Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES

P-ISSN 2581-1657
E-ISSN 2581-2203

Practicality and Effectiveness of Augmented Reality Integrated Learning Media on the Material of Atomic Theory Development on the Learning Outcomes of Phase E SMA/MA Students

Ulfa Septiani*, Guspatni, Yerimadesi, Eka Yusmaita
Departemen of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Padang 25131, Indonesia

ARTICLE INFO

Article history:

Received: 09 Aug 2024
Revised: 03 Jan 2025
Accepted: 04 Jan 2025
Published online: 24 Jan 2025

Keywords:

Practicality;
Effectiveness;
Augmented Reality;
Learning Outcomes;
Development of Atomic Theory

* *Corresponding author:*

E-mail: septianiulfa929@gmail.com

Article Doi:

Doi: https://doi.org/10.31258/jes.9.1.p.90-102

A B S T R A C T

Augmented Reality integrated media has the ability to display concept visualizations. Augmented Reality integrated media on the material of atomic theory development has been developed by previous researchers. This study aims to determine the level of practicality of Augmented Reality integrated media on the material of atomic theory development in learning and its effectiveness on learning outcomes. The type of research used is pre-experimental with a research design, namely One-group Pretest-Posttest Design. The sample class is X E.1 SMA Negeri 1 Sabak Auh. The instrument used in the practicality test is a questionnaire while the effectiveness test uses a cognitive knowledge test instrument in the form of multiple choices. The results of the study obtained a practicality value of 0.92 while the effectiveness test showed an average N-gain value of 0.72 in the high category. Hypothesis testing using the Wilcoxon match pairs test assisted by SPSS at a significance level of 0.05 obtained an Asymp. Sig. (2-tailed) value of <0.000 with the hypothesis decision accepted. So it can be stated that the integrated Augmented Reality learning media on the material on the development of atomic theory has proven effective in significantly improving student learning outcomes.

1. Introduction

Chemistry is a science that studies the composition, structure of chemical substances and their relationship to the properties of the substance, the change of one material into another and the energy involved in the change of matter (Syukri, 1999). Chemistry is still considered difficult by some students because many materials contain abstract and memorization concepts (Rahmi et al., 2021) and cannot be observed directly (Wirya et al., 2009).

The development of atomic theory is one of the chemical materials that has several abstract concepts. The development of atomic theory is a fundamental part

of chemistry. The development of atomic theory has several discussions such as the particles that make up atoms, atomic number and mass number and the development of atomic models. Most students have difficulty distinguishing between various types of atomic theories because all of them are almost the same and how to determine the particles that make up atoms in an element (Afrianis & Ningsih, 2022). Several concepts in the material on the development of atomic theory are difficult for students to understand, one of the contributing factors is the lack of visualization of abstract concepts such as the structure of the atom itself (Wirya et al., 2009).

Based on the results of initial observations conducted on 32 Phase E students and 1 chemistry teacher of SMAN 1 Sabak Auh, it showed that students were not fully active in the learning process so that the learning outcomes obtained by students were also not optimal. This is evidenced by the learning outcomes of students in Phase E, Odd Semester of the 2022/2023 academic year for the material on the development of atomic theory, the average summative value was 68.60 below the Learning Objectives Achievement Criteria (KKTP). It is known that as many as 81.3% of students' understanding of the material on the development of atomic theory is still categorized as moderate. Teachers have used textbooks, LKPD and Power Point in learning. However, the media used have not been able to visualize the abstract concepts contained in the material on the development of atomic theory. Students tend to memorize the concepts in textbooks/textbooks and notebooks, even some students choose not to study them again because students find it difficult to understand the explanation of the material delivered by the teacher. This is in line with research by Afrianis & Ningsih (2022) that students find it difficult to understand the explanations given by teachers and rarely repeat learning at home, students only rely on textbooks available at school.

The results of a study by Fanmita (2023) on 5 teachers and 106 students in three different high schools in Padang City, showed that teachers had used media in the learning process of atomic theory development material. However, the learning media used could not display abstract concepts. The teacher provided explanatory text and images that were not clear enough so that they did not attract students' attention and caused students to be less active during the learning process. As many as 92 students still had difficulty understanding the concept of atomic theory development. So that less than 75% of students still got scores below the KKM.

One way to overcome this is to use learning media that supports visualizing abstract concepts. Learning media is basically an intermediary used by educators in delivering material so that the material reaches and is understood by students (Audie, 2019). The use of learning media can increase learning motivation (Febrita & Ulfah, 2019) and learning interest (Tafonao, 2018) so that it can affect the activeness and cognitive learning outcomes of students. In addition, the use of learning media can help teachers explain material to students so that the learning process becomes more interactive and makes learning time more efficient. Learning media that can visualize concepts are needed to help students understand the material (Novita & Harahap, 2020).

In recent years, Augmented Reality has been considered as one of the technologies that can significantly improve the learning process (Fauziyyah, 2019). Integrated Augmented Reality learning media can help visualize abstract concepts so as to increase students' interest in learning (Mustaqim, 2016), make the material presented easier to understand by users (Mustaqim & Kurniawan, 2017), and can improve student learning outcomes (Acesta & Nurmaylany, 2018). One of the Augmented Reality development technologies that is easily accessible to many users is via mobile phones (Mahendra, 2016). Because of its advantages, integrated Augmented Reality media can be utilized to support the teaching and learning process in order to improve student learning outcomes.

Several studies conducted on the application of Augmented Reality learning media have obtained good results. Research conducted by Apriani et al. (2021) showed that modules based on multiple representations with the help of Augmented Reality technology have been proven to help students understand the concept of chemical bonds. In addition, the modules used are also able to support chemistry teachers in explaining the topic of chemical bonds and make it easier for students to visualize the abstract concept of chemical bonding material. The next study conducted by Ibisono et al. (2020) also obtained results that learning media in the form of pocket books based on Augmented Reality on the material of planetary motion has been proven to be effective in improving student learning achievement. Other research conducted by Husnaini et al. (2023) showed that the Augmented Reality-based teaching materials developed were suitable for use because they were able to improve learning outcomes and student attention.

Currently, integrated Augmented Reality learning media has been developed by Fanmita & Guspatni (2023) which has been tested for validity but has not been tested for practicality and effectiveness. Therefore, this study aims to see the level of practicality and effectiveness of integrated Augmented Reality learning media on the material on the development of atomic theory on the learning outcomes of Phase E SMA/MA students.

2. Methodology

This research is a further development research with the Plomp model which has 3 stages of development, namely: (1) preliminary research stage, (2) prototyping stage and (3) assessment stage. Previous research has conducted the preliminary research stage to the prototyping stage (formation of prototypes 1, 2 and 3).

This study is only limited to the small group stage, where the actions taken are practicality tests and effectiveness tests on integrated Augmented Reality learning media on the material of atomic theory development. The type of research used is pre-experimental with a one-group pretest-posttest design. The design of this study can be seen in Table 1.

Table 1. One Group Pretest-Posttest Design

Class	Pretest	Treatment	Posttest

Eksperiment	O_1	X	O_2

The research population is all research targets (Sugiyono, 2023). The population in this study were all students of Phase E of SMAN 1 Sabak Auh in the 2023/2024 academic year. This study consisted of one sample, namely class X E.1 of SMAN 1 Sabak Auh, consisting of 35 students selected using purposive sampling technique.

The variables in this study consist of independent variables and dependent variables. The independent variable in this study is the integrated Augmented Reality learning media on the material of atomic theory development. The dependent variable is the learning outcomes of students on the material of atomic theory development.

The instrument in the practicality test is in the form of a practicality questionnaire while the effectiveness test uses a test instrument in the form of multiple choices consisting of 20 questions with 5 answer choices, but the questions analyzed in this study were only 9 questions, because only these questions were included in the learning objectives of the development of atomic theory. Before the learning is carried out, the sample will be given an initial test in the form of a pretest to see the initial abilities of students regarding the material to be taught. Furthermore, treatment or treatment is given using integrated Augmented Reality learning media on the material on the development of atomic theory that has been developed. At the final stage of learning, a posttest or final test will be carried out to measure the extent to which students understand the concept of the material that has been studied in order to see the effectiveness and draw conclusions.
Data analysis techniques to obtain research results include a practicality test using a practicality questionnaire with a semantic differential scale which is then analyzed using the Aiken's index formula. While for the effectiveness data analysis using N-gain to determine how effective the media used is. The normality test is carried out to determine whether the sample distribution is normal, the test used is the Shapiro Wilk test with the SPSS application. The hypothesis test aims to determine whether the research hypothesis can be accepted or rejected. The hypothesis test used is the Wilcoxon match pairs test using the SPSS application.

3. Results and Discussion

Result

This study was conducted to determine the level of practicality of Augmented Reality media in learning and its effectiveness on learning outcomes. The results of the research that has been conducted can be seen in Table 2.

Table 2. Practicality Test Results

Rated Aspect	Value V	Category
Ease of Use	0,92	Practical

Learning time efficiency	0,91	Practical
Benefits and attractions	0,92	Practical
Average	0,92	Practical

In Table 2, it can be seen that the integrated Augmented Reality learning media on the material on the development of atomic theory has an average V value of 0.92 with a practical category after being interpreted in the Number of category Aikens'V.

After the media is declared practical, the next stage is to conduct an effectiveness test on the integrated Augmented Reality learning media on the material of the development of atomic theory. Effectiveness is carried out on a small group scale which is measured through the results of processing the pretest and posttest data of students. The following are the average results of the pretest and posttest of students which can be seen in Figure 1.

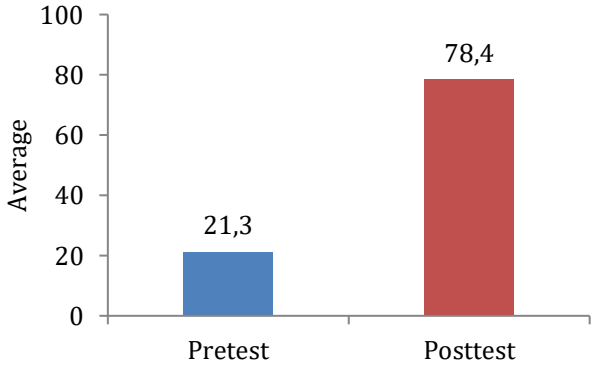

Figure 1. Average Pretest Results and Posttest

From the picture, it can be seen that the comparison of learning outcomes can be seen from the average pretest score, which is 21,3 and the posttest score is 78,4. In addition, the average pretest and posttest scores of students for each sub-material were also calculated. The scores obtained can be seen in Table 3 below.

Table 3. Average Pretest and Posttest of Students for Each Sub-Material

Atomic Theory	**Pretest**	**Posttest**
Dalton's atomic theory	54,3	77,1
Teori atom Thomson	18,6	74,3
Rutherford's atomic theory	20	67,1
Bohr's atomic theory	8,6	77,1
Quantum Mechanics Atomic Theory	14,3	85,7

Table 3 shows the difference in the average pretest and posttest scores on Dalton's atomic theory of 22,8. In the Thomson atomic theory sub-material, the difference in the average pretest and posttest was 55,7, while in Rutherford's atomic theory it was 47,1. For Bohr's atomic theory, the difference in the average pretest and posttest scores was 68,5, while for quantum mechanics atomic theory, the difference in the average pretest and posttest scores was 71,4. From the values

obtained, it is concluded that there is an increase in cognitive learning outcomes in students after using integrated Augmented Reality media.

The N-Gain test was conducted to determine the effectiveness of learning media as seen from the increase in student learning outcomes after being given treatment. The increase in learning outcomes was obtained from a comparison of student pretest and posttest scores. For data analysis, the N-Gain value can be seen in Table 4.

Table 4. N-Gain Test Results

N	Pretest Average	Posttest Average	Average N-Gain	Category
35	21,3	78,4	0,72	Tall

The average pretest score was 21,3 and the average posttest score was 78,4. The increase in the average score analyzed indicated that there was an increase in learning outcomes and understanding of the material in students. While the average N-Gain obtained was 0.72 with a high category. This indicates that providing treatment during learning is effective in improving student learning outcomes.

The normality test is conducted to determine whether the distribution of pretest and posttest data obtained from the sample is normally distributed or not. The normality test used is the Shapiro Wilk test assisted by the SPSS application. Data is normally distributed if Sig. > 0.05 with a real level of $\alpha = 0.05$. The following are the results of the normality test using SPSS which can be seen in Table 5.

Table 5. Results of Normality Test Using SPSS

	α	Statistic	Df	Sig.	Decision
Pretest	0,05	0,881	35	0,001	Not normally distributed
Posttest		0,899		0,004	

Table 5 shows the significant values in the pretest and posttest obtained at 0,001 and 0,004, which means it is smaller than the Sig. level of 0,05. So the data obtained is not normally distributed.

Hypothesis testing is conducted to prove whether the research hypothesis is accepted or rejected. Since the pretest-posttest data are not normally distributed, the hypothesis test used is the Wilcoxon match pairs test using the SPSS application. The test results can be seen in Table 6.

Table 6. Hypothesis Testing Using SPSS

	α	Z	Asymp. Sig. (2-tailed)	Decision
Pretest	0,05	-5,190	0,000	Hypothesis accepted
Posttest				

Table 6 shows the Asymp. Sig. (2-tailed) value of <0,000 with the hypothesis decision accepted. This proves that there is a significant difference between the pretest and posttest values. So it can be stated that the integrated Augmented

Reality learning media on the material on the development of atomic theory has proven effective in significantly improving student learning outcomes.

Discussion

The integrated Augmented Reality learning media on the material of atomic theory development is considered practical in three aspects of assessment, namely the aspect of ease of use, efficiency of learning time and the appeal and benefits of the media. The following is an example of the main page display on the media can be seen in Figure 2 below.

Figure 2. Main Page Display on Media

Judging from the ease of use of the media, the practicality of Augmented Reality integrated learning media on the material on the development of atomic theory can be obtained for several reasons. First, the media contains instructions for using the media. With the instructions for using the media, users can easily use and operate the application. Second, the media also contains images, 3D animations, writing and language that are clear and easy to understand, so that in its application it does not require special skills. This shows that Augmented Reality integrated learning media on the material on the development of atomic theory is easy to use so that it is expected to improve learning outcomes. In accordance with Pratiwi's statement (2022) that media that has clear instructions, language, and flow can help students in learning and improve learning outcomes.

However, in its use, researchers found obstacles for students in positioning 3D objects, where the objects displayed were not directly in a position that could be observed so that students had to rearrange the position of the object so that it could be observed clearly. As expressed by Mustaqim & Kurniawan (2017), Augmented Reality technology also has disadvantages such as: 1) sensitive to changes in viewing angle or easy to change position at certain angles, 2) not yet developed much, and 3) requires a lot of memory space on smartphones. The practicality test on the aspect of time efficiency shows that the media. An example of a 3D object display in Augmented Reality media can be seen in Figure 3.

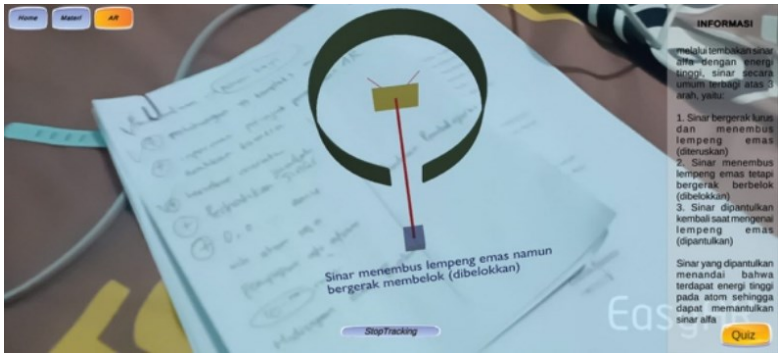

Figure 3. Example of Augmented Reality Page Display on Media

Integrated Augmented Reality learning media on the material on the development of atomic theory is categorized as practical. Augmented Reality media is easy to use on Android smartphones and can be used repeatedly because it does not require an internet network connection. During the learning process, all students use Android smartphones, so that it can support students in the independent learning process to repeat the material studied and the time used is also effective and efficient. Although the application is practical in terms of time efficiency, researchers still find that some Augmented Reality learning media on students' smartphones are sometimes a bit slow to respond. This problem was also found by Mardian, Defit, & Sumijan (2023) who stated that if the application sometimes runs a bit slowly or even errors when used, such obstacles could be caused by the specifications of the smartphone used and the camera of each user so that it can affect the detection time and quality of the objects displayed. In addition, the quality of the camera, lighting and specifications of the cellphone can affect how quickly 3D objects are displayed when the camera reads the marker (Amrina et al., 2023).

Furthermore, the aspect of benefits and attractiveness of the media also shows a practical category. Integrated Augmented Reality learning media can motivate students in learning the material. In the media there are modeling, materials, videos and quizzes. With the use of integrated Augmented Reality media, learning in class is considered to be more enjoyable so that it can increase students' interest in learning. The use of Augmented Reality has an effect on increasing conceptual understanding, motivation, interest in learning, and learning outcomes (Baihaki et al., 2023). Based on the assessment that has been explained, it can be concluded that overall the integrated Augmented Reality learning media on the material on the development of atomic theory is good and suitable for use as a learning medium. Teachers can utilize Augmented Reality technology as a learning medium in conveying information to students (Subagiyo et al., 2023).

Although considered practical, during its implementation, researchers still found that some students were unaware of Augmented Reality technology, so good guidance was needed for its application. However, this is not a difficult problem considering the current condition of students who are already technologically literate, making this technology easy to understand (Rahayu et al., 2022).

After the media is declared practical, the next stage is to conduct an effectiveness test on the integrated Augmented Reality learning media on the material on the development of atomic theory. The results of the data analysis show that the integrated Augmented Reality media on the material on the development of atomic theory is effective in improving student learning outcomes. The findings obtained are in accordance with Acesta & Nurmaylany (2018) who stated that Augmented Reality learning media can improve learning outcomes in students. The increase in student learning outcomes indicates that student mastery of concepts after using the media is able to provide better results. In line with Kuswinardi et al., (2023) that in learning integrated with AR, students have better abilities in understanding concepts.

The achievement of student learning outcomes can be analyzed through grouping answers based on sub-materials in the TP development of atomic theory. The learning objectives achieved in this study were only one TP, namely related to the development of atomic theory because it adjusted the learning objectives contained in the Augmented Reality media. At the time of the study, the test questions given consisted of 20 multiple-choice questions, but the answers to the questions analyzed were only 9 questions because only those questions were included in the TP development of atomic theory.

In the Dalton atomic theory sub-material, it is known that overall students are able to answer the questions given. This is evident from the percentage of correct answer analysis obtained by students when doing the posttest. In addition, the researcher also asked students directly about the answers chosen. When asked, students said that the correct answer was chosen because they knew the answer to the question. Several students stated the reason was because they always repeated the independent quizzes contained in the media. Nofindra (2019) argues that repetition in learning is important and is also one way to recall the learning that has been obtained.

Similar to Dalton's atomic theory, it is known that overall students are also able to answer questions about Thomson's atomic experiment. This could be supported by the Augmented Reality media used. During the learning process, students looked enthusiastic in observing the experiments displayed on the media. Bau et al. (2022), in their research, argued that the use of Augmented Reality media can make students enthusiastic during learning, and can make the learning atmosphere feel fun.

In the sub-material of Rutherford's atomic theory, it is known that almost all students are able to answer questions about the Rutherford atomic model. However, in questions about the weaknesses of Rutherford's atom, only some students answered the questions correctly. When asked directly, students admitted that they forgot about the question. Therefore, repetition is needed by reading a lot, discussing and consolidating the material and practicing questions for students (Fadillah & Iswendi, 2019).

For the Bohr atom sub-material, some students were able to answer the questions correctly. However, there were also some students who answered incorrectly. The reason given was that students forgot about the question. In addition, students were also found to have doubts in choosing answers, which was seen by the many changes in answers found on the students' question sheets. Therefore, students are required to study and practice more and increase literacy on the material so that understanding the concept is much better (Ambarwati et al., 2023).

In the question about the quantum mechanics atomic theory, it is known that most students have answered correctly. However, when the researcher conducted a Q&A about the chosen answers, several students admitted to choosing answers carelessly. This means that the correct answer chosen by students could be because of their knowledge or by guessing. Students' ability to understand concepts certainly affects students in solving questions so that it affects learning outcomes (Widiyowati, 2014).

In the implementation of the learning process, researchers send Augmented Reality learning media to students via a google drive link sent to whatsapp. However, researchers found that not all android smartphones can directly install the integrated Augmented Reality application via the google drive link. Only a few students' smartphones can install the application via the google drive link. Therefore, students who have installed the application will send the application to other students with several supporting applications, namely the SHAREit application, which is an application that can share files including other applications. This integrated Augmented Reality media is 94 MB in size so it does not require too much storage space on the smartphone used.

Based on the discussion that the researcher has outlined, it can be concluded that integrated Augmented Reality learning media on the material on the development of atomic theory can be utilized to support learning and is effective in improving students' cognitive learning outcomes.

4. Conclusion

Based on the research that has been conducted, it can be concluded that the use of integrated Augmented Reality learning media on the material of atomic theory development is considered practical in learning and significantly effective in supporting the improvement of cognitive learning outcomes of Phase E SMA/MA students. This is evidenced by the results of the distribution of practicality questionnaires and student learning outcomes as seen from the pretest and posttest scores during learning. The use of Augmented Reality-based media is the right step in actively involving students during the learning process. In addition to the application of Augmented Reality-based learning media supporting the use of technology in education, the use of Augmented Reality technology-based media in the learning process has been proven to be able to improve conceptual understanding, learning interest, learning motivation and student learning outcomes. Augmented Reality-based learning media is able to create a pleasant

atmosphere so that it involves students to be active during learning. The application of Augmented Reality media has proven to be effective and efficient for use in the learning process. As evidenced by the results of research and student perceptions regarding this media.

References

Acesta, A., & Nurmaylany, M. (2018). Pengaruh Penggunaan Media Augmented Reality Terhadap Hasil Belajar Siswa. *Didaktik : Jurnal Ilmiah PGSD STKIP Subang*, *4*(2), 346–352. https://doi.org/10.36989/didaktik.v4i2.79

Afrianis, N., & Ningsih, L. (2022). Analisis Kesulitan Belajar Siswa Pada Materi Struktur Atom. *Konfigurasi : Jurnal Pendidikan Kimia dan Terapan*, *6*(2), 102–108. https://doi.org/10.24014/konfigurasi.v6i2.18617

Ambarwati, A. H., Aini, H., Putri, N. S., & Fadillah, N. K. (2023). Analisis Literasi Kimia: Pentingnya Pemahaman Konsep Kimia di Sekolah Menengah. *Jurnal Arjuna : Publikasi Ilmu Pendidikan, Bahasa dan Matematika*, *2*(1), 165–174. https://doi.org/10.61132/arjuna.v2i1.474

Amrina, Z., Sari, S. G., Alfino, J., & Mahdiansyah, M. (2023). Pengembangan Media Pembelajaran Matematika Berbasis Augmented Reality untuk Meningkatkan Kompetensi Mahasiswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(1), 380–391. https://doi.org/10.31004/cendekia.v7i1.1932

Apriani, R., Harun, A. I., Erlina, E., Sahputra, R., & Ulfah, M. (2021). Pengembangan Modul Berbasis Multipel Representasi dengan Bantuan Teknologi Augmented Reality untuk Membantu Siswa Memahami Konsep Ikatan Kimia. *Jurnal IPA & Pembelajaran IPA*, *5*(4), 305–330. https://doi.org/10.24815/jipi.v5i4.23260

Audie, N. (2019). Peran Media Pembelajaran Meningkatkan Hasil Belajar. *Posiding Seminar Nasional Pendidikan FKIP*, *2*(1), 586–595.

Baihaki, M. R., Rasyadi, M. J., Hafiz, M., Juliyanto, F., & Rahma, F. (2023). Teknologi Ar Sebagai Media Pembelajaran: Tinjauan Literatur. *Prosiding Sains Nasional dan Teknologi*, *13*(1), 185–188. https://doi.org/10.36499/psnst.v13i1.9139

Bau, C., Olii, S., & Pakaya, N. (2022). Perbandingan Motivasi Belajar pada Mata Pelajaran Kimia Sebelum dan Sesudah Penerapan Media Pembelajaran Augmented Reality Chemistry. *Journal of Information Technology Education*, *2*(1), 44–53. http://ejurnal.ung.ac.id/index.php/inverted

Fadillah, A. R., & Iswendi, I. (2019). Efektivitas Penggunaan Media Pembelajaran Permainan Ludo Kimia Berbasis Chemo-Edutainment (CET) pada Materi Struktur Atom terhadap Hasil Belajar Siswa Kelas X SMA N 3 Padang. *Edukimia*, *1*(3), 102–106. https://doi.org/10.24036/ekj.v1.i3.a76

Fanmita, Z. (2023). *Pengembangan Aplikasi Pembelajaran Terintegrasi Augmented Reality Pada Materi Perkembangan Teori Atom Fase E SMA/MA*. Universitas Negeri Padang.

Fanmita, Z., & Guspatni, G. (2023). Designing Interactive Learning Application Using Markerless Augmented Reality on Evolution of Atomic Theory

Material. *Prisma Sains : Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram*, *11*(3), 778. https://doi.org/10.33394/j-ps.v11i3.8074

Fauziyyah, N. (2019). The Potential of Augmented Reality to Transform Education Into Smart Education. *Jurnal PAJAR (Pendidikan dan Pengajaran)*, *3*(4), 966–973. https://doi.org/10.33578/pjr.v3i4.7433

Febrita, Y., & Ulfah, M. (2019). Peranan Manajeman Media Pembelajaran Untuk Meningkatkan Motivasi Belajar Siswa. *AL-MIKRAJ Jurnal Studi Islam dan Humaniora (E-ISSN 2745-4584)*, 181–188.

Husnaini, Nurhikmah, H., Muin, A., Hakim, A., & Pattaufi. (2023). Pengembangan Bahan Ajar Berbasis Augmented Reality (AR) Pada Mata Pelajaran IPA Siswa Di MIN 1 Kolaka Utara. *AULADUNA: Jurnal Pendidikan Dasar Islam*, *10*(2), 224–232.

Ibisono, H. S., Achmadi, H. R., & Suprapto, N. (2020). Efektivitas Buku Saku Berbasis Augmented Reality pada Materi Gerak Planet untuk Meningkatkan Prestasi Belajar Peserta Didik SMA. *IPF: Inovasi Pendidikan FisikaInovasi Pendidikan Fisika*, *09*(02), 200–206.

Kuswinardi, J. W., Rachman, A., Taswin, M. Z., Pitra, D. H., & Oktiawati, U. Y. (2023). Evektifitas Pemanfaatan Aplikasi Augmented Reality (AR) Dalam Pembelajaran Di Sma : Sebuah Tinjauan Sistematis. *Jurnal Review Pendidikan dan Pengajaran*, *6*(3), 556–563.

Mahendra, I. B. M. (2016). Implementasi Augmented Reality (Ar) Menggunakan Unity 3D Dan Vuporia Sdk. *Jurnal Ilmiah Ilmu Komputer Universitas Udayana*, *9*(1), 1–5.

Mardian, Z., Defit, S., & Sumijan, S. (2023). Implementasi Augmented Reality Berbasis Android sebagai Media Pembelajaran Matematika Dimensi Tiga. *Jambura Journal of Informatics*, *5*(1), 30–44.

Mustaqim, I. (2016). Pemanfaatan Augmented Reality sebagai Media Pembelajaran. *Jurnal Pendidikan Teknologi dan Kejuruan*, *13*(2), 178–183.

Mustaqim, I., & Kurniawan, N. (2017). Pengembangan Media Pembelajaran. *Edukasi Elektro*, *1*(1), 36–48. https://doi.org/10.17977/um034v29i2p97-115

Nofindra, R. (2019). Ingatan, Lupa, Dan Transfer Dalam Belajar Dan Pembelajaran. *Jurnal Pendidikan Rokania*, *4*(1), 21–34.

Novita, R., & Harahap, S. Z. (2020). Pengembangan Media Pembelajaran Interaktif pada Mata Pelajaran Sistem Komputer Di SMK. *Jurnal Informatika*, *8*(1), 36–44. https://doi.org/10.36987/informatika.v8i1.1532

Pratiwi, K. I., & Guspatni, G. (2022). Praktikalitas dan Efektivitas Media Pembelajaran Powerpoint-Ispring Terintegrasi Multipel Representasi Kimia Dan Pertanyaan Prompting Materi Sifat Koligatif Larutan Kelas XII MIPA SMA/MA. *Jurnal Ilmiah Universitas Batanghari Jambi*, *22*(3), 1869–1875. https://doi.org/10.33087/jiubj.v22i3.2721

Rahayu, R., Iskandar, S., & Abidin, Y. (2022). Inovasi Pembelajaran Abad 21 dan Penerapannya di Indonesia. *Jurnal Basicedu*, *6*(2), 2099–2104. https://doi.org/10.31004/basicedu.v6i2.2082

Rahmi, A., Fitriani, H., & Muna, N. (2021). Pengaruh Model Pembelajaran Cooperative Script dengan Media Kartu Gambar terhadap Minat dan Hasil

Belajar Siswa pada Materi Perkembangan Model Atom. *KATALIS: Jurnal Penelitian Kimia dan Pendidikan Kimia*, *4*(1), 33–38. https://doi.org/10.33059/katalis.v4i1.3738

Subagiyo, A., Astutik, W., Wahyuni, E. D., Widhiati, K., Maulidin, M. E., Listiani, W., & Supriadi, M. (2023). Media Pembelajaran Berbasis Augmented Reality (AR) dalam Pembelajaran Matematika di Sekolah Menengah Pertama. *Jurnal Ilmiah Wahana Pendidikan*, *9*(22), 920–925.

Sugiyono. (2023). *Metode Penelitian Pendidikan (Kuantitatif, Kualitatif, Kombinasi. R&D dan Penelitian Pendidikan* (A. Nuryanto (ed.); 3 ed.). Alfabeta.

Syukri, S. (1999). *Kimia Dasar 1* (1 ed.). ITB.

Tafonao, T. (2018). Peranan Media Pembelajaran Dalam Meningkatkan Minat Belajar Mahasiswa. *Jurnal Komunikasi Pendidikan*, *2*(2), 103–114. https://doi.org/10.32585/jkp.v2i2.113

Widiyowati, I. I. (2014). Hubungan Pemahaman Konsep Struktur Atom Dan Sistem Periodik Unsur Dengan Hasil Belajar Kimia Pada Pokok Bahasan Ikatan Kimia. *Pancaran Pendidikan*, *3*(4), 99–116.

Wirya, S., Suyanto, E., & Suyadi, G. (2009). Identifikasi Masalah Kesulitan Dalam Pembelajaran Kimia Sma Kelas X Di Propinsi Lampung. *Journal Pendidikan MIPA (JPMIPA)*, *10*(2), 9–18.

How to cite this article:

Septiani, U., Guspatni., Yerimadesi., & Yusmaita, E. (2025). Practicality and Effectiveness of Augmented Reality Integrated Learning Media on the Material of Atomic Theory Development on the Learning Outcomes of Phase E SMA/MA Students. *Journal of Educational Sciences*, *9(1)*, 90-102.