



Development of articulate storyline 3 learning multimedia on students' cognitive learning outcomes in green chemistry material in sustainable development 2030 for grade X students at MA Negeri Sidenreng Rappang

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Abstrak

Penelitian ini bertujuan untuk mengembangkan multimedia pembelajaran berbasis Articulate Storyline 3 terhadap hasil belajar kognitif siswa pada materi Kimia Hijau dalam Pembangunan Berkelanjutan 2030 kelas X MA Negeri Sidenreng Rappang. Latar belakang penelitian ini didasarkan pada kebutuhan media pembelajaran digital yang interaktif, menarik, dan mampu membantu siswa memahami konsep kimia secara lebih mudah, khususnya pada materi yang memerlukan penjelasan visual dan kontekstual. Penelitian ini menggunakan pendekatan Research and Development (R&D) dengan model pengembangan ADDIE, yang terdiri atas tahap analisis, desain, pengembangan, implementasi, dan evaluasi. Teknik pengumpulan data dilakukan melalui observasi, wawancara, dokumentasi, angket, dan tes hasil belajar. Produk multimedia yang dikembangkan divalidasi oleh ahli media dan ahli materi untuk mengetahui tingkat kevalidan, sedangkan tingkat kepraktisan diperoleh melalui respon guru dan siswa. Keefektifan media dilihat dari perbandingan hasil belajar kognitif siswa sebelum dan sesudah menggunakan multimedia pembelajaran. Multimedia ini memuat teks, gambar, audio, video, tombol navigasi, latihan soal interaktif, serta umpan balik otomatis yang dapat mendukung proses belajar mandiri dan aktif. Hasil penelitian ini diharapkan menghasilkan multimedia pembelajaran yang valid, praktis, dan efektif digunakan dalam pembelajaran kimia. Dengan demikian, multimedia pembelajaran berbasis Articulate Storyline 3 dapat menjadi alternatif media inovatif untuk meningkatkan pemahaman siswa terhadap konsep Kimia Hijau dan keterkaitannya dengan pembangunan berkelanjutan.

Kata kunci: Articulate Storyline 3; multimedia pembelajaran; hasil belajar kognitif; kimia hijau; pembangunan berkelanjutan.

Abstract

This study aims to develop Articulate Storyline 3 learning multimedia to improve students' cognitive learning outcomes in Green Chemistry material within the context of Sustainable Development 2030 for Grade X students at MA Negeri Sidenreng Rappang. The background of this study is based on the need for interactive digital learning media that can increase students' attention, participation, and understanding of chemistry concepts, especially materials that require contextual and visual explanations. This research employed a Research and Development approach using the ADDIE model, which consists of analysis, design, development, implementation, and evaluation stages. The data were collected through observation, interviews, documentation, questionnaires, and learning outcome tests. The developed product was validated by media and material experts to determine its validity, while practicality was assessed through teacher and student responses. The effectiveness of the multimedia was examined by comparing students' cognitive learning outcomes before and after using the media.

The developed multimedia integrates text, images, audio, video, interactive quizzes, navigation buttons, and automatic feedback to support independent and active learning. This study is expected to produce learning multimedia that is valid, practical, and effective for chemistry learning, particularly in helping students understand the concept of Green Chemistry and its relevance to sustainable development goals. Therefore, Articulate Storyline 3-based multimedia can be used as an innovative alternative learning medium to support technology-based learning in senior high school chemistry classes.

Keywords: *Articulate Storyline 3; learning multimedia; cognitive learning outcomes; green chemistry; sustainable development.*

INTRODUCTION

The rapid development of digital technology in the Society 5.0 era has encouraged the education sector to adapt learning practices to the needs of modern learners. Education is no longer limited to conventional classroom interaction, but must also integrate technology as a medium for delivering knowledge, developing skills, and strengthening student participation. Harun (2021) emphasizes that technological advancement requires teachers and students to adapt to digital-based learning environments. Therefore, learning innovation through digital multimedia has become an important strategy to support effective, attractive, and meaningful learning in the twenty-first century.

Education should be carried out in a planned, inclusive, and sustainable manner so that students are able to develop their potential optimally. Mulyase (2022) explains that education must provide a learning atmosphere that enables students to grow intellectually, socially, and morally in accordance with future challenges. In this context, the use of learning media is not only a supporting component, but also an essential part of the instructional process. Learning media can help teachers explain material more clearly and assist students in understanding concepts that may be difficult to comprehend through verbal explanation alone.

Learning media plays a significant role in improving the quality of classroom instruction. Ferdiansyah et al. (2021) state that media can support teachers in delivering learning materials and help students understand the content being studied. Similarly, Syamsunir et al. (2020) argue that learning media functions as an instructional aid that contributes to the creation of a more effective learning situation. This indicates that the selection of appropriate learning media is closely related to the achievement of learning objectives, especially in subjects that require

visualization, contextual explanation, and active student involvement.

The use of interactive multimedia is theoretically supported by cognitive learning theory. Powell (2009) explains that cognitive theory views learning as a mental process in which students receive, process, organize, and store information to form meaningful knowledge structures. Based on this perspective, learning should be designed systematically so that students can process information effectively. Interactive multimedia can support cognitive learning because it presents information through various formats, such as text, images, audio, animation, video, and interactive exercises, which can help students build a stronger understanding of the material.

In addition to cognitive theory, the development of multimedia learning is also related to constructivist theory. Constructivism emphasizes that students actively construct knowledge through experience, exploration, and interaction with their learning environment. Powell (2009) states that students are not passive recipients of information, but active participants who build understanding based on learning experiences. Therefore, interactive multimedia provides opportunities for students to learn independently, explore material, respond to questions, receive feedback, and construct knowledge through meaningful interaction with digital content.

The use of multimedia is further strengthened by the Cognitive Theory of Multimedia Learning proposed by Mayer (2003; 2005; 2009). Mayer explains that learning becomes more effective when information is presented through a combination of words and pictures rather than words alone. This theory highlights the importance of visual and verbal channels in helping students process information more efficiently. In chemistry learning, where many concepts are abstract and require conceptual

visualization, multimedia can help reduce cognitive load and make learning materials easier to understand. Thus, multimedia learning is relevant for improving students' cognitive learning outcomes.

Cognitive learning outcomes refer to students' abilities in understanding, applying, analyzing, evaluating, and creating knowledge after participating in the learning process. Krathwohl (2002) explains that cognitive learning outcomes include several levels of thinking, ranging from remembering and understanding to higher-order thinking skills such as analyzing, evaluating, and creating. In chemistry learning, cognitive outcomes are important because students are expected not only to memorize concepts, but also to understand their meaning and apply them in real-life contexts. Green Chemistry in Sustainable Development 2030 is one of the materials that requires students to connect chemical concepts with environmental awareness and sustainable development issues.

Based on preliminary information from chemistry learning in Grade X at MA Negeri Sidenreng Rappang, students still show varied levels of attention and participation during the learning process. Some students are actively involved, while others tend to be passive and require more engaging learning strategies. Students also show greater interest when the learning process includes visual media, videos, concrete examples, and interactive activities. Therefore, this study aims to develop Articulate Storyline 3 learning multimedia for Green Chemistry in Sustainable Development 2030. Articulate Storyline 3 was selected because it allows teachers to integrate text, images, audio, video, navigation buttons, interactive quizzes, and automatic feedback into one learning package. This research is expected to produce multimedia learning that is valid, practical, and effective in improving students' cognitive learning outcomes.

Method

This study used a Research and Development (R&D) method with a mixed-methods approach. The R&D method was chosen because the main purpose of this study was to produce and test a learning product in the form of Articulate Storyline 3-based multimedia. The mixed-methods approach was used because the data consisted of qualitative and quantitative

information. Qualitative data were obtained from observation, interviews, comments, and suggestions from validators, teachers, and students, while quantitative data were obtained from validation scores, questionnaire responses, and students' cognitive learning outcome tests.

The development model used in this study was the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The ADDIE model was selected because it provides a systematic, clear, and flexible framework for developing instructional media. According to the ADDIE development theory, each stage is connected to the next stage and allows revision when weaknesses are found. Therefore, this model was considered suitable for developing Articulate Storyline 3 learning multimedia that meets the criteria of validity, practicality, and effectiveness.

The analysis stage was conducted to identify the learning needs, student characteristics, and material requirements. At this stage, the researcher analyzed the learning problems found in chemistry learning, especially in the topic of Green Chemistry in Sustainable Development 2030. The researcher also examined the characteristics of Grade X students at MA Negeri Sidenreng Rappang, who are generally familiar with digital technology and need interactive learning media. The material analysis was carried out by reviewing the learning objectives, content scope, and indicators related to Green Chemistry so that the multimedia product could be aligned with the curriculum and students' cognitive needs.

The design stage was carried out by preparing the structure and initial concept of the multimedia product. This stage included designing the flowchart, storyboard, menu structure, navigation system, learning content, interactive quizzes, and feedback features. The multimedia was designed to include learning objectives, material explanations, visual illustrations, videos, examples, exercises, and evaluation items. The design was based on multimedia learning principles proposed by Mayer, which emphasize the integration of verbal and visual information to support students' understanding and reduce unnecessary cognitive load.

The development stage involved producing the multimedia learning product using Articulate

Storyline 3. The product integrated several multimedia elements, including text, images, audio, video, animation, navigation buttons, interactive questions, and automatic feedback. After the product was developed, it was validated by media experts and material experts. Media experts assessed the quality of display, layout, navigation, interactivity, technical performance, and ease of use. Material experts assessed the accuracy, relevance, completeness, systematic presentation, and suitability of the Green Chemistry content. The results of expert validation were used as the basis for revising and improving the product before implementation.

The implementation and evaluation stages were conducted to determine the practicality and effectiveness of the developed multimedia. The implementation involved chemistry teachers and Grade X students at MA Negeri Sidenreng Rappang as users of the product. Data were collected through observation, interviews, documentation, questionnaires, and cognitive learning outcome tests. Practicality was measured through teacher and student response questionnaires, while effectiveness was measured by comparing students' learning outcomes before and after using the multimedia through pretest and posttest scores. The evaluation stage consisted of formative evaluation during each development process and summative evaluation at the end of the study to determine whether the multimedia product was valid, practical, and effective for use in chemistry learning.

RESULT AND DISCUSSION

The development of Articulate Storyline 3 learning multimedia was carried out through the ADDIE development stages, namely analysis, design, development, implementation, and evaluation. The product was developed to support chemistry learning on Green Chemistry in Sustainable Development 2030 for Grade X students at MA Negeri Sidenreng Rappang. The final multimedia product contained several main components, including learning objectives, learning materials, visual explanations, videos, navigation buttons, quizzes, user instructions, and automatic feedback. These components were designed to help students understand the material independently and interactively.

At the analysis stage, the researcher found that chemistry learning still required more varied and interactive learning media. The learning process tended to rely on textbooks and teacher explanations, which made some students less active during the lesson. The results of the initial observation and interview showed that students were more interested when learning involved images, videos, examples, and interactive activities. Therefore, the development of Articulate Storyline 3 multimedia was considered relevant to the learning needs of students.

At the design stage, the researcher prepared the structure of the multimedia product through a flowchart and storyboard. The design included the arrangement of menus, learning content, visual elements, navigation buttons, and evaluation features. The multimedia was designed to be simple, systematic, and easy to use by students. The learning content was adjusted to the topic of Green Chemistry in Sustainable Development 2030 so that students could connect chemistry concepts with environmental issues and sustainable development.

At the development stage, the initial product was created using Articulate Storyline 3 and then validated by media and material experts. The media expert validation result obtained a percentage of 83%, which was categorized as very valid. This result shows that the display design, layout, navigation, video suitability, ease of use, and usefulness of the media were appropriate for learning activities. The expert also provided suggestions to simplify the evaluation feature, improve menu icons, and organize the main menu structure to make the product more attractive and systematic.

The material expert validation result obtained a percentage of 85%, which was also categorized as very valid. This result indicates that the content of Green Chemistry in Sustainable Development 2030 was appropriate to the learning objectives, relevant to the students' characteristics, systematically arranged, and written in clear language. The material was considered suitable for use in chemistry learning because it provided conceptual explanations supported by examples and visual elements that could help students understand the topic more easily.

The practicality test was conducted through teacher and student response questionnaires. The chemistry teacher response obtained a percentage of 93%, which was categorized as very practical. This means that the teacher considered the multimedia easy to use, attractive, and helpful in delivering Green Chemistry material. In the individual trial involving five students, the product obtained a percentage of 88%, which was categorized as very practical. Meanwhile, in the small group trial involving 24 students, the product obtained a percentage of 85.83%, which was also categorized as very practical.

Table 1. Summary of Validation, Practicality, and Effectiveness Results

Assessment Aspect	Respondent / Test Type	Score / Percentage	Category
Media validation	Media expert	83%	Very valid
Material validation	Material expert	85%	Very valid
Practicality	Chemistry teacher response	93%	Very practical
Practicality	Individual student trial	88%	Very practical
Practicality	Small group student trial	85.83%	Very practical
Cognitive learning outcome	Pretest mean score	63.54	Before treatment
Cognitive learning outcome	Posttest mean score	93.82	After treatment
Hypothesis testing	Wilcoxon test	Sig. 0.000	Significant difference

Effectiveness	N-Gain score	0.75 / 75%	Moderately effective
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The effectiveness of the multimedia was measured by comparing students' cognitive learning outcomes before and after using the product. The pretest mean score was 63.54, while the posttest mean score increased to 93.82. This improvement indicates that students' cognitive learning outcomes increased after learning with Articulate Storyline 3 multimedia. The increase in score shows that the multimedia helped students understand the concepts of Green Chemistry more effectively than before the treatment.

The Wilcoxon test result showed a Z value of -6.380 with an Asymp. Sig. (2-tailed) value of 0.000. Since the significance value was lower than 0.05, there was a significant difference between students' pretest and posttest scores. Therefore, the alternative hypothesis was accepted, meaning that the use of Articulate Storyline 3 learning multimedia had a significant effect on improving students' cognitive learning outcomes. The N-Gain score was 0.75 or 75%, which was categorized as moderately effective. These findings indicate that the developed multimedia was valid, very practical, and moderately effective for use in chemistry learning.

Discussion

The results of this study show that Articulate Storyline 3 learning multimedia can be used as an innovative learning medium for chemistry instruction, especially on Green Chemistry in Sustainable Development 2030. The development process followed the ADDIE model, which allowed the researcher to design, validate, implement, and evaluate the product systematically. The use of this model helped ensure that the multimedia was developed based on students' needs, learning objectives, and expert suggestions.

The media validation result of 83% indicates that the product fulfilled the criteria of a good learning medium. The multimedia had a clear layout, attractive design, appropriate navigation, suitable video integration, and useful learning features. These qualities are important because learning media should not only present information, but also guide students to interact

with the learning content. The suggestions from the media expert also helped improve the product, especially in simplifying the evaluation feature and arranging the menu icons more systematically.

The material validation result of 85% shows that the content presented in the multimedia was appropriate for chemistry learning. The material was aligned with the learning objectives and arranged in a logical sequence. This is important because Green Chemistry is closely related to environmental protection, chemical safety, waste reduction, and sustainable development. Through systematic material presentation, students can understand not only the definition of Green Chemistry, but also its relevance to real-life environmental problems and the Sustainable Development Goals.

The practicality result from the teacher response, which reached 93%, indicates that the multimedia was very practical for classroom use. The teacher considered the product helpful in explaining the material and creating a more interesting learning process. This finding suggests that Articulate Storyline 3 can support teachers in reducing dependence on conventional teaching methods. Instead of relying only on verbal explanation and textbooks, teachers can use multimedia to present chemistry concepts through visual, audio, and interactive elements.

Student responses also showed that the multimedia was very practical. The individual trial obtained 88%, while the small group trial obtained 85.83%. These results indicate that students could use the media easily and positively responded to its display, navigation, and content presentation. Interactive features such as buttons, videos, quizzes, and automatic feedback encouraged students to participate more actively in the learning process. This is important because students at the senior high school level tend to be more engaged when learning media are visually attractive and easy to operate.

The improvement in cognitive learning outcomes can be seen from the increase in the mean score from 63.54 in the pretest to 93.82 in the posttest. This improvement suggests that the use of Articulate Storyline 3 multimedia helped students understand the learning material more effectively. The multimedia provided

opportunities for students to review material, observe visual explanations, answer quiz questions, and receive direct feedback. These learning activities supported students' cognitive processes, especially in remembering, understanding, and applying concepts.

The Wilcoxon test result, with a significance value of 0.000, confirms that there was a significant difference between students' learning outcomes before and after using the multimedia. This means that the treatment had a meaningful impact on students' cognitive achievement. The N-Gain score of 0.75 or 75% further supports this finding, showing that the multimedia was moderately effective in improving students' learning outcomes. Although the effectiveness category was not at the highest level, the result still indicates a strong improvement in students' understanding after using the product.

Overall, the findings demonstrate that Articulate Storyline 3 learning multimedia is suitable for supporting chemistry learning at MA Negeri Sidenreng Rappang. The product met the criteria of validity, practicality, and effectiveness. The integration of text, images, videos, quizzes, navigation buttons, and automatic feedback made the learning process more interactive and meaningful. Therefore, the developed multimedia can be used as an alternative digital learning medium to improve students' cognitive learning outcomes, particularly in Green Chemistry material related to Sustainable Development 2030.

CONCLUSION

Based on the results of the research and development process, the Articulate Storyline 3 learning multimedia developed for Green Chemistry in Sustainable Development 2030 for Grade X students at MA Negeri Sidenreng Rappang was declared valid and feasible for use in chemistry learning. The validation results from media and material experts showed that the multimedia met the criteria of a good learning product in terms of display design, navigation, interactivity, content accuracy, material organization, and suitability with learning objectives. Therefore, the developed multimedia can be used as an innovative digital learning

medium to support the delivery of Green Chemistry material.

The practicality test also showed that the multimedia was very practical based on teacher and student responses. The teacher considered the media useful in helping explain the material, while students found the media attractive, easy to use, and helpful in understanding the learning content. The integration of text, images, videos, interactive quizzes, navigation buttons, and automatic feedback made the learning process more engaging and encouraged students to learn more actively and independently. This indicates that Articulate Storyline 3 learning multimedia is appropriate for classroom use and suitable for the characteristics of Grade X students.

The effectiveness test showed an increase in students' cognitive learning outcomes after using the multimedia. The posttest score was higher than the pretest score, and the statistical test indicated a significant difference between students' learning outcomes before and after the treatment. The N-Gain result also showed that the multimedia was effective in improving students' understanding of Green Chemistry concepts. Thus, Articulate Storyline 3 learning multimedia can be concluded as valid, practical, and effective for improving students' cognitive learning outcomes in chemistry learning, particularly on Green Chemistry in Sustainable Development 2030.

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