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The development of interactive learning media to improve music learning outcomes

Yeni Tri Hidayati*, Atip Nurharini
Department of Primary Education, Universitas Negeri Semarang
Raya Banaran Street, Sekaran, Gn. Pati, Semarang City, Central Java 50229, Indonesia
*Corresponding Author. E-mail: yenitrihidayati20@students.unnes.ac.id

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Abstract: Limited use of interactive learning media in elementary schools had contributed to low student engagement and unsatisfactory music learning outcomes, particularly in learning about musical instruments diversity. Therefore, technology-based learning media appropriate to students' characteristics were required. This study aims to develop and evaluate the feasibility and effectiveness of a musical instruments diversity application to improve students of Grade IV music learning outcomes. This research employed a Research and Development (R&D) method adapted from the Borg and Gall model. The research subjects were Grade IV students at Protomulyo 1 Elementary School, Kendal Regency. Data were collected through interviews, observations, documentation, questionnaires, and tests, then analyzed using descriptive analysis, normality testing, N-gain score, and paired sample t-test. The results showed that the application was very feasible, with media expert validation of 96.8% and material expert validation of 95.3%. The paired sample t-test showed a significant value (2-tailed) of 0.000, and the N-gain score was 0.815, indicating high effectiveness. The study concluded that the developed application was feasible and effective in improving Grade IV students' music learning outcomes, offering a practical model for integrating technology into elementary music education. The findings imply that the strategic integration of interactive mobile applications can bridge the gap between traditional music curricula and digital-age learners, providing a scalable framework for enhancing cultural literacy through technology-driven instruction.

Keywords: interactive media, smart apps creator, music learning outcomes, musical instrument diversity

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Introduction

Education is a dynamic process that continuously evolves in response to social, cultural, and technological changes. Education is a fundamental aspect of human life and plays a crucial role in individual and societal development (Wulandari et al., 2021). Today, digital technologies influence almost every area of life, and their impact continues to grow (Laumann et al., 2025). This condition requires the education sector to adapt so that learning processes remain relevant to the needs of learners. The utilization of digital technology in education opens up new opportunities for teachers and learners to share, explain, understand, and create innovative ideas through various easily accessible learning platforms (Wulandari & Nurharini, 2025). Therefore, to enhance educational quality and promote more innovative and diverse learning practices, the education sector needs to adapt to technological advancements and develop technology-integrated learning approaches (Riyanto & Kawuryan, 2025).

Education is currently undergoing rapid transformation driven by continuous advancements in learning methods, techniques, and technologies aimed at improving student learning, retention, and career readiness (Aziz & Younes, 2025). The rapid development of technology, particularly mobile learning platforms, has significantly influenced the education sector by enabling learning activities to take place both inside and outside the classroom in a more flexible and accessible manner (Hayadi &

Hariguna, 2025). Mobile technology facilitates learning by allowing students to access educational content anytime and anywhere, thereby supporting learning beyond traditional classroom boundaries (Kaur et al., 2022). In addition, mobile technologies offer considerable potential for supporting more innovative and effective learning approaches in educational settings (Sung et al., 2016).

The increasing demand for high-quality digital learning tools has led to substantial changes in the field of educational technology (Korobkova et al., 2025). Interactive technologies have been shown to accommodate diverse learning needs and contribute positively to students' academic achievement (Ragab et al., 2025). Previous studies indicate that digital educational games and interactive technologies can enhance students' motivation and engagement, which in turn leads to improved learning outcomes (Ussenova et al., 2025). Multimedia-based learning approaches function as interactive educational systems designed to achieve specific instructional objectives and support meaningful learning experiences (Aldalalah et al., 2025). However, the successful integration of technology in classroom learning depends on the readiness of educational institutions, teachers, and students (Domínguez-González et al., 2025). Therefore, educators are required to integrate pedagogical, technological, and content knowledge effectively in order to design and implement technology-enhanced learning (Camacho-Vásquez et al., 2025). Beyond instructional implementation, schools also have a responsibility to equip students with essential digital skills and technological awareness (Schmitz et al., 2024).

Along with the rapid advancement of technology, understanding the role of technology in education has become increasingly important (Firmansyah et al., 2024). This development challenges educators to move beyond traditional teaching methods by mastering new skills in order to implement technology effectively in the learning process. Advances in web-based educational technologies enable teachers and learners to utilize technology as a supporting tool to enrich and enhance conventional learning (Sharma & Begum, 2024). In addition, the availability of virtual learning spaces allows learning activities to take place more flexibly and be accessed anytime and anywhere (Borrás-Gené & Díez, 2025). Learning environments that involve virtual and mixed reality technologies are also capable of providing interactive content that can be adapted to individual learning styles (Martyniuk et al., 2025). Nevertheless, recent developments in educational technology also present challenges for teachers, particularly in selecting appropriate learning resources related to the use of mobile devices (Esmat & Amasha, 2025). Therefore, teachers are required to consider technological aspects when selecting and developing learning media that align with learners' needs and characteristics (Ramadani & Nurharini, 2024).

Media acts as an intermediary used to convey information from the source to the recipient of the message (Saputra et al., 2025). Media is able to make the abstract concept more concrete so that students can learn according to their stage of learning development (Purwaningsih & Wangid, 2021). Learning media is any form that can be used to convey messages through various channels, which can stimulate students' thoughts, feelings, and motivation, thereby encouraging an effective learning process (Daniyati et al., 2023). In the school learning context, learning media function as supporting tools that assist teachers in implementing the learning process and facilitate the delivery of learning materials more effectively (Sulthon et al., 2021). The appropriate use of learning media not only supports content delivery but also increases learners' interest and helps them understand learning materials more concretely. Therefore, teachers need to utilize learning media that are tailored to learners' characteristics to ensure optimal learning outcomes (Fitriyadi & Wuryandani, 2021). The selection of varied and relevant learning media also plays an important role in preventing learning fatigue and enhancing learners' interest in learning.

Elementary school learners have distinctive characteristics, such as high curiosity, a preference for play-based activities, and a strong tendency to explore their surroundings. These characteristics require teachers to design engaging learning experiences that accommodate learners' learning styles, particularly for those who are less suited to lecture-based instruction or learning that relies solely on textbooks (Primaestri et al., 2023). One strategy that can be implemented is packaging learning materials in electronic formats. Electronic learning materials make it easier for learners to access learning content (Triwahyuningtyas et al., 2022).

One form of technology integration in learning is the use of interactive multimedia. Interactive multimedia presents learning concepts in a more engaging manner by integrating images, animations, and audio elements that support learners' understanding (Aprilia et al., 2023). Technology-based

interactive learning media have also been proven effective in increasing learner engagement in the learning process (Asbah et al., 2025). The implementation of technology-based learning approaches not only fosters learners' creativity and critical thinking skills but also enhances their engagement and interest in learning activities (Kulkarni et al., 2025).

Music education is viewed as a form of human response, expression, and appreciation of real-life experiences, encompassing historical, environmental, cultural, and residential contexts, which are manifested through various emotional expressions and musical structures (Kemdikbud, 2022 in Riyadi & Budiman, 2023). Therefore, the development of engaging learning media is essential to increase learners' interest in music education, particularly in the topic of musical instrument diversity. However, based on preliminary research conducted through observations and interviews at Protomulyo 1 Elementary School, an elementary school in Kendal Regency, it was found that music education in Grade IV had not been implemented optimally. This condition was influenced by various factors originating from learners, teachers, and the learning media used.

Preliminary observations and interviews conducted at Protomulyo 1 Elementary School, Kendal Regency, revealed several problems in Grade IV music learning. Although the school is equipped with supporting facilities such as laptops and LCD projectors, these resources have not been utilized optimally. Teachers still predominantly rely on lecture-based methods and textbooks as the main learning resources, while the learning media used are limited to static images. This condition is partly influenced by teachers' limited mastery of information and communication technology. As a result, students' learning outcomes in music education remain relatively low. Based on preliminary observations involving all Grade IV students at Protomulyo 1 Elementary School, the majority of students' learning outcomes in music education have not yet met the Minimum Competency Achievement Criteria (KKTP in the Indonesian context), as many students have not achieved the expected level of mastery.

The development of interactive application-based learning media is considered capable of making the learning process more engaging and enjoyable, thereby increasing learners' motivation and learning outcomes. Interactive learning applications are computer-based programs designed to support learning processes by enabling two-way interaction between users and systems, creating more dynamic and responsive learning experiences (Nelwan et al., 2020). Teacher creativity in developing learning media is an integral part of educational innovation aimed at creating active and enjoyable learning environments (Nurharini & Yuyarti, 2017). Such creativity develops through efforts to generate new ideas that lead to changes and products used in learning processes, one of which is the development of Android-based learning media using Smart Apps Creator (Aeni et al., 2024). The implementation of innovative and interactive learning media contributes to the creation of enjoyable learning experiences, which have been shown to positively affect learners' cognitive, affective, and psychomotor learning outcomes (Tyas et al., 2021).

However, most previous studies have focused on the development of Smart Apps Creator–based learning media in general subjects, while research specifically addressing music education particularly musical instrument diversity at the elementary school level remains limited. In addition, limited attention has been given to contextual learning media development that aligns with learners' real learning conditions and school facilities. This gap indicates the need for further research that develops and evaluates Smart Apps Creator–based learning media specifically for music learning in elementary schools.

Based on these conditions, this study aims to develop a Smart Apps Creator–based learning application on musical instrument diversity for Grade IV elementary school learners. This study seeks to address existing gaps by providing an interactive, engaging, and contextually relevant learning medium that supports music learning. The results of this study are expected to contribute to the development of innovative learning media in elementary music education and to support the improvement of learning quality and learning outcomes, particularly in the context of elementary education in Indonesia.

This research contributes to the field of educational technology and music pedagogy by providing a practical framework for integrating localized, interactive digital tools into elementary curricula. Theoretically, it expands the application of the TPACK framework within the specific context of music education, demonstrating how teacher-led digital innovation can bridge the gap between traditional lecture-based instruction and the digital-native characteristics of today's learners. Practically, this study

offers a validated, high-efficiency learning resource that empowers educators in schools with limited ICT mastery to utilize existing infrastructure effectively. By focusing on the diversity of musical instruments, this work not only enhances students' cognitive and affective learning outcomes but also serves as a replicable model for preserving cultural literacy through modern, mobile-based interventions.

Methods

This study employed a Research and Development (R&D) approach. According to Sugiyono (2015), research and development was a research method aimed at producing a specific product and testing its effectiveness. Through the application of this method, product development was expected to provide effective alternative solutions to the problems encountered.

The development model used in this study was based on the Borg and Gall model as adapted by Sugiyono. This model consisted of ten systematic development stages. However, the development process of the musical instrument diversity application media in this study was limited to eight stages of the Borg and Gall model, namely: (1) identifying potential and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) product testing, (7) product revision, and (8) usage testing.

Data were collected through interviews, observations, documentation, questionnaires, and tests at Protomulyo 1 Elementary School, Kendal Regency, involving fourth-grade students. The total number of fourth-grade students at Protomulyo 1 Elementary School was 31. The feasibility of the musical instrument diversity application developed using Smart Apps Creator was tested through a small-scale trial involving ten students representing high, medium, and low achievement levels using a pretest–posttest and a response questionnaire. Furthermore, a large-scale trial involving 20 fourth-grade students also used a pretest–posttest and a response questionnaire to test the effectiveness of the developed application in learning musical instrument diversity.

The initial stage of the study involved analyzing the needs of teachers and learners related to the musical instrument diversity application using a questionnaire prepared by the researchers. The product then underwent feasibility testing by media and subject-matter experts to determine its validity. Data analysis to determine the feasibility level of the learning media based on expert validation questionnaires was calculated using the following formula:

$$P = \frac{R}{N} \times 100\%$$

Where:
P = Percentage score
R = Total score obtained
N = Maximum possible score

The results of the validation questionnaires were used to determine the level of product feasibility, which was interpreted based on the feasibility criteria percentage table presented in Table 1.

Table 1. Percentage Criteria for Media Feasibility

Percentage Score	Criteria
75% – 100 %	Very Feasible
50% – 75%	Feasible
25% – 50%	Moderately Feasible
0% – 25%	Not Feasible

Data analysis to determine the practicality level of the learning media based on teachers' and students' questionnaire responses was conducted using the following formula:

$$P = \frac{R}{N} \times 100\%$$

Where:
P = Percentage score
R = Total score obtained
N = Maximum possible score

The results of the questionnaire responses were used to determine the level of product practicality. The percentage criteria for practicality are presented in Table 2.

Table 2. Percentage Criteria for Media Practicality

Percentage Score	Criteria
75% – 100 %	Very Practical
50% – 75%	Practical
25% – 50%	Moderately Practical
0% – 25%	Not Practical

Another component analyzed in this study was the multiple-choice test instrument, which was examined in terms of validity, reliability, item difficulty, and item discrimination using the Statistical Package for the Social Sciences (SPSS). The final stage of data analysis included a normality test, N-gain analysis, and a paired-sample t-test conducted using SPSS.

Data analysis to determine the effectiveness of the developed product was conducted by comparing students' pretest and posttest scores using the following formula:

$$N - gain = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

The obtained N-gain scores were used to determine the level of learning improvement based on the N-gain criteria, as presented in Table 3.

Table 3. N-gain Criteria

N-gain Value	Category
N-gain ≥ 0.7	High
$0.3 \leq$ N-gain < 0.7	Moderate
N-gain < 0.3	Low

The obtained N-gain values were subsequently converted into percentages to determine the level of learning effectiveness, as presented in Table 4.

Table 4. Percentage of N-gain Effectiveness

Percentage	Category
$< 40\%$	Ineffective
40% - 55%	Less Effective
56% - 75%	Moderately Effective
$> 76\%$	Effective

Results and Discussion

Results

This study is oriented toward the development of a learning media application on musical instrument diversity for the subject of music education. The initial stage of the research involved interviews, observations, and questionnaire distribution to teachers and Grade IV students of Protomulyo 1 Elementary School, Kendal Regency. These activities were conducted to identify problems encountered in the learning process at school and to explore the needs of teachers and students regarding the use of Music Education learning media.

The identified problems were then analyzed in depth by the researcher as a basis for designing innovative learning media that could effectively support the learning process and align with the needs of both teachers and students in Music Education. The subjects of this study were Grade IV students of Protomulyo 1 Elementary School. This research aims to provide solutions to the problems occurring during the learning process in Grade IV at Protomulyo 1 Elementary School, Kendal Regency. The researcher expects that the developed solution will help overcome learning obstacles and improve the overall quality of the learning process.

The results of interviews and questionnaires indicate that teachers expect learning media for Music Education, especially on musical instrument diversity, to be engaging for students. The media should feature colorful visuals reflecting the cheerful nature of elementary students and present materials simply and clearly. Content can be delivered through clear and proportional images and text, focusing on musical instrument diversity as the core material. Additionally, the media should match the developmental level of Grade IV students for better comprehension and acceptance. The student needs analysis

The analysis of interview and questionnaire data reveals that teachers require music education media—specifically regarding musical instrument diversity—that aligns with the developmental characteristics of fourth-grade students. Such media should incorporate vibrant visuals and simplified content delivery through clear, proportional imagery and text to ensure better comprehension and engagement. Furthermore, the student needs analysis, which involved the entire fourth-grade cohort at Protomulyo 1 Elementary School, confirmed that students respond most effectively to interactive and innovative instructional tools. Consequently, these findings underscore the necessity of developing a dedicated musical instrument diversity application as a strategic solution to bridge existing learning gaps and foster a more meaningful, technology-integrated educational experience.

Product Design

The results of the needs analysis indicate that the development of a musical instrument diversity application based on Smart Apps Creator can serve as an effective solution to address challenges encountered during the Music Education learning process. The Grade IV teacher stated that this application can assist students in understanding musical instrument materials, recognizing the characteristics of each instrument, and enhancing students' interest and motivation in learning. Furthermore, the integration of technology in the learning process can foster students' enthusiasm in participating in learning activities.

The musical instrument diversity application developed with Smart Apps Creator offers several advantages, including accessibility anytime and anywhere, allowing students to continue learning music materials even when they are not at school. This ease of access also facilitates students in studying the materials and completing exercises, thereby optimizing the use of digital devices in the learning process.

At this stage, the researcher developed a prototype design of the learning media, which serves as the initial framework for further development. The design of the prototype was based on the synthesis of the needs analysis questionnaires completed by both students and the teacher. The aspects considered in developing the media design include content coverage and the visual presentation of the learning media. This stage resulted in a learning media prototype. The final design of the musical instrument diversity application is presented in Figure 1.

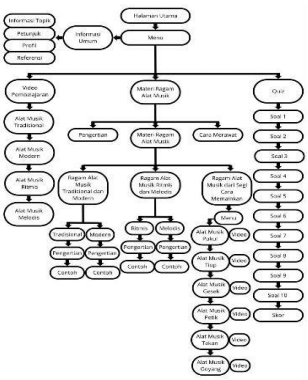

Figure 1. Learning Media Design Application for Musical Instrument Diversity

The media development stage represents the process of transforming the media design blueprint into an implementable learning tool. The musical instrument diversity learning application is designed to be visually engaging, employing bright colors and animations to capture students' attention and stimulate their interest in learning. The design of this musical instrument diversity learning application is presented in Figure 2.

Figure 2. Musical Instrument Diversity Learning Application

The musical instrument diversity learning application includes several menus: the learning material menu covers definitions, types of musical instrument, and instrument maintenance; there are also video materials on musical instrument diversity and quizzes. In addition, the application features other menus such as general information and several user-friendly navigation buttons. Figure 1 presents the design of the developed musical instrument diversity learning application.

Product Validation

The product will undergo testing through two stages of expert review: (1) validation by media experts and (2) validation by content experts. This expert review aims to obtain assessments regarding the feasibility of the learning media before it is implemented in the learning process. The validation instruments that have been developed are subsequently used to collect evaluation data. The media assessment sheet consists of four indicators: presentation feasibility and display quality, multimedia quality, media navigation and interactivity, and readability and clarity of information. The content indicators relate to curriculum alignment, content accuracy, depth and completeness of material, as well as language use and ease of understanding. The quality of the media and content in the musical instrument diversity learning application is ensured through testing and validation conducted by specialists in media and content. The validation by the expert team aims to determine the feasibility of the media and content for students and to ensure alignment with students' cognitive abilities. Additionally, this validation stage provides evaluations and feedback regarding the learning media product. The results of the validation are presented in Table 5.

Table 5. Results of Media Validation

No.	Validation Aspect	Percentage	Category
1.	Media Expert	96.8%	Very Feasible
2.	Material Expert	95.3%	Very Feasible

Table 5 shows that the feasibility evaluation of the musical instrument diversity learning application achieved a media feasibility percentage of 96.8%, which falls into the *very feasible* category. Meanwhile, the feasibility evaluation of the musical instrument diversity content within the learning application obtained a percentage of 95.3%, also classified as *very feasible*.

Trial Use of the Product

At the product trial stage, two phases were conducted, namely a small-scale trial and a large-scale trial. During these trials, students were administered 20 multiple-choice questions on the topic of musical instrument diversity, which had previously undergone validity, reliability, item discrimination, and difficulty level analyses. The trial participants were Grade IV students of Protomulyo 1 Elementary

School. Ten students participated in the small-scale trial, while the remaining 20 students took part in the large-scale trial. The data obtained from these trials are presented in Tables 6 and 7.

Table 6. Results of Small Scale Product Trials

No.	Description	Learning Outcomes	
		Pretest	**Posttest**
1.	Number of Students	10	10
2.	Classical Mastery	30%	100%
3.	Highest Score	85	100
4.	Lowest Score	40	85
5.	Number of Students Achieving Mastery	3	10
6.	Average	55	91.5
7.	Difference	36.5	

According to Table 6, in the small-group trial, the pretest score was 55, while the posttest score reached 91.5, and had a value difference of 36.5.

Table 7. Results of Large Scale Product Trials

No.	Description	Learning Outcomes	
		Pretest	**Posttest**
1.	Number of Students	20	20
2.	Classical Mastery	40%	100%
3.	Highest Score	85	100
4.	Lowest Score	40	80
5.	Number of Students Achieving Mastery	8	20
6.	Average	58.25	92.5
7.	Difference	34.25	

Based on Table 7, the results of both the small-scale and large-scale product trials show an improvement. In the large-group trial, the average pretest score was 58.25, while the posttest score increased to 92.5, resulting in a score difference of 34.25.

Results of Normality Test Analysis

The pretest and posttest results from both the small-group and large-group trials were subjected to a normality test to determine the appropriate statistical techniques for data analysis. This test serves as a prerequisite for conducting further statistical calculations, thereby ensuring the accuracy and reliability of the results. The pretest and posttest data are presented in Table 8.

Table 8. Normality Test Results of Pretest and Posttest Scores

Test of Normality							
		Kolmogorov-*Smirnov*[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Small-Group	Pretest	.238	10	.114	.890	10	.168
	Posttest	.202	10	.200	.878	10	.124
Large-Group	Pretest	.189	20	.059	.912	20	.069
	Posttest	.219	20	.013	.909	20	.062

a. Lilliefors Significance Correction

Based on Table 8, the normality test of the pretest and posttest scores for students' understanding of musical instrument diversity employed two types of normality tests, namely the Kolmogorov–Smirnov and Shapiro–Wilk tests. However, this study utilized only the Shapiro–Wilk test. The Shapiro–Wilk results indicate significance values of 0.168 for the pretest and 0.124 for the posttest in the small-group trial, as well as 0.069 for the pretest and 0.062 for the posttest in the large-group trial. Since all significance values exceed 0.05, it can be concluded that the pretest and posttest scores for both the small-group and large-group trials are normally distributed.

Results of N-gain Test Analysis

The N-gain test was used to evaluate the extent to which students understood the musical instrument diversity material after using the musical instrument diversity learning application. The scores obtained from the pretest and posttest were analyzed by comparing the difference between the pretest and posttest scores relative to the maximum possible score difference. The results of the N-gain test are presented in Table 9.

Table 9. N-gain Test Results

Group	Pretest Average	Posttest Average	Average Difference	N-gain	N-gain (%)	Category	Effectiveness Interpretation
Small-Group	55	91.5	36.5	0.779	77.9%	High	Effective
Large-Group	58.25	92.5	34.25	0.815	81.5%	High	Effective

Based on Table 9, the N-gain value for the small-group trial was 0.779, which falls into the high and effective category. Meanwhile, the large-group trial achieved an N-gain value of 0.815, also classified as high and effective. These results demonstrate an improvement in learning outcomes for both the small-group and large-group trials in the musical instrument diversity material.

Results of Paired Sample t-Test Analysis

The hypothesis regarding the use of the musical instrument diversity application was tested by examining the difference in mean pretest and posttest scores of fourth-grade students at Protomulyo 1 Elementary School, Kendal Regency. The effectiveness of the learning media was determined by identifying a significant difference between students' learning outcomes before and after the implementation of the musical instrument diversity application. The results of the paired sample t-test analysis are presented in Table 10.

Table 10. Paired Sample t-Test on Pretest and Posttest Scores

Paired Samples Test									
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	T	df	Sig. (2 tailed)
Pair 1	Pretest-Posttest Small Group	-36.500	16.168	5.113	-48.066	-24.934	-7.139	9	.000
Pair 2	Pretest-Posttest Large Group	-34.250	14.260	3.189	-40.924	-27.576	-10.741	19	.000

Based on Table 10, the results of the hypothesis testing indicate that the paired sample t-test for the small-group trial yielded a t-value of −7.139, while the large-group trial produced a t-value of −10.741, with a two-tailed significance value of 0.000. The hypothesis is accepted when the significance value is less than α (α = 0.05). In this study, the two-tailed significance value met this criterion (0.000 < 0.05); therefore, the alternative hypothesis (Ha) is accepted. It can be concluded that there is a significant difference in students' music education outcomes before and after the use of the musical instrument diversity learning application.

Results of Teachers' and Students' Responses

Teachers, as educators, completed a response questionnaire regarding the musical instrument diversity learning application. In addition to the pretest and posttest results, students from both the small-group and large-group trials were also asked to provide their responses through questionnaires. The results of the teachers' and students' responses are presented in Table 11.

Table 11. Results of Teachers' and Students' Responses

No.	Respondent	Percentage	Category
1.	Teacher	100%	Very Practical
2.	Small-Group Students	93.67%	Very Practical
3.	Large-Group Students	96.08%	Very Practical

Table 11 shows that the teachers' response achieved a percentage of 100%, which falls into the very practical category. The responses from students in the small-group trial reached 93.67%, also categorized as very practical, while the responses from students in the large-group trial obtained a percentage of 96.08%, classified as very practical. These results indicate that the musical instrument diversity application is feasible to be implemented in Grade IV of Protomulyo 1 Elementary School for music education

Discussion

This section presents an in-depth discussion of the research findings, highlighting the importance of developing learning media using Smart Apps Creator to enhance students' learning outcomes. The Smart Apps Creator–based media was specifically designed to support improvements in student achievement. The findings indicated a significant increase in students' learning outcomes in music education, particularly in the topic of musical instrument diversity. The primary indicator of the media's effectiveness was the measurable improvement in students' learning outcomes, as evidenced by the pretest and posttest results. These findings are consistent with previous studies, which emphasize that interactive learning media need to be developed because they can effectively assist teachers in facilitating the learning process (Silvia et al., 2024).

The development of Smart Apps Creator (SAC)–based learning media aimed to improve students' learning outcomes by addressing individual learning needs and enhancing understanding of musical instrument diversity. Teacher interviews indicated that SAC-based media increased students' motivation and engagement. Its implementation was supported by adequate classroom infrastructure at Protomulyo 1 Elementary School, Kendal Regency, including projectors in every classroom, enabling effective integration of digital media into the learning process.

The findings of this study, which demonstrated the effectiveness of Smart Apps Creator–based media in improving learning outcomes and students' understanding of musical instrument diversity among fourth-grade students, were strongly supported by previous related studies. This finding aligns with research by Maharani et al. (2025), which showed that the use of Smart Apps Creator–based media had a positive effect on improving learning outcomes and students' metacognitive abilities in the learning process for fourth-grade students. The relevance of this study lies in the utilization of the Smart Apps Creator application as a digital media platform in instructional activities. Based on the validity testing results, the developed media achieved feasibility percentages of 96.8% and 95.3%, both classified as very feasible. These results indicated that the media and learning content were developed in accordance with students' learning needs.

The significant improvement in students' understanding of musical instrument diversity observed in this study, with average N-gain values of 0.779 for the small-group trial and 0.815 for the large-group trial, demonstrated a pattern similar to the findings reported by Wulandari and Wulandari (2025), who developed learning media for science learning in fourth-grade elementary school students. Wulandari's study reported an increase in N-gain values from 0.61 to 0.64, which was categorized as moderate. Although the N-gain values obtained in the present study were higher, both studies confirmed that Smart Apps Creator (SAC) had a measurable positive impact on improving elementary school students' learning outcomes. Students' learning outcomes were also influenced by a pleasant learning environment, which aligns with Jeet and Pant's (2023) view that learning can be made enjoyable in an appropriate setting, such as through games.

The practicality of the Smart Apps Creator–based musical instrument diversity learning application received a 100% positive response from teachers. According to the teachers, the developed media presented learning materials in an engaging manner, which enhanced students' learning motivation. This enjoyable learning atmosphere encouraged students to participate more enthusiastically in the learning process (Ningsih et al., 2025). This demonstrates the effects of implementing an

enjoyable learning approach, often termed fun learning, in an appropriately structured instructional process (Wicaksono, 2020).

The responses from students in the small-group trial reached 93.67% and were categorized as very practical, while the responses from students in the large-group trial obtained a percentage of 96.08%, also classified as very practical. These findings are consistent with the study conducted by Syadida and Erita (2022), which reported that the practicality of students' responses to learning media developed using the Smart Apps Creator application in integrated thematic learning for fourth-grade elementary school students achieved a percentage of 92%, categorized as very practical. This comparison strengthens the argument that Smart Apps Creator can be effectively applied across various subjects at the elementary school level.

A related study conducted by Yunita et al. (2022) also found that the average practicality score from teachers reached 91.06%, which was categorized as very high practicality, while students' practicality responses obtained an average score of 87.09%, also classified as very high practicality. The findings of that study indicate that Android-based learning media are highly feasible for use in instructional activities. These results strongly support the present study, demonstrating that Smart Apps Creator–based learning media is highly practical for implementation at the elementary school level. According to Zega et al. (2025), digital media not only assist in delivering complex material but also have the potential to enhance students' learning motivation in a more enjoyable and interactive manner.

The findings regarding the improvement of students' knowledge competencies in this study are supported by Wahyuni et al. (2024), who investigated students' knowledge competencies using SAC in elementary school social studies. The experimental class achieved an average score of 83, higher than the control class, which scored 67, with a significance value of 0.00 in the mean difference test using the Mann–Whitney method. This consistent and significant improvement indicates that Smart Apps Creator has a demonstrable capacity to enhance students' understanding and mastery of subject matter across various fields of study.

The interactive multimedia aspect, a core strength of SAC in this study, is supported both theoretically and empirically by Toyibah et al. (2024), who developed the Sicerdik application for Theme 7, Subtheme 3, in third-grade elementary school. Their study demonstrated that the interactive multimedia was highly valid, enhanced material comprehension, and was well-received by students, with evaluation scores ranging from 60 to 100 and an overall average of 91. This confirms that an interactive multimedia approach, facilitated by Smart Apps Creator, is effective for various types of learning.

Smart Apps Creator 3 is a desktop-based application that can be used to create interactive multimedia content for mobile devices (Suhartati, 2021). This aligns with the view of Shavab et al. (2025) that Smart Apps Creator is software designed to enable users to develop multimedia applications easily and efficiently. Learning facilitated by instructional media keeps students engaged and prevents boredom due to the variety of available learning options. Android applications such as Smart Apps Creator (SAC) serve as a tool for developing learning content that is more interactive, engaging, and easily accessible to students (Sulistiawan et al., 2025). The visuals of the musical instruments learning application are designed to be visually appealing, incorporating bright colors and animations to capture students' interest in learning.

The findings of this study indicate that Smart Apps Creator is an effective and reliable tool for developing digital learning media in elementary schools. Smart Apps Creator learning media demonstrated high effectiveness and provided practical learning for both teachers and students, while being easy to use (Maasawet et al., 2023). The consistent results across various subjects and contexts highlight its role in enhancing learning quality and student achievement. This study also provides a valuable contribution to the literature on the use of educational technology in music learning and can serve as a reference for similar implementations in other schools. Therefore, the findings of this study imply that the integration of Smart Apps Creator–based interactive media in elementary music learning not only supports the achievement of learning objectives but also provides practical guidance for teachers in designing engaging, effective, and technology-supported learning experiences.

Conclusion

Based on the research findings, it can be concluded that the musical instrument diversity application developed for Grade IV music learning is feasible and effective. This is supported by very high validation results from media experts (96.8%) and material experts (95.3%), as well as positive responses from teachers (100%) and students in the large-group trial (96.08%), indicating that the application is suitable for classroom use. Furthermore, the paired sample t-test results showed a significant improvement in students' learning outcomes after using the application (Sig. 0.000), and the N-gain score of 0.815 fell into the high category. These results demonstrate that the application effectively improves students' learning outcomes on the topic of musical instrument diversity. The suggestions that could be conveyed based on the results of this study were as follows: (1) for teachers, the musical instrument diversity application could be used as an alternative interactive learning medium to support music learning and to create more engaging and meaningful learning activities; (2) for students, the use of this application was expected to increase learning motivation, engagement, and understanding of musical instrument diversity; and (3) for future researchers, this study could be used as a reference for developing similar learning media in other music topics or different educational levels to obtain more optimal results.

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