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Development and Test of the Effectiveness of Napier Bone Media in Multiplication Learning in Elementary Schools

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ABSTRACT

This research aims to develop a valid, practical, and effective Napier Bone learning media in improving the understanding of the concept of multiplication for elementary school students. The type of research used is Research and Development (R&D) with the ADDIE model. The subjects of the study were students of grade VI MIN 4 Humbang Hasundutan who were divided into experimental and control groups. The research instruments include expert validation sheets, teacher and student response questionnaires, and concept understanding tests in the form of pretests and posttests. The results showed that Napier Bone media obtained an average validation score of 3.7 (very valid category), practicality score of 3.63 (very practical category), and an N-Gain value of 0.61 (medium-high category) in the experimental group, higher than the control group with an N-Gain of 0.36 (medium category). The t-test also showed a significant difference between the two groups ($p < 0.05$). Thus, Tulang Napier media is declared worthy of use as an innovative alternative in multiplication learning in elementary schools because it is able to bridge abstract concepts to concrete and support the achievement of the Independent Curriculum and 21st century skills.

INTRODUCTION

At the elementary/middle school level, multiplication is a basic competency that requires a transition from additive reasoning to multiplicative reasoning. Many students are not yet able to unitize grouping units into equivalent bundles so the meaning of "a×ba \times b" as "aa groups containing bb objects" is not firmly embedded. As a result, they tend to memorize facts without understanding the structure (equal groups, factor–outcome relationships, distributive properties), which leads to difficulties in applying multiplication to contextual problems. Cross-contextual research shows that concrete representational support (arrays, bundling sticks, manipulative tools) is needed for students to move from procedure to connected conceptual understanding (Hurst & Linsell, 2020). However, the effectiveness of manipulatives is largely determined by pedagogical design—without explicit attribution to symbols and directed classroom discussions, their use often remains procedural and lacks the construction of the meaning of the concept of multiplication (Hurst & Linsell, 2020).

On the other hand, memory load is a typical source of obstacles to mastering multiplication tables. The multiplication facts have a high similarity (e.g. 6×8 and 8×6; or the family of facts 6,7,8,9) so that they cause *interference* when memorized at the same time. A controlled experiment on early elementary school students showed that grouping facts that

had minimal similarities and were given temporal breaks resulted in better learning and lasted longer than similar groupings of facts (Dotan S., 2022). These findings indicate that memory interference is a real barrier to the automation of multiplication facts, and pedagogically hint at the need for a tiered training strategy that reduces interference while still fostering an understanding of the meaning of operations.

The findings in Indonesia show ontogenic, epistemological, and didactic obstacles to the topic of multiplication: (1) the transition from the concrete to the abstract that is stalled; (2) failure to apply the concept to the story problem; and (3) teaching practices that are too procedural so that students memorize results without understanding the structure. This obstacle can be seen in misunderstanding the "×" symbol, errors in place values in the stacked algorithm, and procedural errors (Rohimah et al., 2024). Other qualitative studies also found internal (interest, math anxiety, fatigue) and external factors (variation in teachers' strategies, lack of media, learning environment) that worsened students' ability to interpret multiplication (Muthma'innah, 2023). Concrete/manipulative-media-based interventions that represent multiplication as repeated addition—e.g., *smart suitcases* (a hands-on practice tool integrated with mathematical worksheets)—showed significant improvements in elementary student performance. The key to success lies in *hands-ons* tied to meaningful tasks as well as worksheets that direct the construction of representation and reasoning (Rejeki et al., 2024). Thus, media support designed to orchestrate the transition from the concrete → representational → symbolic (CRA) is relevant to address common misconceptions (e.g., interpreting 3×4 as 3+3+3+3 versus 4×3).

Specifically for the Indonesian context, traditional/classical manipulative tools such as *Napier's Bones* can reportedly help students visualize multi-digit multiplication structures and foster interest in learning when integrated into gradual classroom actions. Evidence of classroom action shows an increase in achievement from cycle to cycle when media is packaged as a practical tool that is easy to operate and accompanied by adequate socialization and *scaffolding* (Fakhroni, 2023). This reinforces the argument that conceptual difficulties can be solved with appropriate concrete media, provided that the teacher links concrete activities to conceptual strategies (arrays, distributives, place values) and does not stop at procedural demonstrations alone.

Mathematics is abstract in nature: concepts such as multiplication, numbers, number structures, or operating relationships are often presented in the form of symbols and procedures that are difficult for young students without concrete experience to understand. Piaget and the theory of cognitive development show that students at the elementary school level are at the stage of concrete operations, where the use of real objects is helpful in building conceptual understanding before students are able to move to the representational and abstract stages. Without manipulative media, an understanding of "what multiplication means" or "how numbers interact in operations" can remain superficial—simply memorizing symbols without understanding their meaning.

Recent quasi-experimental research shows that the use of concrete manipulatives (physical tactile objects) significantly improves students' mathematical achievement compared to traditional instruction that relies only on symbolic abstraction or lectures (Siller & Ahmad, 2024). In addition, blended instruction that blends concrete and virtual manipulatives also showed higher results in mathematical achievement, including in difficult concepts such as fractions, decimals, and number operations. In the context of basic education, concrete media helps students build a "bridge" between sensory experience and

mental patterns: students can see, touch, group, or arrange objects to describe mathematical operations such as multiplication as grouping or repetition.

The need for manipulative media also arises from practical needs in the field of education in Indonesia and other countries: many students have difficulty in understanding mathematical concepts because the material is delivered too quickly in symbols, the lack of concrete models is used, and teachers have limited auxiliary media. Manipulative media that is inexpensive, accessible, and relevant to local contexts—such as those specifically designed to teach multiplication—can be an effective solution. That said, the development of media such as Napier Bone has great potential to meet that need, helping students understand not only how multiplication works, but also why the operation works the way it does.

The counting tool known as *Napier's Bones* or in Indonesian often called *Napier's Bones* was first introduced by John Napier in the early 17th century through his work *Rabdologiae* which was published in 1617. Napier developed this tool as part of his efforts to simplify the operations of multiplication, division, square root, and cubic root by reducing these operations to addition and subtraction through rods arranged in such a way that the multiplication table has been inscribed on them. This concept is also called "rabdology" — from the Greek rhabdos (rod) and logos (calculation) — as a technique of counting with rods (Wikipedia).

Furthermore, the working principle *of Napier's Bones* is the use of marked bars that show the result of multiplication from the numbers 1 to 9 for each bar. For example, if we want to multiply a number of many digits by a single digit, the bar that represents each digit of the large number is set next to an index bar, then the rows of those bars that correspond to the digits of the multiplier number are read, and the partial results are summed using the diagonal parts of the bar. Thus multiplication operations are broken down into a number of addition operations and the use of existing tables. In modern applications, research shows that the use of *Napier's Bones* as a learning medium is proven to improve student learning achievement on multiplication materials in elementary schools.

As it has evolved, variations and innovations have emerged. For example, the incorporation of *Napier's Bones real media* with technology (e.g., Geogebra) to strengthen the visualization of mathematical concepts and computational operations, including division. Innovations like this maintain the classic principles of Napier Bones—rod manipulation and marking table reading—but combined with digital interactive elements that help students understand the process of multiplication/division in a more concrete and visual way. Recent studies have shown that these media can provide significant improvements in problem-solving skills and understanding of mathematical concepts when applied in the right learning design.

The change in the educational paradigm in Indonesia through the Independent Curriculum provides flexibility for teachers and educational units to choose and develop learning methods and media that are in accordance with the characteristics of students and the local context. One of the main goals of the Independent Curriculum is to make the learning process more contextual, creative, and focus on understanding concepts through real learning experiences. Research shows that the optimization of the Independent Curriculum in mathematics learning in elementary schools is highly dependent on the availability of learning materials that are relevant and adaptive to the needs of students, including manipulative media and teaching aids, so that conceptual abstraction can be bridged effectively (Rahmawati F. and Ghufron, A., 2024).

In line with the demands of 21st Century Skills, the Merdeka Curriculum emphasizes the development of 4C skills: *Critical Thinking, Creativity, Communication,* and *Collaboration*. The implementation of this Curriculum in elementary schools has shown that student-centered learning methods, group discussions, and the use of contextual assignments or projects facilitate students in developing these skills (Rahmawati, 2024). Manipulative media—which allows students to interact directly with concrete objects—can be an important means of strengthening understanding of mathematical concepts, especially in materials that tend to be abstract such as multiplication, as well as training critical thinking and creativity skills. With both aspects in mind—the flexibility of learning media and the demands of 21st century skills—the development of Napier Bone media becomes particularly relevant. Not only does it support concrete representations of abstract multiplication concepts, but it also provides students with an active learning experience: exploring, manipulating, and visualizing numbers and mathematical operations. Thus, the use of media such as Tulang Napier can increase engagement, understanding of concepts, and at the same time form critical and creative thinking skills that are at the core of the Independent Curriculum (Rahmawati, Puji Rahmawati, & Ghufron, 2024; Rahmawati, 2024).

The formulation of the problem in this study focuses on two main aspects, namely the development process and the effectiveness of the use of Napier Bone learning media. First, how to develop Napier Bone media that meets the criteria of validity and practicality so that it can be used optimally in multiplication learning in elementary schools. Second, whether the Tulang Napier media that has been developed has proven to be effective in improving students' understanding of the concept of multiplication material, so that it is able to answer learning needs that are contextual, interesting, and in accordance with the demands of the Independent Curriculum and 21st century skills. The purpose of this research is to develop Tulang Napier learning media that is suitable for use in the multiplication learning process in elementary schools by paying attention to the aspects of validity, practicality, and suitability with the needs of students and the demands of the Independent Curriculum. In addition, this study also aims to test the effectiveness of Tulang Napier media in improving students' understanding of the concept of multiplication, so that the media produced is not only useful as a visual and concrete aid, but also able to make a real contribution to improving the quality of mathematics learning at the elementary school level.

The theoretical benefit of this research is that it contributes to the development of mathematics learning media, especially in bridging abstract concepts to concrete. The use of Napier Bone as a manipulative medium is expected to enrich the literature on mathematics learning strategies and innovations in elementary schools, as well as provide a scientific basis for further research on the effectiveness of classical media contextualized in modern learning. Thus, this research expands theoretical insights on the integration of traditional learning media with the demands of the Independent Curriculum and 21st century skills. From a practical perspective, this research provides an alternative innovative media for teachers in carrying out multiplication learning. Napier Bone Media can be used as a concrete tool to make it easier for students to understand the concept of number operations, while adding a variety of learning strategies that are not only centered on textbooks or verbal explanations. The existence of this media can help teachers to create more interactive, interesting, and appropriate learning for diverse students.

In addition, for students, the Napier Bone media offers a more active and enjoyable learning experience. By directly involving students in the process of media manipulation, it is

hoped that a deeper and more durable understanding of the concept will be created. This can also foster students' confidence in solving multiplication problems, as well as foster an interest in learning mathematics which has often been considered difficult and boring.

METHODE

The type of research used in this study is Research and Development (R&D), which is a research method that aims to produce a specific product and test the effectiveness of that product in learning practice. Research and development models that can be used include ADDIE (Analysis, Design, Development, Implementation, Evaluation) and the Borg & Gall model which emphasizes systematic steps starting from preliminary studies, product development, to field trials. The ADDIE model is considered more concise and applicable for the development of learning media at the elementary school level because it is able to provide a structured framework, while the Borg & Gall model is more comprehensive in involving validation and testing of product effectiveness (Branch, 2009; Gall J. P. and Borg, W. R., 2003). The use of this R&D approach is relevant to the research objective, which is to develop a valid, practical, and effective Napier Bone media to improve students' understanding of the concept of multiplication. Through the systematic stages offered by both ADDIE and Borg & Gall models, the research is not only oriented towards product development, but also ensures its quality and usefulness in the field. Thus, the R&D approach was chosen because it provides a strong methodological foundation to produce innovative and empirically tested learning products (Aldoobie, 2015; Scott, 2017).

The subject of this research is grade VI students at MIN 4 Humbang Hasundutan, who were chosen because at this level students have learned the concept of multiplication formally but still often experience difficulties in understanding number operations in the abstract. The location of the research is centered at MIN 4 Humbang Hasundutan because this school represents the condition of madrasah ibtidaiyah in an area with limited innovative learning media. Thus, the application of Tulang Napier media is expected to make a real contribution to improving the quality of mathematics learning, especially in multiplication materials. The number of samples in the study was determined based on the needs of the experimental research design, involving two groups of students, namely the experimental group using Napier Bone media and the control group using conventional learning methods. The sampling technique used is purposive sampling, taking into account the suitability of the class, the availability of time, and the homogeneity of students' initial abilities. The group was randomly assigned from the available classes, so that the comparison of learning outcomes between the experimental and control groups could be objectively analyzed to assess the effectiveness of the developed media.

This research procedure begins with a needs analysis stage, which is carried out through observation of learning activities, interviews with mathematics teachers, and giving initial tests to students. This stage aims to identify the main difficulties experienced by students in understanding the concept of multiplication and gather information related to the limitations of the learning media used in the classroom. The results of the needs analysis are an important basis in determining the specifications of the Napier Bone media that will be developed to suit the needs of students and the learning context in elementary schools. The next stage is the design and development of the media, which includes designing media specifications, selecting materials, and making the Napier Bone display so that it is easy for students to use. The media that has been designed then goes through an expert validation process, involving mathematics education lecturers, media experts, and practitioner teachers.

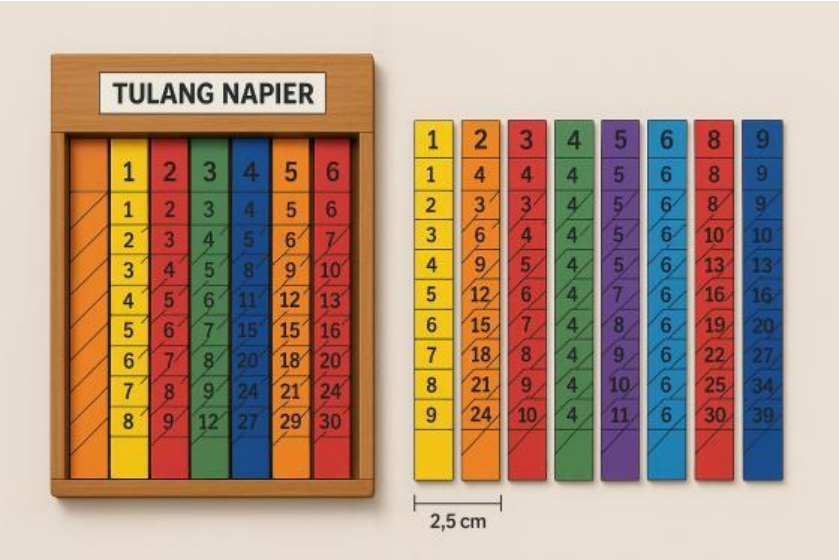
This validation covers aspects of content, design, and language, to ensure that the developed media is suitable for use in learning. After obtaining input from experts, product revisions were made so that Napier Bone media was more in line with the expected learning quality standards.

The next stage is a field trial. The limited trial was conducted first in small groups of students to see the comprehension, ease of use, and potential for media improvement. After that, a broad trial was carried out using *a pretest-posttest control group design*, by comparing the learning outcomes of students in the experimental group using Napier Bone media with the control group using conventional learning methods. Through this experimental design, the effectiveness of the media in improving the understanding of the concept of multiplication can be measured objectively. The research instruments include expert validation sheets, teacher and student response questionnaires, and pretest-posttest understanding tests. This is consistent with the research practice of developing valid and practical learning media as reported in previous research, where validation instruments of material and media experts are used to determine product feasibility, student/teacher response questionnaires to measure satisfaction/practicality, and pretest-posttest to measure improvement in learning outcomes (Firdaus H., 2021). The data analysis technique in this study covers three main aspects, namely the validity, practicality, and effectiveness of the Napier Bone learning media. The validity of the product was analyzed using the Content Validity Ratio (CVR) or Content Validity Index (CVI) method as well as the calculation of the average score given by the validators to assess the feasibility of the content, design, and language of the media. Practicality was measured through the results of teacher and student response questionnaires which were analyzed descriptively to see the level of convenience, attractiveness, and usefulness of media in supporting learning. Meanwhile, the effectiveness of the media was analyzed using statistical tests, both through the calculation *of Normalized Gain (N-gain)* to determine the improvement of students' understanding of concepts, and *the t-test* test to compare the results of the pretest and posttest between the experimental and control groups. This data analysis approach is in accordance with educational development research standards that emphasize the feasibility, practicality, and effectiveness aspects of products (Putra I. G. W., 2020).

RESULT AND DISCUSSION

The Napier Bone learning media developed in this study is designed as a concrete tool to make it easier for students to understand the concept of multiplication. This medium is made using simple materials such as thick cardboard and laminated ivory paper to make it more durable and visually appealing. Each bone is rectangular in size with a size of 2.5 × 15 cm, making it easy to grasp and use by elementary school students. On each bone is printed a series of multiplication numbers according to the Napier's Bones principle, equipped with a diagonal line to separate the unit and tens digits, so that students can easily read and operate the multiplication results. In terms of design, this medium uses different colors on each bone to make it easier to identify the basic numbers and increase visual appeal. The selection of contrasting colors aims to help students focus on the number operations being studied while adding an aesthetic aspect so that it is more liked by children. The bones are placed in a simple storage box that also serves as a work board, making it easier to use in the classroom and maintaining the neatness of the media.

In addition to the physical appearance, this media also comes with a simple user guide sheet so that teachers and students can understand the steps to operate the Napier Bone correctly. This guide includes examples of uses for one-digit and two-digit multiplication, so that it can be used flexibly according to the student's ability level. With a practical, attractive, and easy-to-use design, the Napier Bone media developed is considered ready to be tested for its validity, practicality, and effectiveness in supporting multiplication learning in grade VI elementary school.



Napier Bone Media Validation Results Table

Aspects Assessed	Validator 1	Validator 2	Validator 3	Average	Category
Contents	3,6	3,8	3,7	3,7	Highly Valid
Language	3,5	3,6	3,4	3,5	Valid
Display	3,7	3,9	3,8	3,8	Highly Valid
Total Average	3,6	3,8	3,6	3,7	Highly Valid

Remarks: Assessment scores use a scale of 1–4:
1 = Invalid ; 2 = Less Valid; 3 = Valid; 4 = Very Valid

The results of expert validation showed that the Napier Bone learning media obtained an average score of 3.7 out of a scale of 4 with a very valid category. These findings confirm that the developed media has met the feasibility aspects of content, language, and display as well as the standard for the development of learning tools. The score on the content aspect (3.7) shows that the content of the multiplication material presented is in accordance with the demands of the curriculum, and is able to help students understand the concept of multiplication more concretely. This is in line with the opinion of Akker (1999) that content validation is the main indicator in ensuring the connection of the media with learning

objectives. In the language aspect, the media obtained an average score of 3.5 with a valid category. These results show that the language used in the guidesheets and media instructions is communicative and understandable by elementary school students, although there are still some minor notes that can be improved, such as the selection of simpler terms. According to Rahmat (2019), language clarity in learning media is very important so that learning messages can be conveyed effectively according to the level of students' cognitive development.

The display aspect received the highest score with an average of 3.8 in the category of very valid. This indicates that Napier Bone media is not only functional but also visually appealing, so that it is able to motivate students to be actively involved in the learning process. The visualization of different colors on each bone stem, proportional media size, and neatness of the design are considered to make a positive contribution to student engagement in learning. These findings support previous research that states that attractive visual displays in learning media can increase learning interest and strengthen students' understanding of concepts (Sadiman R. and Haryono, A. and Harjito, 2020).

Thus, the results of expert validation provide evidence that Napier Bone media is suitable for use in multiplication learning in elementary schools. However, the recommendations for improvement from the validators remain an important basis for improving the media to be more effective and adaptive when implemented in the classroom.

Tabel Hasil Praktikalitas Media Tulang Napier

Responden	Convenience Aspect	Attractiveness Aspect	Aspects of Usefulness	Average	Category
Teacher 1	3,6	3,8	3,7	3,7	Very Practical
Teacher 2	3,5	3,6	3,6	3,6	Practical
Students (30 people, average)	3,7	3,8	3,6	3,7	Very Practical
Total Average	3,6	3,7	3,6	3,63	Very Practical

Remarks: Rating scale 1–4: 1 = Impractical, 2 = Impractical, 3 = Practical, 4 = Very Practical

Based on the table above, the results of the Napier Bone media practicality test showed an overall average value of 3.63 with a very practical category. In terms of convenience, an average score of 3.6 indicates that this medium is easy to use by both teachers and students, especially because it is simple in shape, proportional size, and clear guidelines for use. In terms of attractiveness, a score of 3.7 shows that the visual display of colorful media makes students more interested in trying, thereby increasing motivation to learn. Meanwhile, the usefulness aspect obtained a score of 3.6, which means that this media is considered useful in helping students understand the concept of multiplication, although there are inputs for this media to be expanded to other calculation operations.

The results of this practicality test confirm that Tulang Napier media has a good level of acceptance among teachers and students. The high score in the ease aspect shows that this media is in accordance with the principle *of user* friendliness, which is easy to understand and operate without requiring special skills. This is in line with the opinion of Nieveen (1999) that one of the indicators of the success of educational products is the level of suitability or practicality in the classroom. The attractiveness aspect that obtained a high score proves that media with attractive visual designs can increase students' attention and interest in mathematics learning. Color, size, and simplicity of design play an important role in building learning motivation, as emphasized by Mayer (2014) that the visual aesthetic aspect in learning media has a significant effect on student engagement. Thus, the Napier Bone media is able to function not only as a calculation aid, but also as a means to foster an interest in learning.

Meanwhile, the usefulness aspect shows that teachers and students feel a real contribution from the use of this media to the understanding of the concept of multiplication. This is in line with the findings of Prastowo (2020) that manipulative media can make it easier for students to bridge abstract concepts to concrete. Nevertheless, there is still a suggestion that this medium should not only be focused on multiplication, but also be developed for other computational operations such as division, so that its use is becoming more widespread. Overall, these findings prove that Napier Bone media is declared practical and ready to be implemented in multiplication learning in elementary schools. This practicality also strengthens the results of expert validation that states that this media has met the standards of feasibility of content, language, and display.

Tabel Pretest–Posttest

Groups	Number of Students	Rata-rata Pretest	Average Posttest	N-Gain	Category
Experiments (with Napier Bones)	30	55,2	82,6	0,61	Medium–High
Control (conventional learning)	30	54,8	71,3	0,36	Medium

Description:
Maximum test score = 100.
N-Gain is calculated by the formula: (Posttest Score – Pretest Score) / (100 – Pretest Score).
N-gain categories: low (<0.3), medium (0.3–0.7), high (>0.7).

Based on the table, the experimental group using Napier Bone media experienced a significant increase with an average pretest of 55.2 to 82.6 in the posttest. An N-Gain value of 0.61 indicates an increase in the medium-high category, which means that this media is quite effective in improving students' understanding of the concept of multiplication. Meanwhile, the control group only increased from an average of 54.8 to 71.3 with an N-Gain of 0.36 (moderate category). This suggests that despite the improvement in understanding in the control group, their achievement was still lower than in the experimental group. Independent t-test between the results of the posttest of the two groups showed a significance value ($p < 0.05$), so it can be concluded that there was a significant difference between the group that used Napier Bone media and those that did not.

The results of this study prove that the use of Napier Bone media contributes positively to improving the understanding of the concept of multiplication in elementary school

students. The significant increase in the experimental group compared to the control group confirms the effectiveness of this medium as a concrete means that make it easier for students to understand abstract concepts in mathematics. In line with Bruner's (1966) theory, the use of manipulative media is able to bridge the enactive (concrete) stage to the symbolic (abstract) stage, so that the understanding of concepts is stronger. The moderate-high N-Gain category in the experimental group showed that this media succeeded in substantially improving learning outcomes. These results are consistent with the research of Firdaus and Hamidah (2021) which found that the use of mathematics teaching aids can increase students' understanding of concepts and learning interests. Meanwhile, the acquisition of N-Gain, which was only moderate in the control group, showed the limitations of conventional methods that tended to be verbalistic and lacked concrete experience for students.

Practically, these findings reinforce that Napier Bone media can be an alternative solution in multiplication learning in elementary schools, especially in areas with limited technological facilities. In addition, the results of this research are relevant to the demands of the Independent Curriculum and 21st century skills, because this media encourages students to think critically, creatively, and actively in constructing concept understanding. The results of this study show that the Napier Bone media developed has met the criteria of valid, practical, and effective in learning multiplication in elementary schools. In terms of validity, the media obtained an average score of 3.7 with *a very valid category*, indicating that the content, language, and display of the media have been in accordance with the learning feasibility standards. This is in line with the opinion of Akker (1999) who stated that content and design validation is an important step to ensure the integration of media with learning objectives. The high score on the display aspect also shows that an attractive visual design can increase students' attention, supporting the findings of Sadiman et al. (2020) that the aesthetic aspect of media can affect learning motivation.

In addition to being valid, the Napier Bone media has also proven to be practical based on the responses of teachers and students. An average practicality score of 3.63 indicates a very practical category, which means that the media is easy to use, interesting, and useful in supporting concept understanding. The high score of the convenience aspect indicates that this media is in accordance with the principle *of user friendliness* as affirmed by Nieveen (1999). Meanwhile, the attractiveness aspect showed that the use of different colors and simple shapes increased students' motivation to be actively involved, in line with Mayer's (2014) theory about the importance of multimedia design that supports cognitive engagement. Furthermore, the results of the effectiveness test proved that the Napier Bone media was able to significantly increase students' understanding of the multiplication concept. The average posttest score of the experimental group was higher than that of the control group, with an N-Gain of 0.61 (moderate–high category) compared to 0.36 (moderate category). This significant difference shows that Napier's Bone media can bridge students' difficulties in understanding the abstract concept of multiplication through concrete learning experiences. These findings support Bruner's (1966) theory of the importance of using manipulative media to facilitate the transition from the enactive to the symbolic stage. Similar research by Firdaus and Hamidah (2021) also shows that mathematics teaching aids are able to improve students' understanding of concepts and learning motivation.

Thus, the integration of the results of this study strengthens that Napier Bone media is feasible to be implemented in multiplication learning in elementary schools. In addition to

supporting the achievement of curriculum objectives, this media is also in line with the demands of the Independent Curriculum and 21st century skills, as it encourages students to think critically, creatively, and actively in the learning process. However, the limitation of this study is the scope of the material that focuses only on multiplication operations. Therefore, further research is recommended to extend the development of this medium to other mathematical operations, such as division or fractional numbers, so that the benefits are more comprehensive.

CONCLUSION

This research produced a learning media of Tulang Napier which was declared valid, practical, and effective in improving the understanding of the concept of multiplication for elementary school students. From the validity aspect, the media obtained an average score of 3.7 (very valid category), which indicates that the content, language, and display are in accordance with learning needs and curriculum standards. From the practicality aspect, the results of the teacher and student questionnaire showed an average score of 3.63 (very practical category), which means that the media is easy to use, interesting, and useful in supporting learning. Furthermore, in terms of effectiveness, the results of the trial showed that students who learned to use Napier Bone media obtained a significant increase in conceptual understanding compared to the control group, with an N-Gain value of 0.61 (medium-high category) compared to 0.36 (medium category).

Thus, Napier Bone media is worthy of being used as an innovative alternative in multiplication learning in elementary school. This media not only helps students understand abstract concepts concretely, but also supports the achievement of the goals of the Independent Curriculum as well as 21st century skills, especially critical, creative, and active thinking skills. However, this research is still limited to multiplication material, so further research is recommended to extend the development of the medium to other mathematical operations, such as division or fractional numbers, so that the benefits are more comprehensive and sustainable.

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