

Fostering Creative Thinking in the Digital Era: Integrating Ethnoscience and TikTok into Science Edutainment

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Abstract: Students' creative thinking skills remain relatively low in science learning, mainly due to a limited variety of learning media and a lack of integration of local wisdom. This study aims to develop Ethno-Tok edutainment-based learning media that integrates the ethnoscience of making nopia cakes into TikTok video content to train the creative thinking skills of seventh-grade students at SMP Negeri 1 Kejobong. The novelty of this study lies in integrating ethnoscience, the TikTok social media platform, and the edutainment approach into a structured, contextually grounded design for science learning media. This study used the Research and Development (R&D) method with the ADDIE model, comprising the Analysis, Design, Development, Implementation, and Evaluation stages. There were 42 students in the study, including 10 in the small group and 32 in the large group. Data were collected through expert validation, student response questionnaires, and creative thinking skills essay tests assessing the indicators of fluency, flexibility, originality, and elaboration. Data analysis was performed descriptively and inferentially using the Shapiro-Wilk normality test and the paired sample t-test. The validation results showed that the Ethno-Tok media was in the highly feasible category, and student responses were in the very good category. Students' creative thinking skill scores increased significantly from the pretest to the posttest, both in the small group (23.6 to 85.8) and the large group (24.06 to 88.19). The paired-samples t-test showed a significant difference between pretest and posttest scores ($p < 0.05$). The N-gain analysis showed that the fluency and flexibility indicators were in the very good category, while originality and elaboration were in the good category. Ethno-Tok edutainment media shows potential to support the improvement of students' creative thinking skills in science learning through a local culture-based approach and project-based learning. The integration of local wisdom contexts with digital media familiar to students can strengthen learning engagement and conceptual understanding. However, because this study did not include a control group, the findings should be interpreted cautiously and considered preliminary evidence that requires further testing through experimental research designs.

Keywords: ethnoscience, TikTok, edutainment, creative thinking skills.

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■ INTRODUCTION

The rapidly evolving digital era has brought significant transformations to education, particularly with advances in information and communication technology (Akour & Alenezi, 2022). Learning that utilizes digital technology can help develop students' creative thinking competencies in this digital era (Dilekçi & Karatay, 2023). In the midst of the Fourth Industrial Revolution, marked by the rapid

development of the internet and digital technologies, several key competencies are increasingly essential, including creativity, innovation, effective communication, collaboration, critical thinking, and problem-solving (Legowo *et al.*, 2019).

Creative thinking skills are among the important 21st-century skills that every individual must possess (Purwati & Alberida, 2022). These skills have four indicators, namely fluency,

flexibility, originality, and elaboration (Susanti & Lestari, 2023). This has been regulated in the Ministry of Education, Culture, Research, and Technology Regulation No. 56 concerning Guidelines for the Implementation of the Independent Curriculum, which has established the theme of Engineering and Technology in the Pancasila Student Profile Strengthening Project, which encourages students to develop critical, creative, and innovative thinking skills. Creative thinking skills enable students to view problems from multiple perspectives and develop innovative alternative solutions (Albab & Wangguway, 2020).

Several international studies show that developing creative thinking skills in science learning does not always have an equal impact across all indicators of creativity. Studies based on project-based learning and contextual learning report that indicators of fluency and elaboration tend to develop more easily because students are accustomed to generating many ideas and developing detailed solutions through exploratory and collaborative activities. Conversely, indicators of originality and flexibility often require learning designs that are more open and challenging, and that provide space for students to take intellectual risks (Beghetto & Kaufman, 2016; Kwon & Lee, 2025). These findings indicate that the impact of a learning medium or model on creativity cannot be understood in aggregate; it must be analyzed more specifically for each indicator. Therefore, research examining the influence of learning media on each indicator of creative thinking, separately, is important for obtaining a more comprehensive picture of the quality of students' creative development.

However, the level of creative thinking skills in Indonesia remains comparatively low. According to the 2015 Global Creativity Index, Indonesia ranked 115th out of 139 assessed countries (Dewi *et al.*, 2019). Indonesia's PISA score in 2018 also declined from 403 to 396 in

the science performance category compared to 2015 (Cahyani & Setiawan, 2024). PISA questions require reasoning and argumentation skills, which require creativity to solve. One factor contributing to the decline in student creativity is the lack of teacher-led training in creative competencies, the emphasis on memorization over conceptual understanding, and limited variety in learning media (Retno *et al.*, 2025).

Based on preliminary observations and interviews with science teachers at SMP Negeri 1 Kejobong, students' creative thinking skills are still relatively low. The observations indicate that most students provide similar answers to open-ended questions, resulting in a limited range of ideas. In addition, only a small number of students actively express their opinions or offer alternative solutions during class discussions. These findings are reinforced by interviews with science teachers, who reported that students often wait for their friends' answers and lack the confidence to express diverse ideas. Students are also relatively passive in class discussions, as indicated by the low frequency of questions and opinions. This condition is related to the learning process, which remains dominated by lecture methods and lacks variety in learning media, generally relying on blackboards and printed books.

The effective use of learning media can support the development of creative thinking skills (Yulianci *et al.*, 2021). TikTok, a popular social media platform, can be an effective learning medium for conveying complex concepts in more engaging and entertaining ways (Radin & Light, 2022). This application offers a range of user-friendly features, making it an interactive learning tool. Interactive media, such as TikTok, also enable students to gain insights not directly taught by educators, thereby making learning more efficient and effective (Alino *et al.*, 2024).

From a cognitive perspective, the use of short video-based learning media in science education can be explained through recent

developments in Cognitive Load Theory and Cognitive Theory of Multimedia Learning. Learning is more effective when information is presented concisely, segmented, and focused on core concepts, so that students' working memory capacity is not overloaded and knowledge schema formation can proceed effectively (Sweller, 2020). Short-duration video media are considered capable of reducing extraneous cognitive load because they present information directly, visually, and contextually, characteristics that align with the nature of science material involving abstract processes and phenomena (Mayer, 2020). In addition, integrating dynamic visuals, audio narration, and short texts into instructional videos can encourage generative learning through coordinated multisensory processing, so that students not only receive information passively but also actively construct understanding (Fiorella & Mayer, 2020). Thus, the characteristics of short-form video media, such as TikTok, have strong cognitive potential to support science learning when designed pedagogically and aligned with multimedia learning principles.

Integrating local wisdom into learning contributes meaningfully to educational practices. A cultural dimension that may be aligned with science education is the community-based knowledge system known as ethnoscience (Kasi et al., 2020). Ethnoscience is a learning approach that uses local knowledge as both a source and an object of learning, presented in a contextual manner (Sudarmin *et al.*, 2019). Applying ethnoscience in education seeks to link local cultural knowledge with classroom material, making it easier for students to understand concepts that relate directly to their daily lives (Hikmawati et al., 2021).

International studies show that integrating local cultural knowledge into science education enhances the relevance of the learning context and student engagement, as scientific concepts

are directly linked to social and cultural experiences in everyday life (Aikenhead & Michell, 2011; Snively & Williams, 2018). However, the application of ethnoscience in formal science education still faces conceptual challenges, particularly when cultural knowledge is presented without an explicit scientific reconstruction within the conceptual framework of modern science. Contextual integration alone can limit learning to the level of experience without encouraging students to deepen their scientific understanding (McKinley & Stewart, 2011). In addition, the limitations of learning media that can represent cultural practices and local knowledge within a systematic conceptual model of science can hinder the transition from everyday knowledge to a more formal scientific understanding (Zidny et al., 2020). Therefore, there is a need to develop innovative learning media that explicitly bridge local cultural context with scientific concepts, so that ethnoscience not only serves as a contextual backdrop but also strengthens students' conceptual understanding and develops higher-order thinking skills.

In this study, nopia cake was chosen as the context for ethnoscience because it is a typical food of the Purbalingga region, widely known and produced for generations by the local community. Nopia cake is closely related to the social and cultural environment of students at SMP Negeri 1 Kejobong, so the learning context is easily recognized and understood by students. The process of making nopia cake involves science concepts related to substances and their changes, such as mixing ingredients, heating, and the physical and chemical changes that occur during baking. Therefore, nopia cake is a relevant ethnoscience-based learning context for linking local knowledge with scientific concepts in a contextually and meaningfully relevant way.

Interesting learning for students can be achieved through the concept of edutainment. Edutainment is a combination of the words

“education” and “entertainment” (Feiyue, 2022). Edutainment is a learning process that combines educational and entertainment elements in a balanced way, creating an enjoyable learning experience (Dahlan, 2025). In science subjects, edutainment is referred to as science edutainment. The application of science edutainment in learning is expected to increase students’ interest in science, thereby improving learning outcomes (Prasetyaningsih et al., 2024).

Theoretically, edutainment is conceptualized as a pedagogical approach rooted in constructivism and experiential learning, in which learning is understood as an active process of simultaneous cognitive and affective engagement by learners (Kolb & Kolb, 2012). International research shows that edutainment can increase intrinsic motivation, attention, and learning engagement, which are important prerequisites for meaningful learning and the development of higher-order thinking skills (Plass et al., 2020). However, critical studies also emphasize that edutainment that is not systematically designed risks reducing the depth of cognitive processing because the focus of learning shifts to entertainment alone, without being balanced with clear conceptual objectives (Lamb et al., 2018). Therefore, the application of edutainment in science learning should be designed around structured pedagogical objectives and integrated with conceptual content, so that the entertainment element serves as a facilitator of learning rather than a mere distraction.

Previous research by Flores et al. (2024) indicates that TikTok can serve as an alternative to improve students’ understanding of the material, as it meets criteria for an effective learning medium. Another study by Bali & Hishnuddin (2023) states that the edutainment method can create a more engaging learning experience and has been used in various education systems worldwide. However, no research has integrated the concepts of ethnoscience, the TikTok platform, and the edutainment approach

into a single learning medium to train students’ creative thinking about substances and their transformations.

Recent studies indicate that the use of video media in science education remains largely focused on increasing learning motivation and basic conceptual understanding, whereas those that specifically examine the development of creative thinking skills through structured pedagogical design remain relatively limited (Brame, 2017; Fiorella & Mayer, 2020). On the other hand, research on culture-based science learning emphasizes the importance of integrating local culture to develop meaningful learning. However, its implementation remains largely conventional and has not been optimally integrated with digital media that align with the characteristics of students in the digital generation (Snively & Williams, 2018). Meanwhile, the edutainment approach in science learning is often applied only partially and emphasizes engagement without systematic cognitive design to train students’ creativity (Plass et al., 2020). Therefore, there remains a significant research gap regarding the development of learning media that integrate ethnoscience, short video media, and the edutainment approach into a structured pedagogical design to support the development of students’ creative thinking skills, particularly in the subject matter of substances and their changes.

Based on this description of the problem, it is necessary to research the development of an alternative science learning medium, namely, edutainment-based ethnoscience, to train students’ creative thinking. Therefore, this study is guided by the following research questions: (1) How feasible is the edutainment-based Ethno-Tok learning media for training students’ creative thinking skills? (2) How effective is the edutainment-based Ethno-Tok learning media in training students’ creative thinking skills? This research is novel in several aspects, namely developing edutainment-based learning media by

integrating the concepts of ethnoscience and TikTok, which have not been widely developed before, utilizing social media platforms as learning tools that are not only entertaining but also educational, and focusing on developing students' creative thinking skills through an approach that is more relevant to their daily lives.

■ **METHOD**

Participants

This study was conducted at SMP Negeri 1 Kejobong in the odd semester of the 2025/2026 academic year. The research subjects were students in class VII B, selected through purposive sampling based on theoretical and practical considerations. Class VII B was chosen because students in this class had not yet received material on substances and their changes, so the use of learning media would not be influenced by prior understanding of the concepts. In addition, this class had never used Ethno-Tok media in science learning, making it suitable for evaluating students' initial responses to the developed media. This selection was supported by recommendations from science teachers, who considered Grade VII B to represent the average academic characteristics of seventh-grade students, as well as adjustments to the school's learning schedule.

The effectiveness evaluated in this study refers to within-group changes in students' creative thinking skills before and after using the media, not to a causal comparison between groups. Therefore, these findings provide preliminary empirical evidence for the potential use of Ethno-Tok media, which can be further tested in subsequent research using a quasi-experimental design with a control group.

Research Design and Procedures

This research employed a Research and Development (R&D) approach. It utilized the ADDIE model introduced by Dick and Carey, which includes five sequential stages: analysis,

design, development, implementation, and evaluation. The research was conducted from July 21 to August 9, 2025.

The analysis stage was conducted to identify learning problems and instructional needs through interviews with science teachers, student needs questionnaires, and classroom observations. The results of the teacher interviews indicated that science instruction was primarily delivered through lectures, which in turn reduced student engagement. The use of technology-based media remained limited, and the integration of local knowledge remained minimal. These conditions formed the basis for developing interactive media content that integrates local wisdom. Questionnaires and observations revealed low student engagement and limited opportunities to express ideas; therefore, the media were designed to increase student interaction and active participation. Based on these findings, the media was developed by integrating local wisdom, using familiar digital platforms as TikTok, and presenting interactive visual content to increase student engagement.

The design stage translated the analysis findings into a structured media plan, including the creation of a storyboard with consistent narratives to overcome low engagement and facilitate understanding of scientific concepts. The TikTok platform was chosen because students are familiar with digital platforms, and the storyboard was developed with a narrative structure and visual animations to overcome low engagement and difficulty in understanding concepts. In addition, the research instruments were designed in accordance with the study objectives, including a validation questionnaire to assess media quality and content accuracy, essay-based test questions to measure creative thinking skills, and a student response questionnaire to capture learners' perceptions of the media.

The development stage produced Ethno-Tok media according to the storyboard, featuring

the process of making nopia cakes that convey local wisdom, and employing narration, animation, and visual editing to explain changes in substances interactively, thereby helping students understand concepts that had previously been difficult to explain in lectures. The initial product was then evaluated by subject-matter and media experts to assess content validity, presentation quality, and usability. The validation process input served as the basis for revising the media before classroom implementation.

The implementation stage aims to test the feasibility of the media developed in a real classroom learning environment. Ethno-Tok media is implemented over four lesson periods (4 JP) using the Project-Based Learning (PjBL) model, where students observe changes in substances in nopia cakes and complete project-based worksheets that integrate local wisdom, thereby encouraging the development of creative thinking skills and active student participation. The final product of this learning process was a creative poster presenting each group's scientific analysis of the selected local wisdom, which was then presented to the class.

The evaluation stage involved administering a pretest before implementation to measure students' initial abilities and a posttest after implementation to assess improvements in their creative thinking skills. The pretest and posttest consisted of essay questions, with a 35-minute time limit. A comparison of pretest and posttest results was used to assess the limited effectiveness of Ethno-Tok-based edutainment media in developing students' creative thinking skills in science learning.

Instruments

This research employed a test instrument to assess improvements in students' creative thinking skills. The instrument consisted of an essay-based assessment on substances and their changes. A total of 15 items were developed with

reference to Torrance's creative thinking indicators, encompassing four key aspects, namely: (1) fluency (fluency in generating ideas), (2) flexibility (flexibility in providing various alternative answers), (3) originality (uniqueness in providing answers), and (4) elaboration (detail in describing answers). The test instrument was developed independently and underwent several quality-assurance procedures prior to use in the study. It was evaluated through expert validation and tests of validity, reliability, item difficulty, and discrimination power, all conducted in SPSS.

Instrument validation was conducted with four experts using a validation questionnaire covering three main aspects: construction, content, and language. In terms of construction, validators assessed the clarity of instructions, the appropriateness of questions, and the ease with which the material was understood by students. Content was assessed based on the suitability of the questions to learning indicators, their relevance to concepts of matter and its changes, their connection to creative thinking skills, their use of images, and their relevance to students' daily lives. Language was evaluated based on the use of proper, correct, and communicative Indonesian. Each aspect is assessed using a score of 1-4, where 1 is very inappropriate, 2 is inappropriate, 3 is appropriate, and 4 is very appropriate. In addition to completing the checklist, validators provide written comments and suggestions for improvement for each question. Next, the author followed up on the input by making minor revisions to the wording, sentence structure, and illustrations, based on the validator's suggestions. The validation results showed that the student creative thinking skills test instrument had high validity in its construction, materials, and language, making it suitable for use in research following the revisions.

Empirical validity testing was conducted on eighth-grade students using the Pearson product-moment correlation test with the help of SPSS.

Of the 15 questions tested, 10 met the validity criteria, while five (1, 3, 9, 13, and 14) were declared invalid because they were unclear, the indicators were inappropriate, or they were difficult for students to understand. Empirical validity testing was conducted on eighth-grade students because the material tested, concerning substances and their changes, had already been taught in this grade, so that students had sufficient knowledge to understand and answer the questions correctly. The instrument's reliability was assessed using Cronbach's Alpha in SPSS, yielding a value of 0.709, which is considered high or acceptable. These results indicate that the instrument used in the study comprises 10 valid items for measuring students' creative thinking skills.

Data Analyses

The data analysis techniques employed in this study included analyses of product validity, media practicality, and learning effectiveness. A product validity analysis was conducted to determine the feasibility of Ethno-Tok edutainment-based media and to ensure that the instruments used aligned with the set learning objectives.

Media practicality was assessed using a 4-point Likert scale: 1 (strongly disagree), 2 (disagree), 3 (agree), and 4 (strongly agree). This questionnaire was used to measure students' responses to five aspects of media practicality: media display, interactivity, clarity and relevance of the material, creativity, and learning effectiveness. Practicality data were analyzed descriptively by calculating the average score and the percentage of achievement relative to the maximum score for each aspect.

To facilitate the interpretation of the practicality analysis results, the average scores were classified into five categories of practicality levels, namely very low, low, medium, high, and very high, based on certain score ranges as presented in Table 1.

Table 1. Categorization of media practicality scores

Score	Category
$80\% < x \leq 100\%$	Very High
$60\% < x \leq 80\%$	High
$40\% < x \leq 60\%$	Medium
$20\% < x \leq 40\%$	Low
$0\% < x \leq 20\%$	Very Low

The effectiveness of the media was evaluated by comparing pretest and posttest scores on students' creative thinking skills. The test instrument consisted of 10 essay questions that measured four indicators of creative thinking skills, namely fluency, flexibility, originality, and elaboration, which were given before and after learning, with a time allocation of 35 minutes. The test results were analyzed using the Shapiro–Wilk normality test to assess the distribution of the data, followed by a paired-samples t-test to assess significant differences between pretest and posttest scores.

To determine the extent of the effect of Ethno-Tok edutainment-based media on students' creative thinking skills, the effectiveness analysis was supplemented by effect-size calculations using Cohen's *d*. Cohen's *d* values were used to interpret the strength of the learning intervention effect, with criteria of $d < 0.20$ (small), $0.20 \leq d < 0.50$ (medium), $0.50 \leq d < 0.80$ (large), and $d \geq 0.80$ (very large). In addition, improvements in student learning outcomes were analyzed using N-gain calculations to assess the extent of improvement in creative thinking skills following the use of the media. All statistical analyses were performed using SPSS software.

■ RESULT AND DISCUSSION

The development of edutainment-based ethno-Tok learning media to train students' creative thinking skills in the subject of substances and their changes, through the reconstruction of

the ethnoscience process of making nopia cakes, has been implemented using the ADDIE model. The ADDIE model was chosen because it provides a systematic framework for developing effective learning media by incorporating continuous evaluation at each stage.

Analyses

The analysis process was conducted through interviews with science teachers, the distribution of questionnaires to students and educators, and the observation of classroom learning activities. The purpose of the analysis was to determine the appropriate learning media for developing students' creative thinking skills. The main problems identified included the dominance of conventional methods, limitations of technology-based learning media, and limited integration of local wisdom into science learning, which resulted in difficulties for students in understanding concepts and developing creativity. The needs survey revealed that teachers needed digital technology learning media, and it approved the development of TikTok-based Etno-Tok, which combines science and local culture. Students faced obstacles in understanding scientific concepts but demonstrated strong enthusiasm for TikTok-based learning media that integrate science with local wisdom, and they believed these media could enhance student creativity. The implementation of digital technology-based learning media that integrate local wisdom has been shown to improve students' understanding of science concepts and develop their creative thinking skills (Syahfitri, 2024).

Design

The design stage involved developing a product that provided a comprehensive overview of the learning media content to be created. The learning media developed were educational videos on the TikTok platform, in the etno-tok format, integrating ethno-science content with

material on substances and their changes. The TikTok platform was selected for its capacity to support microlearning through short videos aligned with the content-consumption patterns of the current digital generation (Alias & Razak, 2025). TikTok, as a learning media platform, has been shown to increase creativity and foster creative thinking among students through active participation in the learning process (Genelza, 2024). The short video format on TikTok enables the delivery of concise yet easily digestible information (Adelhardt & Eberle, 2024), making it suitable for explaining complex scientific concepts through an ethnoscience approach that is close to students' daily lives.

The steps taken include creating a TikTok account to understand the platform's characteristics and available features, compiling an ethno-Tok storyboard that describes the storyline and visual concepts of each episode, and planning a content structure that integrates ethnoscience reconstruction with the material and its changes. The storyboard was designed for a 45-90-second video, characteristic of TikTok, with a consistent narrative structure: an engaging hook, main content explaining authentic science, a section on scientific topics, and a conclusion that invites viewers to continue to the next content and sparks curiosity about the next topic. The design of the animated character serving as the main presenter was also developed at this stage, with a friendly, communicative avatar wearing a headscarf to foster emotional connection with the students. The expert validation sheets and response questionnaires in this study were systematically prepared in accordance with comprehensive guidelines and grounded in relevant theoretical frameworks to ensure the feasibility and effectiveness of the learning media developed.

Development

The development stage began with on-site video recordings of the nopia cake-making

process to ensure cultural authenticity and provide clear visual documentation. The recording was done from multiple camera angles to produce diverse, engaging videos. In addition, original scientific data on the production process of nopia cakes were collected, including the physical and chemical changes in the dough during baking, which were then analyzed and used as learning materials in science education. Examples of comparisons between traditional processes and scientific explanations are presented as infographics and animations to reinforce students' understanding. The narrative used explains authentic science and scientific science coherently. An example of the narrative is as follows: "In authentic science or traditional knowledge, clay pots are chosen because they are heat-resistant, not easily broken, and believed to preserve the distinctive taste of nopia cakes. This knowledge has been passed down from generation to generation by the community. Meanwhile, from a scientific perspective, clay pots are solid objects composed of tightly packed, strong particles. Therefore, their shape does not change even when exposed to high temperatures, making them suitable for baking nopia cakes."

The character animation was created using Adobe Express, which automatically generates character movements and expressions from uploaded voice recordings. Researchers only need to record a high-quality narration using text that experts have checked to ensure the content is accurate and appropriate for students' abilities. The Adobe Express website automatically processes the voice recording into character animations that move and express themselves in response to the narration's intonation and content. The character animation produced by Adobe Express is shown in Figure 1, featuring a hooded avatar as the presenter of the Etno-Tok learning media.

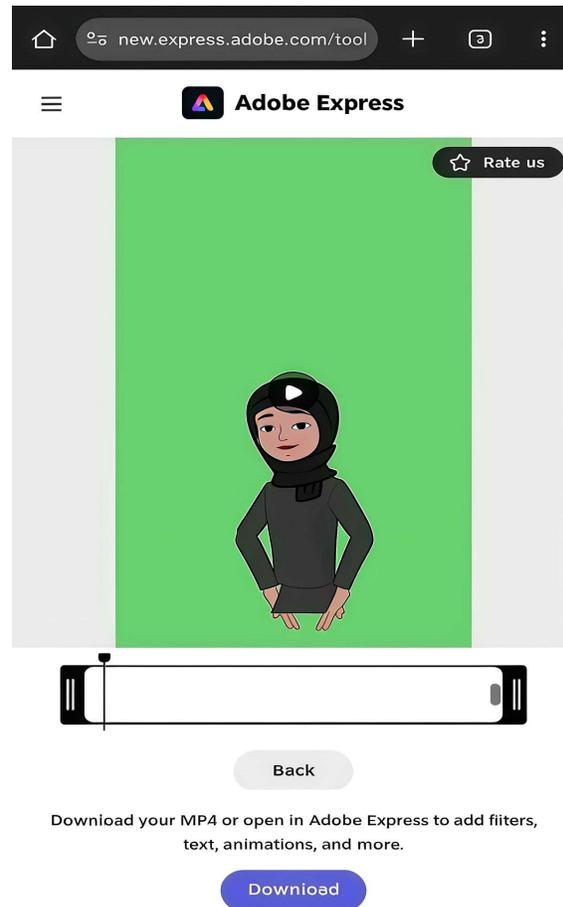


Figure 1. Character animations generated by adobe express

The editing process uses CapCut as the main platform, focusing on combining various elements into a complete educational video. Editing includes combining videos of the nopia cake-making process with character animation, applying visual and sound effects, and incorporating traditional music as background. The video is produced with a 16:9 frame ratio for optimal display across various devices, using a technique that combines several visual layers, including self-recorded and internet-sourced videos, with clear source citations, as shown in Figure 2.

Smooth transitions between scenes, using various types, provide interesting visual continuity

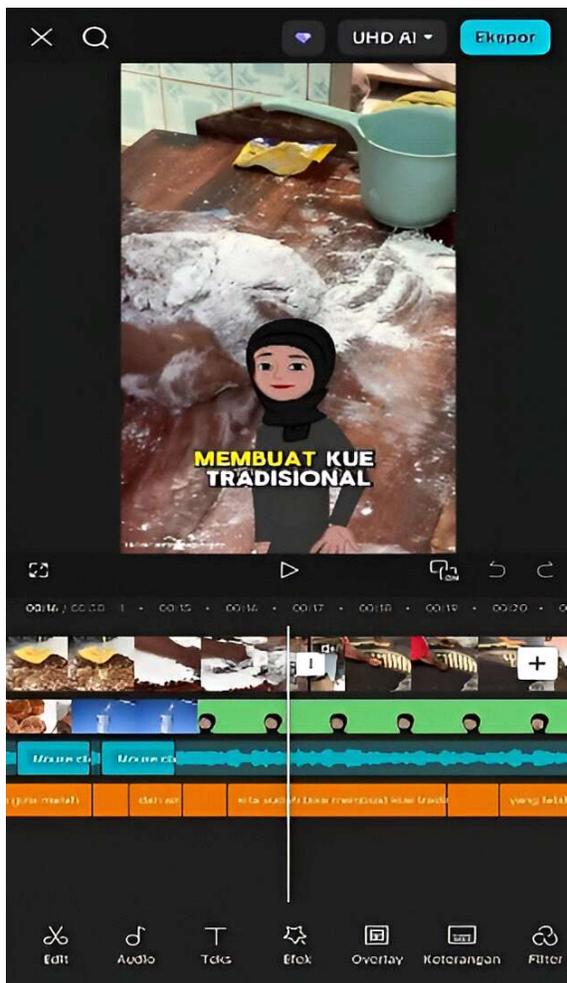


Figure 2. CapCut interface display during video editing

and help maintain students' attention. Traditional music is selected based on its tempo compatibility with the visuals and its ability to foster a comfortable learning environment without distracting from concentration.

The final product undergoes quality control to ensure proper audio and video synchronization, consistent display quality across episodes, and platform-specific file adjustments for TikTok. After editing and quality control are complete, the content is uploaded to TikTok, with a cover title tailored to the ethnoscience reconstruction of the nopia cake-making process and a caption that aligns with the content. There are 9 TikTok videos: the first 2 serve as

introductions to nopia cake, and the remaining 7 reconstruct the nopia cake-making process, integrating materials and their changes. The ethno-Tok media can be accessed via the link <https://bit.ly/etnopia>. The main TikTok account features a video grid that lets users view the entire content collection at a glance, as shown in Figure 3.

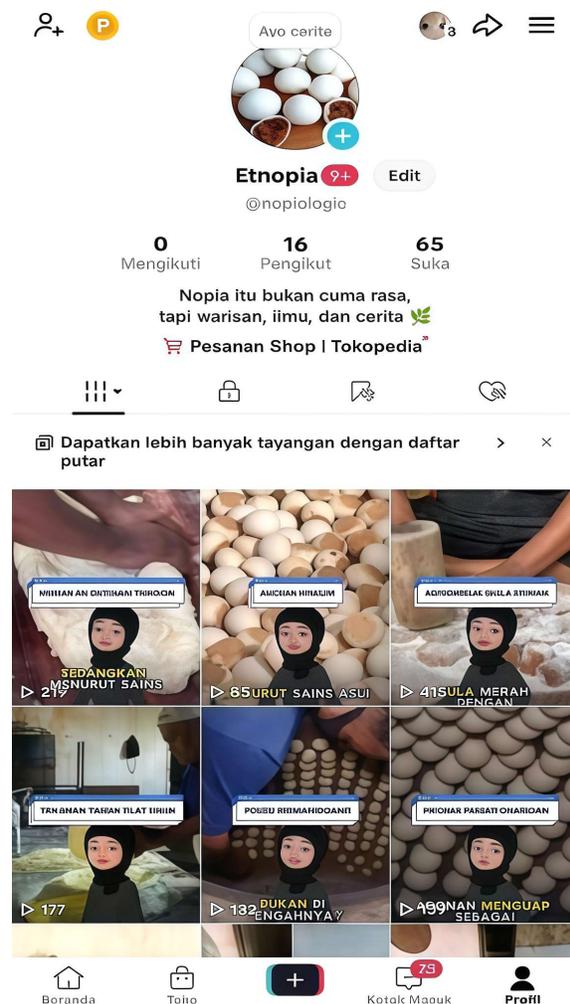


Figure 3. TikTok profile display with a grid of videos

The expert validation stage comprises two main categories: subject-matter expert validation and media expert validation, each involving five validators: two junior high school science teachers and three lecturers. The average result of subject-matter expert validation was 96.25%.

In comparison, media expert validation averaged 95%, indicating that this edutainment-based ethno-Tok media is highly valid and suitable for use in science education to train students' creative thinking skills. Feedback and suggestions from the validators informed improvements prior to entering the field trial stage.

Implementation

The implementation stage involved applying the developed learning media, namely, edutainment-based ethno-Tok media, in learning activities on substances and their changes. The learning activities were conducted with 10 students from class VII D in small groups and 32 students from class VII B in large groups over 4 lessons (JP) in the 2025/2026 academic year. This trial aimed to measure the increase in students' creative thinking skills after learning through edutainment-based ethno-Tok media that reconstruct the process of making nopia cakes.

The implementation process began with a pretest to assess students' initial creative thinking skills prior to using the developed learning media. The core learning activity was implemented using the Project-Based Learning (PjBL) model integrated with the ethno-Tok media. In the initial stage, all students explored the ethno-Tok media that showcased the reconstruction of the traditional nopia cake-making process. Through this media, students could observe the stages of making nopia cake, from mixing the ingredients and stirring the dough to shaping and baking, and analyze the changes that occurred at each stage as an example of learning.

During small-group trials in class VII D, researchers identified an obstacle: students with low abilities needed more intensive guidance when analyzing Ethno-Tok content and relating it to the concept of substance change. Based on these findings, during the large-scale implementation in class VII B, the researchers adjusted the learning scenario by providing more structured scaffolding,

including step-by-step guidance, individualized support, and targeted questions for students who needed additional help. This adjustment was intended to enable the entire group to complete the project assignment well and understand the material thoroughly.

The large-scale pilot test was implemented in class VII B with 32 students participating. At this stage, students were systematically divided into 5 groups to carry out project-based learning activities. Each group received a Student Worksheet (LKPD) containing various local wisdoms related to matter and its changes, such as the process of making brown sugar, salt, tempeh, pottery, and traditional dodol.

The LKPD was designed with systematic work stages, with each group working on one type of local wisdom identified in the worksheet. Through the LKPD, students were directed to analyze the local wisdom process using the concept framework of substance change, which had been learned from the ethno-Tok media. Each group is guided to complete the tasks in the LKPD in stages: identifying the materials used, observing the processes, analyzing the types of physical and chemical changes, and creating a poster as the final product, following the instructions provided in the LKPD.

During the learning process, students used the ethno-Tok content as the primary reference and conducted integrated activities guided by the LKPD. Students used their understanding of the process of making nopia cakes to analyze the local wisdom listed in the LKPD. Each group held in-depth discussions to understand the mechanisms underlying the changes in local wisdom that were the focus of their group, then presented the results of their analysis in creative posters in accordance with the LKPD guidelines. An example of the poster results compiled by group 1 is shown in Figure 4, which integrates the local wisdom of the salt-making process with the concepts of substances and their changes.



Figure 4. Example of a poster from group project 1

Although the Ethno-Tok media developed focuses on a single context, namely the process of making nopia cakes, the learning design is deliberately designed to facilitate knowledge transfer to other contexts of local wisdom. This knowledge transfer is facilitated by preparing student worksheets based on the same conceptual framework of substance change as that presented in the Ethno-Tok media.

Through the Ethno-Tok media, students are first guided to understand the basic concepts of physical and chemical changes through a concrete example close to their lives: the making of nopia cakes. Next, during the LKPD development stage, students are instructed to apply the same analytical framework, including identifying

materials, processes, and types of substance changes across different local wisdom contexts. With this approach, the Ethno-Tok media serves as an initial conceptual model (anchoring context), while the LKPD generalizes concepts to new contexts.

This approach aligns with the principles of contextual learning and Project-Based Learning, in which conceptual understanding does not stop at a single example but extends to application across various situations. Therefore, although the media focuses on nopia cakes, students are still equipped with a relevant framework for analyzing other local wisdom processes.

During the learning process, students used ethno-Tok content as the primary source and conducted integrated activities under the guidance of LKPD. Classroom observations indicated that most initially passive students became more enthusiastic, asking questions, discussing, and collaborating in groups to analyze the process of substance change. Post-learning interviews revealed that the media helped students understand previously difficult concepts, encouraged them to think creatively, and facilitated the innovative design of posters.

Each group presented the project results as part of the learning process. These presentations enabled each group to present their analysis and understanding of local wisdom and the changes that had occurred, using creative posters. Through these presentations, students developed their communication, critical thinking, and creativity skills while sharing knowledge with other groups, thereby strengthening their understanding of the concepts they had learned.

The implementation concluded with a post-test to assess improvements in students' creative thinking skills. The final product was a creative poster produced by completing the worksheet, displaying an analysis of the local wisdom provided in the worksheet and a scientific

explanation of the changes that occurred, combining the value of local wisdom with an understanding of the scientific concepts learned through the ethno-Tok media.

Evaluation

The evaluation of edutainment-based ethno-Tok media was conducted through limited trials with small groups and through field trials with large groups. The assessed aspects included media display, interactivity, material relevance, creativity, and learning effectiveness, each with 2 questions.

In a small-group trial involving 10 students, all respondents scored 4 (strongly agree) on all assessed aspects of practicality. With a maximum of 20 responses per aspect, all aspects received the maximum score of 100%. Thus, the distribution of student perceptions in the small-group trial was entirely in the very-high category. These results indicate that Ethno-Tok media is perceived as very practical, easy to use, visually appealing, and capable of supporting students' understanding of changes in the form of substances.

Furthermore, a large-group trial was conducted with 32 students. Regarding media display, there was 1 response in the disagree category and 63 responses in the strongly agree category, with no responses in the strongly disagree or agree categories. Based on this distribution of responses, the media display aspect was classified as very high. Regarding interactivity, all student responses were in the strongly agree category, so this aspect was classified as very high. In terms of material relevance, 12 responses were in the disagree category and 52 in the strongly agree category, with none in the strongly disagree or agree categories. Based on this distribution of responses, the material relevance aspect was classified as very high. Furthermore, the creativity aspect received 1 response in the disagree category and 63 responses in the strongly agree category, placing this aspect in the very high category. Similarly, regarding learning effectiveness, there was 1 response in the disagree category and 63 in the strongly agree category, indicating that this aspect falls into the very high category.

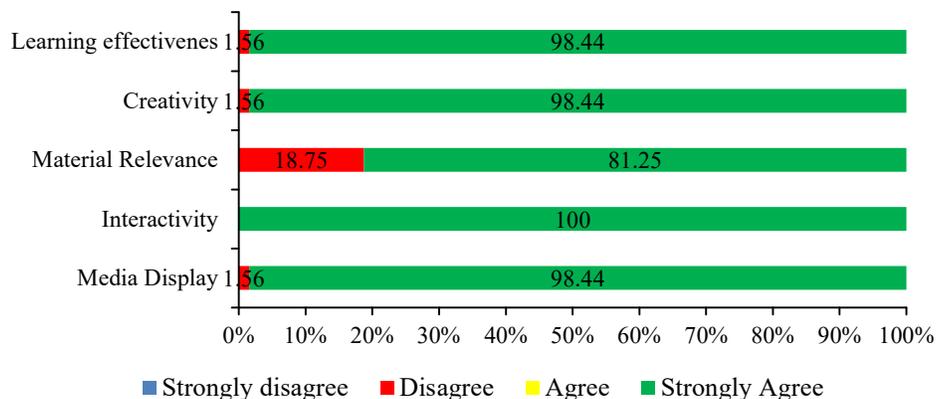


Figure 5. Distribution of students' practicality perception based on likert scale categories

Based on Figure 5, the distribution of student perceptions in the large-group trial shows a dominance of responses in the strongly agree category across almost all assessed aspects of

practicality. The aspects of media display, creativity, and learning effectiveness each showed a strongly agree response rate of 98.44%, while interactivity reached 100%. Regarding material

relevance, 81.25% of responses were strongly agree, although a small number were in the disagree category. However, the dominance of responses in the strongly agree category indicates that students perceived the material as very relevant. Overall, the response distribution in Figure 5 confirms that Ethno-Tok-based edutainment media is perceived as highly practical across all assessed aspects.

Nevertheless, variation in responses regarding material relevance suggests that some students still have difficulty connecting ethnoscience content to the scientific concepts under study. In this context, the traditional process of making nopia cakes as a form of local wisdom is not yet fully understood by all students as a concrete representation of the abstract concept

of substance change. Therefore, although Ethno-Tok media is generally considered very practical and has received positive responses, further development should focus on strengthening the explicit connection between examples of local wisdom and scientific concepts to optimize students' conceptual understanding.

The effectiveness of edutainment-based ethno-Tok media was analyzed by comparing pretest and posttest scores on students' creative thinking skills. The test instrument, in the form of essay questions, was administered before and after learning to measure improvements in four main indicators: fluency, flexibility, originality, and elaboration. The analysis showed an increase in scores after using the media, as shown in Figure 6, which presents the average test results.

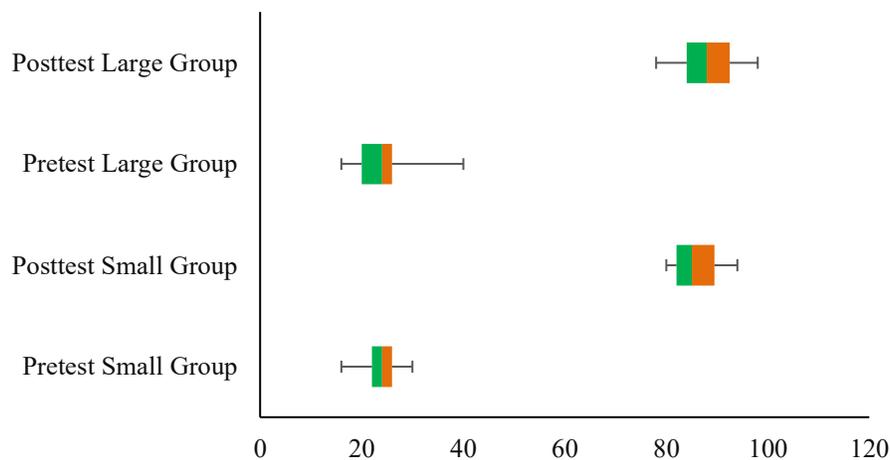


Figure 6. Average results of pretest and posttest values

Based on Figure 6, the small group showed an increase in the mean score from 23.60 on the pretest (SD = 4.30) to 85.80 on the posttest (SD = 5.03). Meanwhile, in the large group, the pretest mean score of 24.06 (SD = 5.04) increased to 88.19 on the posttest (SD = 6.10). The increase in the average score, accompanied by a relatively controlled standard deviation, indicates that the improvement occurred relatively evenly across students rather than being dominated by a small number of high-achieving individuals.

The effectiveness of Ethno-Tok media was evaluated using the Shapiro-Wilk test for normality and the paired t-test. For the small group, the normality test produced significance values of 0.838 for the pretest and 0.403 for the posttest, while for the large group, the significance values for the pretest and posttest were 0.064 and 0.150, respectively. Since all values exceeded 0.05, the pretest and posttest data in both groups were considered to be normally distributed. The paired-samples t-test results showed a statistically

significant difference between pretest and posttest scores in both groups. In the small group, the t-count was -37.807, exceeding the t-table value of 2.262; in the large group, the t-count was -55.941, exceeding the t-table value of 2.040. These findings indicate a significant improvement in students' creative thinking skills after using Ethno-Tok edutainment media.

Furthermore, to strengthen the evaluation of media effectiveness, Cohen's *d* was also calculated. In the small group, Cohen's *d* was 1.33; in the large group, it was 1.15. Based on

standard interpretation, a value of 1.33 falls into the very large category. In contrast, 1.15 falls into the large category, indicating that the improvement in students' creative thinking skills after using Ethno-Tok media was not only statistically significant but also substantial and practical. These results show that Ethno-Tok media has the potential to strongly improve students' creative thinking skills.

Table 2 shows the variation in achievement of the creative thinking skill indicator between small and large groups after the application of

Table 2. Table of percentage criteria for creative thinking scores

Indicators of Creative Thinking Skills	Small Group		Large Group	
	N-Gain	Category	N-Gain	Category
Fluency	90.6%	Very Good	87.12%	Very Good
Flexibility	86.11%	Very Good	93.04%	Very Good
Originality	71.62%	Good	83.40%	Very Good
Elaboration	75.63%	Good	77.52%	Good

Ethno-Tok media integrated with the Project-Based Learning (PjBL) model. In small groups, the fluency indicator achieved the highest percentage of 90.6%, placing it in the very good category. These results indicate that structured learning stages and visual and audio stimulation in Ethno-Tok media can help students generate more ideas more easily. The flexibility indicator also achieved an excellent rating of 86.11%, indicating students' ability to adapt and explore various alternative ideas during learning.

Conversely, the originality indicator in the small group was lower, at 71.62% in the good category, indicating that generating truly unique ideas remains a challenge for students. The elaboration indicator was in the good category, at 75.63%, indicating that developing ideas in detail requires more time, concentration, and higher cognitive abilities than simply generating ideas.

In large groups, the flexibility indicator achieved the highest score of 93.04% in the excellent category, presumably because more

intense group interactions enabled students to adjust, refine, and develop ideas through discussion and collaboration. The fluency and originality indicators also showed excellent results, at 87.12% and 83.40%, respectively, indicating an increase in students' ability to generate and develop new ideas. However, the elaboration indicator remained the lowest in the large group, at 77.52% in the good category, indicating that detailed idea development still requires more intensive learning support.

The difference in creative thinking skills between small and large groups was also influenced by differences in learning treatments, particularly in scaffolding. In the small-group trial, low-ability students still required intensive assistance in linking Ethno-Tok content to the concept of substance change. These findings served as a basis for researchers to provide more structured scaffolding during large-group implementation, including step-by-step guidance, more focused prompting questions, and individual assistance for students who experienced

difficulties. This intervention enabled large-group students to receive more effective cognitive support in developing ideas and elaborating their analysis results. Therefore, the difference in N-Gain scores, particularly on the originality indicator, cannot be interpreted solely as a difference in media effectiveness, but also as the impact of different scaffolding strategies. These findings indicate that the success of developing creative thinking skills depends not only on the media but also on the quality of pedagogical support during the learning process.

Overall, the use of edutainment-based Ethno-Tok media with the PjBL model has the

potential to improve students' creative thinking skills, particularly in fluency and flexibility rather than originality and elaboration. This pattern aligns with the characteristics of PjBL, which emphasize exploration and collaboration, so that more structured creativity indicators tend to yield higher achievements. To provide a more detailed view of individual student performance, a scatter plot was generated to visualize the distribution of pretest and posttest scores for each participant, as shown in Figure 7.

The overall differences in achievement across indicators are shown in Figure 8, which is consistent with the data in Table 2.

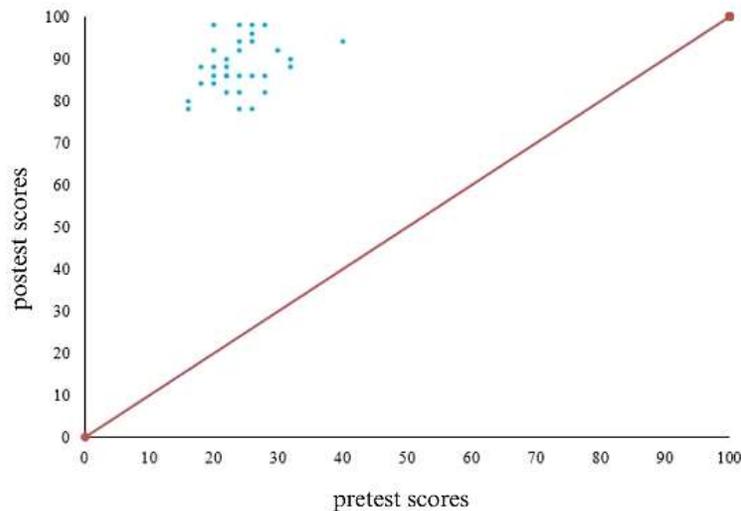


Figure 7. Scatter plot of pretest and posttest scores for each student

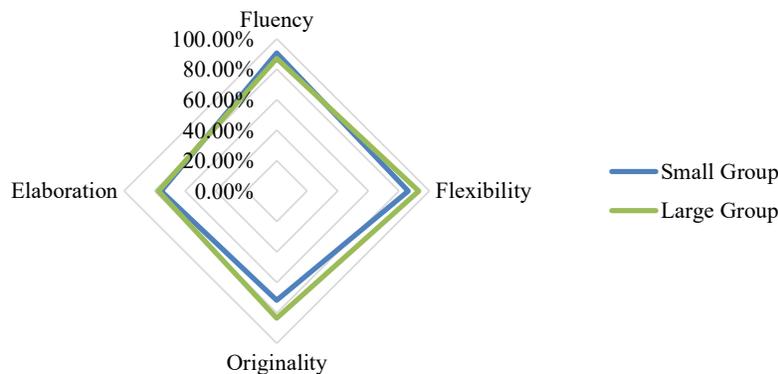


Figure 8. Chart of percentage criteria for creative thinking skills scores

The results of the analysis of students' creative thinking skills show that the indicators of fluency and flexibility achieve relatively higher

levels than those of originality and elaboration. These findings indicate that students tend to find it easier to generate many ideas and adapt them

during the learning process than to produce truly unique ideas or develop them in detail.

In addition to quantitative analysis using N-Gain scores and statistical tests, the final product in the form of creative posters produced by each group was also analyzed qualitatively to reinforce the research findings. Qualitative analysis was conducted using a content analysis approach based on a poster assessment rubric that included indicators of creative thinking skills, namely fluency of ideas, flexibility of concepts, visual originality, and elaboration of scientific detail.

The assessment results showed that the fluency indicator achieved the highest average score, namely 23.2 out of 25, reflecting the students' ability to generate and present ideas fluently about various types of substance changes. The flexibility indicator also showed relatively high achievement, with an average score of 22.8, as evidenced by students' ability to adapt ideas and relate local wisdom processes to the concepts of physical and chemical changes through various representations, such as flowcharts, comparison tables, and process illustrations.

Meanwhile, the originality indicator averaged 21.4, indicating that although some groups presented unique visual ideas, most posters still tended to follow examples from Ethno-Tok media, so the level of idea novelty had not developed optimally. The elaboration indicator received an average score of 21.9, indicating that students still struggle to develop ideas in depth and to present more detailed scientific explanations.

Overall, the results of this analysis indicate that achievement on the fluency and flexibility indicators is higher than on the originality and elaboration indicators. These findings indicate that students tend to find it easier to generate many ideas and adapt ideas in the learning process than to generate truly unique ideas or develop ideas in depth, which is in line with the results of the quantitative analysis showing the potential of

Ethno-Tok media in supporting the development of students' creative thinking skills.

Several international studies indicate that the effects of digital media on student creativity are not uniform. For example, in a literature review, Tang et al. (2022) found that the influence of digital technology products on student creativity is highly dependent on learning design and learning behavior, such that not all dimensions of creativity develop evenly. Furthermore, international evidence from PISA data (Kaplan et al., 2025) indicates that digital technology can support creativity-related problem-solving. However, when its integration is inappropriate, not all indicators of creative thinking will be optimized.

The differences in achievement between these indicators are thought to be related to the characteristics of the media and the pedagogical approach used. The edutainment-based Ethno-Tok media in this study were designed with a clear learning structure and integrated with the Project-Based Learning (PjBL) model, thereby demonstrating potential to support the development of fluency and flexibility indicators. Meanwhile, the indicators of originality and elaboration, which require a deeper understanding of concepts, reflection, and detailed idea development, still require more intensive learning support. Thus, these findings indicate that cultural context, media design, and pedagogical strategies play important roles in shaping students' development of creative thinking skills.

■ CONCLUSION

The results of this study indicate that Ethno-Tok edutainment-based media shows potential to support science learning about substances and their changes. There was a significant improvement in students' creative thinking skills, especially in fluency and flexibility, although originality and elaboration remained lower. These findings answer the research question regarding the extent to which Ethno-Tok media can improve

students' creative thinking skills through project-based learning (PjBL) using a contextual, locally based approach.

Theoretically, this study confirms that integrating local wisdom elements, digital technology, and edutainment strategies can strengthen students' creative thinking processes through relevant and meaningful learning experiences. In practice, the results of this study guide teachers in designing learning media that combine cultural context and educational entertainment to enhance students' creativity, engagement, and understanding of science concepts.

However, this study has limitations, primarily because it lacked a control group; therefore, the generalizability of the findings should be interpreted with caution. For further research, it is recommended to conduct experiments with control groups, increase the sample size, and explore more specific strategies to enhance originality and elaboration. In addition, developing more interactive media features, such as simulations or additional creative challenges, can be tested to maximize all aspects of creative thinking.

■ DECLARATION ON THE USE OF GENERATIVE AI IN THE WRITING PROCESS

In writing this manuscript, the author used ChatGPT to assist with language refinement, grammar checking, and sentence structure. The author has reviewed and edited all content generated by this tool and takes full responsibility for the content of the published manuscript.

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