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Design of a Chemistry Learning on Android Media (CHEMONDRO) Assisted by Articulate Storyline to Improve Students' Motivation and Learning Outcomes in Green Chemistry

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ABSTRAK

Penelitian ini bertujuan untuk mendesain media pembelajaran kimia berbasis Android yang kreatif dan inovatif, yaitu Chemistry Learning on Android (CHEMONDRO) yang didukung oleh Articulate Storyline, untuk meningkatkan motivasi dan hasil belajar peserta didik pada materi kimia hijau. Penelitian ini termasuk dalam jenis Research and Development (R&D) dengan model pengembangan Four-D (4D) yang disederhanakan menjadi Three-D (3D): Define, Design, dan Develop. Penelitian ini mempertimbangkan aspek kelayakan, keefektifan, dan respons peserta didik terhadap media yang dikembangkan. Hasil validasi menunjukkan bahwa media sangat layak digunakan, dengan nilai validasi ahli materi sebesar 97,66%, ahli media sebesar 97,62%, dan validasi guru sebesar 92,86%. Peningkatan hasil belajar dianalisis menggunakan uji N-Gain, yang menunjukkan rata-rata sebesar 0,70 dan 0,79 dengan kategori peningkatan sedang dan tinggi. Selain itu, hasil pada ranah afektif dan psikomotorik peserta didik juga menunjukkan capaian yang sangat baik. Uji keterbacaan dalam skala kecil memperoleh skor sebesar 95,10%, dan uji keterlaksanaan sebesar 93,89%. Respons peserta didik pada skala besar menunjukkan hasil sangat positif dengan persentase sebesar 94,46%. Berdasarkan temuan tersebut, CHEMONDRO dinyatakan sangat layak, sangat efektif, dan mendapatkan respons yang baik sebagai media pembelajaran kimia, khususnya untuk meningkatkan motivasi dan hasil belajar peserta didik pada materi kimia hijau.

ABSTRACT

This study aims to design a creative and innovative Android-based chemistry learning media, Chemistry Learning on Android (CHEMONDRO), supported by Articulate Storyline to enhance students' motivation and learning outcomes, particularly in the topic of green chemistry. The research employs the Research and Development (R&D) method using the Four-D (4D) development model, which was simplified into Three-D (3D): Define, Design, and Develop. The feasibility, effectiveness, and user responses toward the media were the main considerations in this study. CHEMONDRO was validated by experts in both content and media, with results showing a material expert validation score of 97.66%, media expert validation of 97.62%, and teacher validation of 92.86%, indicating a very high level of feasibility. The learning outcome improvement was analyzed using the N-Gain test, which resulted in an average N-Gain of 0.70 and 0.79, categorized as moderate and high improvement. In addition, affective and psychomotor domains of the students showed very good results. Readability testing in a small group reached 95.10%, while the implementation feasibility scored 93.89%. Large-scale student responses showed a very positive result of 94.46%. Based on these findings, CHEMONDRO is considered highly feasible, effective, and well-received as a media tool to support chemistry learning and improve student engagement and outcomes, particularly in green chemistry material.

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INTRODUCTION

Science and technology (IPTEK) has developed very rapidly in various fields, including in the world of education. Mulyani *et al.* (2021) stated that significant advances in science and technology have produced various equipment and applications that are easy to understand and utilize as learning media. According to Nurdyansyah (2019), learning media is one of the important elements in teaching and learning activities that have a significant role. Along with these advances, the Indonesian nation has succeeded in creating a quality next generation. Therefore, the use of technology in education and training must be done creatively and wisely.

Education can be defined as a process that is carried out consciously to direct changes in individual behavior in a group. Education has three main functions, namely maintaining and uniting traditions, forming new social patterns, and encouraging creativity (Isha *et al.*, 2023). In the modern era, these functions are further strengthened by the utilization of innovative learning media that allows the educational process to be more dynamic and effective.

One of the fast-growing innovations is learning through mobile devices, such as smartphones and tablets. These devices are recognized as an effective method to enrich learners' learning experience, both inside and outside the classroom, as they have become part of their daily lives. The use of mobile apps in education not only increases learners' motivation to learn, but also strengthens their curiosity about the material and encourages team spirit. This contributes to the achievement of more holistic and interactive learning objectives (Wang *et al.*, 2022).

Mobile learning is the development of digital learning that gives learners access to information, resources, and learning activities anytime and anywhere through mobile devices and information and communication technology. Liu *et al.* (2021) state that mobile learning generally has a positive impact on education. This approach, if well designed, can improve learners' achievement, motivation and interest in learning. Based on Ninghardjanti *et al.* (2020), mobile learning can utilize the infrastructure provided by mobile operators. Along with the development of mobile apps and online learning resources, it has become an important element in modern education.

Green chemistry is an important matter that needs to be considered in addressing current environmental degradation. Voukkali et al. (2024) explained that green chemistry is an effort to minimize or eliminate the use of hazardous materials through product and process redesign based on sustainability principles. In addition, mobile apps can be an effective tool to introduce this concept to learners. In this way, learners not only understand the theoretical aspects of green chemistry, but are also able to see its practical application in everyday life.

The use of technology in education has become an increasingly urgent need in the digital era. However, the practice at SMA Negeri 12 Semarang shows that the utilization of technology by chemistry teachers is still minimal, especially in developing interactive and interesting learning media. Chemistry teachers at SMA Negeri 12 Semarang tend to rely on conventional learning media, such as Learner Worksheets (LKPD), which are passive and lack direct interaction with students. Although this media still has its benefits, the learning approach is often one-way and unable to maximally improve students' motivation and learning outcomes due to the lack of challenges that encourage their active participation.

This situation becomes more evident in learning green chemistry, which is an important concept related to the application of environmentally friendly principles in chemistry. Unfortunately, the delivery of green chemistry by teachers at SMA Negeri 12 Semarang does not explore the application aspect and its application in everyday life. In fact, this material is closely related to the Sustatnable Development Goals (SDGs), which can provide a broader dimension in understanding the benefits and positive impacts of green chemistry practices. This limitation results in students not being able to see the relevance between the chemistry studied and global issues such as climate change, environmental conservation, and sustainability of natural resources. As a result, learning green chemistry is less interesting, and students are not motivated to explore further how chemistry can play a strategic role in achieving SDGs. The ARCS model is the result of a review of various studies on motivation and successful learning practices, which have been validated through a number of studies (Sutarman et al., 2022).

In addition, another challenge faced is the low motivation of students in dealing with chemical materials that are often considered abstract and difficult to understand. The learning media used by chemistry teachers at SMA Negeri 12 Semarang has not been able to present the material dynamically and interestingly. As a result, students have difficulty connecting chemistry concepts with everyday life, making learning less relevant and boring. In this case, technology acts as a bridge to create learning media that is more interactive, contextual, and relevant to students.

In this case, the development of innovative technology-based learning media is a potential solution to overcome the challenges of chemistry learning. The design of Chemistry Learning on Android (CHEMONDRO) application assisted by Articulate Storyline is expected to be able to answer this need, especially in green chemistry. By utilizing technological devices that are familiar to students, such as Android-based smartphones, this learning media offers a more interactive and contextual learning experience. The technology-based learning makes students become technology literate. This study aims to design Chemistry Learning on Android (CHEMONDRO) media assisted by Articulate Storyline on

green chemistry material with the aim of increasing student motivation and learning outcomes by considering the feasibility, effectiveness and response to the media.

METHODS

This research is a type of Research and Development (R&D) research, with the main objective of producing a specific product. This research is a type of Research and Development (R&D) research, with the main objective of producing a specific product. This research uses the Four D (4D) design, but is simplified to 3D because the research is only conducted up to the development stage. The design stage includes (1) format selection, (2) media selection, and (3) initial design preparation. The define stage includes (1) needs analysis, (2) material analysis, and (3) independent curriculum syllabus analysis. The develop stage includes (1) expert team validation, (2) small-scale testing, (3) product revision, (4) large-scale testing, and (5) final product.

This research was conducted at SMA Negeri 12 Semarang located at Jalan Raya Gunungpati, Plalangan, Gunungpati Sub-district, Semarang City, Central Java. This research took place during the even semester of the Xth grade of SMA Negeri 12 Semarang in the 2024/2025 academic year, from January 21 to March 14, 2025. The study included 15 students of class XII F-7 at SMA Negeri 12 Semarang who had already learned green chemistry as small-scale test subjects. In addition, this study consisted of 35 students of class XE 1 SMA Negeri 12 Semarang as large-scale test subjects. The independent variable of this study is the Chemistry Learning on Android (CHEMONDRO) media design assisted by Articulate Storyline while the dependent variable of this study is the motivation and learning outcomes of students.

Primary data used in this study include (1) results of interviews with teachers related to media needs, (2) validation data on the feasibility of learning media obtained from material experts, media experts, and teachers, (3) assessment of readability tests and implementation tests by students of the product, (4) students' responses to the use of learning media in learning green chemistry, (5) pretest and posttest results of students; and (6) affective and psychomotor results of students. Secondary data were collected from school archives, literature review, previous research, books, journals, scientific publications, the internet, and other sources.

Data collection was carried out through test instruments, namely pretest conducted before treatment and posttest conducted after treatment was completed. In addition, non-test instruments included (1) interviews, which were conducted in a structured manner with a total of 20 questions, (2) questionnaires, which included expert validation questionnaires, teacher validation questionnaires,

readability test questionnaires, implementation test questionnaires, learner response questionnaires, and affective questionnaires; (3) psychomotor observations to collect data related to the psychomotor assessment of students, and (4) documentation, which was in the form of writings, pictures, and videos related to the research process at SMA Negeri 12 Semarang.

Data validity is done by analyzing the validity, reliability, difficulty level, and differentiation of test instruments. Data analysis was carried out by analyzing the research validation questionnaire, readability test questionnaire, implementation test questionnaire, learner response questionnaire, effectiveness test, learner cognitive test, learner affective questionnaire, and learner psychomotor observation. The content validation was carried out first on each statement item of the readability test questionnaire, the implementation test questionnaire, and the learner response questionnaire, as well as the learner cognitive test items.

Data sourced from questionnaires there are validation of media experts and material experts, teacher validation, readability tests, implementation tests, and learner responses to the products developed then analyzed descriptively into interval data using a Likert scale based on the average score, while data from motivation assessments, cognitive tests, affective assessments, and psychomotor assessments are used to see the ability of the products developed to motivate and learners' learning outcomes. Quantitative data in the study was obtained from a questionnaire in the form of average scores from teacher validation, readability tests, implementation tests, and learner responses. While qualitative data is obtained from comments and suggestions for improvement from experts, teachers, and students as a basis for improving the product.

RESULT AND DISCUSSION

Result

This study aims to design Chemistry Learning on Android (CHEMONDRO) media assisted by Articulate Storyline on green chemistry material with the aim of increasing the motivation and learning outcomes of class X students. This research activity took place from January 21 to March 14, 2025, at SMA Negeri 12 Semarang. This research belongs to the type of Research and Development (R&D) using the Four D (4D) development model, which should include four stages, namely defining, designing, developing, and disseminating. However, the model was simplified to 3D because the research only reached the development stage. The dissemination stage was not conducted in several schools due to time constraints, so the implementation was only conducted in one school, SMA Negeri 12 Semarang.

Needs Analysis

Needs were analyzed through literature studies and field research. The literature study was conducted by tracing references related to the independent curriculum and technology-based chemistry learning in relation to increasing motivation and learning outcomes. Meanwhile, field research was conducted by directly interviewing chemistry teachers and students at SMA Negeri 12 Semarang. The questions asked include the implementation of the independent curriculum, media utilization in the learning process, motivation and learning outcomes of students, students' responses to learning implementation, and other additional information.

Based on the results of interviews at SMA Negeri 12 Semarang, it is known that all grade levels have implemented the Merdeka Curriculum, including in chemistry learning, which uses more Problem-Based Learning (PBL) models and a variety of methods such as practicum and demonstration to facilitate students' understanding. Students' responses to this learning vary, depending on their individual characters, but in general, class conditions are quite conducive Chemistry materials are delivered in accordance with the Learning Outcomes (CP) and the Flow of Learning Objectives (ATP), with learning tools that are already available so that teachers can focus on implementing learning without significant obstacles. Students' understanding is measured through evaluation and individual assignments, with remedial for those who have not reached the target. The main obstacle during learning is the different characters of students who demand a more varied approach. In green chemistry, students are generally active although there are still difficulties in linking concepts with everyday applications. The model used is information discussion with media such as LKPD and PPT, while students' motivation and understanding of the material varies.

Therefore, the interview results show that teachers agree to the development of Android-based learning media that can increase students' motivation and learning outcomes, especially in green chemistry. In the opinion of teachers, interesting learning media are those that contain problems in everyday life related to the concept of green chemistry. These criteria are used as one of the guidelines in designing effective Android-based learning media.

At this stage, a needs analysis was also conducted on the availability of facilities and infrastructure at SMA Negeri 12 Semarang. The evaluation results show that SMA Negeri 12 Semarang has adequate facilities that are suitable for the research needs. The school has provided LCD projectors to support technology-based learning. In addition, the school policy that allows students to bring and use gadgets in the learning process also supports the implementation of this research, especially in developing learning media.

Although not all students have laptops, all of them are known to have gadgets such as cellphones that are always brought to school Based on this information, it can be concluded that research on the development of Android-based learning media can be implemented. Support from the teachers for this research is also an indicator that the use of Android-based learning media is not an obstacle in the learning process at school.

Material Analysis

Learning materials are often delivered through media such as LKPD and PPT, but the delivery is still not optimal and interactive. Therefore, it is necessary to develop more interesting learning media to increase students' motivation and learning outcomes. One example is Chemistry Learning on Android, a learning media that not only contains material, LKPD, and practice questions, but also features interactive games and background music. The presence of this feature makes learning more fun and not boring, so it is expected to increase students' motivation and learning outcomes.

Analysis of the Kurikulum Merdeka Syllabus

The purpose of this curriculum analysis is to ensure that after the use of Chemistry Learning on Android media, students are able to master the knowledge, attitudes, and skills in accordance with the competencies contained in the independent curriculum. In this case, an analysis of learning objectives on green chemistry material is also carried out which is detailed in Table 1.

Table 1. Learning Objectives for Green Chemistry Materials

Learning Objectives	Explanation
10.8	Learners can understand green chemistry reaction equations.
10.9	Learners can analyze the principles of green chemistry in supporting environmental conservation efforts.
10.10	Learners can create sustainable life activities in accordance with the UN 2030 sustainable development agenda.

Referring to Table 1, the indicators designed aim to measure the achievement of students' competencies in green chemistry through learning using the Chemistry Learning on Android media. At this stage, the material is part of the initial steps used as the basis for developing Chemistry Learning on Android media.

Media Selection

Determining the media is the first step before the process of making learning media (Wardana *et al.*, 2022). In the process of developing Chemistry Learning on Android media, choosing the right platform is an important step to ensure the learning media can achieve the objectives of validity and effectiveness. Articulate Storyline and Canva were chosen as the main platforms for media design

because both are able to produce visual displays that are attractive, interactive, and easily accessible to learners. Articulate Storyline allows the creation of click and game-based interactive media, while Canva supports simple yet communicative visual design.

In addition, YouTube is used as a source of reference for supporting materials that can enrich learning content in Chemistry Learning on Android media. Relevant educational videos help provide real illustrations of the application of Green Chemistry principles in everyday life. To measure the level of understanding of learners before and after using the media, Google Forms was used in making pretests and postests. This platform was chosen due to its flexibility in composing questions, ease of access through various devices, and its ability to process test result data quickly and accurately, which is useful in analyzing the effectiveness of the developed learning media.

In order to make the media that has been designed more widely accessible in the form of Android applications, APK Builder Pro was used. This application allows the conversion of web based learning media into APK format so that it can be downloaded and run on Android devices without requiring a continuous internet connection. The use of this platform supports effective media dissemination plans, so that learners can learn more flexibly.

Format Selection

According to Putri *et al.* (2023), the choice of format must be adjusted to the learning material and the chosen form of presentation must also be in line with the learning media to be used. Determining the format in accordance with the validity and effectiveness criteria is an important stage in the development of Chemistry Learning on Android assisted by Articulate Storyline. The validity of the media is reviewed from the suitability of the content of the material with the learning objectives of green chemistry material and its integration with the principles of technology-based learning The format chosen must be able to display material accurately, use communicative language, and present visualizations that support concept understanding. Therefore, each element in the media must go through a validation process by media and material experts to ensure the correctness of the content and accuracy of presentation.

In addition to validity, the effectiveness of Chemistry Learning on Android media is also the main focus in the process of determining the format. Effectiveness is measured by the ability of the media to increase learners' learning motivation and learning outcomes. The developed media format allows the integration of interactive elements designed to increase learner engagement. The selection of this format is adjusted to the characteristics of learners who tend to be familiar with the use of Android devices, so that learning is expected to be more interesting, fun, and meaningful.

Preparation of Initial Design

The selected media and format are then developed into a Chemistry Learning on Android media design with content presentation that is designed to be more interesting, interactive, and detailed to increase the attractiveness and understanding of the material presented. This development process involves adjusting the material with the characteristics of students and utilizing digital features that support contextual and fun chemistry learning. The initial design of this learning device is an important stage that must be arranged systematically and purposefully before testing the device. The preparation of the initial design serves as a basic framework in evaluating feasibility, effectiveness, and response.

The initial design of Android-based learning media contains components that must exist in Android-based learning media, such as the initial appearance (intro), login section, and main menu. The main menu includes an introduction consisting of media description, media characteristics, instructions for use, media features, learning outcomes and objectives, and concept maps. In addition, there are learning activities 1 to 3 which are equipped with materials, learning evaluations, learning videos, games, and additional information.

Chemistry Learning on Android Media Validation

This stage involves the validation process of Chemistry Learning on Android media conducted by experts, namely two chemistry lecturers from Semarang State University as material experts, one Articulate Storyline software expert and two chemistry lecturers from Semarang State University as media experts, as well as a teacher from SMA Negeri 12 Semarang. The material validation focused on the content and linguistic aspects, while the media validation included the appearance and usefulness. The validation by teachers covered aspects of learning media, materials, and usefulness. The validation data obtained from the material experts are shown in Table 2.

Table 2. Results of Material Validation by Validators

No	Validator	Total Assessment	Percentage	Criteria
1.	Material Expert 1	62/64	96,88%	Very Valid
2.	Material Expert 2	63/64	Very Valid	Very Valid
Average Assessment		62,5	97,66%	Very Valid

The material experts also provided a number of comments and suggestions for improvement to the Chemistry Learning on Android media as part of the validation process. Each comment and suggestion provided by the material expert is a very valuable input in an effort to improve the quality of the content presented. The details of these comments and suggestions are presented in Table 3, which contains improvement notes based on the assessment items that have been reviewed.

Table 3. Learning Objectives of Green Chemistry Materials

No	Comments and Suggestions
1.	The question in the game challenge is only 1, if added it will be better.
2.	The use of language and the arrangement of sentences are made more effective so that the material presented is clearer, continuous, and not ambiguous.
3.	Learning videos from YouTube should be able to be opened in the application.

The detailed data of the validation results given by media experts can be seen in Table 4, which presents the results of the assessment of each aspect along with its eligibility category.

Table 4. Results of Media Validation by Validators

No	Validator	Total Assessment	Percentage	Criteria
1.	Media Expert 1	81/84	96,43%	Very Valid
2.	Media Expert 2	82/84	97,62%	Very Valid
3.	Media Expert 3	83/84	98,81%	Very Valid
Average Assessment		62,5	97,66%	Very Valid

Details of the comments and suggestions given by the media validators are presented systematically in Table 5.

Table 5. Media Validation Comments and Suggestions for Improvement

No	Comments and Suggestions
1.	The image on learning slide 1 (problem orientation) is not clearly visible, it should be replaced with another object that can be opened so that students mean the problem. Then it would be great if there was a video.
2.	The size of the writing on the slides "Instructions for Use" and "Media Features" should be enlarged so that the writing can be read more clearly.
3.	The background image is removed so that the writing color looks striking (on the learning material slide 3).
4.	It is better to pay attention to the buttons according to their habits and functions.
5.	Challenge game is developed again by utilizing other types of games.
6.	Note the permission/license to use assets/videos in the media.

The results of media-related validation obtained from teachers are 52 points with an average assessment of 92.86% so that they are included in the criteria very valid.

Response to Chemistry Learning on Android Media Usage

After the validation stage, field trials were carried out including two stages, namely small-scale and large-scale trials to determine the response of students to the feasibility of Chemistry Learning on Android media. The small-scale trial was conducted in class XI F-7 SMA Negeri 12 Semarang with a total of 15 students. This activity is aimed at students who have obtained green chemistry material, using a

readability test questionnaire and an implementation test questionnaire for Chemistry Learning on Android media. The results of filling out the readability test questionnaire by students on the learning media are presented in Table 6.

Table 6. Results of the Learner Readability Test Questionnaire Assessment

Score in Percent	Criteria	Frequency	Percentage
85 – 100	Very Valid	14	93,33%
75 – 84	Valid	1	6,67%
55 – 74	Less Valid	0	0%
<55	Invalid	0	0%

At the small-scale trial stage, an applicability test was conducted to determine the extent to which the media could be applied. A total of 15 students used the media and filled out the applicability questionnaire. The results of the applicability test are presented in Table 7.

Table 7. Results of the Learner Implementation Test Questionnaire Assessment

Score in Percent (%)	Criteria	Frequency	Percentage
85 – 100	Very Valid	14	93,33%
75 – 84	Valid	1	6,67%
55 – 74	Less Valid	0	0%
<55	Invalid	0	0%

The large-scale trial was conducted on 35 students who had not received green chemistry material. The results of the assessment of students' responses are presented in Table 8.

Table 8. Assessment Results of the Learner Response Questionnaire

Score in Percent (%)	Criteria	Frequency	Percentage
85 – 100	Very Valid	32	94,28%
75 – 84	Valid	3	5,72%
55 – 74	Less Valid	0	0%
<55	Invalid	0	0%

Furthermore, a comparison was made to determine the consistency of the feasibility of Chemistry Learning on Android media when applied to a larger number of students. The comparison of the assessment of each aspect between the small-scale and large-scale trials is presented in detail in Table 9.

Table 9. Assessment Results of the Learner Response Questionnaire

No	Assessment Aspect	Small Scale Average (%)	Large Scale Average (%)
1.	Media Presentation	92,92%	93,75%
2.	Material	95, 83%	96,07%
3.	Media Usability	92,92%	93,57%
	Average	93,89%	94,46%

Effectiveness of Chemistry Learning on Android Media in Improving Students' Motivation and Learning Outcomes

One of the main objectives of this study is to determine the extent to which the use of Chemistry Learning on Android media can increase students' learning motivation in understanding green chemistry materials. To measure the level of increase in motivation, an instrument was used in the form of a learning motivation questionnaire prepared using a Likert scale, consisting of four answer choices. The questionnaire was given to 35 students involved in the large-scale trial, both before the learning process began (prenest) and after the learning ended (postrest). Furthermore, the data obtained were analyzed using the N-Gain test to determine the magnitude of the increase in learning motivation quantitatively (Awwaliyah *et al*., 2021).

The learning motivation questionnaire presents data to see a comparison of students' motivation levels in the two conditions. The results of the assessment are then displayed in detail in Table 10.

Table 10. N-Gain Test Results of the Assessment Aspects of the Learner Learning Motivation Questionnaire

No	Assessment Aspect	Motivation Assessment Before Learning	Motivation Assessment After Learning	N-Gain
1.	*Attention*	518/700	630/700	0,62
2.	*Relevance*	517/700	643/700	0,69
3.	*Confidence*	459/700	617/700	0,66
4.	*Satisfaction*	483/700	622/700	0,64
	Average	494,25	628	0,65

In addition to aiming to determine the increase in learning motivation, this study was also directed to measure cognitive improvement through pretest and posttest through the N-Gain test. The N-Gain test results are with an average of 0.79, with high criteria.

The assessment illustrates that the use of Chemistry Learning on Android media not only helps students understand the material cognitively, but also has a positive impact on the development of their affective domain. This can be seen based on the results of the affective questionnaire assessment of students can be seen in Table 11.

Table 11. Results of the Assessment of the Learners' Affective Questionnaire

Score in Percent (%)	Criteria	Frequency	Percentage
85 – 100	Very Good	18	51,43%
70 – 84	Good	17	48,57%
55 – 69	Good Enough	0	0%
<54	Need Guidance	0	0%

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Assessment of the psychomotor domain has the main objective of identifying learners' skills during the learning process, especially in activities that reflect their direct involvement in learning activities. In this study, the psychomotor assessment focused on five main indicators, namely the ability of students to make presentations, the ability to work together in groups, an open attitude in accepting friends' opinions, the ability to answer questions, and the level of mastery of the material studied. The results of the assessment obtained through the observation of students' psychomotor skills are then arranged and presented systematically in Table 12 for further analysis. The observation assessment is displayed in percentage form.

Table 12. Results of Assessment of Psychomotor Observation of Students

Score in Percent (%)	Criteria	Frequency	Percentage
85 – 100	Very Good	29	82,86%
70 – 84	Good	6	17,14%
55 – 69	Good Enough	0	0%
<54	Need Guidance	0	0%

Discussion

Feasibility Chemistry Learning on Android Media

Based on the assessment results, the average assessment of the three material experts reached 97.66%, which is included in the very valid category. The results of this study are in line with research conducted by Daniar *et al.* (2022), which shows that the learning media developed has met the criteria for material feasibility with a validity level of 88%. In addition, based on the assessment results, the average assessment of the three media experts is 97.62% so that it is in very valid criteria. This research is in line with the results of research by Ashari *et al.* (2022), which shows that the Movie Learning media developed has met the media feasibility with very good criteria. Then, based on the media-related validation obtained from the teacher, the average assessment is 92.86% so that it is included in the very valid criteria. This research is in line with the results of research by Hapsari *et al.* (2021), which shows that the animated video media developed has met the eligibility criteria of the teacher with a validity level of 85.57%.

Response to Chemistry Learning on Android Media Usage

Based on the results of filling out the students' readability test, 93.33% of students who gave an assessment with very valid criteria were obtained, while 6.67% of students gave an assessment with valid criteria. This research is in line with the results of a study conducted by Maulidiyah *et al.* (2022), which states that the interactive learning media developed has met the eligibility criteria because the readability validity level is 85.57%. Not only that, based on the results of filling out the students' implementation

test, it was obtained that 93.33% of students gave an assessment with very valid criteria, while 6.67% of students gave an assessment with valid criteria. This research is in line with the results of a study conducted by Sasmita *et al*. (2024), which shows that the learning media developed has met the eligibility criteria with a validity level of 88%.

After that, based on the results of filling out the response questionnaire by 35 students, the data showed that 94.28% of them gave an assessment with very valid criteria, while the other 5.72% rated it with valid criteria. There was an increase of 0.57%, which is likely due to the analysis and improvement of each statement item after the implementation of the small-scale trial, resulting in a higher assessment on the large-scale trial. This research is in line with research conducted by Firmansah *et al*. (2021), which also noted an increase in learner responses after going from small scale to large scale and then no further revisions were made because the results obtained were very suitable.

The Effectiveness of Chemistry Learning on Android Media in Improving Students' Motivation and Learning Outcomes

Based on the assessment results, the attention aspect obtained an N-Gain of 0.62, which is included in the medium criteria. The relevance aspect received an N-Gain of 0.69, which is an increase in medium criteria. Meanwhile, the confidence aspect obtained an N-Gain of 0.66, which is included in the medium criteria. Furthermore, the satisfaction aspect with an N-Gain of 0.64 so that it is included in the medium criteria. The results of this study are in line with previous research by Febrianti *et al*. (2021), which states that interactive multimedia assisted by Articulate Storyline as a learning media that can increase student learning motivation with an average assessment of 95.2%. This research is also supported by the results of research Putri *et al*. (2022) who developed chemistry learning media that used the N-Gain test to determine the magnitude of the increase in student learning motivation.

The cognitive N-Gain value with an average of 0.79 with high criteria provides a comprehensive picture of the improvement of student learning outcomes in the cognitive domain, as well as an indicator of the success of Chemistry Learning on Android media as an innovative and effective learning tool. This research is in line with the results of research by Purnamawanti er al (2023), which concluded that the results of the effectiveness test using the N-Gain formula were 0.9 which was included in the high criteria, or if it was percented to 90%.

The assessment illustrates that the use of Chemistry Learning on Android media not only helps students understand the material cognitively, but also has a positive impact on the development of their affective domain. This is made clear that there are 18 students (51.43%) who get an assessment with very good criteria and 17 students (48.57%) get an assessment with good criteria. These results are in line with

research conducted by Jama'ah *et al*. (2024) which shows that there are 8 students who are included in the very good criteria with a percentage of 57%, 4 students who are included in the good criteria with a percentage of 28%, and 2 students are included in the good enough criteria with a percentage of 15%. The increase in affective values shown by students reflects a higher sense of pleasure, interest, and commitment in participating in learning activities. Thus, it can be concluded that this media contributes significantly in shaping positive attitudes and supporting the achievement of learning objectives.

Based on the results of the assessment of the psychomotor domain of students, it is known that 29 students (82.86%) are in the very good category. Meanwhile, 6 learners (17.14%) were in the good category. Psychomotor assessment depends on observations made by two observers. This study is in line with the results of research by Dewi *et al*. (2023), which showed that the average score of students was 74.00 with a percentage of learning completeness in the psychomotor domain of 42.5%.

CONCLUSION

Based on the results of research on the design of Chemistry Learning on Android media assisted by Articulate Storyline to increase student motivation and learning outcomes in green chemistry material, it can be concluded that Chemistry Learning on Android (CHEMONDRO) media assisted by Articulate Storyline on green chemistry material is very feasible to use to increase student motivation and learning outcomes based on the results of material expert validation of 97.66%, the results of media expert validation of 97.62%, and validation by teachers of 92.86%. Furthermore, Chemistry Learning on Android (CHEMONDRO) media assisted by Articulate Storyline on green chemistry material is very effective in using it to increase students' motivation and learning outcomes based on the results of the N-Gain test which are in the medium and high criteria with an average N-Gain value of 0.70 and 0.79, supported by the affective and psychomotor domains of very good students, Then, students' responses are very good in supporting the feasibility of using Chemistry Learning on Android (CHEMONDRO) media assisted by Articulate Storyline in increasing students' motivation and learning outcomes in green chemistry based on the results of a small-scale readability test of 95.10%, the results of a small-scale implementation test of 93.89%, and a large-scale response of 94.46%.

As for researchers, research needs to use experimental and control classes in order to ensure that there is an increase in motivation and learning outcomes really from the use of learning media. The learning media can only be installed on Android-based devices and does not yet support the iOS operating system and the media file size is relatively large so that future researchers need to pay attention to the

storage capacity of the device. Not only that, as a reference for further research, the media still needs further design so that it can be used more practically and in line with current technological developments.

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