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DEVELOPING MACROMEDIA FLASH–BASED ETHNOMATHEMATICS LEARNING MEDIA FEATURING MAMUJU TRADITIONAL CAKES FOR TEACHING POLYHEDRA

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ABSTRACT

Learning polyhedra requires students to connect spatial representations with formal geometric concepts, yet instruction in many Indonesian junior secondary schools remains textbook-centred and offers few culturally familiar representations. This study developed an ethnomathematics-based interactive learning resource on polyhedra using Macromedia Flash and traditional Mamuju cakes, and evaluated its validity, practicality, and associated learning progress. The ADDIE model guided the research and development process. The resource links cubes, cuboids, prisms, and pyramids with traditional cakes of Mamuju, West Sulawesi, through a culture-to-concept sequence that moves from the cultural object to its geometric elements, idealization, and calculation. Three experts validated the media and content; seven Grade VIII students took part in a limited trial, and a separate class of 25 students at SMP Negeri 3 Mamuju took part in a field trial. Data were collected through validation sheets, student response questionnaires, observation, interviews, and pretest–posttest achievement tests. Mean media and content validation scores were 4.75 and 4.88 on a five-point scale (valid). Students in both trials operated the resource without major difficulty and responded positively to its visual presentation, navigation, and cultural examples. The mean score increased from 56 to 85; the mean individual normalized gain was 0.71 (high), and the class-average gain was 0.66 (medium). Because no comparison group was used, these results are interpreted as descriptive learning progress. The study contributes an explicit design for turning local cultural artefacts into objects of geometric reasoning.

Keywords: Ethnomathematics; Interactive Learning Media; Macromedia Flash; Polyhedra

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INTRODUCTION

Understanding polyhedra involves more than memorizing formulas. Students need to recognize the faces, edges, and vertices of three-dimensional objects and relate these features to surface area and volume. When instruction relies mainly on textbook descriptions and teacher explanations, these relationships can remain difficult to visualize. A qualitative study of elementary geometry learning identified difficulties with basic concepts, geometric representations, and limited visual support (Putri & Fitriyani, 2024). Although the participants in that study were younger than those in the present research, the findings underline the need to examine how visual and contextual resources can support geometry instruction.

Initial observations at SMP Negeri 3 Mamuju indicated that lessons on polyhedra relied largely on textbooks, with limited use of technology-supported learning media. Interviews with the mathematics teacher and students suggested that the lack of varied representations made the lessons repetitive and difficult to follow. Students experienced difficulty interpreting the forms and properties of the solids under discussion. These observations identified a local instructional need: a resource that could combine visual representations with examples familiar to students.

Ethnomathematics offers a way to connect mathematical ideas with cultural objects and practices. Its educational value lies in making these connections explicit, rather than using culture only as decoration. Prahmana and D'Ambrosio (2020), for example, showed how the geometric patterns of Yogyakarta batik can serve as a basis for learning geometric concepts together with the cultural values embedded in them. In their mapping of ethnomathematics research, Serepinah et al. (2023) highlighted both the range of cultural objects examined and the limited classroom application documented in some studies. Traditional foods and their preparation can provide concrete starting points for mathematical inquiry. Nursyahidah and Albab (2021) developed a learning sequence on the surface area and volume of cylinders using traditional cake moulds and GeoGebra, while Faqih et al. (2021) developed interactive multimedia around traditional cooking utensils. These studies support examining everyday cultural representations as resources for geometry learning.

Digital learning media can combine explanatory text, images, animation, navigation, and practice activities. Development studies have examined animated videos for mathematics (Prasetya et al., 2021), educational games for elementary arithmetic (Juhaeni et al., 2023), and Android applications for mathematical problem solving (Mahuda et al., 2021). These studies provide precedents for designing interactive materials and evaluating their suitability for particular learners and instructional goals. Research on Flash-based geometry media (Armila, 2021), together with the literature review by Setyaningsih and Farida S. (2023), also provides a foundation for using this authoring environment in educational development.

Research combining ethnomathematics and digital media already includes several relevant precedents. Arif et al. (2019) developed Macromedia Flash media for cubes and cuboids and compared posttest outcomes between experimental and control classes. Putra and Haqiqi (2022) evaluated the validity and attractiveness of a culturally contextualized electronic module, whereas Sholeh et al. (2021) examined an Android-based ethnomathematics pocketbook for triangles and quadrilaterals. Nabila et al. (2023) developed iSpring Suite media for polyhedra, but their study was limited to the development and expert validation stages. More recently, Maryanti and Suwardi (2024) examined web-based ethnomathematics media for the same geometry topic and reported expert assessments and student responses.

These studies establish a basis for combining ethnomathematics with digital instruction, but three issues remain. First, their reports focus mainly on product quality, student responses, or posttest differences; the mechanism by which the media guide students from a cultural object to the idealized solid it approximates is described less explicitly. In Arif et al. (2019), the scope was limited to cubes and cuboids and the emphasis was on comparing classes; Nabila et al. (2023) stopped at expert validation; and Maryanti and Suwardi (2024) reported expert assessments and student responses without examining learning progress. Second, evidence that spans the complete ADDIE cycle—validation, limited and field trials, and learning gains—for a single culturally grounded resource on polyhedra remains limited. Third, the food culture of Mamuju, West Sulawesi, whose traditional cakes are familiar to local students and approximate several polyhedra, has not yet been used for this purpose.

The present study addresses these issues through an explicit *culture-to-concept* design. For each solid, the learning sequence moves students through four steps: (a) recognizing a traditional Mamuju cake that students know from daily life, (b) identifying the faces, edges, and vertices of the solid that the cake approximates, (c) discussing where the physical object departs from the ideal solid, and (d) applying the relevant dimensions to surface area and volume problems. Unlike Arif et al. (2019), the resource covers prisms and pyramids in addition to cubes and cuboids; unlike Nabila et al. (2023) and Maryanti and Suwardi (2024), it is evaluated through classroom implementation and pretest–posttest gains in addition to expert validation and student responses. The resource also runs offline, which suits schools with limited internet access. Accordingly, this study aimed to (1) develop an ethnomathematics-based learning resource on polyhedra using Macromedia Flash and traditional Mamuju cakes and (2) evaluate its validity, practicality, and the learning progress of students who used it. We argue that making the culture-to-concept steps explicit helps students treat cultural representations as objects of geometric reasoning rather than as decorative illustrations.

METHOD

Research Design

This research and development study followed the ADDIE instructional design model, comprising analysis, design, development, implementation, and evaluation (Branch, 2009). The product was an interactive ethnomathematics-based resource for teaching polyhedra, developed using Macromedia Flash. A mixed-methods approach was used: descriptive quantitative analyses of expert ratings and achievement tests were combined with qualitative information from questionnaires, observations, interviews, and expert feedback. Learning outcomes were examined through a one-group pretest–posttest design during the field trial. Because no comparison group was included, outcome data were interpreted descriptively as indicators of learning progress rather than as evidence of a causal effect.

During analysis, the researchers examined instructional needs, student characteristics, classroom conditions, and the content of the polyhedra unit. Observations and interviews identified learning difficulties and the need for visual, contextual resources, as well as the teacher's need for media that could be opened directly from a laptop without an internet connection. During design, the researchers prepared a flowchart, storyboard, instructional content, images, animations, practice questions, and evaluation instruments. Traditional Mamuju cakes were selected as cultural representations using three criteria: (a) students recognize them from daily life, (b) their shapes approximate one of the target solids, and (c) they are part of the local food culture of Mamuju. Candidate cakes were identified from interviews with the mathematics teacher and students during the analysis stage.

During development, the resource was authored in Macromedia Flash and published as a stand-alone application that runs offline on a laptop or desktop computer without additional installation; in the classroom, it could be displayed with a projector for whole-class discussion. The platform was selected for three reasons: (a) it does not require an internet connection, which suited the school's conditions; (b) the teacher needed a file that could be opened directly from a laptop or flash drive; and (c) it integrates images, animation, navigation buttons, and interactive quizzes with immediate feedback in a single file (Armila, 2021; Setyaningsih & Farida S., 2023). Because browser support for Flash Player ended in 2020, the stand-alone format, which does not depend on a web browser, was used. Media and content experts then reviewed the prototype. Their comments on the visual presentation, content, and language were

addressed before the limited trial, and the problems students identified in the limited trial were corrected before the field trial. Evaluation was conducted formatively after each stage and summatively at the end, drawing on expert assessments, student responses, observations, and achievement test results.

Sample or Informants

The study was conducted at SMP Negeri 3 Mamuju, a public junior secondary school in Mamuju, West Sulawesi Province, Indonesia. Participants were Grade VIII students, the level at which polyhedra are taught in the national curriculum. Participating classes were determined purposively in consultation with the mathematics teacher, taking into account the scheduling of the polyhedra unit. The limited trial involved seven students who did not take part in the field trial; its purpose was to identify initial responses, usability problems, and aspects requiring revision before classroom implementation. The field trial involved one intact class of 25 students, all of whom completed both the pretest and the posttest, yielding 25 matched pretest–posttest pairs.

In the limited trial, students explored all menus of the resource, completed the practice questions, and commented on navigation, readability, and content. The field trial took place during regular mathematics lessons on the polyhedra unit: the pretest was administered before the first lesson with the resource, and the posttest and student response questionnaire were administered after the final lesson. During the lessons, the teacher presented the resource to the class, introduced the traditional cake associated with each solid, and guided discussion of its geometric features. Students then navigated the content pages and completed the practice questions, while the researcher observed classroom activities.

Expert validation involved three validators, comprising mathematics education lecturers and mathematics teachers. The same three validators assessed both the media and the content components using separate instruments, yielding three sets of ratings per component (Tables 8 and 9).

Data Collection

The instruments comprised a media validation sheet, a content validation sheet, a student response questionnaire, an observation sheet, an interview guide, and a learning achievement test. The media validation instrument was adapted from Marlini and Rismawati (2019), and the content validation instrument from Hapsari and Zulherman (2021). The questionnaire items on ease of use drew on Marisda et al. (2020), while the achievement test and student response instruments were adapted from Buhaerah et al. (2018). Tables 1–4 present the assessment dimensions and indicators, and Table 5 summarizes the respondents, items, response format, and analysis for each instrument.

Table 1. Media Validation Instrument

Dimension	Indicators
Visual presentation	Color selection, font use, layout, and visual emphasis
Media quality	Ease of use and instructional usefulness
Language	Clear, concise, and effective wording

Source: Study instrument, adapted from Marlini and Rismawati (2019).

Table 2. Content Validation Instrument

Dimension	Indicators
Content suitability	Alignment with basic competencies and learning indicators; logical sequencing; appropriate illustrations; mathematical accuracy
Presentation	Ease of understanding; coordination of colors, text, and images; clarity of illustrations
Language	Clear sentence structure, accessible wording, and conformity with Indonesian language conventions

Source: Study instrument, adapted from Hapsari and Zulherman (2021).

Table 3. Learning Achievement Test Blueprint

Dimension	Indicator	Cognitive level
Conceptual understanding	Identify the properties of polyhedra	C2: Understand
Calculation	Calculate the surface area and volume of a cube	C3: Apply
Calculation	Calculate the surface area and volume of a cuboid	C3: Apply
Problem solving	Solve contextual problems involving surface area	C4: Analyze
Ethnomathematical connections	Connect concepts of polyhedra with local culture	C4: Analyze

Source: Study test blueprint. Cognitive levels follow the classification specified in the blueprint.

Items for the problem-solving indicator presented contextual situations requiring the calculation of surface area, whereas items for the ethnomathematical-connection indicator asked students to relate the traditional cake forms presented in the resource to the corresponding solids and to use the identified elements in calculations. Both indicators were placed at the analysis level (C4) because students had to select the relevant geometric information before computing.

Table 4. Student Response Questionnaire

Dimension	Indicators
Format	Clarity of images and text
Relevance	Connections with students' experiences, usefulness, and alignment with learning needs
Interest	Curiosity and participation
Satisfaction	Positive feelings about the learning experience
Confidence	Positive expectations after using the learning media

Source: Study questionnaire, adapted from Buhaerah et al. (2018).

Because the source instruments were developed for other subjects or levels (beginning reading, animated video media, physics multimedia in higher education, and a mathematics learning model), they were adapted in three steps. First, only indicators relevant to interactive geometry media for junior secondary students were retained. Second, the wording was revised to refer to polyhedra, the traditional cake representations, and the learning objectives of the unit. Third, the adapted instruments were reviewed by the validators for relevance and clarity, and the limited trial served to check that students understood the questionnaire and the operation of the resource before the field trial.

Table 5. Summary of research instruments

Instrument	Respondents	Content and items	Response format	Analysis
Media validation sheet	3 validators	9 items: visual presentation (4), media quality (3), language (2)	5-point rating scale	Mean rating (Equation 1)
Content validation sheet	3 validators	9 items: content suitability (4), presentation (3), language (2)	5-point rating scale	Mean rating (Equation 1)
Student response questionnaire	Limited and field trial students	Statements on format, relevance, interest, satisfaction, and confidence (Table 4)	Closed statements and open comments	Descriptive
Achievement test	25 field trial students	Items on the five indicators in Table 3 (C2–C4)	Scored 0–100	Means and normalized gain (Equation 2)
Observation sheet	Classroom lessons	Participation, engagement, and use of the resource	Field notes	Descriptive
Interview guide	Teacher and students	Learning needs and perceptions of the resource	Semi-structured	Descriptive

Data Analysis Techniques

Qualitative data from questionnaires, observations, interviews, and expert feedback were analysed descriptively to identify instructional needs, judge practicality, and guide product revision. Quantitative validation data were summarized as mean item ratings on a five-point scale. Each validation sheet contained nine items distributed across three dimensions (four, three, and two items). For each dimension, the total score across experts was divided by the number of item ratings (number of items × number of experts). The overall validation score was the unweighted mean of the dimension scores, retaining unrounded values until the final calculation.

$$V_a = \frac{\Sigma x}{n} \quad (1)$$

In Equation (1), V_a denotes the mean rating for an assessment dimension, Σx is the sum of the ratings, and n is the number of ratings. Table 6 presents the criteria used to interpret these mean scores. Expert assessment is a common component of development research, including the studies by Prasetya et al. (2021) and Mahuda et al. (2021).

Table 6. Interpretation of validation ratings

Mean rating (V_a)	Category
$V_a = 5$	Very valid
$4 \le V_a < 5$	Valid
$3 \le V_a < 4$	Moderately valid
$2 \le V_a < 3$	Less valid
$1 \le V_a < 2$	Not valid

Practicality was judged descriptively for the limited trial and the field trial separately. Evidence came from students' questionnaire responses and comments on the five dimensions in Table 4, observations of how students operated the resource, and interviews with the teacher and students. The resource was considered practical when students could operate it independently, the teacher could integrate it into regular lessons, and no unresolved usability problems remained after revision.

Learning outcomes were analysed descriptively using pretest and posttest means and normalized gain. Normalized gain expresses an increase in test scores relative to the maximum possible improvement (Hake, 1998):

$$g = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \quad (2)$$

Here, S_{pre} and S_{post} denote the pretest and posttest scores, respectively, and $S_{max} = 100$ is the maximum possible score. Normalized gain was first computed for each of the 25 students and then averaged (mean individual gain). For comparison, the class-average gain was also computed by entering the group means into Equation (2). Gains were categorized as high ($g \geq 0.70$), medium ($0.30 \leq g < 0.70$), or low ($g < 0.30$) (Hake, 1998). Both indices are reported because they can differ when gains vary across students.

RESULTS AND DISCUSSION

Results

The development process produced an interactive resource that combined geometric content with representations of traditional Mamuju cakes. The needs analysis identified textbook-centered instruction, limited visualization, and difficulties connecting abstract geometric descriptions with familiar objects. The main menu provided access to learning objectives, instructional content, and practice questions. The resource covered cubes, cuboids, prisms, and pyramids, with surface area and volume as its principal mathematical topics.

The cultural component pairs each target solid with a traditional cake form. The content pages present the definition and properties of the solid (for example, a cuboid has six faces, twelve edges, and eight vertices), its geometric model, and a photograph of the corresponding cake. As shown in Figure 2 and Table 7, the cuboid page pairs the cuboid with a layered cake cut into rectangular pieces, and the pyramid page pairs the pyramid with small leaf-wrapped cakes. These images represent geometric approximations: the features of physical objects are related to those of ideal mathematical solids. Figures 1–3 illustrate the Indonesian-language interface, including the opening screen, main menu, content pages, and practice activities.

Table 7. Examples ff Traditional Cake Representations and Culture-To-Concept Activities

Solid	Cultural representation in the resource	Geometric features emphasized	Culture-to-concept activity
Cuboid	Layered cake cut into rectangular pieces	Six rectangular faces, twelve edges, eight vertices; length, width, and height	Compare the dimensions of a slice; decide which dimensions are needed for surface area and volume
Pyramid	Small cakes wrapped in banana leaves in a pyramid form	Polygonal base, triangular lateral faces meeting at an apex; base area and height	Name the base, lateral faces, and apex; discuss why the folded leaf only approximates a pyramid; estimate the volume

On the pyramid page, for instance, students first recognize the leaf-wrapped cake from their daily experience. They then identify the base, lateral faces, edges, and apex of the corresponding pyramid, consider why the folded leaf has slightly curved edges and an uneven base, and agree on an idealized model. Finally, they apply the base length and height to calculate the volume, interpreting the result as an estimate for the real cake. In this way, cultural knowledge provides the context, while the comparison between object and model requires students to reason about the defining properties of the solid.



Figure 1. Opening screen (left) and main menu (right). "Mulai" means Start; "Tujuan Pembelajaran," "Materi," and "Kuis" denote Learning Objectives, Content, and Quiz



Figure 2. Content pages relating cuboids ("Balok," left) and pyramids ("Limas," right) to traditional cake representations



Figure 3. Practice entry screen (left) and a sample quiz item (right). "Latihan Soal" means Practice Questions and "Nama" means Name; the item asks for the volume of a cube with a 24 cm edge

Expert review addressed visual presentation, media quality, language, content suitability, and instructional presentation. Table 8 presents the media validation results. The dimension means ranged from 4.67 to 4.83, and the overall mean was 4.75. Table 9 presents the content validation results, with means ranging from 4.83 to 4.92 and an overall mean of 4.88. Under the criteria in Table 6, both overall scores fall within the valid category. The lowest-rated dimensions—media quality (4.67) and language (4.83)—indicated where revision was most needed, and the experts' comments on the interface, instructional content, and wording were incorporated into the revised version used in the trials.

Table 8. Media Validation Results

Dimension	Expert 1	Expert 2	Expert 3	Maximum per expert	Mean rating
Visual presentation	18	19	20	20	4.75
Media quality	13	14	15	15	4.67
Language	9	10	10	10	4.83
Total / overall mean	40	43	45	45	4.75

Table 9. Content Validation Results

Dimension	Expert 1	Expert 2	Expert 3	Maximum per expert	Mean rating
Content suitability	19	20	20	20	4.92
Presentation	14	15	15	15	4.89
Language	9	10	10	10	4.83
Total / overall mean	42	45	45	45	4.88

In the limited trial (n = 7), students were able to open the resource, move between menus, and complete the practice questions. Their comments concerned navigation, readability, and the clarity of some content, and these points were addressed before the field trial. In the field trial (n = 25), the teacher integrated the resource into regular lessons, and students operated it with little assistance. Questionnaire responses and comments indicated that students found the visual presentation attractive, the navigation easy to follow, and the cake examples helpful for recognizing the properties of the solids. Classroom observations showed active participation and enthusiasm during the learning activities. Taken together, these findings indicate that the resource was practical for classroom use in this setting.

All 25 field-trial students completed both tests. The mean score increased from 56 on the pretest to 85 on the posttest on a 0–100 scale, a gain of 29 points (Table 10). The mean of the individual normalized gains was 0.71, whereas the class-average gain computed from the group means was (85 − 56)/(100 − 56) = 0.66. The two indices differ because normalization is applied before averaging in the first case and after averaging in the second, so they diverge when gains vary across students with different pretest scores. Under Hake's (1998) criteria, the mean individual gain falls in the high category and the class-average gain in the upper medium category. Because no comparison group was included, these results indicate descriptive learning progress during the field trial rather than an effect attributable solely to the resource.

Table 10. Pretest–Posttest Results and Normalized Gain (n = 25)

Pretest mean	Posttest mean	Mean individual N-gain	Class-average N-gain
56	85	0.71 (high)	0.66 (medium)

Evaluation brought together expert assessments, student responses, observations, and achievement test results to guide further development. Revisions addressed the visual presentation, navigation, instructional content, and language. The resource met the study's validity criteria, was practical in classroom use, and was accompanied by measurable learning progress, supporting its use as an alternative resource for teaching polyhedra.

Discussion

The expert ratings indicate that the resource met the study criteria for content and media validity. Comparable findings have been reported for culturally contextualized electronic modules (Putra & Haqiqi, 2022), iSpring Suite materials (Nabila et al., 2023), and web-based polyhedra resources (Maryanti & Suwardi, 2024). These studies show how cultural

representations can be incorporated into resources evaluated for content, presentation, and usability. In the present study, the ratings support the suitability of the resource's design and mathematical content for classroom use.

The pedagogical value of the Mamuju examples lies in connecting familiar objects with formal geometry. In the culture-to-concept sequence, a food representation is not merely an illustration but a starting point for identifying faces and edges, comparing solids, judging how far a physical object departs from its ideal model, and selecting the dimensions required to calculate surface area or volume. This interpretation is consistent with the traditional cake-mould learning design developed by Nursyahidah and Albab (2021), the cooking-utensil multimedia developed by Faqih et al. (2021), and the use of batik patterns to learn geometric concepts and values (Prahmana & D'Ambrosio, 2020). Teachers can extend these representations through discussion of how a physical object approximates an ideal solid and which features are relevant to a particular calculation.

The practicality findings suggest that the combination of visual content, accessible navigation, offline operation, and familiar examples supported classroom use, and that the revisions made after the limited trial removed the main usability obstacles. This finding is consistent with research emphasizing usability and learner acceptance. Marlini and Rismawati (2019) examined the practicality of Flash-based beginning-reading media, while Marisda et al. (2020) described positive responses to interactive Flash multimedia in higher education. Hapsari and Zulherman (2021) also evaluated expert judgments and student outcomes when developing animated instructional videos. Although these studies involved different populations and subjects, they illustrate the value of examining students' experiences alongside expert assessments when evaluating instructional media.

The increase in mean test scores, with a mean individual gain of 0.71 and a class-average gain of 0.66, provides preliminary evidence of learning progress during the field trial. Arif et al. (2019) compared experimental and control classes when evaluating ethnomathematics-based Flash media, while Sholeh et al. (2021) used normalized gain to examine outcomes associated with an ethnomathematics pocketbook. These studies support evaluating learning outcomes as part of media development. However, differences in content, participants, instruments, and classroom implementation limit direct comparison across studies. The present pretest–posttest findings should therefore be interpreted within the context of this local trial, where teacher support, practice, and repeated testing may also have contributed to the observed improvement.

Beyond its local setting, the study makes three contributions. Conceptually, it articulates a culture-to-concept sequence recognition, identification of geometric elements, idealization, and calculation that can be transferred to other cultural objects and other solids. Compared with Arif et al. (2019), it extends Flash-based ethnomathematics media from cubes and cuboids to prisms and pyramids and makes the link between cultural objects and geometric properties an explicit part of the learning activity. Compared with Nabila et al. (2023) and Maryanti and Suwardi (2024), it moves beyond validation and student responses by reporting classroom implementation in two trials and pretest–posttest gains. This responds to the need for classroom applications of ethnomathematics identified by Serepinah et al. (2023). For teachers, the resource offers a way to introduce geometric ideas through familiar objects before moving to formal explanations and calculations. Further examination of students' written work, explanations, and errors would help clarify how they develop mathematical understanding through these representations.

The study has several limitations. The trials involved small samples at a single school, which limits the generalizability of the findings. The one-group pretest–posttest design does not isolate the contribution of the resource from other aspects of instruction. Practicality was judged descriptively rather than with a quantified scale, and instrument quality rested on expert judgement without statistical reliability estimates. The content was also restricted to polyhedra. In addition, Macromedia Flash presents compatibility constraints as educational technologies change. Future studies should involve more schools, include comparison groups, use quantified practicality and reliability measures, examine students' reasoning when moving from cultural objects to geometric models, and investigate retention and transfer of learning. Adapting the resource to accessible HTML5 web or mobile formats would also broaden opportunities for classroom use.

CONCLUSION

This study developed an ethnomathematics-based resource using Macromedia Flash to teach polyhedra through traditional Mamuju cakes. The mean media and content validation scores were 4.75 and 4.88, respectively, both classified as valid. The limited and field trials showed that students could operate the resource and that the teacher could integrate it into regular lessons, indicating practicality. The mean achievement score increased from 56 to 85, with a mean individual normalized gain of 0.71 (high) and a class-average gain of 0.66 (medium). These findings support the suitability of the resource as an alternative for geometry instruction and provide preliminary, descriptive evidence of its potential to support learning. By making the steps from familiar food representations to formal geometric concepts explicit, the resource offers a transferable culture-to-concept approach to teaching cubes, cuboids, prisms, and pyramids. Further research should evaluate the resource with larger and more varied samples and comparison groups, quantify practicality, analyse students' reasoning processes, and extend the approach to other mathematics topics. Development for HTML5 web and mobile platforms could improve access while retaining the cultural context and instructional purpose.

DECLARATIONS

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Author Contributions Statement

Feby Febriani A: Conceptualization, methodology, investigation, and writing original draft. Muh Awal Afriansyah: Validation, supervision, and writing review and editing.

AI Usage Statement

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) and Claude (Anthropic) for translation from Indonesian into English, language editing, organization, and formatting to the journal template. The authors reviewed and edited the output and take full responsibility for the content. Generative AI was not used to produce data, analyses, findings, or references.

Conflict of Interest

The authors declare that they have no conflicts of interest related to the research, authorship, and/or publication of this article.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Ethical Approval

This study was conducted with the permission of SMP Negeri 3 Mamuju. Students took part as part of their regular mathematics lessons, participation in the questionnaires and interviews was voluntary, and all data were anonymized before analysis.

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