and revision. The limited implementation stage consisted of two classroom trials, with revision conducted after the first trial. The evaluation stage examined student and teacher responses, classroom implementation notes, and students' work.

Data were collected using instruments aligned with each DBR phase. During the needs analysis, teacher interviews and curriculum document analysis were used to identify students' difficulties, current instructional practices, media use, and curriculum expectations. During the validation phase, expert validation sheets were used to assess content suitability, student appropriateness, illustration, SPUR alignment, language, digital integration, and student engagement. Validators provided both numerical scores and qualitative comments (Chua, 2025).

During the implementation and evaluation phases, data were collected through classroom observations, field notes, students' worksheets, digital quiz results, SPUR-based tasks, and student and teacher response questionnaires. The student questionnaire consisted of 16 items covering instructional implementation, learning media, and worksheet use. The teacher questionnaire covered lesson planning, instructional implementation, media and worksheet use, and the enactment of SPUR dimensions.

The data were analyzed descriptively using qualitative and quantitative procedures. Qualitative data from interviews, observations, field notes, and validator comments were grouped into themes to identify learning needs, implementation constraints, and revision decisions. Quantitative data from expert validation were analyzed by calculating the mean score for each aspect and the overall mean score on a 1–5 scale. Student and teacher responses were analyzed using mean scores on a 1–4 scale; for student responses, the percentage of positive responses was calculated from the combined responses of "Strongly Agree" and "Agree." Trial implementation data were compared descriptively between the first and second trials. Because the study did not include a control group or rigorous pre-test/post-test analysis, learning outcome claims were limited to feasibility, preliminary practicality, user response, and pedagogical potential.

The study was conducted after obtaining approval from the schools and classroom teachers. Student data were used only for academic purposes, and students' identities were not disclosed in the manuscript. Learning documentation was treated as supporting data and used carefully. Teachers were involved as classroom partners, and their feedback was used to assess whether the learning design was realistic, understandable, and appropriate for Grade V elementary classrooms (Ruiz-Fernandez, 2025).

RESULT AND DISCUSSION

The needs analysis showed that the central issue in Grade V fraction learning was not merely students' ability to perform calculations, but their limited ability to explain the meaning of fraction operations, connect symbolic forms with visual representations, and apply fractions in contextual situations. Teachers from SDN Mancogeh and SDN 2 Sukamaju reported a similar pattern: students could often follow procedural examples, yet struggled when asked to explain the mathematical reasoning behind their answers. Instruction was still largely based on lectures, worked examples, and routine exercises. Although concrete media and ICT tools were available, they had not been used systematically to support conceptual, contextual, and representational understanding.

Curriculum document analysis confirmed this gap. The learning outcomes and objectives in the number domain require students to understand fractions not only as symbolic operations but also as concepts that can be represented, explained, and used in real-life contexts. This mismatch between classroom practice and curricular expectations became the empirical basis for developing the ASSURE–SPUR learning design.

The results in Table 2 indicate that the development need emerged from the convergence of classroom evidence and curriculum expectations. Teacher interviews highlighted the procedural orientation of current practice, while curriculum documents showed the need for broader conceptual, contextual, and representational understanding. This finding justified the development of a learning design that is both systematically organized through ASSURE and mathematically oriented through SPUR.

Based on the needs analysis, the initial product was developed as a set of instructional tools for teaching fraction multiplication in Grade V. The product consisted of lesson plans/teaching modules, student worksheets, contextual videos accessed through QR Codes, Mathigon, Quizizz, manual representation tasks, and SPUR-based assessment activities. The design did not merely arrange classroom activities; it mapped each instructional decision onto the ASSURE stages and the SPUR dimensions.

In this design, ASSURE structured the instructional sequence, while SPUR guided the mathematical understanding to be developed. The learning activities were designed to support procedural fluency through fraction multiplication exercises, conceptual reasoning through explanatory questions, contextual application through word problems, and representation through drawings, area models, and digital visualization. The initial ASSURE–SPUR design matrix is presented in Table 1.

Table 1. Initial assure spur design matrix.

ASSURE Component	SPUR Dimension	Learning Activity	Expected Outcome
Analyze Learners	Skills	Identify students' prior knowledge of fractions	Determine learning needs and readiness
State Objectives	Properties	Formulate learning objectives for fraction multiplication	Clarify conceptual and procedural targets
Select Methods, Media, and Materials	Uses	Prepare worksheets, visual models, and digital media	Support contextual understanding and application
Utilize Media and Materials	Representation	Use drawings, area models, and digital visualization	Develop multiple representations of fractions
Require Learner Participation	Skills, Properties, Uses	Solve fraction multiplication exercises, explanatory questions, and word problems	Enhance procedural fluency, conceptual reasoning, and problem-solving ability
Evaluate and Revise	All SPUR Dimensions	Assess student performance and collect feedback	Improve design validity, practicality, and learning quality

The matrix demonstrates the integration of the ASSURE instructional model and the SPUR framework within the learning design. ASSURE provides the structure for planning and implementing instruction, while SPUR defines the mathematical understanding to be developed through four dimensions: Skills, Properties, Uses, and Representation. Learning activities were designed to foster procedural fluency through fraction multiplication exercises, conceptual understanding through explanatory questions, contextual application through word problems, and representational competence through visual and digital models. Together, these components ensure that instructional processes and mathematical learning goals are aligned within a unified design framework.

The matrix in Table 1 shows that ASSURE and SPUR were not treated as separate components. ASSURE organized the instructional process, while SPUR clarified the mathematical depth expected from the learning activities and assessment. The implementation structure of this design is visualized in Figure 2. Figure 2 summarizes how the fraction multiplication topic, Grade V learner characteristics, learning resources, ASSURE stages, and SPUR dimensions are connected within the classroom implementation.

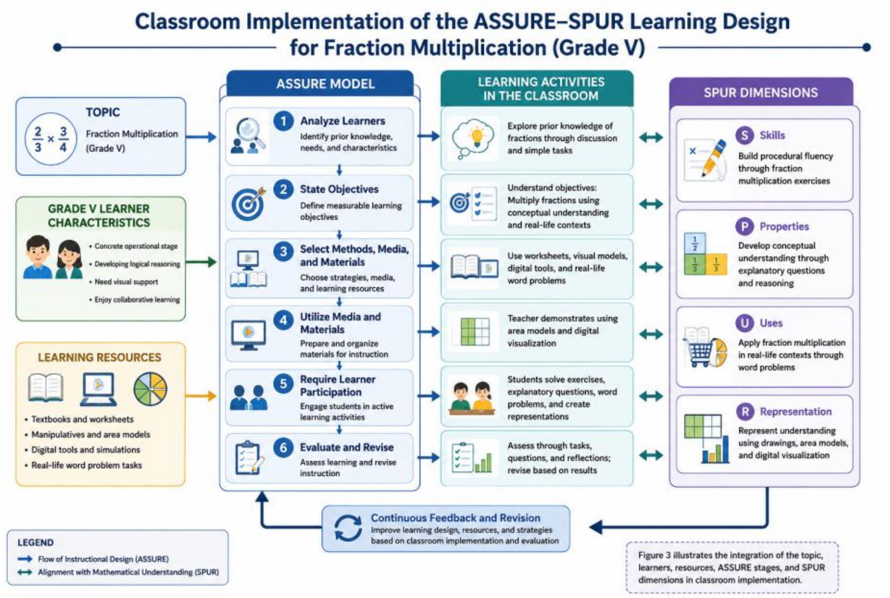

Figure 2. Integration of fraction multiplication content, grade v learner characteristics, assure stages, and spur dimensions in classroom implementation

Conceptual framework of the ASSURE–SPUR learning design implemented in Grade V fraction multiplication instruction. The figure demonstrates how the fraction multiplication topic, learner characteristics, and available learning resources are systematically connected through the six stages of the ASSURE model: Analyze Learners, State Objectives, Select Methods, Media, and Materials, Utilize Media and Materials, Require Learner Participation, and Evaluate and Revise. Simultaneously, the SPUR framework comprising Skills, Properties, Uses, and Representation guides the development of mathematical understanding throughout the learning process.

The integration of these two frameworks ensures that instructional activities not only follow a structured pedagogical sequence but also promote procedural fluency, conceptual understanding, contextual application, and multiple mathematical representations. As a result, the learning design provides a coherent connection between instructional planning and the intended mathematical learning outcomes.

The learning tools were validated before the classroom trials by three validators: a mathematics education expert, an instructional technology/media expert, and an elementary school teacher practitioner. The validation covered content suitability, alignment with Grade V students' thinking, illustration quality, SPUR alignment, language, digital integration, and student engagement.

The validation results showed an overall mean score of 4.46 out of 5, placing the learning tools in the highly valid category. The strongest aspect was content alignment with learning objectives, while illustration and language received more specific revision notes. The validators considered the tools feasible for limited classroom trials after minor revisions, particularly in simplifying instructions, strengthening contextual illustrations, and clarifying the use of digital media.

The results in Table 4 indicate that revisions were mainly directed at improving classroom usability rather than changing the core design. The main structure of the ASSURE–SPUR design was retained, while instructions, contextual illustrations, media guidance, and collaborative activities were refined to make the learning tools more accessible for Grade V students.

The first trial was conducted at SDN Mancogeh with 21 Grade V students. The design could be implemented according to the planned sequence, including contextual videos, group discussion, worksheets, fraction visualization, presentations, and digital quizzes. Students appeared more active than in routine exercise-based instruction; however, several constraints emerged, including unstable internet access, students' unfamiliarity with Mathigon, lengthy worksheet instructions, and a tendency to produce procedural answers without sufficient representational explanation.

The findings from the first trial were used to revise the learning tools. Worksheet instructions were shortened, contextual problems and guiding questions were clarified, and digital media were supported with manual alternatives. The revised design was then implemented in the second trial at SDN 2 Sukamaju with 28 Grade V students. The instructional sequence ran more smoothly: students followed the worksheets more easily, the use of QR Codes and videos was more organized, and representation activities became more flexible. Approximately 80% of students achieved mastery in the Skills dimension, while more than 70% showed adequate responses in Properties and Representations tasks. Nevertheless, students' written mathematical explanations remained an area for further improvement.

The comparison in shows that revisions between trials were substantive rather than cosmetic. Improvements in worksheet instructions, media flexibility, contextual tasks, and guiding questions helped make the second trial more stable. Even so, students' written reasoning and independent use of representations still require further scaffolding.

Student responses to the ASSURE–SPUR design were categorized as positive to highly positive. The highest student score was found in the learning media aspect, with a mean of 3.4 out of 4 and 85% positive responses. The instructional implementation aspect obtained a mean score of 3.2 with 81% positive responses, while worksheet use obtained 3.3 with 82% positive responses. Overall, the mean student response score was 3.3, with 83% positive responses.

Teachers also gave positive to highly positive responses. The highest teacher score was found in the implementation of SPUR, with a mean of 3.5 out of 4, followed by lesson planning (3.4), media and worksheets (3.3), and instructional implementation (3.2). The overall mean teacher response score was 3.35, categorized as highly positive. A summary of student and teacher responses is presented in Table 6.

The findings in Table 6 show that the design was well received by students and teachers. Students responded most strongly to the learning media, while teachers gave the highest score to the implementation of SPUR. These results support the preliminary acceptance and practicality of the ASSURE–SPUR design, but they are not used to claim learning effectiveness because such claims require stronger pre-test and post-test evidence.

The findings of this study indicate that the challenges of learning fractions in Grade V cannot be understood merely as problems of computational ability. Teacher interviews and curriculum analysis showed that students were relatively able to follow procedural examples, but still struggled to explain the meaning of operations, connect fraction symbols with visual representations, and use fractions in contextual situations. This pattern is consistent with studies showing that procedural mastery in fraction learning does not always develop alongside conceptual understanding (Hidayat, 2026; Matta, 2025). In this study, the need for an ASSURE–SPUR learning design emerged from this tension between procedural fluency and broader mathematical understanding.

The main contribution of this study lies in bringing together two complementary frameworks in an operational design. ASSURE was used to structure the instructional process, while SPUR was used to clarify the quality of mathematical understanding targeted in the learning activities and assessment. This integration helped align learning objectives, media, student participation, and evaluation more coherently. Contextual videos were directed toward supporting the Uses dimension, Mathigon and manual drawings supported Representations, Quizizz provided quick evidence of Skills, and open-ended questions created space for Properties. In this way, media and activities were not treated as isolated classroom tools, but as parts of a design intended to connect procedure, concept, context, and representation.

The expert validation results support the initial feasibility of the developed learning tools. The overall mean score of 4.46 out of 5 indicates that the tools were highly valid in terms of content alignment, SPUR integration, and suitability for Grade V fraction learning. However, the validators' comments also show that learning tools for elementary school students must be more than conceptually accurate. They must be readable, visually familiar, technically simple, and manageable within classroom time. Revisions to worksheet instructions, contextual illustrations, media guidance, and collaborative activities therefore played an important role in improving the usability of the design before classroom implementation (Lavarzaei, 2025).

The limited trials further demonstrated the value of the DBR approach. The first trial revealed several constraints, including unstable internet access, students' unfamiliarity with Mathigon, lengthy worksheet instructions, and a tendency to produce procedural answers without sufficient explanation. These findings were not treated as implementation failures, but as design information. Revisions after the first trial shortened worksheet instructions, clarified guiding questions, provided manual alternatives to digital representations, and strengthened the link between contextual tasks and mathematical reasoning. In the second trial, the learning sequence ran more smoothly, and students were better able to follow the worksheets and engage with representation activities. Even so, students' written mathematical explanations remained an area that required further scaffolding.

The use of digital and manual representations appears to be an important feature of the ASSURE–SPUR design. Students were more easily engaged when fractions were not presented only as symbols, but were also modeled through drawings, concrete situations, or digital media. This finding supports the view that visual models, digital manipulatives, and carefully designed representations can support fraction understanding when they clarify quantitative relationships rather than merely decorate instruction (Qin, 2025). At the same time, the study shows that representation is not an ability that develops automatically once media are provided. Some students still needed support to explain the relationship among images, operations, and results. Thus, representation should be treated as a mathematical practice that needs to be taught, discussed, and assessed.

Student and teacher responses also suggest that the design has preliminary practicality. Students gave highly positive responses, with the strongest response in the learning media aspect, while teachers gave the highest score to the implementation of SPUR. This indicates that students valued the engaging learning environment created through videos, QR Codes, Mathigon, and Quizizz, whereas teachers valued the way SPUR broadened fraction learning beyond computational practice. These responses support the acceptance of the design by the two main user groups. However, response data should be interpreted as evidence of acceptance and preliminary practicality, not as direct evidence of learning effectiveness.

Theoretically, this study extends the use of ASSURE in elementary mathematics learning by adding a more specific mathematical orientation. ASSURE provides the instructional structure, while SPUR provides a lens for the depth of mathematical understanding. The integration of the two frameworks produces a design that is systematic in process and multidimensional in mathematical orientation. Practically, the design offers teachers a template for planning fraction learning: analyzing student needs, formulating SPUR-oriented objectives, selecting available media, organizing active participation, and assessing more than procedural answers. The design also remains adaptable because manual representations can complement digital tools in schools with limited technology access.

This study has several limitations. First, the trials were conducted in only two elementary schools, so the findings cannot yet represent a wide range of school contexts. Second, the study did not use a control group and therefore cannot compare the ASSURE–SPUR design experimentally with other instructional approaches. Third, students' learning improvement was not examined through a rigorous pre-test and post-test design. Fourth, the SPUR assessment still needs a more detailed rubric so that each dimension of understanding can be examined more accurately. Therefore, the safest claim is that the ASSURE–SPUR design is valid, implementable in limited trials, positively received by students and teachers, and shows pedagogical potential for supporting more multidimensional fraction learning. Future research should test this design with broader samples, stronger evaluation designs, pre-test and post-test measures, and more operational SPUR rubrics. Further testing on other fraction topics, such as addition, division, comparison of fractions, or decimals, is also needed to examine whether the ASSURE–SPUR framework can be applied beyond fraction multiplication.

CONCLUSION

This study developed an ASSURE–SPUR learning design for fraction multiplication among Grade V elementary school students, positioning ASSURE as the framework for the instructional design process and SPUR as the framework for multidimensional mathematical understanding. The needs analysis showed that fraction learning still needs to move beyond procedural practice toward activities that provide space for conceptual understanding, the use of real-life contexts, and visual representations. The developed learning tools were rated as highly valid by experts, were implementable through two limited classroom trials, and received positive responses from both students and teachers. The revisions made between the trials indicated that clear instructions, flexible use of digital and manual media, and guiding questions played an important role in making the learning process easier for students to follow. Thus, the ASSURE–SPUR design can be regarded as a feasible and preliminarily practical learning design with pedagogical potential to support more systematic and multidimensional fraction learning. However, because this study did not use a control group and did not present a rigorous pre-test–post-test analysis, the effectiveness of the design in improving learning outcomes needs to be examined further through studies with broader samples, a more operational SPUR rubric, and a stronger evaluation design.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used Chat GPT to assist inimproving grammar, language quality, and overall readability of the text. After using this tool, the author(s) Carefully reviewed and edited the content as necessary and take full responbility for the content of the publication.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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