Development of an Ethnoscience-Based Interactive Educaplay Game to Improve Students' Problem-Solving Skills

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Abstract: This study aims to develop an Ethnoscience-integrated Educaplay interactive learning game that is valid, practical, and effective in enhancing elementary students' problem-solving abilities (PSA). This study adopted the Research and Development (R&D) method using the Dick and Carey development model, comprising nine systematic stages. The research subjects were fourth-grade students at SD Negeri Pranti (as the experimental class) and SD Negeri Pragu (as the control class) in Sulang District, Rembang Regency. Product validation was conducted by two experts (media and material experts), while practicality testing was measured through teacher and student response questionnaires. Effectiveness testing was measured using a Pretest Posttest Control Group Design and analyzed via the N-Gain Score. The results showed that the developed product is highly feasible and valid for use, with an average media expert validity reaching 98.96% and material expert validity 99.48%, both falling into the Very Valid category. Practicality testing also yielded high responses from students (92%) and teachers (91%), confirming the product is Very Practical. The key finding is the effectiveness test result, where the average N-Gain score in the experimental class reached 77.74 (or 0.7774), which is classified in the high category. This significant increase indicates that the Ethnoscience-based Educaplay Interactive Game effectively boosts students' problem-solving ability through a relevant and interactive learning context.

Introduction

Education is an essential aspect of human life, and every citizen has the right to continue to develop it (Sofyan & Sanusi, 2023). In an effort to improve the quality of education in Indonesia, the implementation of the Independent Curriculum requires teachers as facilitators to provide innovative learning that can accommodate 21st century skill development (Choirunnisa et al., 2023). In the context of learning in the classroom, especially in the subject of science (science), innovation is needed because it is concrete in nature and requires real examples so that students can think, explore curiosity, and develop attitudes such as responsibility and perseverance (Septia Devega & Buchori, 2024).

The dynamics of 21st century development place Problem-Solving Skills (PSS) as the most crucial cognitive skill to produce a generation that is ready to face new challenges. Students' PSS, which includes the ability to solve problems creatively, adaptively, and with deep understanding, is critical to the growth of their basic education (Khaulani et al., 2020). The reality in the field shows that students' ability to solve problems is still low, especially in science subjects. This condition is reflected in the 2018 PISA data, which places Indonesia at 73rd in the field of science out of 79 participating countries, as well as Indonesia's science literacy position at 43rd out of 48 countries. This deficit is also in line with the findings at Pranti State Elementary School, where 64.71% of students have

difficulty understanding and solving problems in science lessons. This low PSS is often caused by learning that is still limited to conventional methods (Lestari, 2024).

To overcome the challenges of conventional learning and improve low student learning outcomes, it is necessary to design attractive models and media where students can learn innovatively and cooperatively, as well as be free to ask questions and express opinions (Inayah et al., 2021). This is where the integration of digital technology becomes the main urgency. Advances in digital technology have a significant impact on various aspects of human life, one of which is in the field of education (Indriani et al., 2025). Technological advances provide opportunities to create learning strategies that are more student-centered, interactive, and accessible at any time. Therefore, teachers need to be open to learning and actively update their knowledge and skills related to technology (Buchori, 2024). This effort is essential to increase the effectiveness and efficiency of the learning process.

Digital games provide a variety of opportunities to create more student-centered learning strategies. Digital games have the potential to enhance linguistic, social, and other skills necessary for learning in the 21st century, which require a more qualitative approach and an emic perspective to empower learning and harness learners' identities (Zhang, 2025). By utilizing digital tools and platforms, teachers can present more interesting and interactive materials, as well as provide various learning resources, including learning media that can be accessed anytime and anywhere.

Students who generally have good technology literacy tend to get bored quickly when learning is done conventionally (Apriansyah, 2020). Therefore, a learning strategy that focuses more on learners is needed to maximize their potential (Saiful Anwar & Jasiah Jasiah, 2024). Science learning using digital games based on regional culture, unique knowledge of an area and the behavior of the community around where students live can help make 21st century learning a success, especially in improving students' creative thinking skills (Maryanti et al., 2023).

As a solution to conventional learning challenges and to improve students' problem-solving skills, which are still low, this study proposes the development of Educaplay Interactive Games. Educaplay was chosen because it has been shown to have a positive influence on students' science learning achievements, increase participation, and deepen understanding of concepts (Suryaningsih Ge' & Dahlan, 2025). Mobile-based games are one of the media to increase students' learning creativity through playing while learning, and the most important thing is that the game contains educational elements (Setiawan & Buchori, 2021).

Although digital media such as Educaplay have been shown to be effective, there is a significant research gap. Previous studies of digital game-based learning have tended not to integrate the local cultural context in depth. This limitation can hinder effectiveness, because learning that is separate from the reality of students can complicate the first step of PSS, namely Understanding Problems (Polya). Relating material to local culture increases students' interest and learning achievement (Syahidul Shidiq, 2016). This approach is in line with the Independent Curriculum, which emphasizes culturally based contextual learning. Ethnoscience knowledge allows students to better understand the surrounding environment through the learning process and hands-on experience (Hasan et al., 2025).

Therefore, the main distinguishing element of this research is the integration of the Ethnoscience Approach. Ethnoscience is an effort to combine modern science with local wisdom to make learning more contextual and meaningful. In this context, Ethnoscience is realized through the removal of the process of making palm sugar from legen liquid, a local

phenomenon in Rembang that contains the concept of changing the form of objects. Strengthening with Ethnoscience serves to close the research gap and is in line with the Independent Curriculum, which emphasizes culture-based learning.

The holistic synthesis of these three elements became the novelty of the research. Educaplay (technology) provides an interactive platform and instant feedback that is essential for training the steps of implementing and evaluating PSS Solutions. On the other hand, Ethnoscience (local context) serves to make problems relevant and concrete, thus directly strengthening the Understanding Problem step. By associating the material with the local culture, this media has been proven to improve students' problem-solving skills.

The novelty of this research lies in the production of Ethnoscience-based Educaplay Interactive Game products that specifically unite: modern digital media, authentic local cultural contexts, and measurable PSS Polya targets. The product is developed through Dick and Carey's systematic Research and Development (R&D) model, ensuring high validity, practicality, and effectiveness. Thus, this research produces innovative and effective specific media solutions to overcome the problem of conceptual abstraction and low PSS of elementary school students (Khairani & Prodjosantoso, 2024).

The objectives of this research include: first, producing an Ethnoscience-based Educaplay Interactive Game that is valid and feasible based on expert judgment; second, determining the practicality of the media when implemented by teachers and used by elementary students; and third, evaluating its effectiveness in significantly improving the problem-solving abilities of Grade IV students compared to a conventional control group, thereby contributing to innovation in science education in Indonesia.

Research Methods

This research is classified as research and development (R&D), which aims to produce Ethnoscience-based Educaplay Interactive Game media products that are proven to be valid, practical, and effective. The selection of R&D methods is based on the need to create new learning products that are solution-oriented and systematic, different from descriptive research or pure experimentation(Wahyuningtyas & Sulasmono, 2020). The development model used is the Dick and Carey model, which is known for its comprehensive and linear approach, ensuring each learning component is designed in an integrated manner and focuses on specific learning outcomes (Dick & Carey, 2015). This model is particularly suitable for complex learning media development because it emphasizes formative evaluation at each stage of product development. This process ensures that the resulting product is truly effective in achieving the goal of improving students' Problem-Solving Skills (PSS).

The Dick and Carey model is a systematic and procedural model consisting of nine design steps that must be carried out continuously and end with a learning evaluation stage (Setyosari, 2020). The first step starts from the pre-development stage, which includes the identification of learning objectives and learning analysis. This stage is continued with the analysis of children's characteristics and learning contexts, which is crucial to ensure that palm sugar ethnoscience media is relevant to the cultural background of students in Sulang district. After that, the researcher formulated a Special Learning Objective and developed an Assessment Instrument to measure PSS, which was followed by the Development of Learning Strategies and the Development of Teaching Materials (Educaplay) in parallel. The crucial stage is Design and Conduct Formative Evaluation, which includes expert trials (validation) and limited trials. These nine stages are carried out systematically to ensure

product quality before being tested for effectiveness, as well as to produce quality HOTS evaluation instruments (Suttrisno, 2025).

Product effectiveness tests were carried out using a quasi-experimental design with a Nonequivalent Control Group Design. This design was chosen because the research subjects, namely grade IV students of Pranti State Elementary School and Pragu State Elementary School could not be randomized perfectly into experimental and control groups. The research subjects consisted of Class IV of Pranti State Elementary School (17 students) as an experimental group, and Class IV of Pragu State Elementary School (19 students) as a control group. Although there is a difference in the number of samples between groups, this can be justified in a quasi-experimental context in the school environment (Amaliyah et al., 2023). The difference in school locations was deliberately chosen to minimize the risk of contamination or diffusion of interventions between groups, so that the internal validity of the study became stronger (Khairani & Prodjosantoso, 2024). The research subjects in these two schools were considered equal in terms of curriculum and basic proficiency level before treatment.

The experimental group was treated with Ethnoscience-based Educaplay media while the control group used conventional learning (lectures and LKS). The research location at Pranti State Elementary School was chosen based on the results of a needs analysis that showed the low PSS of students in the material of changes in the shape of objects. The study subjects were divided into two groups to compare the increase in PSS measured through pretest and posttest (Amaliyah et al., 2023). The selection of quasi-experiment designs is considered the most realistic for research conducted in a school context (Khairani & Prodjosantoso, 2024).

Primary data collection was carried out through three main instruments: Expert Validation Sheet, Practicality Questionnaire, and Problem-Solving Ability Test in the form of Polya description questions. The validation sheet is filled out by three experts (material experts, media experts, and learning tool experts) to assess the suitability of Ethnoscience content and the accuracy of the question construction, thereby ensuring the validity of the content and constructs of the media. The practicality questionnaire, given to teachers and students, is used to measure ease of use, time efficiency, and level of engagement in learning (Mukni'ah et al., 2025). Meanwhile, the PSS Test is used to measure the initial score (pretest) and final score (posttest) of PSS students in both groups. This data collection process is systematically designed according to the R&D stages that prioritize continuous evaluation (Dick & Carey, 2015).

The data obtained was analyzed using three different techniques. Expert validity data were analyzed descriptively and quantitatively using Aiken's Formula V with a minimum threshold value of $V \geq 0.75$. The actual results showed that the validity of media experts reached an average of 98.96% and material experts 99.48%, with an overall average of 99.31%, which was classified as the Very Valid category. Practicality data were analyzed using percentage descriptive statistics. The practicality threshold is interpreted through a percentage category with a minimum threshold of 75%. The results showed that the practicality of the product was in the Very Practical category, with a percentage of 91% for teacher responses and 92% for student responses. Effectiveness was measured using the N-Gain Score to see an improvement in students' problem-solving skills (PSS). The interpretation of the upgrade category (Low, Medium, High) is based on the N-Gain score achieved. The experimental class achieved an N-Gain score of 0.77 (or 77.74%), which was classified in the High category. While the control class only reached an N-Gain of 0.15, it was classified in the Low category.

Before conducting a follow-up effectiveness test using a t-test (Independent Sample T-Test), the researcher conducted a prerequisite test, namely normality and homogeneity on PSS posttest data. The normality test uses the Shapiro-Wilk test. The assumption of normality was met because the significance value (Sig.) for both groups (experiment and control) was greater than the threshold $\alpha = 0.05$. The Sig. value for the experimental group was 0.200 and for the control group was 0.131. This confirms that the PSS posttest data of the two groups are distributed normally. Homogeneity is tested using Levene's Test. The homogeneity assumption is met because the significance value obtained is 0.396, which is also greater than the threshold $\alpha = 0.05$. This shows that the PSS data variants between the experimental and control groups are homogeneous or equivalent. With the fulfillment of both prerequisites (normality and homogeneity), the use of the t-test to compare significant differences between the experimental and control groups was declared feasible, and the results were valid. The statistical software used in this study is SPSS 25.0.

Results and Discussion
Product Validation Results (Expert Test)
The initial stage of this *Research and Development* (R&D) research is a validation test that aims to ensure the feasibility of *Ethnoscience-based Educaplay Interactive Game* products before being tested. The validation results of three experts (Subject Matter Experts, Media Experts, and Practitioners) showed an average score of 98.96%, which is in the "Highly Valid" category and meets the minimum validity criteria. The highest validation was obtained from the Material Expert (99.48%), confirming that the integration of local cultural content in the palm sugar-making process was successfully and accurately linked to the concept of changing the shape of objects. This series of tests is crucial to guarantee that the resulting product is not only innovative but also meets the academic standards and technical feasibility required to support learning objectives (Dick & Carey, 2015).

Table 1. Validity Score

Validator	Percentage Score %	Category
Content Suitability	98,96	Very Valid
Practicality	99,48	Very Valid
Learning Tool Expert	99,48	Very Valid
Average	**99,31**	**Very Valid**

Product Practicality Test Results (Teacher and Student Test)
The results of the product's practicality test were measured through a questionnaire of teacher and student responses during classroom implementation. The teacher's response showed a very high level of practicality, with an average score of 91%, categorized as "Very Practical". This practicality is supported by the ease with which teachers operate the Educaplay platform and integrate the Ethnoscience context into learning scenarios. Meanwhile, the students' responses also showed high enthusiasm, with a percentage score of 92%, indicating that this interactive game media is interesting and easy to use (Wahyuningtyas & Sulasmono, 2020). This data consistently shows that Ethnoscience-based Educaplay is effective in increasing student motivation and engagement, because it is packaged to resemble challenging games (Mukni'ah et al., 2025).

Table 2. Practicality Test Score

Respondents	Percentage of Practicality	Category
Teacher	91%	Very Practical
Student	92%	Very Practical
Average	91.5%	Very Practical

Results of the Prerequisite Test Analysis (Normality and Homogeneity)

Before the Independent Sample T-Test effectiveness test, the researcher is required to conduct a prerequisite test for the normality and homogeneity of the posttest data to ensure the validity of the statistical results (Amaliyah et al., 2023). The results of the Shapiro-Wilk normality test in the experimental and control groups showed Sig. significance values of 0.200 and 0.131 respectively ($p > 0.05$). These results confirm that the Problem-Solving Ability (PSS) posttest data of the two groups are distributed normally, thus meeting one of the main prerequisites for parametric analysis.

Table 3. Normality Test Results

Group	Test Shapiro-Wilk (Sig.)	Category
Eksperimen	0.200	Normal
Control	0.131	Normal

Furthermore, the variance homogeneity test using Levene's Test showed a significance value of 0.396 ($p > 0.05$). This figure shows that the PSS data variants between the experimental group and the control group are homogeneous or equivalent. With the fulfillment of both prerequisites (normality and homogeneity), the next statistical analysis, namely the t-test, can be performed, and the results are valid to draw conclusions about significant differences between groups (Khairani & Prodjosantoso, 2024).

Results of PSS Improvement Effectiveness Test (N-Gain and t-Test)

Effectiveness testing was carried out by comparing the improvement of Problem-Solving Ability (PSS) between the experimental group (Educaplay Ethnoscience) and the control group (Conventional) through pretest and posttest analysis. The experimental group experienced a significant improvement with an N-Gain Score of 0.77 (High Category), much higher than the control group, which only achieved an N-Gain of 0.15 (Low Category). The results of the t-test (Independent Sample T-Test) showed a significance value (Sig.) of 0.007 ($p < 0.05$), which means that there was a very significant difference between the posttest scores of the two groups (Khairani & Prodjosantoso, 2024). This confirms that the use of Ethnoscience-based Educaplay Interactive Games has proven to be statistically effective in increasing students' PSS in material changes in the form of objects compared to conventional methods.

Table 4. N-Gain Test Results

Group	The Battle of the War	Post-test war-rata	N-Gain Score	Category
Eksperimen	63.76	91.29	0.77	High
Control	65.26	74.74	0.15	Low

Figure 1. Design of Product

The significant improvement in students' PSS N-Gain scores (average of 0.77, classified as the High category) was driven by the synergy of two key components focusing on the holistic training of Polya's PSS measures. Educaplay Interactive Games serve as a cognitive accelerator and a medium that provides feedback, primarily contributing to the final stages of problem-solving. The challenging game format encourages students to try again and directly practice the steps of Implementing Solutions and Evaluating Solutions through instant feedback, which is a key principle of game-based learning (Suryaningsih Ge' & Dahlan, 2025).

Meanwhile, the Ethnoscience Approach, which integrates the process of making palm sugar from local Rembang sap (legen), plays an important role in the early stages of PSS Polya, namely Understanding the Problem. This authentic cultural context makes the problems presented more relevant, concrete, and bridges the abstraction of science concepts, thereby strengthening students' understanding (Jumini dkk., 2024). Thus, this medium successfully addresses the main problems of passive learning and concept abstraction identified in the introduction (Syahidul Shidiq, 2016).

This research succeeded in overcoming the research gap by explicitly testing a development product that combines three specific elements, namely Educaplay Interactive Games (modern digital media), Ethnoscience of the Palm Sugar Making Process (authentic local cultural context), and PSS Polya improvement (measurable cognitive skill target). The results of this study confirm the high validity (99.31%) and practicality (91.5%) of the use of the structured R&D model (Dick and Carey), in line with the findings of other digital media development studies such as Maola & Irianto (2023) and Indriani et al. (2025). However, the study expands the scope of previous findings. If the previous Educaplay study (Suryaningsih Ge' & Dahlan, 2025) proved to be positive for general learning outcomes, this study proves the effectiveness of the media to structurally train every step of PSS Polya.

The most significant expansion is the Ethnoscience layer that addresses the tendency of previous game-based learning digital studies that often do not integrate the local cultural context in depth, and overcomes the tendency of previous ethnoscience studies that often focus on strategies such as Project-Based Learning or conventional modules, rather than the systematic development of interactive game products. Therefore, this study presents empirical evidence on the importance of integrating local wisdom into educational technology to produce valid, practical, and effective solutions in improving students' critical thinking skills.

The results of the study that prove the effectiveness of Ethnoscience-based Educaplay Interactive Games have important implications for pedagogical innovation in elementary schools. Its main contribution is to provide alternative digital learning media that is tested for validity, practicality, and effectiveness, which can be used by teachers to overcome low PSS and concept abstraction in science materials. This product is a real solution to implement 21st century learning that prioritizes critical thinking and problem-solving skills (Wahyuningtyas & Sulasmono, 2020). In addition, this study provides empirical evidence on the importance of integrating local wisdom (Ethnoscience) into educational technology, making it a reference for the development of culture-based HOTS evaluation instruments in the future (Suttrisno, 2025).

The results of this research definitely make a significant contribution in overcoming the challenges of 21st century learning, especially in instilling Problem-Solving Skills. These skills, along with critical thinking, are core competencies that are demanded in the digital age. The contribution of the Ethnoscience-based Educaplay Interactive Game

product is strengthened by empirical data that not only proves its effectiveness, but also its readiness to be implemented. Explicitly, the effectiveness of this media in training PSS is evident from the comparison of the N-Gain scores achieved: the experimental group showed a high increase in PSS with an N-Gain of 0.77, far exceeding the control group, which only achieved an N-Gain of 0.15 (low category). This difference was confirmed to be statistically valid through a t-test with a significance value (Sig.) of 0.007 ($p < 0.05$). This data concretely proves that this media is a valid, practical, and effective alternative digital solution to overcome the problem of low PSS that was previously identified.

Therefore, the objectives of the study have been answered based on data analysis. First, the Ethnoscience-Based Educaplay Interactive Game has been tested for validity and feasibility through expert assessment. Second, based on the results of testing the level of practicality of the media when applied by teachers and used by students in elementary schools, it shows very practical results. Finally, the most crucial goal is the level of media effectiveness in improving students' Problem Solving Skills (PSS) which shows very significant results, compared to conventional control groups, to make a real contribution to science education innovation in Indonesia.

Conclusion

There are three main points that are the conclusion of this study, namely that the Ethnoscience-based Educaplay Interactive Game media product is stated to be very valid, showing that the integration of Ethnoscience content in the palm sugar making process is scientifically accurate, and the media construction is feasible to use. Ethnoscience-based Educaplay Interactive Game Media is stated to be very practical, which emphasizes that this media is easy to operate, efficient, and effective in increasing students' motivation to learn in the classroom. Ethnoscience-based Educaplay Interactive Game Media was also found to be significantly effective in improving students' Problem-Solving Skills (PSS). Thus, this product developed has proven to be an alternative solution for digital learning media that is based on cultural context, valid, practical, and effective to improve the PSS of elementary school students.

Recommendation

This research has successfully developed and implemented an interactive game, Educaplay, with an ethnoscience approach to improve students' problem-solving skills related to changes in material in the form of objects. As a follow-up, teachers are advised to make use of Educaplay interactive games with an ethnoscience approach in a sustainable manner, not only for material on the change in shape of objects, but also for other relevant materials such as food chains, and food webs (the mutual relationship between rice, pests, and natural predators in the rice fields or gardens of residents), water cycle and its utilization (the flow of water turnover related to the use of water for salt processing or irrigation rice fields), and the human respiratory system. This can enrich learning variety, create a more interactive learning atmosphere, and help teachers evaluate learning outcomes more effectively. For further research, it is recommended to expand the development of interactive educational games by involving more material in IPAS subjects. Therefore, technology-based learning innovations can continue to be developed and make a significant contribution to improving the quality of education in Indonesia.

This research has successfully developed and implemented an interactive game, Educaplay, with an ethnoscience approach to improve students' problem-solving skills on material changes in the form of objects. As a follow-up, teachers are advised to take

advantage of the Educaplay interactive game with an ethnoscience approach in a sustainable manner, not only for material on changing the shape of objects, but also for other relevant materials. This can enrich learning variety, create a more interactive learning atmosphere, and help teachers evaluate learning outcomes more effectively. For further research, it is recommended to expand the development of Educaplay interactive games by involving more material in IPAS subjects. Therefore, technology-based learning innovations can continue to be developed and make a significant contribution to improving the quality of education in Indonesia.

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