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Development of an Interactive Web-Based Multimedia Platform (GlideApps) Integrating Cepak Kapung Ethnoscience to Enhance Conceptual Understanding Among Junior High School Students

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Abstract. This study was motivated by students' low conceptual understanding of temperature, heat, and thermal expansion at SMP Negeri 28 Batanghari, where learning achievement remained below 50%. Instruction predominantly used PowerPoint-based media, resulting in passive learning and limited contextual engagement. This study aimed to develop web-based interactive multimedia (GlidesApps) integrated with Cepak Kapung ethnoscience that is valid, practical, and effective in improving seventh-grade students' conceptual understanding. The study employed a Research and Development (R&D) approach using a development model consisting of five stages: analysis, design, development, implementation, and evaluation. The resulting product, named LokaSains, is a web-based learning application accessible via smartphone, laptop, or computer without installation. It presents learning content on temperature, heat, and thermal expansion integrated with the ethnoscience of Cepak Kapung, a traditional cake from Batanghari Regency. Content expert validation obtained a score of 91.07% (very valid), while media expert validation reached 87.50% (very feasible) after two revisions. Teacher practicality assessment produced 98.33% (very practical), and student responses in small-group and large-group trials reached 94% and 90.35%, respectively (very good). During implementation with 28 seventh-grade students, the mean pretest score increased from 46.07 to 76.79 in the posttest. A paired samples t-test produced $t = -13.053$ with Sig. (2-tailed) = $0.000 < 0.05$, indicating a significant difference in conceptual understanding before and after using the multimedia. The N-Gain score of 0.57 indicated moderate effectiveness in improving learning outcomes. Accordingly, the LokaSains interactive multimedia is considered valid, highly practical, and effective for teaching temperature, heat, and thermal expansion at junior high school level.

Keywords: Cepak Kapung; Conceptual Understanding; Ethnoscience; GlidesApps; Interactive Multimedia.

1. BACKGROUND

Education, in the broadest sense, encompasses all learning experiences that take place throughout a person's life in all environments and situations, and which have a positive influence on an individual's development. Education plays a vital role in improving the quality of human life (Arifin et al., 2024). In order to prepare a generation ready to face the world of work in the 21st century, one of the key players is the world of education, particularly schools and teachers. According to Mariani et al., (2021), schools are not merely places for the transfer of knowledge, but also function as institutions that shape the nation's future generations. The output of the educational and learning processes in schools is expected to produce graduates with the skills, knowledge, and character necessary to compete in the world of work.

In junior secondary school science education, a solid grasp of concepts is essential as a cognitive foundation that cannot be overlooked. Conceptual understanding is not merely the ability to recall definitions, but encompasses pupils' capacity to explain phenomena in their own words, classify natural phenomena, and apply scientific principles in real-life contexts (Anderson & Krathwohl, 2001). This urgency is all the more relevant within the framework of the Merdeka Curriculum, which explicitly promotes student-centred and contextual

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learning so that students do not merely passively receive information, but actively construct their own knowledge (Kemendikbudristek, 2022). In the context of physics, particularly temperature, heat and thermal expansion, a solid grasp of the concepts is crucial, as this subject matter involves abstract concepts such as the transfer of thermal energy, phase changes in substances, and the behaviour of particles phenomena that cannot be directly observed by students. Without a firm understanding, these concepts are likely to give rise to persistent misconceptions that are difficult to correct at later stages of learning (Fuadi et al., 2020).

The reality on the ground reveals a significant gap between curriculum requirements and actual learning conditions. Based on interviews with science teachers at SMP Negeri 28 Batang Hari, the teaching of topics such as temperature, heat and expansion still relies heavily on static PowerPoint presentations shown via a projector. This approach results in a learning environment dominated by passive activities, where pupils tend not to be actively involved in the process of constructing knowledge. The consequences are directly reflected in learning outcomes: student achievement in these topics remains below 50% of the Learning Objective Achievement Criteria (LOAC). This situation aligns with the findings of Fitriani et al. (2022), who state that science teaching that does not actively involve students and is not supported by adequate media has a direct impact on students' low conceptual understanding. This fact indicates the need for innovative learning media that is not only visually appealing but also capable of facilitating meaningful cognitive engagement among students.

Based on the results of interviews and a questionnaire distributed to Year 7 pupils at SMP Negeri 28 Batang Hari, untapped potential has been revealed. A total of 96% of pupils own a personal smartphone which they use regularly, 84% are accustomed to using it for significant periods of time, and 72% stated that they require interactive multimedia integrated with local contexts to learn about temperature, heat and expansion. This data indicates that students not only have access to technology but are also aware of the need for more contextual learning materials. These findings are supported by research by Nur Jannah et al. (2020), which demonstrates that the use of multimedia in learning has a significant impact on improving learning outcomes as it engages more sensory modalities than conventional media.

Based on this needs analysis, this study developed a web-based interactive multimedia tool using the GlidesApps platform. This platform was chosen due to a number of technical advantages relevant to the research context: it is no-code, meaning development does not require complex programming skills; it can be accessed directly via a browser without the need to install an application; it is cross-platform, making it compatible across various operating systems; and it supports the integration of text, images, audio, video, and interactive

quizzes within a single responsive interface. These characteristics make GlidesApps technically superior to native app-based media, which require installation and specific device specifications, whilst also being more interactive than the static PowerPoint presentations traditionally used. The flexibility of web-based access also aligns with students' digital habits, as they are accustomed to accessing information via smartphones, meaning the adoption of this medium into students' learning routines can occur more naturally.

The development of this research draws not only on the platform used, but also on the local ethoscience context integrated into the learning content. Ethoscience, as an approach that integrates local cultural knowledge into science learning, has proven effective in enhancing conceptual understanding whilst fostering pupils' appreciation of local wisdom (Ardianti & Raida, 2022; Sarini & Selamet, 2019). In this study, the ethoscience context examined is the process of making the traditional cepak kapung cake from Terusan, Batanghari Regency. Scientifically, the process of steaming this cake batter concretely illustrates the concepts of heat, temperature change, and the effect of heat on matter: the batter, which is initially soft, absorbs heat during the steaming process, its temperature rises, and its texture changes to become firm. The amount of heat absorbed and the duration of steaming directly determine the quality of the final product; thus, if the process is not carried out optimally, the heat received is insufficient and the dough does not cook thoroughly. By using a cultural experience familiar to pupils as a bridge to scientific concepts, this approach has the potential to strengthen contextual understanding of concepts whilst building connections between school science and pupils' real lives (Hidayati & Dewi, 2023).

2. RESEARCH METHODOLOGY

This study is a research and development (R&D) project aimed at producing a web-based interactive multimedia tool (GlidesApps) integrated with the local ethnoscience of 'cepak kapung' to enhance students' understanding of the concepts of temperature, heat and expansion (Meliala et al., 2024). The research subjects comprised 3 expert validators, 6 Year 7 pupils as small-group test subjects, and 28 Year 7 pupils at SMP Negeri 28 Batanghari as class test subjects during the period from October 2025 to May 2026.

The development model used in this study is the Lee & Owens (2004) model, which was selected because it is specifically designed for multimedia product development and includes a more structured needs analysis (front-end analysis) phase compared to other generic models. It consists of five development stages: analysis, design, development, implementation, and evaluation.

The first stage is analysis, which covers the analysis of needs, student characteristics, learning objectives, materials, media, and educational technology. This analysis was carried out through field observations, the distribution of questionnaires, and interviews with science teachers at SMP Negeri 28 Batanghari. The results of the analysis showed that student achievement in the topics of temperature, heat, and expansion remained below 50% of the National Curriculum Standards (KKTP), teaching still relied on static PowerPoint presentations, and 72% of students stated they required interactive multimedia integrated with ethoscience. The second stage is design, which involves the development of the material structure, flowcharts, and storyboards as a blueprint for product development. The third stage is development, which involves realising the design into an interactive multimedia product using the GlidesApps platform, guided by the principles of the Cognitive Theory of Multimedia Learning (Mayer, 2009). Expert validation was also conducted during this stage to obtain a feasibility score and feedback for product improvements.

The research subjects involved various parties according to their roles. Product validation was carried out by three expert validators: a subject matter expert, a media expert, and a learning expert. The practicality assessment was conducted by one science teacher from SMP Negeri 28 Batanghari as a practitioner. Product testing involved Year 7 pupils at SMP Negeri 28 Batanghari, divided into two stages: a small-group test with 8 pupils and a field test with 20 pupils.

The fourth stage is implementation, comprising a small-group trial to assess the initial practicality of the product based on student responses, followed by a field trial involving 28 Year 7 students to gather data on the practicality and effectiveness of the developed multimedia. The fifth stage is evaluation, conducted formatively at each stage of development and summatively at the end of implementation to measure the achievement of the product development objectives.

The research data consists of qualitative data in the form of comments and suggestions from validators and teachers, as well as quantitative data in the form of validation scores, student response scores, and conceptual understanding test results. The instruments used include an expert validation sheet, a teacher response questionnaire, a student response questionnaire, and concept comprehension test questions in the form of contextual descriptions based on ethnoscience.

Data analysis techniques employ two approaches. First, qualitative descriptive analysis to process data in the form of comments and suggestions from validators as material for product revision. Second, quantitative descriptive analysis to process validation scores,

practicality, and effectiveness. Product feasibility was assessed using a 1 to 5 Likert scale with a minimum feasibility threshold of 61%. The practicality of the interactive multimedia was determined by calculating the percentage of scores from the teacher and student response questionnaires. The effectiveness of the product was measured using a one-group pretest-posttest design with N-Gain Score analysis based on Hake's (1999) criteria: high if the N-Gain is greater than 0.7; moderate if the N-Gain is in the range of 0.3 to 0.7; and low if the N-Gain is less than 0.3.

3. RESULTS AND DISCUSSION

Product Development Process

The development of LokaSains interactive multimedia was carried out through five stages of the Lee & Owens (2004) model. The *analysis* stage revealed that science learning on the topics of temperature, heat, and thermal expansion at SMP Negeri 28 Batanghari had not yet been supported by interactive media: instruction relied on static PowerPoint presentations, classroom engagement was passive, and student attainment of the Learning Objective Achievement Criteria (LOAC) remained below 50%. Questionnaire data further indicated that 96% of students owned personal smartphones, 84% had used smartphones for more than two years, and 72% expressed a need for interactive multimedia integrated with local ethnoscience. These findings provided the empirical foundation for the subsequent design stage.

During the *design* stage, the material structure, flowchart, storyboard, and interface layout of the multimedia were developed. The *development* stage realised these designs into the LokaSains web application using the GlidesApps platform, incorporating content on temperature, heat, and thermal expansion integrated with the ethnoscience of Cepak Kapung. Expert validation and product revision were also conducted at this stage. The *implementation* stage comprised small-group and large-group trials to assess practicality, followed by classroom implementation with 28 seventh-grade students to measure effectiveness using a one-group pretest-posttest design. Finally, the *evaluation* stage assessed product feasibility holistically through analysis of validity, practicality, and effectiveness data obtained across all preceding stages.

The LokaSains application features a Student Profile page as the entry gate, a Home page as the main menu, a Usage Instructions page, a Materials page containing four sub-topics (Temperature, Heat, Thermal Expansion, and Science Behind Cepak Kapung), a Practice Exercises page, an educational Games page based on Wordwall, as well as Pretest and Posttest

pages linked to Google Form. Screenshots of the developed product are presented in Figure 1.

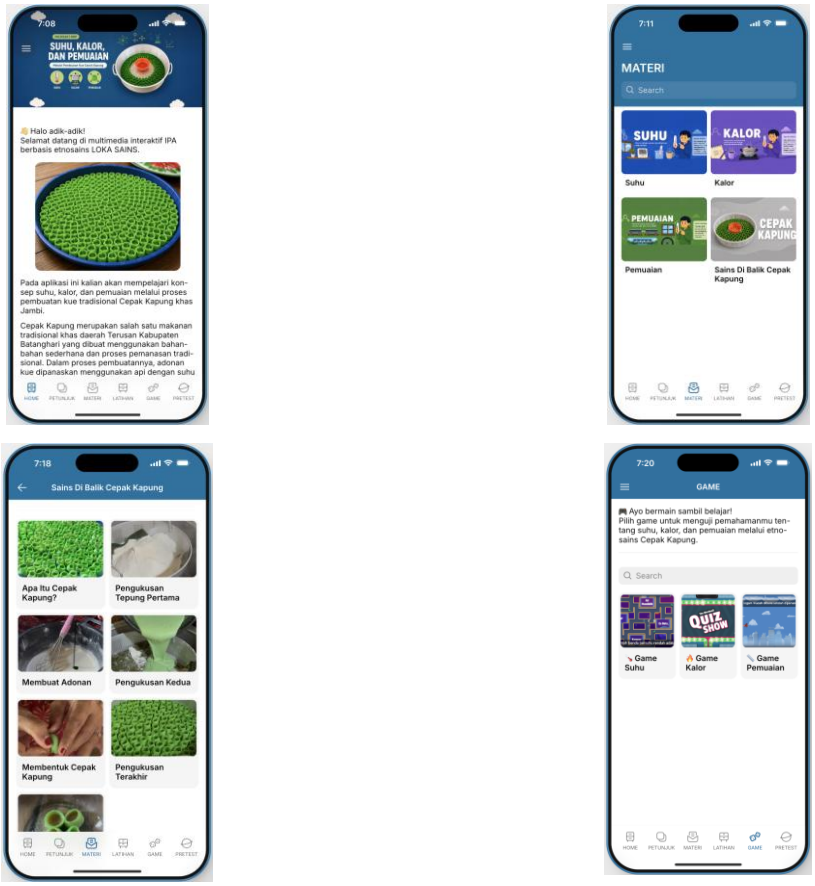

Figure 1. Screenshots of the LokaSains Interactive Multimedia.

Content Expert Validation

Content expert validation was conducted by one subject matter expert using an instrument comprising 14 indicators across four aspects: content appropriateness, conceptual understanding, contextual and ethnoscience integration, and language. Assessment was based on a rating scale of 1 to 4. The results of content expert validation are presented in Table 1.

Table 1. Results of Content Expert Validation per Aspect.

Aspect	Score Obtained	Maximum Score	Percentage	Category
Content Appropriateness	14	16	87.50%	Very Valid
Conceptual Understanding	15	16	93.75%	Very Valid
Contextual & Ethnoscience	11	12	91.67%	Very Valid
Language	11	12	91.67%	Very Valid
Total	**51**	**56**	**91.07%**	**Very Valid**

Based on Table 1, the LokaSains multimedia obtained a total score of 51 out of a maximum of 56, yielding a percentage of 91.07% with a category of Very Valid. All four aspects received ratings above 87%, indicating that the content is scientifically accurate, systematically structured, and contextually relevant to the Merdeka Curriculum Phase D learning objectives for seventh-grade science.

Media Expert Validation

Media expert validation was conducted by one media expert using an instrument comprising 20 indicators across three aspects: multimedia design based on Mayer's principles, media display, and navigation and interactivity. Validation was carried out in two rounds, with the second round following product revisions based on the expert's feedback. The results are presented in Table 2.

Table 2. Results of Media Expert Validation (Round I and Round II).

Aspect	Max Score	Round I Score	Round II Score	% Round II	Category (Round II)
Multimedia Design (Mayer's Principles)	48	32	40	83.33%	Very Feasible
Media Display	16	11	14	87.50%	Very Feasible
Navigation & Interactivity	16	16	16	100%	Very Feasible
Total	**80**	**59**	**70**	**87.50%**	**Very Feasible**

Table 2 demonstrates a significant improvement between the two validation rounds. In Round I, the multimedia received a score of 59 out of 80 (73.75%, categorised as Feasible), with the media expert recommending improvements to colour combinations, icon and text usage, layout of navigation buttons, illustrations and images, and the spatial placement of text relative to images. Following revisions based on these recommendations, Round II yielded a score of 70 out of 80 (87.50%, categorised as Very Feasible). The notable gains in the multimedia design and media display aspects confirm that the revision process effectively addressed the identified shortcomings.

Teacher Practicality Assessment

Practicality assessment was conducted by one science teacher from SMP Negeri 28 Batanghari using an instrument comprising 15 items based on Mayer's multimedia principles, with a rating scale of 1 to 4. The assessment covered fifteen aspects derived from Mayer's multimedia learning principles, including coherence, signaling, redundancy, spatial and temporal contiguity, segmenting, pre-training, modality, multimedia principle, personalization, usage instructions, image principle, navigation, interactivity, and

ethnoscience integration. The teacher awarded the maximum score of 4 on fourteen of the fifteen aspects, with a score of 3 on the personalization aspect, yielding a total score of 59 out of 60, equivalent to 98.33%, which falls within the Very Practical category. The teacher concluded that LokaSains is ready for classroom use without further revision, with one minor suggestion that the language used in certain sections be further adapted to suit the linguistic characteristics and comprehension level of seventh-grade students.

Student Response: Small-Group and Large-Group Trials

Student responses were collected using a questionnaire comprising 10 items on a 1-to-5 Likert scale, covering five indicators: presentation technique, presentation support, content presentation, learning motivation, and learning evaluation. The small-group trial involved 6 students, while the large-group trial involved 28 students. The results are presented in Table 3.

Table 3. Comparison of Student Response Results.

Indicator	Small-Group (%)	Large-Group (%)
Presentation Technique	93.33%	83.56%
Presentation Support	95.00%	84.00%
Content Presentation	94.44%	83.33%
Learning Motivation	93.33%	87.33%
Learning Evaluation	93.33%	87.33%
Average	**94.00%**	**90.35%**

The small-group trial yielded an average student response score of 94.00%, while the large-group trial produced an average of 90.35%, both categorised as *Very Good*. The slight decrease from small-group to large-group results is a common pattern in multimedia development research, attributable to greater variability in individual learning styles, technological familiarity, and classroom dynamics when the sample size is larger. Nevertheless, the consistently high scores across both trials confirm the multimedia's broad acceptability among students.

Pretest and Posttest Results

Conceptual understanding was assessed through a pretest administered before learning with LokaSains and a posttest administered after. Implementation was conducted with 28 seventh-grade students. Descriptive statistics of pretest and posttest scores are presented in Table 4.

Table 4. Descriptive Statistics of Pretest and Posttest Scores.

Statistic	N	Pretest	Posttest
Lowest Score	28	25	60
Highest Score	28	75	90
Mean	**28**	**46.07**	**76.79**

All 28 students experienced an increase in scores from pretest to posttest, with no student showing a decrease or unchanged score. The mean score increased by 30.71 points, from 46.07 to 76.79.

Normality Test

A normality test was conducted as a prerequisite for parametric hypothesis testing. Given that the sample size was fewer than 50, the Shapiro-Wilk test was used as the primary reference. Results are presented in Table 5.

Table 5. Results of Normality Test (Shapiro-Wilk).

Variable	Statistic	df	Sig.	Decision
Pretest	0.965	28	0.450	Normal
Posttest	0.938	28	0.097	Normal

Both pretest (Sig. = 0.450) and posttest (Sig. = 0.097) data yielded significance values greater than 0.05, confirming that both datasets are normally distributed. Accordingly, hypothesis testing proceeded using a parametric approach via the paired samples t-test.

Paired Samples T-Test

A paired samples t-test was conducted to determine whether a statistically significant difference existed between students' conceptual understanding before and after using the LokaSains multimedia. Results are presented in Table 6.

Table 6. Results of Paired Samples T-Test.

Statistic	Pretest – Posttest
Mean Difference	-30.714
Std. Deviation	12.451
Std. Error Mean	2.353
95% CI (Lower)	-35.542
95% CI (Upper)	-25.886
t	-13.053
df	27
Sig. (2-tailed)	**0.000**

The paired samples t-test yielded t = -13.053 with df = 27 and Sig. (2-tailed) = 0.000. Because the significance value (0.000) is less than 0.05, H_0 is rejected and H_1 is accepted: there is a statistically significant difference in students' conceptual understanding before and after using the LokaSains interactive multimedia integrated with Cepak Kapung ethnoscience.

N-Gain Score

The magnitude of improvement in conceptual understanding was quantified using the normalised N-Gain score based on Hake's (1999) criteria. The result is presented in Table 7.

Table 7. N-Gain Score.

Mean Pretest	Mean Posttest	N-Gain	Category
46.07	**76.79**	**0.57**	**Moderate**

The N-Gain score of 0.57 places the improvement in the moderate category ($0.3 \leq$ N-Gain ≤ 0.7), indicating that the LokaSains multimedia was moderately effective in improving students' conceptual understanding of temperature, heat, and thermal expansion.

Validity of the LokaSains Multimedia

The LokaSains multimedia demonstrated high content validity, with the content expert awarding a score of 91.07% (Very Valid). This result reflects the successful alignment of the multimedia content with the Phase D Learning Objectives of the Merdeka Curriculum, the scientific accuracy of the IPA concepts presented, and the relevance of the Cepak Kapung ethnoscience context to the material on temperature, heat, and thermal expansion. The highest-scoring aspect was conceptual understanding (93.75%), which indicates that the instructional design of the multimedia effectively supports students in building conceptual knowledge, consistent with the cognitive objectives outlined in Anderson and Krathwohl's revised taxonomy (Anderson & Krathwohl, 2020). The integration of ethnoscience received a score of 91.67%, affirming that the phenomenological context of Cepak Kapung cake preparation is scientifically legitimate and pedagogically appropriate as a bridge between students' cultural experiences and scientific concepts (Ardianti & Raida, 2022).

Media validity improved substantially between Round I (73.75%) and Round II (87.50%), reflecting the critical role of iterative revision in multimedia development. The lowest-scoring aspect in Round I was multimedia design based on Mayer's principles, particularly spatial contiguity, temporal contiguity, segmenting, and the multimedia principle, all of which were improved following revision. This iterative refinement process is consistent with evidence-based multimedia design research, which demonstrates that adherence to

Mayer's Cognitive Theory of Multimedia Learning (CTML) reduces extraneous cognitive load and supports dual-channel information processing, thereby facilitating deeper understanding (Mayer, 2009). The perfect score on navigation and interactivity (100%) across both rounds confirms that the GlidesApps platform provides a technically stable and user-friendly interface, which is a prerequisite for effective multimedia-based learning (Mariani et al., 2021).

Practicality of the LokaSains Multimedia

The practicality of LokaSains was affirmed by both teacher assessment (98.33%) and student responses in the small-group (94.00%) and large-group trials (90.35%), all categorised as Very Good or Very Practical. The teacher's near-perfect score across all 15 items based on Mayer's principles indicates that the multimedia satisfies the professional standards expected of instructional media in a classroom context. The sole item receiving a score below maximum concerned language personalisation, suggesting a minor need for further linguistic adaptation to suit seventh-grade students' vocabulary level, a finding consistent with Fadjarajani et al. (2020), who emphasise that instructional language must be calibrated to learners' developmental stage.

The consistently high student response scores across both trial phases confirm broad student acceptability. The slight decrease from 94.00% in the small-group to 90.35% in the large-group trial is attributable to increased variability in individual characteristics, technological familiarity, and classroom dynamics at a larger scale, which is a well-documented phenomenon in multimedia development studies (Nur Jannah et al., 2020). Notably, the learning motivation indicator received a relatively higher score in the large-group trial compared to other indicators, suggesting that the integration of ethnoscience context and educational games (Wordwall) contributed to sustaining student engagement even in a larger group setting. This is consistent with the finding of Ardianti & Raida (2022) that ethnoscience-based learning increases student motivation by connecting scientific concepts with culturally familiar phenomena.

Effectiveness of the LokaSains Multimedia in Improving Conceptual Understanding

The paired samples t-test result ($t = -13.053$, Sig. = 0.000) provides statistically robust evidence that the use of LokaSains multimedia produced a significant improvement in students' conceptual understanding of temperature, heat, and thermal expansion. The mean score increased from 46.07 on the pretest to 76.79 on the posttest, representing a gain of 30.71 points, with all 28 students recording an improvement. These results confirm that the

LokaSains multimedia is effective as an instructional intervention, beyond what might be attributable to chance or repeated testing effects.

The N-Gain score of 0.57, falling within the moderate category, indicates a meaningful but not maximal improvement in conceptual understanding. This result is contextually appropriate for several reasons. First, the study employed a one-group pretest-posttest design without a control group, which inherently limits the ceiling effect that might otherwise yield a higher N-Gain. Second, the material on temperature, heat, and thermal expansion involves inherently abstract concepts including heat transfer mechanisms and particle behaviour, which research has consistently shown to be among the most challenging topics for junior high school students due to the prevalence of entrenched alternative conceptions (Fuadi et al., 2020; Kapul et al., 2023). Third, the moderate N-Gain is consistent with comparable studies: Rahmawati et al. (2022) reported similar N-Gain values for interactive simulation-based learning in chemistry, and Anto et al. (2024) obtained comparable gains in physics learning using interactive multimedia based on Jambi local wisdom.

The improvement in conceptual understanding can be theoretically explained through two complementary frameworks. From the perspective of Cognitive Theory of Multimedia Learning (Mayer, 2009), the LokaSains multimedia engages students' visual and verbal processing channels simultaneously through the combination of text, images, and video, enabling more efficient construction of mental models compared to single-modality media such as static PowerPoint. From the perspective of ethnoscience-based learning theory (Ardianti & Raida, 2022; Sarini & Selamet, 2019), the integration of Cepak Kapung steaming process as a contextual scaffold allowed students to anchor abstract concepts to concrete, culturally familiar experiences. The observation that the batter absorbs heat, its temperature rises, and its texture changes upon steaming directly and tangibly illustrates the concepts of heat absorption, temperature change, and the effect of heat on matter. This contextualisation is particularly significant for rural students in Batanghari Regency, for whom Cepak Kapung represents a familiar cultural artefact, and aligns with Ausubel's meaningful learning theory as applied to science education by Ardiani & Agung (2022).

The variation in individual score gains, ranging from +5 to +55 points, warrants acknowledgment. Students with higher pretest scores (e.g., M-11 with 75 points) showed smaller absolute gains, a pattern consistent with ceiling effect expectations. Students with lower pretest scores demonstrated the most substantial improvements, suggesting that LokaSains was particularly effective in supporting students who had limited prior conceptual knowledge. This differential effectiveness implies that the multimedia's scaffolded,

segmented content presentation was well-suited to building foundational understanding from a low starting point. Taken together, the statistically significant paired t-test result and the moderate N-Gain confirm that the LokaSains interactive multimedia is effective for improving the conceptual understanding of seventh-grade students on temperature, heat, and thermal expansion, complementing and extending prior findings on the effectiveness of ethnoscience-integrated interactive media in Indonesian science education (Anto et al., 2024; Hidayati & Dewi, 2023).

4. CONCLUSIONS AND RECOMMENDATIONS

This development study has produced a web-based interactive multimedia tool (GlidesApps) called LokaSains, which integrates the local ethnoscience of ‘cepak kapung’ into teaching materials on temperature, heat and expansion for Year 7 secondary school pupils. The product, developed using the Lee & Owens model, was found to be highly valid based on subject matter expert validation results of 91.07% and media expert validation results of 87.50%, and highly practical based on teacher evaluations of 98.33% and student responses in small-group and large-group tests of 94% and 90.35% respectively. In terms of effectiveness, there was a statistically significant improvement in conceptual understanding between the pre-test score (46.07) and the post-test score (76.79) based on a paired t-test with a significance level of 0.000, with an N-Gain value of 0.57, which falls into the moderate category. Future researchers are advised to expand the scope of the test subjects, integrate diverse ethoscience contexts into other science materials, and enhance the product’s interactive features to maximise the potential for improving students’ conceptual understanding.

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