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Interactive multimedia development for science education in class IX at SMPN 2 Galesong Utara

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ABSTRACT

This research was conducted to address the need for interactive multimedia in science learning. The main objective is to identify these needs, design interactive multimedia learning, and measure validity, practicality, and effectiveness. This research is important because analyzing needs, science material, and student characteristics shows that interactive multimedia can improve student understanding. The methods used include Smart Apps Creator (SAC) based design and product trials on class IXA students at SMPN 2 Galesong Utara. Interactive multimedia designs are developed using the Smart Apps Creator (SAC) application, which integrates multimedia elements such as text, audio, images, and video. The validity of multimedia is tested through evaluation by material and media design experts. The research findings show that the multimedia design has valid qualifications according to the assessments of validators and experts. The product's practicality is proven through trials that show practical results. In contrast, its effectiveness is proven by the N-gain value, which shows significant differences in student learning outcomes. This research concludes that the interactive learning multimedia design is proven valid, practical, and effective, so it is recommended for use in science learning.

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ABSTRAK

Penelitian ini dilakukan untuk mengatasi kebutuhan akan multimedia interaktif dalam pembelajaran sains. Tujuan utama adalah untuk mengidentifikasi kebutuhan tersebut, merancang multimedia pembelajaran interaktif, dan mengukur tingkat validitas, praktikal, serta efektivitasnya. Alasan penelitian ini penting adalah karena hasil analisis kebutuhan, materi sains, dan karakteristik siswa menunjukkan bahwa multimedia interaktif dapat meningkatkan pemahaman siswa. Metode yang digunakan meliputi desain berbasis Smart Apps Creator (SAC) dan uji coba produk pada siswa kelas IXA di SMPN 2 Galesong Utara. Desain multimedia interaktif dikembangkan menggunakan aplikasi Smart Apps Creator (SAC), yang mengintegrasikan berbagai elemen multimedia seperti teks, audio, gambar, dan video. Validitas multimedia diuji melalui evaluasi oleh ahli materi dan desain media. Temuan penelitian menunjukkan bahwa multimedia yang dirancang memiliki kualifikasi valid menurut penilaian validator dan ahli. Kepraktisan produk dibuktikan melalui uji coba yang menunjukkan hasil praktis, sedangkan efektivitasnya dibuktikan dengan nilai N-gain yang menunjukkan perbedaan signifikan dalam hasil belajar siswa. Kesimpulan dari penelitian ini adalah bahwa multimedia pembelajaran interaktif yang dirancang terbukti valid, praktis, dan efektif, sehingga direkomendasikan untuk digunakan dalam pembelajaran IPA.

Kata Kunci: *IPA; multimedia pembelajaran interaktif; smart apps creator*

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INTRODUCTION

The demands of 21st-century education necessitate a significant transformation in learning approaches to equip young people for the challenges and opportunities in an ever-changing world. An essential aspect of educational reform involves integrating technology to enhance learning effectiveness (Lavi et al., 2021). The current development of Information and Communication Technology (ICT) has shifted the traditional learning paradigm towards a more interactive and contemporary direction, making the application of technology in learning an urgent necessity (Vieira & Pedro, 2023).

Interactive learning, as defined by Caroline in the book titled "*Multimedia Interaktif,"* involves students' participatory activities in the learning process, emphasizing the use of various tools and resources to increase student engagement, such as digital media, simulations, and interactive discussions, which theoretically can positively impact learning motivation and understanding of concepts. Development competence in the 21st century challenges teachers to create and develop designs for effective learning strategies through learning experiences and quality learning. The development of interactive learning multimedia is based on the idea that learning activities will be successful, effective, and enjoyable if they are supported by learning media that can attract children's interest and attention, especially if students can operate them. Learning methods using computers or Android devices are more popular with children. If linked to intelligence, child growth is closely related to the theory of multiple intelligences, namely the ability to solve problems or create products assessed in one or more cultural settings based on Fikri and Madona in the book titled "*Pengembangan Media Pembelajaran Berbasis Multimedia Interaktif*".

Through the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia, the government has changed the Indonesian education curriculum to the Kurikulum Merdeka. The official Kemdikbudristek website states that the Kurikulum Merdeka provides flexibility, makes it easier for educators to apply deeper learning according to students' needs, and focuses on strengthening character. One of the goals of implementing the Kurikulum Merdeka aligns with the demands of 21st-century education, namely preparing the nation to face the global challenges of the era of revolution 4.0. The development of 21st-century competencies challenges teachers to be able to create and develop various effective learning designs through learning strategies to provide quality learning experiences. This is regulated in Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Nomor 16 Tahun 2022 tentang Standar Proses pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah, chapter 7, paragraph 2, which reads:

> *"Strategi pembelajaran yang dirancang untuk memberi pengalaman belajar yang berkualitas sebagaimana dimaksud pada ayat (1) dilaksanakan dengan: a) memberi kesempatan untuk menerapkan materi pada problem atau konteks nyata; b) mendorong interaksi dan partisipasi aktif Peserta Didik; c) mengoptimalkan penggunaan sumber daya yang tersedia di lingkungan Satuan Pendidikan dan/atau di lingkungan masyarakat; d) dan/atau menggunakan perangkat teknologi informasi dan komunikasi."*

One way to realize the learning experience process according to process standards is by integrating learning with technology. Teachers are expected to be able to design innovative, creative, efficient, and effective learning media to increase student activity in the learning process (Nurhikmah H & Haling, 2020). Design learning is expected to be capable of fulfilling the needs of students, interesting and fun. One of the efforts made by the teacher is to design learning using effective, interesting, and efficient media; media selection is directed following the competence to be achieved by students (Pattaufi, 2020). Effective teaching requires appropriate mediums that suit students' characteristics, lesson content, and supportive facilities and infrastructure. Learning media, as described by Nurdyansyah in the book titled "*Media Pembelajaran Inovatif,"* plays a vital role in the teaching and learning process, with the accuracy of its use influencing the quality of the process and outcomes achieved.

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One application that can be used in developing interactive multimedia learning is by using Smart Apps Creator, in the future abbreviated as SAC, which is software that can be used to create various multimedia applications that can be published on Android devices, laptops, or computers and can be accessed via HTML5 (Sutejo & Fadrial, 2021). In interactive learning multimedia that uses the SAC application, various animations, audio, video, and navigation buttons have been designed as attractively as possible to attract students' learning interest.

The use of interactive learning multimedia developed with the smart apps creator application can be a good and appropriate reference in the learning process, especially for schools with good internet network facilities, and the ownership of smartphones by students has the potential to develop interactive learning multimedia to become increasingly open. One of them is at SMP Negeri 2 Galesong Utara, which is located in the border area of Makassar City and Gowa Regency; supported by good internet network access, and the use of cellular telephones is also permitted in the school environment in the limited category, meaning their use is only permitted during learning under teacher supervision. This can be used as a potential for the school environment to design learning integrated with technology.

Based on initial data collection at SMPN 2 Galesong Utara during the odd semester of the 2023/2024 academic year, the first is in the form of observation results, which show that science learning has so far been carried out conventionally focuses on the role of the teacher as the center of learning. Teachers still use static media, such as images from printed books or PowerPoint presentations, which tend not to allow students to be actively involved in learning. Not actively engaged students tend to lose interest in the material being taught. This raises concerns about learning effectiveness and student interactivity in the learning process. Learning limited to image media or presentations can make students lose practical experience, which is important for understanding science concepts based on Azis in the book "*Solusi Peningkatan Pemahaman Konsep Pembelajaran"*. Students need more than just looking at pictures or listening to explanations to understand science material truly.

This could cause student learning outcomes in science subjects not to reach the expected level. Namely, the average class score was 68 out of a KKM score of 80. This analysis shows that the learning method is ineffective enough in transferring knowledge to students. One solution that can overcome this problem is to develop interactive multimedia in science learning. Uno, in the book "*Pengembangan Teknologi Pendidikan IPA Berbasis Multimedia dalam Meningkatkan Minat Belajar Siswa"* stated that interactive multimedia can increase interaction between teachers and students, stimulate student involvement in learning, provide better practical experiences, and allow students to explore science concepts more broadly.

Further data from an interview with one of the science teachers at SMP Negeri 2 Galesong Utara shows that they have not used interactive multimedia learning because they have not found interactive multimedia content that is easy enough to use or integrate into learning. He further stated the need for varied learning media because a lack of media variety in learning can significantly impact the needs of all students in the class. Some students may understand the material better because it suits their learning style, while others may have difficulty understanding it. The use of diverse media in science learning is very important.

Other data collection as a support for the results of students' initial competency tests in the learning style categories, namely visual, auditory, and kinesthetic, resulted from 32 students, 51% of whom were in the visual category, 32% in the auditory category, and 17% in the kinesthetic category. With this, teachers should pay attention to students' different learning styles during the learning process. It can help make it easier for teachers to determine appropriate teaching methods and deliver acceptable material to students. Increasing media diversity in science learning is hoped to increase students' understanding and interest in these subjects and create a more inclusive learning environment for various student learning styles. Interactive learning multimedia can help visualize complex scientific concepts in science lessons. Through

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animation, pictures, and simulations, students can more easily understand natural phenomena and scientific principles (Muzana et al., 2021).

Development of learning multimedia interactive with the Smart Apps Creator (SAC) application can give various choice style Study for appropriate students with learning strategies differentiate with integration of various learning media platforms online. This strategy is expected to make learning more interesting, fun, and meaningful. Therefore, from various background descriptions, the author is interested in carrying out "Interactive multimedia development for science education in class IX at SMPN 2 Galesong Utara ".

LITERATURE REVIEW

Instructional Media

The current Industrial Revolution 4.0 emphasizes rapid technological progress. This statement suggests that due to the fast-paced advancements in technology, there is a demand for innovation in technological development to enhance the effectiveness of the current learning process. One such innovation is the evolution of learning media, which plays a crucial role in the learning journey (Daryanes et al., 2023). According to Akhiruddin in the book "*Belajar dan Pembelajaran,"* media can be defined as an intermediary or connector between two entities: the message's originator and receiver. Therefore, learning media can be defined as tools or resources that facilitate the transmission of educational messages between the sender and the recipient. Learning media encompasses any entity, material, tool, or event that enables students to acquire knowledge, skills, and attitudes. This includes teachers or lecturers, textbooks, and the learning environment, among other resources and factors. Every media is a means to achieve a goal. It contains information that can be communicated to other people.

Anwar also put forward the definition of media in the book "*Pengembangan Media Pembelajaran "Telaah Perspektif pada Era Society 5.0"* Media in the learning process tend to interpret as tools photographic, graphic, or electronic for processing, capturing, and compiling return verbal or visual information. Restrictions regarding understanding internal media education include the media used as tools and materials for activity learning. So, media is a tool to deliver a message from the source message to the audience. Message can be delivered through media with various types of Good That in audio, visual and audiovisual forms.

Through media, messages can be delivered to intertwine good communication. Many kinds of media are available for building A communication, including visual, audio, and audio-visual media. Visual media is a medium that can see its form and can also read the meaning it contains. Examples of this visual media include image media, photos, tools displays,, etc. Audio media is a media that can understand its contents through the senses' hearing. For example, from this audio medium, radio broadcasts, instruments, music, and songs it contains can be understood through the senses' vision or hearing. Some examples of audiovisual media include impressions from television, video, film, and so on (Suprianto, 2020).

Multimedia Learning Theory

Interactive learning, according to Caroline in the book titled "*Multimedia Interaktif,"* is a learning approach that involves students' participatory activities in the learning process. This theory emphasizes using various tools and resources to increase student engagement, such as digital media, simulations, and interactive discussions. Interactive learning can theoretically provide a positive stimulus for learning motivation and understanding concepts.

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Interactive learning, in line with the context of cognitivist learning theory which emphasizes the active role of students in learning. Interactive learning provides opportunities for students to actively participate in the learning process through simulations, experiments, and interactive activities (Herianto & Lestari, 2021). Cognitive development is related to thinking, rationalizing, understanding, and remembering the world around us. Cognitive development involves mental processes related to receiving, organizing, and giving meaning to information. This process includes perception, attention, understanding, and recall of information based on Duchesne et al. in the book "*Educational Psychology for Learning and Teaching"*. Cognitivist theory, which emphasizes the importance of developing thinking skills, follows interactive multimedia-based learning in which some activities encourage students to analyze, evaluate, and synthesize information.

The view of cognitive learning theory states that students are individuals who actively study science. In the learning process, students are not just passive in receiving. Students actively seek and process information to overcome their problems and organize this knowledge to gain a new understanding or insight into the knowledge learned. An important concept put forward in cognitive learning theory is information processing, which explains the activity of an individual's mind in receiving, storing, and using the information being studied based on Pribadi in the book "*Teknologi Pendidikan: Desain dan Konsep Esensial"*.

The constructivist approach is one of the schools that originates from cognitive learning theory. A constructivist approach to learning aims to help improve students' understanding of the content or substance being studied. The constructivist approach is closely related to discovery learning methods and the concept of meaningful learning. These two learning methods are in the context of cognitive learning theory (Mahbubi et al., 2023). One-way learning that only fills students with irrelevant information and knowledge must be avoided. This contrasts the constructivist learning theory view, which emphasizes the meaning of experienced experiences. Learning needs to be designed systematically to facilitate students in gaining meaningful learning experiences. Gagnon and Collay, in Cruickshank et al. in the book "The Act of Teaching,*"* argue that students learn and build knowledge when actively involved in learning activities. Learning activities that mark students' constructing knowledge can be observed in several forms of activity, such as:

1. Formulate questions collaboratively;
2. Explaining phenomena;
3. Think critically about complex issues;
4. Solve the problems encountered.

A person is the creator of knowledge for himself. According to Cruickshank et al. (2016), in building this knowledge, a person needs to carry out several essential activities, including (1) asking questions, (2) exploring knowledge, and (3) clarifying the knowledge that has been learned. The purpose of the learning process is to build their knowledge, not memorize the answers provided, and not simply swallow the meaning given by others. By understanding the principles of cognitivism learning theory, interactive multimedia developers can design more effective and engaging learning experiences for students. By adapting design to an understanding of students' cognitive processes, interactive multimedia can become a powerful tool in facilitating meaningful and sustainable learning.

Learning Multimedia Interactive

Multimedia refers to supplies of various audio and video elements in teaching and training materials. Usually, media delivery is done by computer, and it increasingly involves the Internet in one way or another. However, its storage and delivery devices, such as those mentioned above, are less important than the stimulant form that reaches its users. The definition assumes that media are used but does not address

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design issues, such as the choice of specific media for different pedagogical purposes and levels of user control, based on Caroline in the book titled "*Multimedia Interaktif."* Interactive multimedia in learning refers to using various media such as text, images, audio, video, animations, and other interactive elements to deliver learning materials more dynamically and engagingly. Setiyanto et al., in the book "*Multimedia dan Sains,*" stated that this concept aims to enhance student engagement and understanding by providing opportunities to interact directly with the learning content. Here are some examples of interactive multimedia in learning:

1. Simulations: Software or applications that allow students to engage in virtual experiments or simulate specific situations, such as physics, chemistry, or biology simulations. This enables students to understand abstract concepts more visually and practically.
2. Interactive Concept Maps: Interactive concept maps allow students to explore the relationships between concepts in a particular subject. Students can click on specific nodes to obtain more information or see connections between these concepts.
3. Interactive Videos: Videos equipped with interactive features such as multiple-choice questions, immediate feedback, or options to explore further content. This allows students to engage in learning while watching videos actively.
4. Educational Games: Games specifically designed for learning purposes. These games can cover material from various subjects and present them in an engaging and interactive format.
5. Mobile Applications: Learning applications designed for use on mobile devices, which can include various interactive features such as quizzes, exercises, or simulations.

The advantages of using interactive multimedia in learning include increasing student engagement, facilitating a deeper understanding of the material, promoting self-directed learning, and providing variation in teaching styles. Learning media consists of two syllables, namely, media and learning. The first is the word "media". Media comes from the Greek word for medium means middle, middleman, or introduction. Media means Middle because media is located between students and the knowledge being studied, not directly absorbed, but through a medium's medium. The second word is "learning". Learning according to language means teaching, a combination to achieve goals and make learning. Surur in the book "*Pengembangan Media Pembelajaran: Teori, Aplikasi dan Publikasi,* " learning means learning, meaning that students who have not initially carried out learning activities are then given instructions by educators so that learning occurs. Students also experience the learning process. So, that information will be discussed through media intermediaries. If there is no media, it is hoped that you can learn this independently.

Multimedia has a big influence on the learning process. Multimedia can accurately present information because its components adapt to students' learning needs. According to Jayusman (2019), multimedia has seven elements or components: text, graphics, images, audio, interactivity, and video and interactivity. The following is an explanation of several multimedia components, namely:

1. Text is a combination of letters that form one word or sentence that explains a purpose. Text is the basis of word processing and multimedia-based information. When using text in multimedia, you must pay attention to font type, font size, and font style.
2. Graphics also mean (image, picture or drawing). The image is the right means for presenting information, especially since users are oriented towards visual images. Information using images, animations and videos is easier to digest compared to information in text form.
3. Images are the delivery of information in visual form. Images are used in presentations or multimedia presentations because they attract more attention and can reduce boredom compared to text.
4. Videos are a tool or media that can simulate real objects. Multimedia videos are used to describe an activity or action. Video provides rich and lively resources for multimedia applications.

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5. Animation is a display that combines text, graphics, and sound media in a movement activity. In multimedia, animation uses a computer to create movement on layers. Animation is used to explain and simulate things that are difficult to do with video
6. Audio (voice, sound) is defined as various types of sound in digital form, such as sound, music, narration, and so on, which can be heard for background sound purposes, conveying messages, and so on. On the other hand, audio can also improve memory and can help users who have visual impairments.
7. Interactivity: Interactive multimedia can be used in navigation, simulation, games, and exercises. If multimedia users are given the ability to control existing elements, then the multimedia is called Interactive Multimedia.

Learning media, including multimedia, should be designed to clarify and enhance the delivery of learning materials the teacher delivers visually. This means that multimedia content should be clear and visually appealing to assist students in understanding the concepts taught. Using multimedia, students can access learning materials anytime and anywhere, according to their needs, overcoming the limitations of space, time, and sensory perception limitations. In addition, multimedia also has the potential to spark students' interest in learning, thus fostering motivation to explore the material independently. For example, incorporating interactive elements or interesting visuals can significantly increase student engagement and understanding (Magdalena et al., 2020).

We can understand the context of multimedia-based learning with a significant difference because it has provided various characteristics and principles so that learning can be said to use multimedia if it contains certain characteristics of multimedia learning. These characteristics can be seen from the presentation by combining all media in the learning process. The media unification in question combines computer media, video, audio, images, text, and animation into one link in one interactive digital presentation device. Thus, multimedia can activate all students' five senses. The characteristics of multimedia learning mentioned above, learning multimedia must be interactive. Therefore, an educator must understand that multimedia must be rich in interactive processes and is expected to be able to interpret learning multimedia correctly.

Innovation in Learning Multimedia Development

Innovation in the development of learning multimedia in education currently entering the 4.0 era includes various technological advances and new approaches designed to face the challenges and opportunities that arise in this digital era. According to Purba et al. (2023), learning in the Industry 4.0 era refers to the educational transformation in response to digital technology, artificial intelligence, robotics, and automation developments that define this new industrial era. In the Industry 4.0 era, learning is experiencing significant changes in various aspects, including teaching methods, curriculum, learning infrastructure, and the abilities of students and educators. Some of the characteristics of learning in the Industry 4.0 era based on Ibda et al., in the book "*Media Game Digital SD/ MI Berbasis Karakter P5 dan PPRA"* include:

1. Technology-Based Learning: Digital technologies, such as computers, mobile devices, and the internet, are becoming an integral part of the learning process. Learning software, mobile applications, and online platforms are becoming more common in providing access to information and learning resources.
2. Flexible and Independent Learning: Access to distance learning and online resources allows students to learn independently and flexibly, anywhere and at any time. This allows adaptation to individual learning styles and diverse learning needs.
3. Skills-Oriented Learning: Curriculum and teaching methods are beginning to emphasize developing 21st-century skills, such as critical thinking, creativity, collaboration, communication, and problem-solving skills. The main aim is to prepare students to face the demands of an increasingly complex and changing world of work.

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4. Project-Based and Collaborative Learning: Project-centered learning, where students work in teams to complete challenging and authentic tasks. Collaboration between students and the outside world, including employers and industry professionals, becomes an important part of the learning process.
5. Use of Advanced Technology: Advanced technology such as augmented reality (AR), virtual reality (VR), artificial intelligence (AI), and robotics are used in learning to provide a deeper, immersive, and realistic learning experience.
6. Learning Analytics: Using learning data and analytics helps educators monitor student progress, adjust learning approaches, and provide relevant feedback. This allows for more personalized and effective learning.
7. Digital Skills Development: Learning in the Industry 4.0 era also aims to develop students' digital literacy and technological skills to adapt to technological changes and become competent actors.

Thus, learning in the Industry 4.0 era emphasizes the use of technology, the development of 21st-century skills, project-based and collaborative learning, and the use of advanced technology to create learning experiences that are relevant, in-depth, and in line with the demands of the times.

A teacher can utilize innovation in learning in various ways to increase teaching effectiveness and create a more interesting learning experience for students. Teachers can utilize learning software, mobile applications, online learning platforms, and hardware such as laptops or tablets in their learning. This allows teachers to present learning materials more interactively, access a wider variety of learning resources, and provide faster feedback to students. Teachers can design challenging and relevant real-life projects, motivating students to learn more deeply and meaningfully. Another important thing is encouraging collaboration between students and active discussions in class through collaboration and discussion. Teachers can use technology such as online forums or discussion groups to facilitate student interaction, exchange of ideas, and joint problem-solving.

Game-based learning uses educational games to increase student engagement and deepen their understanding of the concepts being taught. Teachers can design fun and educational games appropriate to the studied learning material. Teachers are also expected to be able to design different learning experiences to meet the diverse learning needs of each student. Teachers can use technology to provide learning materials tailored to students' ability levels, interests, and learning styles (Evandri & Auna, 2024). By utilizing innovation in learning, a teacher can create a learning environment that stimulates, motivates, and supports students' holistic development to the maximum.

Using Smart Apps Creator in Learning

Smart Apps Creator (SAC) is a tool for crafting learning content in Android and iOS app formats, eliminating the need for programming skills. The output includes HTML5 and .exe formats, making the application compatible with various devices and touch screens. The Smart apps creator is a learning media application designed for creating educational materials effortlessly, without the need for complex programming. It enables users to seamlessly input or design learning content, facilitating the creation of teaching materials suitable for offline and online use. Furthermore, developers can customize these materials according to their requirements, making versatile products accessible anytime, anywhere (Khasanah et al., 2020).

The smart apps creator offers a user-friendly multimedia tool that does not require programming skills, making it accessible for teachers without coding backgrounds to create compelling mobile applications. Its intuitive interface is easy to navigate and does not demand substantial RAM usage. Supported by a range of features and tools, it simplifies media creation. Users can utilize the insert menu to add various elements like images, music, videos, and text, while the edit menu facilitates text organization. Additionally, the interaction menu enables users to apply effects to images or animations. However, its limitation lies in its capability to create only basic applications. Nonetheless, it adequately equips users to develop learning

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media, offering easy animation creation and compatibility with Android and iOS devices to save results (Yallah & Huda, 2022).

Mobile learning is a form of development of alternative media for the learning process in Indonesia, which still implements distance learning. Students carry out the learning process using smartphones. Many things can be learned during the current pandemic, namely, creating a flexible learning paradigm for the learning process. The current learning process leads to learning that requires students to be independent and creative. The consideration in developing Android-based mobile learning media is that teachers and students already have smartphones; even during the pandemic, smartphones deliver learning material. Various software applications are available to develop learning media that are practical, interesting, and easy to use, one of which is the smart apps creator (SAC). Preparing and creating smart apps and creator-based learning media can be made more interesting because the templates available in the application make it easier for teachers to design material that will be delivered to students in the form of text, images, or videos (Nasir et al., 2022).

Utilizing the smart apps creator application with developments in the current technological era, almost all students have smartphones, one of which is in the online learning process; students use smartphones during the learning process as a medium for learning based on Anwar in the book "*Pengembangan Media Pembelajaran "Telaah Perspektif pada Era Society 5.0"*. The problem is that not all students have computers or laptops but prefer using smartphones as a learning medium. However, several obstacles occur, namely, students with smartphones sometimes do not have a good signal for following the learning process. Some do not have the data to follow the learning. Therefore, teaching staff must be able to find a way out of this problem. The development of Android-based mobile learning media can produce effective and efficient forms of mobile learning applications for learning. They are developing an Android-based learning media by creating a mobile learning application with the help of Smart Apps Creator by utilizing smartphones owned by students (Karim et al., 2020).

Implementing learning using Android applications is expected to help teachers adapt to technological advances packaged in the form of Android applications in implementing learning. According to Mas'ud et al. (2023) smart apps creator is an application for creating Android and iOS mobile applications without programming code, and can produce HTML5 and EXE formats. Smart app creators can be used to create mobile multimedia learning applications, cities, guides, marketing, games, etc. Moreover, it can also be taught to elementary, middle, and high school/vocational school students to increase their creativity in managing content and creating interesting mobile applications. Smart Apps Creator is a multimedia application capable of designing and creating interactive learning media based on Android and iOS without coding. Smart Apps Creator can be an alternative when studying online (on the network).

Relevant Research

Multimedia tools in the teaching and learning processes: A systematic review conducted by Abdulrahman et al. (2020) presents a general overview of the role of multimedia in opening access to quality education in developing countries. This research illustrates that access to quality education is still a major obstacle in developing countries. Efforts to open access to education for most citizens in developing countries have explored various strategies, including multimedia technology. The research concludes that multimedia applied to teaching and learning provides solutions to the pedagogical content of the subject of interest and user audience.

An adaptive and interactive learning toolkit (iLearn) by Jayasiriwardene and Meedeniya (2023), this research shows that mobile-based learning applications can support student learning independently, proven innovative and effective. Adaptive, interactive features and customizable lesson creation tools to enhance student learning experiences make it easier for teachers to organize learning materials. Further

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research from Vagg et al. (2020) shows that multimedia is recognized as a valuable tool and can enrich the learning experience. The students who were the objects of this research expressed a special interest in interactive tools, such as simulators, which could complement and enhance their learning.

Utilizing the Smart Apps Creator application as an Arabic learning media, research from Dewi et al. (2021) states that the Smart Apps Creator application is considered an effective solution for improving Arabic language learning by presenting interactive multimedia content that can be accessed flexibly by educators and students. This application provides convenience, including 1) Learning activities are not tied to the classroom; 2) Can be used by educators who teach the same subjects and materials; 3) Providing interesting animations and videos to increase enthusiasm for learning Arabic; 4) Can be used offline without needing to connect to the internet; 5) Students can directly interact with the media that has been designed without the need for special training.

Another research entitled Android-Based Multimedia Learning for Vocational High Schools by Nurhikmah et al. (2020) states that this research is a development study for interactive multimedia, which consists of several stages, including planning, design, development, and attribution. The results are that: 1) internet use in learning is not optimal. 2) The Android-based multimedia developed has been validated by learning content and media experts and is considered valid and suitable for application. 2) The scores resulting from individual trials are in the "very feasible" category, so they are considered valid, while small group trials show scores in the "valid and practical" category.

METHODS

This research follows the research and development (R&D) approach, focusing on several key objectives: identifying the necessity for interactive learning multimedia, designing such multimedia, and evaluating its validity, practicality, and effectiveness. The development model employed is the ADDIE development model based on Lee and Owens in the book "*Multimedia Based Instruction Design,"* which consists of analysis, design, development, implementation, and evaluation stages. This research was carried out in the even semester of the 2023/2024 academic year at SMP Negeri 2 Galesong Utara, Jl. Kaharuddin Dg. Sikki Aeng Batu-Batu, North Galesong District, Takalar Regency, South Sulawesi. The participants included 32 students from class IX.A, one science teacher, and two validators.

Procedure Study

During the analysis phase, the necessity for interactive media aligned with competency-based needs was assessed by analyzing student characteristics, curriculum materials, and available facilities and infrastructure. In the design phase, the researcher created an initial design for Interactive Science Learning Multimedia, including learning materials, flowcharts, storyboards, and assets such as images, videos, and sound. The software chosen for development was Smart Apps Creator 3.5 (SAC)

The development stage involved producing the Interactive Science Learning Multimedia, adhering to the previously designed flowcharts and storyboards. Multimedia creation was conducted using Smart Apps Creator (SAC) to combine materials and assets. Subsequently, design and media experts tested the multimedia's validity, evaluating all research components, including the interactive multimedia, teaching modules, and research instruments.

The implementation stage involved trialing the interactive multimedia learning product with class IX. A student at SMP Negeri 2 Galesong Utara, aligning it with the learning activities. Lastly, the evaluation stage aimed to determine the practicality and effectiveness of interactive multimedia learning in science.

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The evaluation included individual, small group, and large group assessments (field tests) using pretests, posttests, and questionnaires to measure knowledge enhancement and gather feedback.

Data collection technique

The data collection techniques used in this research are observation, interviews, questionnaires, and learning outcomes tests.

1. Observation
   Observations were conducted to obtain initial data about the analysis needs at SMP Negeri 2 Galesong Utara, which will be carried out during the odd semester of the 2023/2024 academic year. The purpose of observation is to find out the difficulties faced by students. Observation is used in preliminary study activities by observing learning situations and conditions with interactive multimedia provided at the implementation or trial stage to determine learning activities. Observations were also carried out by providing questionnaires for analysis of student needs. This questionnaire contains statements and questions related to student needs and what facilities the student or school has. This student needs analysis questionnaire focused on students' needs for learning media, especially Android-based learning media.
2. Interview
   In this research, teacher interviews were conducted to analyze students' needs and characteristics and to determine the needs in selecting materials for developing interactive multimedia products. Interviews are open and structured to obtain direct assessment.
3. Questionnaire
   In this research, the questionnaire was carried out at the expert validation and testing stages of student practicality. The validation test sheet aims to determine the valid level based on validators appointed as material experts, design experts and learning media experts. The practicality test sheet aims to determine the practical level of multimedia assessed by selected students based on high, medium, and low levels of knowledge. Apart from that, questionnaires were also given to teachers to obtain an assessment of the products being developed.
4. Test learning outcomes
   The test was carried out at the evaluation stage at the last research meeting. This test contains questions that measure students' depth of knowledge (cognitive level) after using interactive multimedia in learning. Tests are given to determine the effectiveness of teaching materials. The effectiveness of teaching materials can be seen from the achievement of learning objectives reflected in students' understanding of concepts. Understanding of concepts can be determined by assessing students through tests after students learn from interactive multimedia-based teaching materials. Test data was taken twice during evaluation as pretest and posttest.

Research Instrument

Instruments are tools used to obtain information. Instruments are closely related to the choice of data collection techniques. If the technique chosen is observation, then the instruments are observation sheets and questionnaires; if the data collection technique chosen is questionnaires, then the instruments are questionnaires and tests. An explanation of the research instruments used is as follows.

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1. Interview sheet
   The interview sheet is one of the instruments used in this research to collect qualitative data from respondents, namely science subject teachers. The grid of questions on the interview sheet to identify the need for interactive learning multimedia in **Table 1** below.

Table1. Grille question interview

No	Aspect	Item principal
1	Learning	• Obstacle • Achievements Learning • Teaching Module • Media • Facilities and infrastructure
2	Material	Material Contents

(Source: Research 2024)

2. Questionnaire sheet
   The material is assessed regarding content quality, language use, and motivation. The description of these aspects in **Table 2** is as follows.

Table 2. Material Validation Instrument Indicators

No	Indicators	Criteria
1	Content quality	Suitability of material to Learning Outcomes, Depth of material with indicators, Accuracy of material, Accuracy of material, Orderliness in presenting material, Accuracy in placing detail level of material
2	Language use	The language used in interactive multimedia must be appropriate to the target user. Instructions delivered in interactive multimedia are clear and complete.
3	Motivation	Ability to attract the attention of many students.

(Source: Research 2024)

Interactive learning multimedia assessment includes displays and programming. The description of these aspects in **Table 3** is as follows.

Table 3. Media Validation Instrument Indicators

No	Indicators	Criteria
1	Appearance	The display must be visually and aesthetically attractive to attract the user's attention. The appearance must follow the theme and content presented in interactive multimedia. The display design must be user friendly and easy to use by various groups of users.
2	Programming	Appropriate programming technology according to the needs and specifications of interactive multimedia projects. The program structure is organized so that it is easy to understand and manage. All features and functionality work well without bugs.

(Source: Research 2024)

Assessment of interactive learning multimedia design includes suitability of design to material, method of delivering material (methodology), and interactivity. The description of these aspects in **Table 4** is as follows:

Table 4. Media Design Validation Instrument Indicators

No	Indicators	Criteria
1	Design suitability with material	Interactive multimedia design must be consistent with the theme and visual style of the material presented. This includes choosing colors, fonts, graphics, and other design elements that match the content of the learning material.

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No	Indicators	Criteria
2	Method delivery material	Material should be presented in a way that is easy for users to read and understand. The use of clear, well-structured text, including short paragraphs, highlighting important points, and orderly organization of information, will help improve the readability and understandability of the material.
3	Interactivity	The design must have sufficient flexibility and interactivity to allow users to explore the material's content according to their needs and preferences.

(Source: Research 2024)

3. Learning outcomes test
   Learning outcomes from formative and summative tests measure students' mastery of the subject matter after using interactive multimedia learning. The tests refer to indicators of basic competency achievement and are carried out after the entire learning process has been carried out at the trial stage.

Data Analysis Techniques

Data analysis techniques involved both qualitative and quantitative descriptive analysis. The qualitative analysis encompassed the interpretation of interview and observation data, following the guidelines outlined by Sugiyono in the book "*Metode Penelitian Pendidikan: Pendekatan Kualitatif, Kuantitatif dan R&D"*. On the other hand, quantitative analysis utilized the percentage formula for evaluating questionnaire findings as recommended. Based on the collected data, the research findings will be presented in paragraph form.

$$P = \frac{f}{n} \times 100\%$$

Information:
P : Percentage of student scores
f : frequency of student scores
n : number of students

Furthermore, the needs analysis results are displayed in tables and graphs to make it easier to read the data resulting from the needs analysis. Experts assessed the questionnaire used to test validity. The data obtained will result from research on the validity of SAC-based interactive science learning multimedia. The expert validation instrument has five answer choices, namely numbers 1 to 5. The scores obtained from the experts are averaged using the formula:

$$Me = \frac{\sum x_i}{n}$$

(Source: Sugiyono in book "Statistika untuk Penelitian" 2015)

Information:
Me : Average value
$\sum x_i$: Number of average values
n : Lots of data

The average value of the validators' assessment results is then categorized as valid. The validity level criteria are in Table 5 as follows:

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Table 5. Validity Level Criteria

Score	Criteria
Me = 5	Very Valid
$\mathbf{5 < Me \leq 4}$	Valid
$\mathbf{4 < Me \leq 3}$	Fairly Valid
$\mathbf{3 < Me \leq 2}$	Invalid
$\mathbf{2 < Me \leq 1}$	Very Invalid

(Source: Arifin 2023)

Questionnaires to test practicality were assessed by students as users. The data obtained will result from research into the practicality of interactive multimedia in science learning. The multimedia practicality instrument has five answer choices, namely numbers 1 to 5. The scores obtained from the students are averaged using the formula:

$$Me = \frac{\sum x_i}{n}$$

(Source: Sugiyono in book "Statistika untuk Penelitian" 2015)

Information:
Me : Average value
$\sum x_i$: Number of average values
n : Lots of data

The average value of student assessment results is then categorized as practical. The practicality level categories are listed in Table 6 as follows:

Table 6. Practicality Level Criteria

Score	Criteria
Me = 5	Very Practical
$\mathbf{5 < Me \leq 4}$	Practical
$\mathbf{4 < Me \leq 3}$	Enough Practical
$\mathbf{3 < Me \leq 2}$	Impractical
$\mathbf{2 < Me \leq 1}$	Very Impractical

(Source: Arifin 2023)

The qualitative research data, including comments and suggestions, will serve as the foundation for refining interactive learning multimedia developed with SAC.

At the product trial stage, students are tested. The tests were a pretest before learning using SAC-based interactive science multimedia learning and a posttest after learning. Data from the pretest and posttest results are calculated using the following formula.

$$Score = \frac{accurate\ quantity.}{number\ of\ questions} x\ 100$$

The N-gain normalized gain was then used based on the calculation results seen from each respondent's pretest and post-test scores, according to Fadaei (2019). Gain Hake can measure the relative effectiveness of various teaching techniques and for learning using SAC-based interactive science multimedia learning. N gain can be calculated with the following formula.

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$$N_{gain} = \frac{\bar{x}\, posttest - \bar{x}\, pretest}{100 - \bar{x}\, pretest}$$

(Source: Fadaei 2019)

Information:
$\bar{x}\, pretest$: the average score of the initial test
$\bar{x}\, posttest$: final test average score

To measure the effectiveness of SAC-based interactive science learning multimedia, *the N gain results* are then interpreted based on the following table:

Table 7. Criteria for Obtaining Ngain Score

Critical N-gain Value	Criteria
If $\boldsymbol{N_{gain} \geq 0,7}$	Tall
If $\boldsymbol{0,7 > N_{gain} \geq 0,3}$	Currently
If $\boldsymbol{N_{gain} < 0,3}$	Low

(Source: Fadaei 2019)

RESULTS AND DISCUSSION

In this section, students' understanding of science subjects explains the results and discussion the process of developing interactive learning multimedia to improve it. The research outcomes address the problem statement by providing insights into the requirement for interactive learning multimedia, its design process, and assessing its validity, practicality, and effectiveness using the ADDIE development model.

Analysis of Needs

The analysis stage of this research involved gathering data through interviews and observations at SMP Negeri 2 Galesong Utara to assess various aspects, including needs, materials, infrastructure, student characteristics, and media analysis. Findings from interviews with teachers revealed several key insights: 1) Students exhibited disinterest and lack of motivation towards science lessons when presented solely with text and images, leading to decreased engagement; 2) The prevailing teaching methods, primarily centered on theory projection, lectures, and discussions, failed to cater to the diverse learning needs of every student; 3) Some students struggled with understanding certain science materials, resulting in below-average performance. Students preferred interactive learning methods, such as games, and indicated a desire for learning materials accessible via smartphones. They were incorporating multimedia elements into teaching enhanced student motivation and engagement, as interactive and visually appealing materials can sustain student interest.

Design of Interactive Learning Multimedia

Researchers utilized the Smart Apps Creator (SAC) application during the design stage to create an initial design for Interactive Learning Multimedia. This design process involved several steps, including creating flowcharts and storyboards to outline the sequence and relationship between processes and instructions in alignment with the learning concept design. Flowcharts served as visual representations of the instructional process, while storyboards provided a design illustration of the interactive multimedia to be developed. Assets, including buttons, navigation elements, images, videos, and sound, were then collected and prepared for integration into the multimedia platform. The creation of assets aimed to ensure

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a comprehensive and engaging multimedia experience for students, encompassing various forms of media such as text, audio, and visuals. Flowchart for learning multimedia interactive described based on **Figure 1** below.

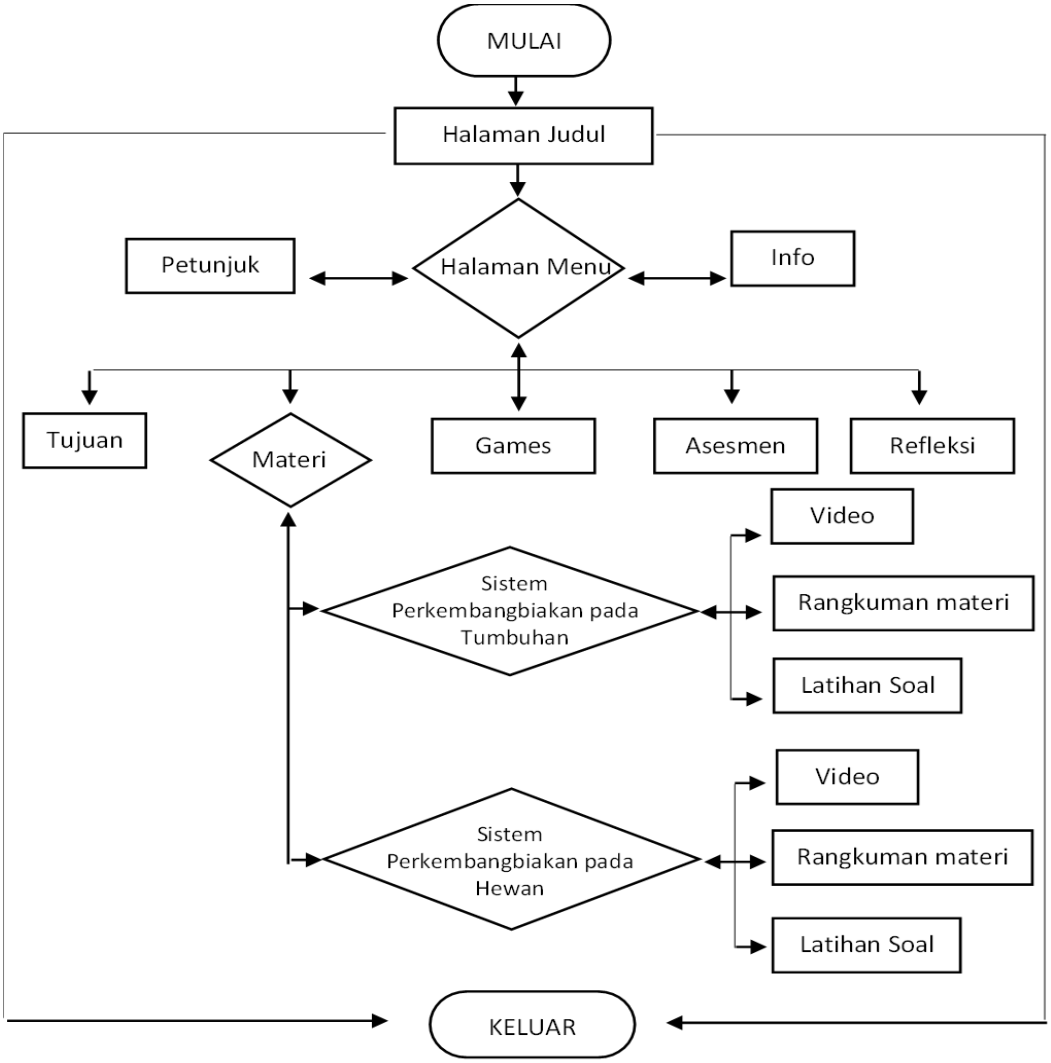

Figure 1. Learning Multimedia Flowchart Interactive
(Source: Research 2024)

Analysis Validity of Learning Multimedia Interactive

This research analyzed the validity of interactive learning multimedia during the development stage, following the ADDIE model. Researchers focused on obtaining a valid product during this stage. Before testing the validity of interactive learning multimedia, learning tools, and materials were developed to create interactive multimedia products. This multimedia validity analysis evaluates the extent to which the material presented in multimedia is relevant to the material or learning objectives set. This includes understanding whether the information presented is appropriate to the knowledge level and needs of the target audience.

This stage holds significant importance as the media created will undergo an assessment by experts to ascertain whether the product falls within the valid category and is appropriate for testing in the learning process. In research, there are two validators for evaluation: expert validators' material and expert validators' design and media. This test assesses material aspects, design and media aspects, teaching modules, as well as instrument tests. Others will used to evaluate the practicality and effectiveness of learning multimedia. As for the description results, validation is outlined in the following table:

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Table 8. Validation of Learning Multimedia Interactive from Material Experts and Media Design Experts

No	Instrument	Results	Criteria
1	Design and Media	4.6	Valid
2	Material	4.2	Valid
3	Questionnaire teacher response	4.3	Valid
4	Questionnaire response student	4.3	Valid
5	Learning Results Test	4.6	Valid
6	Teaching Module	4.6	Valid
7	Observation implementation learning	4.4	Valid

(Source: Research 2024)

After validation tests were carried out, revisions were made based on suggestions and comments provided by experts. Revisions were made to the design and media to give identity to the video used. Whereas feedback, suggestions, and comments from experts related material with learning multimedia interactive science, namely Paying attention to adequacy material and checking suitability with purpose, images/ videos can take direct main pictures or videos found in the environment around, from these suggestions responded by inspecting the return multimedia content and ensuring that all necessary materials for reaching objective learning included. Including ensuring that relevant concepts are explained with enough details and materials required to understand more carry-on has been provided, as for the results at stage development for learning multimedia interactive products used in stages implementation. Learning multimedia displays are described in **Figure 2** and **Figure 1** below.

Figure 2. Learning Multimedia Display Interactive on smartphones
(Source: Research 2024)

Figure 3. Learning Multimedia Display Interactive on Desktop for Laptop/ Computer
(Source: Research 2024)

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Analysis Practicality of Learning Multimedia Interactive

The level of practicality in this research was carried out at the implementation stage, namely by testing interactive science learning multimedia products using teacher and student response questionnaires. Practical instruments include four aspects, namely design (Presentation design), ease of use (Interaction usability), ease of access (Accessibility), and ease of reuse to develop other media (Reusability). The results of interactive multimedia's practicality are tabulated in **Table 9**.

Table 9. Practical Results of Teacher Response Questionnaire

No	Aspect	Amount item	Amount Respondent	Ideal Score	Total
1	Interaction User	6	1	30	28
2	Presentation Design	5	1	25	23
3	Usefulness	7	1	35	34
4	Conformity curriculum	2	1	10	8
Total			**20**	**100**	**93**
Average				**4.65**	

(Source: Research 2024)

These results show that interactive multimedia's practicality level is 4.65 in the practical category, so it can be used in the next stage of implementing science learning.

Next, test the practicality involving ten class IX A students divided into two groups. Group first consists of the five students with the criteria to understand material magnetism, and Group second consists of the five students who do not understand material magnetism. The practical results of interactive multimedia are tabulated in **Table 10** as follows:

Table 10. Practical Results of MPI IPA Small Group Trials

No	Aspect	Amount item	Amount Respondent	Ideal Score	Total	
					Group I	Group II
1	Presentation design	3	5	75	68	71
2	Interaction user	3	5	75	72	75
3	Accessibility	2	5	50	44	44
4	Usage return	2	5	50	45	46
Total			**50**	**250**	**229**	**236**
Average					**4.58**	**4.72**

(Source: Research 2024)

Based on the practicality level criteria of the two groups, the science interactive learning multimedia product was in the practical criteria.

Analysis Effectiveness of Learning Multimedia Interactive

The Pretest learning results test was carried out in class IX A of SMP Negeri 2 Galesong Utara with as many as 32 students as respondents before studying the material with science interactive learning multimedia. This aims to measure students' initial knowledge of science material before learning. After studying the material with interactive learning multimedia, students work on posttest questions to measure their level of knowledge (absorptive capacity students) after studying science material with interactive multimedia learning.

Below are presented the results of the recapitulation of pretest scores with an average score of 67.5 carried out by 32 students in class IX A of SMP Negeri 2 Galesong Utara.

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Table 11. Recapitulation of Pretest Results

Value Range	Predicate	With letter	Amount Respondent
90 - 100	Very good	A	2 participants
80 - 89	Good	B	8 participants
70 - 79	Enough	C	14 participants
60 - 69	Bad	D	8 participants
0 - 59	Very bad	E	0 participants

(Source: Research 2024)

Based on the data above, many students still do not understand magnetism material, so a stimulus is needed to increase understanding, increasing students' knowledge competency regarding magnetism material. Next, students carry out the learning process using interactive learning multimedia.

Posttests are given to students after learning using the developed interactive multimedia learning science material on magnetism. The posttest was conducted using questions with the same difficulty level (Cognitive Domain) with 15 multiple choice questions and essays. The average student's post-test results showed a score of 84.53. The recapitulation of posttest results can be seen in table 12 below:

Table 12. Recapitulation of Posttest Results

No	Value Range	Predicate	With letter	Amount Respondent
1	90 - 100	Very good	A	11 participants
2	80 - 89	Good	B	14 participants
3	70 - 79	Enough	C	7 participants
4	60 - 69	Bad	D	0 participants
5	0 - 59	Very bad	E	0 participants

(Source: Author Research 2024)

These results show increased student scores on posttest activities after using interactive science learning multimedia based on smart app creators. The effectiveness assessment is measured using Ngain so that it is obtained from the average value of the pretest and posttest scores as follows:

$$Ngain = \frac{84{,}53 - 67{,}50}{100 - 67{,}50}$$

$$Ngain = \frac{17{,}03}{32{,}50}$$

$$Ngain = 0{,}52\ (sedang)$$

Ngain score was obtained with a value of 0.52 in the medium category. This demonstrates that using interactive science learning multimedia created with smart app creators positively impacts student learning outcomes. The observed rise in student scores from the pretest to the posttest indicates that interactive science learning multimedia boosts student motivation, enhancing knowledge acquisition. The notable improvement in scores between the pretest and posttest varied depending on students' engagement with the multimedia. Nevertheless, collectively, the influence of the developed interactive learning multimedia assists students in grasping the concepts conveyed through this medium.

Discussion

Creating interactive learning multimedia using Smart Apps Creator (SAC) aimed at improving students' understanding of Class IX science subjects at SMP Negeri 2 Galesong Utara has smoothly advanced through all procedural stages. It is anticipated that this interactive multimedia will offer fresh knowledge

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and a conducive learning environment for students who face limitations in participation. Moreover, this multimedia tool is expected to optimize the learning process by leveraging technology.

The need for developing interactive learning multimedia products in this research was obtained from needs analysis, student character analysis, and material analysis. Each analysis indicates the need for creative and innovative learning references. The analysis of student characteristics shows that: 1) Most students have better learning abilities through visual experiences. They revealed that visualization in the form of videos helped them understand science concepts better than verbal explanations or static images. 2) Students show great interest in using game-based media in science learning, especially when working on practice questions. They feel that games provide an interactive, competitive, and fun learning experience, which can increase their involvement and motivation in solving problems. 3) The character of students who have good technological skills and are familiar with using electronic devices such as computers, smartphones, and tablets so that they can use various applications and multimedia platforms easily. In this regard, the results of the analysis of facilities and infrastructure also show support for the use of technology in learning, such as ownership of personal smartphones by students, good internet networks, and school regulations that allow the use of smartphones during the learning process.

The results of the analysis of science material show that the concepts are complex and abstract, which are difficult to understand using traditional media such as images or text alone. Science learning often requires flexibility in presenting information and content, especially because this subject involves continuous new developments and discoveries. Effective science learning requires the active involvement of students in the learning process based on Batubara in the book "*Media Pembelajaran Efektif*". Pribadi, in the book "*Teknologi Pendidikan: Desain dan Konsep Esensial,"* in line with this opinion, cognitive learning theory emphasizes that students are active in learning. Students receive information passively and actively seek process and use that information to solve problems and gain new understanding. Based on the needs analysis that has been carried out, it shows that using interactive multimedia in science learning can help increase learning effectiveness by presenting complex concepts in a way that is easier to understand and can increase student involvement and understanding in learning. This follows research by Hayadi et al. (2024), which states that interactive multimedia products can effectively improve students' critical thinking skills in science learning.

The design stage begins with installing the application used, namely the smart apps creator 3.5 application, designing a flowchart and creating a storyboard, and collecting the assets that will be used, such as navigation buttons, background images, material images, animation, audio and video that suit the material. This asset design can be done with additional applications such as Canva, or assets can be taken from the freepik.com website. Next, based on the flowchart and storyboard, the developer creates the appropriate logic in the SAC application to create the parts that have been designed in full. The design results are then used as output in the form of an application with the APK extension used for Android smartphone displays and the exe extension for displays on PCs/ laptops. As Sutrisno et al. (2020) stated, the design process must make it easier for application users to absorb all the information and displays presented. It must be able to attract the user's attention. Apart from that, research by Amali et al. (2019) stated that the response shown by students to the design using the SAC application was in the very good category. Based on this stage, it can be concluded that planning to create learning media using the smart apps creator (SAC) application requires careful and careful preparation.

The interactive learning multimedia design developed can be accessed offline and online. Online access is designed by integrating various learning platforms, such as Wordwall for game-based practice questions, learning evaluation by integrating Google Forms or Quizizz, and student reflection by integrating the Padlet platform. This is an advantage of interactive multimedia products used in learning strategies, namely that they can be developed for direct and indirect learning. The validity of interactive learning multimedia products in this research was measured by testing the validity of a team of material, media,

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and design experts who obtained results within valid criteria. Based on the validity analysis, it was found that the interactive science learning multimedia developed was in the valid category from every aspect. The indicators used in validating the material are 1) The content/material is relevant to the learning objectives, 2) The language used is appropriate to the target user, and 3) Increases motivation with the ability to attract the user's attention.

Indicators of media and design validation used in this research are 1) Appearance, with design criteria that are visually and aesthetically attractive so that they attract the user's attention, according to the theme and content; 2) Appropriate programming according to the needs and specifications of the interactive multimedia project, structured so that it is easy to understand and all features and functionalities work well without bugs, 3) Interactivity, namely the design must have sufficient flexibility and interactivity to allow users to explore the material content according to their needs. The interactive multimedia results from these indicators obtained a valid category.

The practical category obtained from the research results is because the developed multimedia met students' needs. The indicators to assess practicality include presentation design, Interaction usability, Accessibility, and Reusability. The resulting interactive learning multimedia product also provides a more interesting learning experience for students by allowing them to interact with visual elements, understand the material through videos, and practice game-based questions, which are considered fun. According to Belawati in the book "*Pembelajaran Online*," the practical category of online learning media includes several aspects: 1) Affordability, interactive multimedia must be easy to access. As many users can use them as possible. 2) Clear functionality: Interactive multimedia designs must have clear and easily understood functions. Users must be able to quickly find out the main purpose of the multimedia and how to use its features; 3) Content availability: interactive multimedia must provide relevant and useful content for users. Content must be appropriate to the learning objectives and can provide added value in understanding the material, as well as 4) Easy navigation, users must be able to navigate interactive multimedia easily. It includes an intuitive interface, well-structured menus, and clear navigation buttons.

The final stage is to test the level of multimedia effectiveness. Interactive learning that has been developed. Effectiveness is influenced by the attractive multimedia display of interactive science learning and the material is accessed via an application on a smartphone, making it easier to learn anywhere and anytime, attracting attention so that students follow the delivery of the material from start to finish. The material presented in text, images, and videos in interactive science learning multimedia is easy to understand. In this study, effectiveness was assessed from the significance of the comparison of learning results tests before using interactive learning multimedia (pretest) and results after learning using interactive learning multimedia (posttest). The study from (Dong et al., 2024) used a pretest-posttest quasi-experimental design involving three groups: the control group, multimedia group, and non-multimedia group showed that interventions using interactive visual multimedia technology were effective in improving the learning of schoolchildren in rural China.

Based on the discussion above, the advantages of interactive learning multimedia include: 1) Interactive learning multimedia offers the flexibility of accessibility, being available for use both offline and online; 2) Display language that is easy to understand, making it easier for users to access; 3) Interactive multimedia content equipped with audio, images, and video; 4) Integrated with various interesting learning platforms such as Wordwall, Padlet, and Googleform; 5) Science interactive learning multimedia has been proven to increase effectiveness as seen from student pretest and posttest learning outcomes as measured by N-gain. Apart from the advantages, this research has weaknesses, including 1) These science interactive learning multimedia require a fairly large space capacity of around 200-500 MB because it is an application that will be installed on students' devices, so space preparation is needed before installing 2) Science interactive learning multimedia what has been developed is only designed to be accessible to smartphones

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with android specifications, but if at the beginning the design is needed for other specifications, for example iOS, it can be developed again.

CONCLUSION

In conclusion, the research findings regarding developing interactive multimedia learning in science subjects at SMP Negeri 2 Galesong Utara offer valuable insights. Firstly, analyzing material needs underscores the importance of addressing students' difficulties understanding science lesson material. Integrating various online-based learning media platforms, particularly interactive multimedia, tailored to different learning styles, is a promising solution to enhance engagement and comprehension. Secondly, the meticulous design process of interactive science learning multimedia, including using Smart Apps Creator (SAC), ensures the creation of engaging and effective learning materials. However, further revisions based on validation feedback are necessary to optimize its utility. Thirdly, the validation tests affirm the validity of interactive science learning multimedia, paving the way for subsequent testing and refinement. Practical assessments involving small groups demonstrate promising practicality scores, indicating the feasibility of implementation in classroom settings. Moreover, the effectiveness of interactive learning multimedia in enhancing student competence is evident from the observed improvement in pretest and posttest scores. This underscores the potential of interactive multimedia to positively transform learning experiences and outcomes.

Based on the findings of research into the creation of interactive learning multimedia aimed at enhancing junior high school students' comprehension of science, several recommendations: 1) Educators should capitalize on the developed interactive learning multimedia to enhance students' understanding of complex science topics such as magnetism, plant and animal breeding systems, and biotechnology. 2) Students are encouraged to actively engage with interactive learning multimedia as a supplementary tool to augment their learning outcomes in science subjects. 3) Future researchers are urged to leverage the insights gained from this study to refine and expand interactive learning multimedia, thereby advancing the effectiveness and accessibility of digital learning resources.

AUTHOR'S NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The author confirms that the data and content of the article are free from plagiarism.

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