Vol 12(2),2023, 299-313 DOI: 10.23960/jppk.v12.i2.2023.30
Jurnal Pendidikan dan Pembelajaran Kimia
e-ISSN: 2714-9595| p-ISSN 2302-1772
http://jurnal.fkip.unila.ac.id/index.php/JPK/index

Design of Augmented Reality Integrated Interactive Learning Media on Salt Hydrolysis Material

Sausan Hani Fadhilah [1], Guspatni [2]

1,2 Chemistry Education, Faculty of Mathematics and Natural Science, University of Padang, Jl. Prof. Dr. Hamka, Air Tawar, Kota Padang, Sumatera Barat, Indonesia.

*Correspondinge-mail: guspatni@fmipa.unp.ac.id

Received: July 29th, 2023 Accepted: August 4th, 2023 Online Published: August 13th, 2023

Abstract:Design of Augmented Reality integrate Interactive Learning Media on Salt Hydrolysis Material. The research was conducted with the aim of designing interactive learning media integrated with Augmented Reality. The design of learning media is an attractive choice for increasing student knowledge and enriching learning experiences. This is due to the fact that learning media using Augmented Reality can combine the concept of salt hydrolysis with technology that can build two- and three- dimentional virtual objects, so that it will encourage the creation of a generation that can compete in today's world. This research is an Educational Design Research (EDR) that uses the Plomp development model. The steps in this study are the preliminary research stage which consist of needs and context analysis, literature review, and the development of the conceptual framework as well as the prototype building stage which consist of the initial design and self-evaluation. The result of the self-evaluation analysis showed that the media made using the Plomp model produced prototype II which worked well and could provide an overview of the submicroscopic of salt hydrolysis.

Keywords: Design, Interactive Learning Media, Augmented Reality, Salt Hydrolysis

Abstrak:Perancangan Media Pembelajaran Interaktif Terintegrasi Augmented Reality pada Materi Hidrolisis garam. *Penelitian dilakukan dengan tujuan merancang media pembelajaran interaktif yang terintegrasi Augmented Reality. Perancangan media pembelajaran ini menjadi pilihan yang menarik untuk meningkatkan pengetahuan siswa dan memperkaya pengalaman belajar. Hal ini disebabkan oleh fakta bahwa media pembelajaran menggunakan Augmented Reality dapat menghubungkan konsep hidrolisis garam dengan teknologi yang dapat membangun benda maya dua dan tiga dimensi, sehingga akan mendorong terciptanya generasi yang dapat bersain di dunia saat ini. Penelitian ini merupakan jenis penelitian Educational Design Research (EDR) yang menggunakan model pengembangan Plomp. Langkah-langkah dalam penelitian ini adalah tahap penelitian pendahuluan yang terdiri dari analisis kebutuhan dan konteks, tinjauan literatur, dan pengembangan kerangka konseptual serta tahap pembentukan prototipe yang terdiri dari rancangan awal dan evaluasi diri sendiri. Hasil analisis evaluasi diri sendiri menunjukkan bahwa media yang dibuat dengan menggunakan model Plomp menghasilkan prototipe II yang dapat berjalan dengan baik dan dapat memberikan gambaran mengenai bentuk submikroskopik hidrolisis garam.*

Kata kunci: *Perancangan, Media Pembelajaran Interaktif, Augmented Reality, Hidrolisis Garam*

▪ INTRODUCTION

Education and technology are developing rapidly in the 21st century. The 21st century skills that students must possess and master are innovation skills and learning, life and career, and information technology and media skills (Wijaya et al., 2016). Augmented Reality is a technological advancement created and utilized by many researchers in scientific learning to train 21st century skills (Vari & Bramastia, 2022). Augmented Reality is a technology that is in line with today's education.

Augmented Reality refers to a situation where the virtual world and the real computer-generated world are connected in such a way that there is very little difference. One's perception of the world around is enhanced by Augmented Reality, which transforms several real and virtual worlds into new interfaces that can display relevant information and assist in education, training, repair or maintenance, military, manufacturing, games and all forms of entertainment (Zainil & Hesla, 2019).

The use of Augmented Reality in education is expected to create an interesting and fun atmosphere. This is because Augmented Reality can display 3D objects that support a learning atmosphere (Atmajaya, 2017). Learning with Augmented Reality technology is able to stimulate students' critical thinking patterns (Mustaqim, 2016), improve students' cognitive learning outcomes (Qorimah & Sutama, 2022), student independence (Atmajaya, 2017), students' mastery of concepts and creative thinking (Wulandari et al., 2020) (Nasution, 2021), as well as students' abstract thinking skills (Vari & Bramastia, 2021). This indicates that learning with AR technology is in accordance with current scientific developments.

Learning media supported by Augmented Reality can visualize abstract concepts for understanding and structure of an object model, which allows AR as a more effective medium according to the objectives of learning media (Mustaqim, 2016). Augmented Reality-based learning media is effective in increasing conceptual understanding (Ummah & Ariwibowo, 2021), student activity (Litanianda & Setyawan, 2017), and learning outcomes (Acesta & Nurmaylany, 2018).

Augmented Reality learning media is also effectively used in improving learning outcomes in chemistry lessons, such as in basic chemistry material (Kamelia, 2015), molecular shapes (Supriono & Rozi, 2018) and the atomic structure of organic hydrocarbon compounds (Alfian et al., 2019). So, AR learning media is a set of tools that are needed in the chemistry learning process.

Hydrolysis of salt is a chemical material for SMA/MA phase F. Salt hydrolysis is a difficult subject for students and misconceptions often occur (Amelia et al., 2014). The level of students' understanding of salt hydrolysis material is only 38% (Nusi et al., 2021). Students are confused about the meaning of acids and bases, determining acids and bases, scientific knowledge, determining pH values, submicroscopic images of salt in water, and the effect of Ka, Kb, volume and concentration in salt solutions (Arsyad et al., 2016). Salt hydrolysis has visualizations of pictures, models, videos and animations. Augmented Reality can display these visuals in a good way.

▪ METHOD

This research is a type of Educational Design Research (EDR) research. This design serves as a research strategy for field instruction. By leveraging design research, this research has given an important role to media design (Bakker, 2004). Augmented Reality integrated learning media is designed using the Plomp model. The stages in this

study include the preliminary research stage and the prototype formation stage. Preliminary research is needed to obtain information about educational problems that occur or there is a discrepancy between the current situation and what is desired (Plomp & Nieveen, 2013). The limitation of this research is self-evaluation which will produce prototype II. The subjects in this study were 3 chemistry teachers and 100 Phase F students at SMAN 2 Padang, SMAN 3 Padang and SMA Pembangunan Lab UNP. The object of this study is an interactive learning media product integrated with Augmented Reality on salt hydrolysis material. The preliminary research can be seen in Figure 1 below.

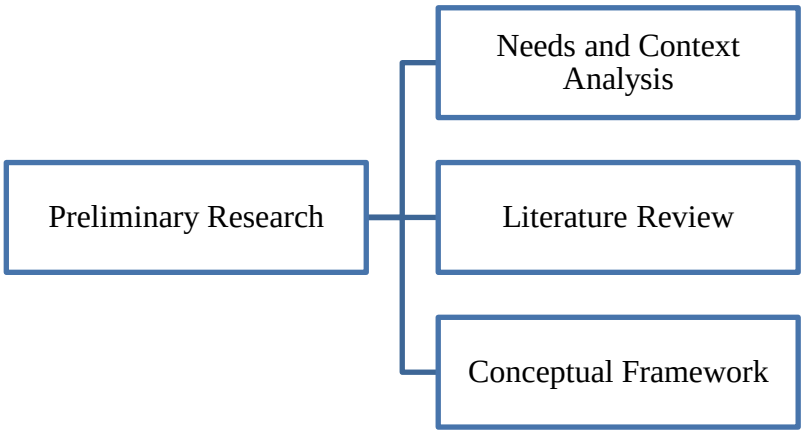


Figure 1. Stage of Preliminary Research

Needs and Context Analysis

Needs analysis in this study refers to the situations experienced by teachers and students in the learning process, such as analyzing how the learning process works, the media used, and the learning situations desired by teachers and students. While the context analysis in this research is to examine the issues raised from the needs analysis. Data collection in this needs and context analysis was the distribution of questionnaires to 3 chemistry teachers and 100 Phase F students at SMAN 2 Padang, SMAN 3 Padang and SMA Pembangunan Lab UNP.

Literature Review

In this literature review step, it is carried out by finding and understanding relevant sources related to the product to be designed as well as an analysis of the surrounding conditions regarding the learning process in salt hydrolysis material. Books, journals, theses, and other documents can be used as reference sources.

Conceptual Framework

The conceptual framework contains the results of the needs and context analysis along with the literature review that has been carried out. The conceptual framework contains an arrangement of concepts that have been identified with a function as a reference in making Augmented Reality integrated interactive learning media. The stages of Prototyping Phase can be seen in Figure 2 below.

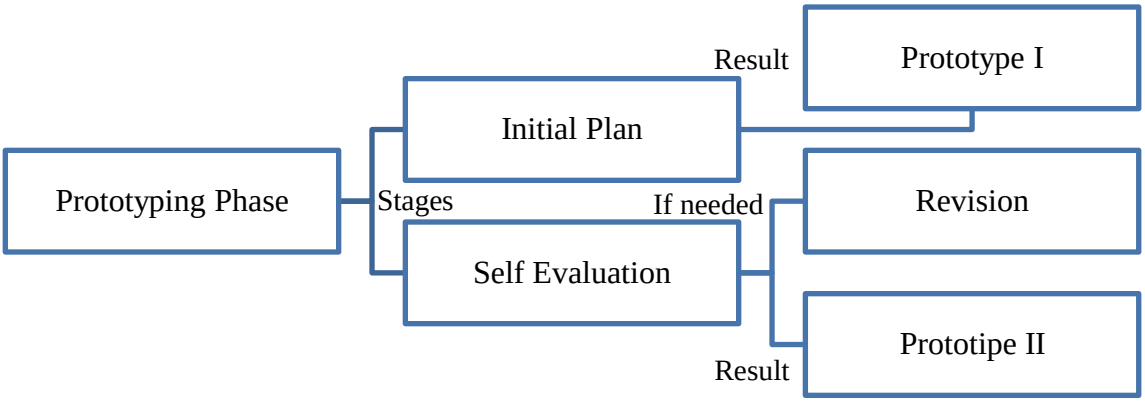


Figure 2. Stages of Prototyping Phase

Initial Plan

The initial design in this study was based on preliminary research. starting from the media framework process to become a complete media. In this initial design prototype I was obtained.

Self Evaluation

Self-evaluation was carried out after prototype was formed. The system used is a checklist system where the assessment is carried out by selecting important parts that must be included in the learning media. If there are still parts that are incomplete, revisions can be made to produce prototype II.

▪ RESULT AND DISCUSSION

This study uses the Plomp development model which aims to produce prototype II which can be used properly according to the initial design that has been prepared.

Needs and Context Analysis

Needs and context analysis aims to identify the needs of teachers and students and analyze the problems faced by teachers and students. With the analysis of needs and context, the design of learning media becomes more focused and the media designed is better. The data was obtained from the results of distributing questionnaires to 3 teachers and 100 students at SMAN 2 Padang, SMAN 3 Padang and SMA Pembangunan Lab UNP.

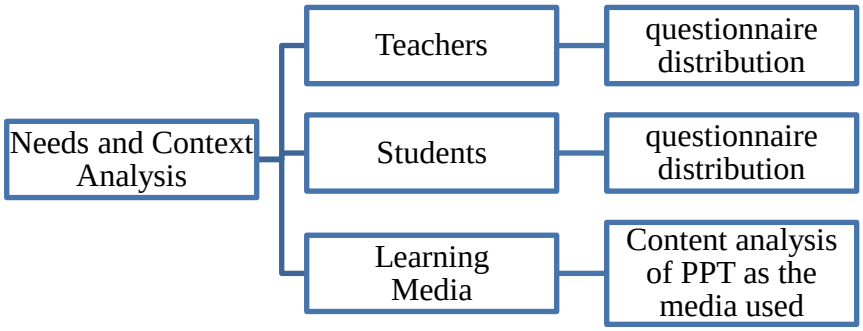


Figure 3. Needs and Context Analysis

Salt hydrolysis is a chemical material that has abstract and complex characteristics. To understand the material of salt hydrolysis, it is necessary to have integration between macroscopic, microscopic, and symbolic aspects. The abstract nature of this material lies in the macroscopic aspects contained in the solution. Meanwhile, the complex nature of this material lies in its relation to previously studied material which is a prerequisite in studying these two materials. These prerequisite materials include acid-base and equilibrium. The characteristics of the material can trigger difficulties for students in understanding salt hydrolysis material. This is in accordance with the results of distributing the questionnaire given to 100 students in phase F, from the results of the questionnaire there were 84 students who had some difficulties in understanding salt hydrolysis material.

One of the causes of difficulties in understanding hydrolysis salt material is the use of inadequate media. Teachers tend to use print and electronic media which cannot present the abstract concept of salt hydrolysis. This is due to differences in students' absorption in listening to and understanding the contents of the media so that learning tends to be monotonous and boring. Therefore the learning process using visual media can increase creativity and motivation for students to learn (Budiman, 2016). Based on the distribution of questionnaires given to 3 chemistry teachers in phase F, it turned out that teachers still used printed books and PowerPoint as learning media. In fact, both teachers and students need media that can display microscopic, microscopic and symbolic student masks from salt hydrolysis materials, while the media used is not sufficient. Students also do not reuse learning media when outside of school. That is, teachers and students need learning media that can be used anytime and anywhere, easily accessible and fun media.

Selection of learning media is very important in learning. Learning media does not only act as a complement to the teacher in conveying information to students, but can also be a reference in achieving student learning outcomes (Mahmun, 2012). The media needed by teachers and students is innovative media, namely media that can display images, videos and animations, so the right technology is needed to run the media. Some of them are Smartphone technology, computers, tablets, and so on. Smartphones can be used in education. This is because Smartphones have features that can present interactive, collaborative and interesting learning. Of the 100 students in phase F, none of them did not use a smartphone. This means that Smartphone use is very high among students. This can be used as a reference in designing technology-based learning media. Appropriate technology-based learning media is interactive learning media integrated with Augmented Reality.

Literature Review

Literature review aims to get an overview of what other researchers have done. The literature review stage has been carried out by seeking information through various sources in the form of books, journals, theses and other sources from the internet.

Augmented Reality learning media get good and positive responses from teachers and students. This is in accordance with research conducted by Mukti (2019) where the results of his research namely the use of Augmented Reality learning media can encourage students to increase their academic scores. According to Burhanudin (2017) Augmented Reality media is also a media that is suitable for use in learning. Augmented Reality learning media has great potential in 21st century education. This is in line with research conducted by Amalia et al (2022) where the resulting research is that Augmented Reality can be used as 21st century technology that can answer future

challenges and can also improve students' skills . Augmented Reality learning media can also improve students' critical thinking. This is supported by a literature study conducted by Veronika et al (2022) which says that the implementation of Augmented Reality in the world of education can help process learning activities more efficiently. Augmented Reality learning media also plays a positive role in increasing student understanding. This is supported by research conducted by Karuni (2021) which states that students' understanding of material when using Augmented Reality media increases and Augmented Reality media is effective in its application as learning media that can help students understand material so that it is worthy of being an auxiliary media or alternative media for students . Augmented Reality learning media can train students' mental models. This is supported by research conducted by Supriadi et al (2023) which states that most students can develop synthetic mental models in learning chemistry.

Conceptual Framework

Preparation of a conceptual framework based on needs and context analysis as well as a review of the literature. The conceptual framework can be seen in Figure 3 below.

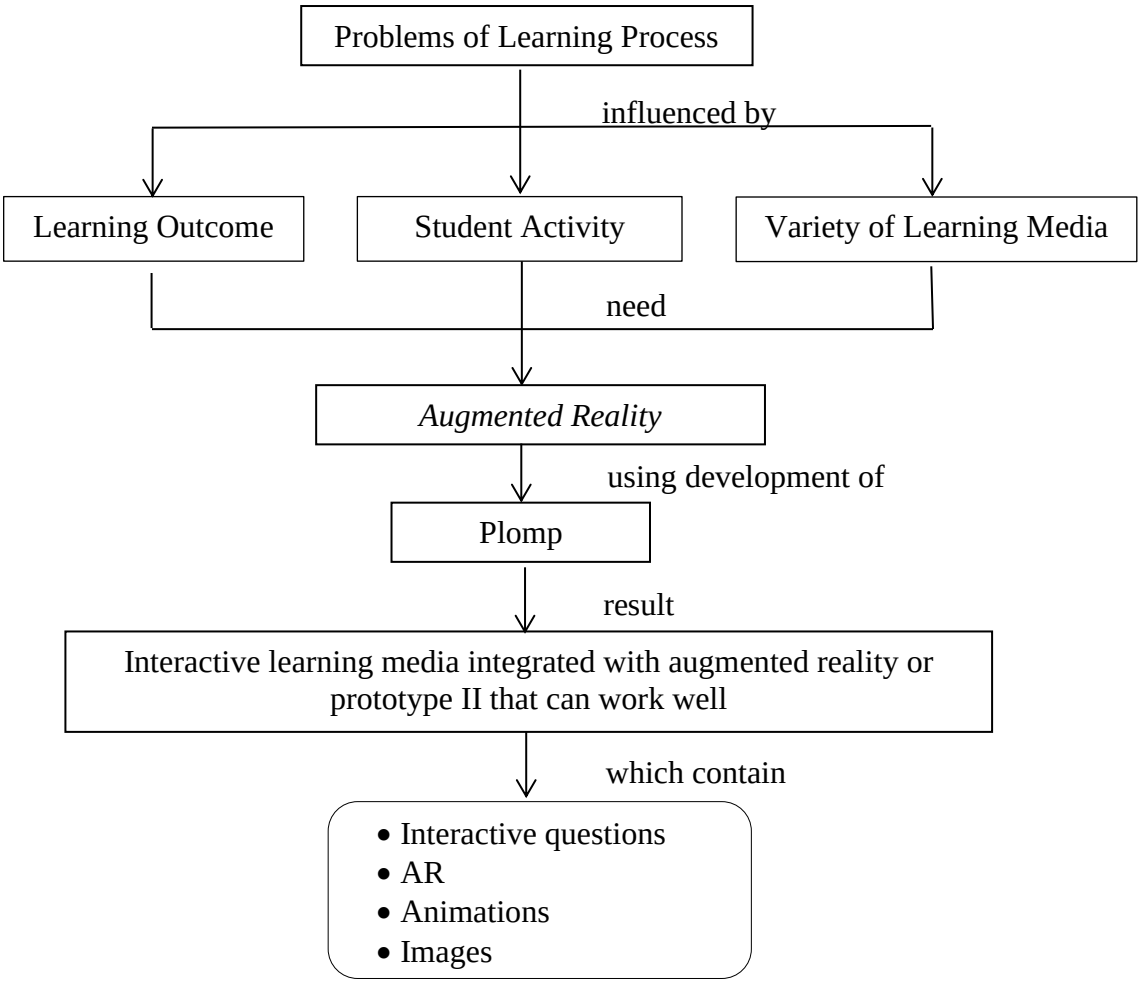


Figure 4. Conceptual Framework

Initial Plan

In designing interactive learning media integrated with Augmented Reality, it is necessary to use some software, including Unity 3D, Blender, Vuforia Engine, and Visual Studio. The integrated Unity 3D tools can be used to create 3D objects in video games as well as in other interactive contexts such as architectural visualization and real time 3D animation. Augmented Reality integrated interactive learning media uses markers to display 3D animation. Markers can be made using the Vuforia Engine. Vuforia Engine is a software platform that assists in the development of learning media. Vuforia has the ability to recognize and detect and track multiple images so Markers can be used. The animation displayed in the AR camera was created using the Blender software. Blender provides all the features needed to create highly realistic 3D models for animation, movies and games. Visual Studio is software that can be used in media or application development. Visual Studio can edit code that can complete the entire development cycle. Based on the presentation of the software above, a flowchart of interactive learning media integrated with Augmented Reality can be formed. The flow can be seen in Figure 5 below.

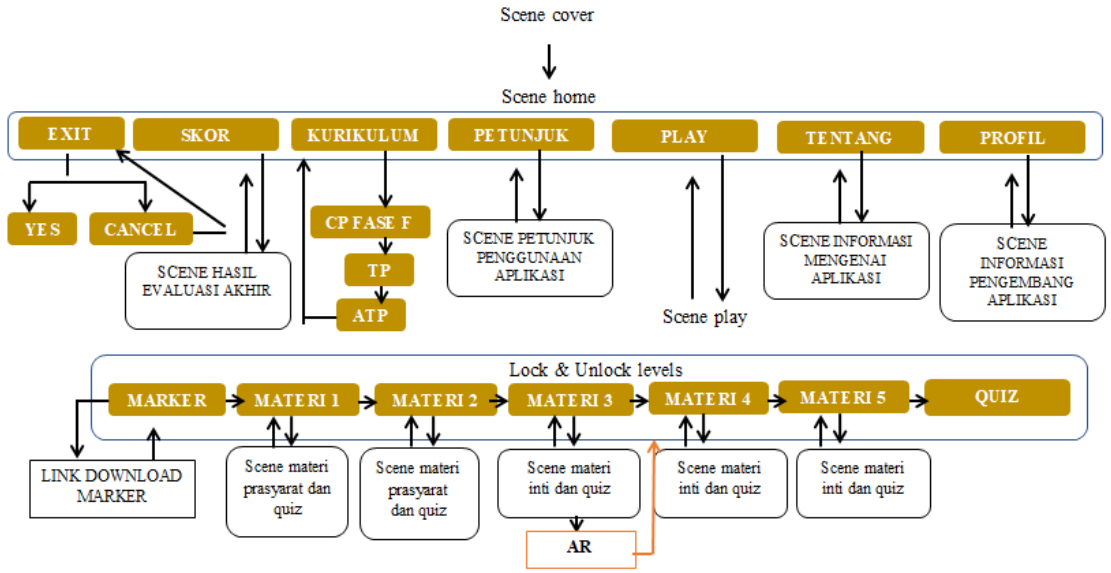
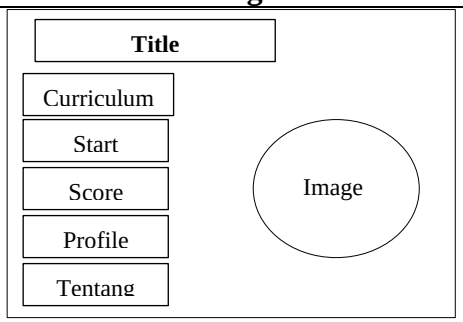
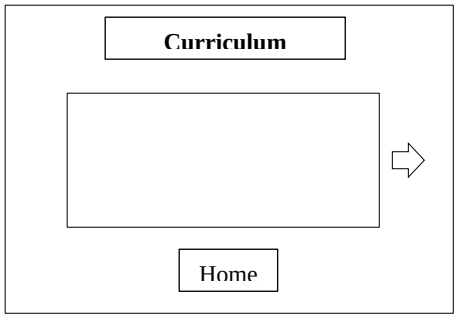
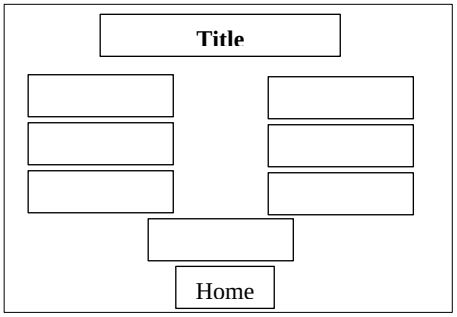
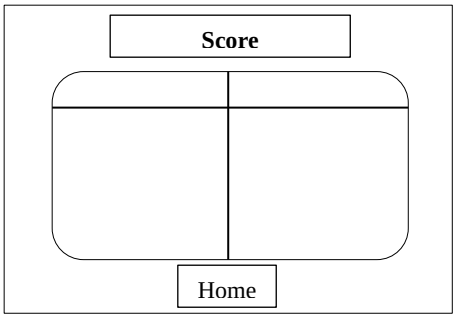
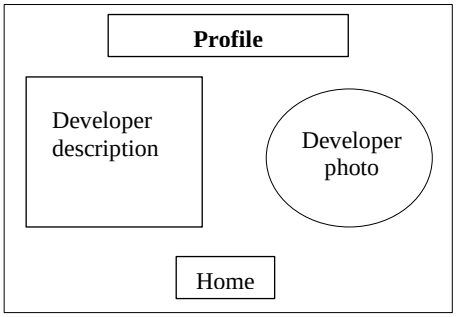
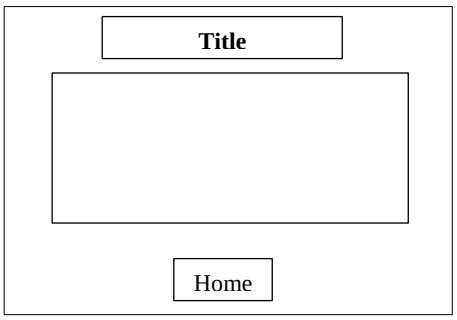
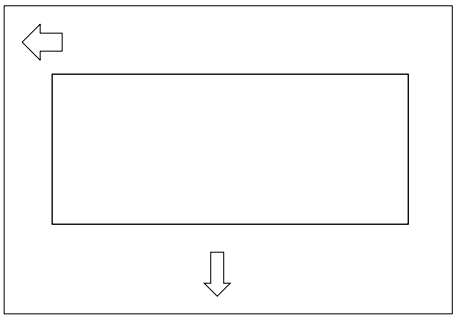
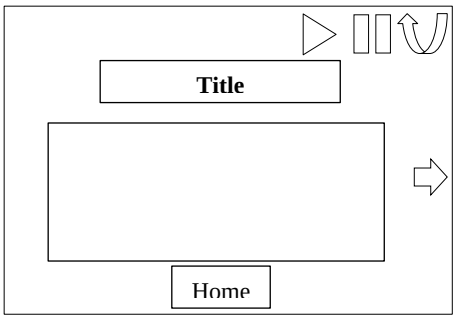
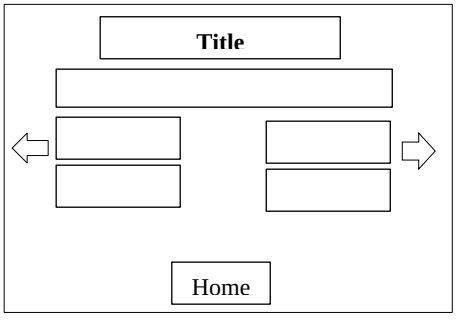


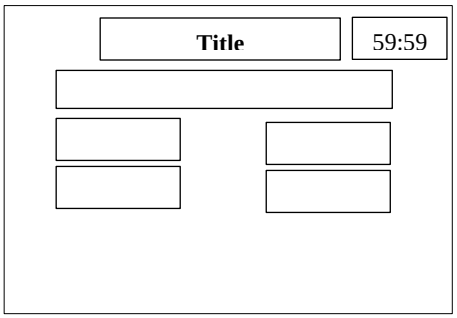
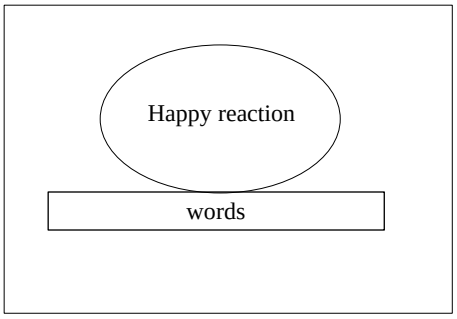
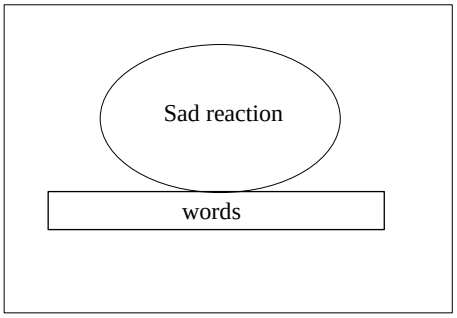
Figure 5. Flowchart

In this initial design, a series of sketches of learning media images were also made sequentially to form a groove. This series of sketches is called Storyboard. The storyboard can be seen in Figure 6 below.

Table 1. Storyboard of Media

Pages	Design	Explan.
Homepage		On the main page, there is the title "salt hydrolysis" and a picture of salt. There are also several components, namely: 1. Curriculum 2. Start 3. Score 4. Profile 5. About
Curriculum Page		On the curriculum page contains learning outcomes, learning objectives, and the flow of learning objectives. The curriculum page has the next and home buttons.
Start Page		On the start page, contains download markers, materials (prerequisites, introduction, and core material), and evaluation. In the material there is an AR camera and several quizzes in each of these materials.
Score Page		On the score page, there are the results of the evaluation carried out.

Developer Page		On the developer page, there is brief information about the developer and is also equipped with a photo of the developer.
About Media Page		On the about media page, there is a brief description of the media being developed.
Download Marker Page		On the download marker page, there are steps to download the marker. There is also a back button and a download button. When the download button is clicked, it will be directed to download the marker and there are instructions for using the marker to bring up AR.
Material		On the material page, material is displayed with sound recordings and animations. users can replay, click, and stop the material. Then, the user can click the next button to take the quiz.
Quiz		On the quiz page, there are questions and answer options. After answering the question, a notification will appear whether the answer is correct or incorrect. Then, the next button will appear.

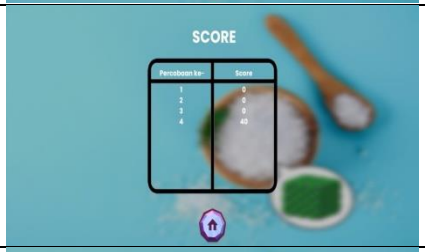
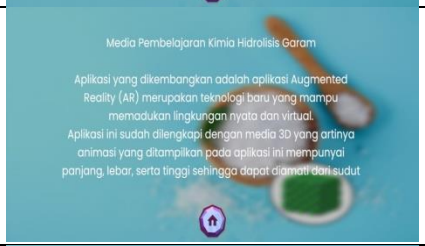
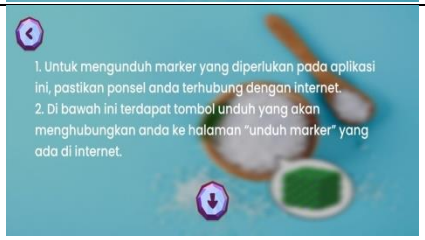
Evaluation		On the evaluation page, there are questions and answer options. There is also a time limit in working on evaluation questions.
Correct Answer		There was a happy reaction for having correctly answered the quiz questions and there were also words.
Wrong Answer		There was a sad reaction because the answer was not quite right and there were also words.

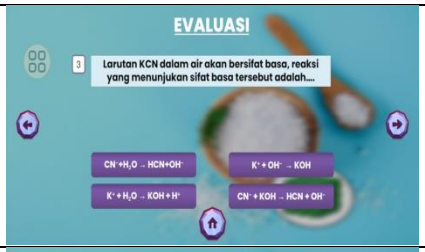
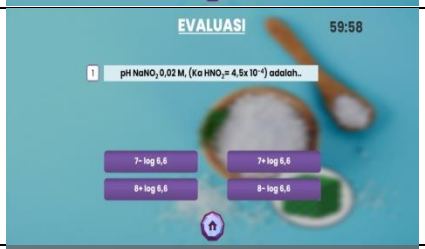
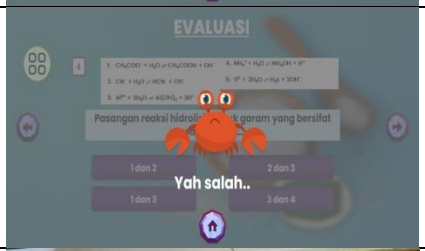
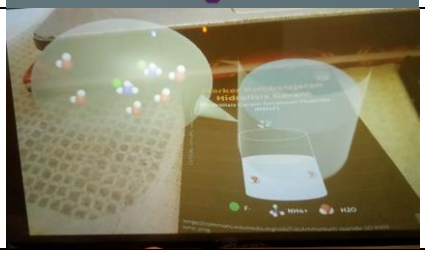
Self Evaluation

The prototype I that has been developed will be assessed formatively using a self-evaluation instrument to see the completeness of the Augmented Reality integrated learning media component in the salt hydrolysis material that has been developed. The media is designed in such a way as to present several components that can help students understand the salt hydrolysis material. The media has quizzes on every given material. The media also has a final evaluation which contains a collection of questions related to salt hydrolysis. This development research uses the Plomp model and the scoring system uses a checklist system. The results of self-evaluation will be seen in table 2 below.

Table 2. Self-Evaluation Result

No	Page	Description	Displays	Conclusion
1	Homepage	Managed to load the initial page which contains several components.		Succeed

2	Curriculum Page	Successfully present the curriculum. All buttons can be used.		Succeed
3	Start Page	Managed to display all the components. All buttons can be used.		Succeed
4	Score Page	Succeeded in displaying the score. All buttons can be used		Succeed
5	Profile	Successfully displaying developer profile. All buttons can be used		Succeed
6	About Media	Successfully displays about media. All buttons can be used.		Succeed
7	Download Markers	Managed to navigate to where to download the marker and was able to load instructions for using the marker to display the AR camera. All buttons can be used.		Succeed

8	Material	Animation on the material runs smoothly. The sound on the material page is also clearly audible. All buttons work fine.		Succeed
9	Quiz	Questions can be read clearly. Option buttons works fine. And all buttons can be used properly.		Succeed
10	Evaluation	Questions can be read clearly. Option buttons works fine. And the timer runs smoothly.		Succeed
11	Feedback (Correct Answer)	The reactions and posts shown went well.		Succeed
12	Feedback (Wrong Answer)	The reactions and posts shown went well.		Succeed
13	AR Camera	The AR camera was used without a hitch		Succeed

The process of designing learning media is structured through the initial research design so that the desired learning media is formed. In the "start" section, students can access materials and evaluations. The material displayed will require students to find out the concept of salt hydrolysis on their own. The material is also equipped with quizzes, so that it will improve students' critical thinking. In this material there is also an AR camera which directs students to scan markers to display 3D objects. In the evaluation section there are interactive questions that train students' mindsets. Thus all

the components in the learning media are used successfully, so that the next prototype can be made.

▪ CONCLUSION

Based on the results of the research that has been carried out which includes preliminary research and the development stage, it can be concluded that the design of interactive learning media integrated with Augmented Reality using the Plomp development model can produce a successful prototype II that runs well and has a good design. With the hope that users can be assisted in the learning process of salt hydrolysis with this integrated Augmented Reality interactive learning media.

▪ REFERENCES

Acesta, A., & Nurmaylany, M. (2018). Pengaruh Penggunaan Media Augmented Reality Terhadap Hasil Belajar Siswa. *Didaktik : Jurnal Ilmiah PGSD STKIP Subang, IV(2)*. https://journal.stkipsubang.ac.id/index.php/didaktik/article/view/79

Alfian, A., Hamid, M., & Suhardi, I. (2019). Pengembangan Media Pembelajaran Aplikasi Augmented Reality Berbasis Android Menggunakan Unity untuk Pembelajaran Struktur Atom Senyawa Organik Hidrokarbon. *Indonesian Journal of Educational Studies, 21*(2), 123–131. https://ojs.unm.ac.id/Insani/article/view/8642

Amalia, D., Rahmadayanti, A., Supriatno, B., Riandi. (2022). Potensial Augmented reality sebagai Media Pembelajaran Biologi Abad 21: Literatur Artikel dan Desain Inovasi Media. *Biology Education Science & Technology, Vol.5(2).* https://jurnal.uisu.ac.id/index.php/best/article/view/5478/4171

Amelia, D., Marheni, M., & Nurbaity, N. (2014). Analisis Miskonsepsi Siswa Pada Materi Hidrolisis Garam Menggunakan Teknik Cri (Certainty of Response Index) Termodifikasi. *JRPK: Jurnal Riset Pendidikan Kimia*, *4*(1), 260–266. https://journal.unj.ac.id/unj/index.php/jrpk/article/view/4726

Aprilinda, Y., Endra, R. Y., Afandi, F. N., Ariani, F., Cucus, A., & Lusi, D. S. (2020). Implementasi Augmented Reality untuk Media Pembelajaran Biologi di Sekolah Menengah Pertama. *Explore:Jurnal Sistem Informasi Dan Telematika*, *11*(2), 124. https://www.neliti.com/id/publications/331286/implementasi-augmented-reality-untuk-media-pembelajaran-biologi-di-sekolah-menen

Arsyad, M., Sihaloho, M., & Kilo, A. La. (2016). Analisis Miskonsepsi pada Konsep Hidrolisis Garam Siswa Kelas XI SMAN 1 Telaga. *Jurnal Entropi Inovasi Penelitian, Pendidikan Dan Pembelajaran Sains*, *11*(2), 190–195. https://www.neliti.com/id/publications/277665/analisis-miskonsepsi-pada-konsep-hidrolisis-garam-siswa-kelas-xi-sman-1-telaga

Atmajaya, D. (2017). Implementasi Augmented Reality Untuk Pembelajaran Interaktif. ILKOM *Jurnal Ilmiah*, *9*(2), 227–232. https://jurnal.fikom.umi.ac.id/index.php/ILKOM/article/view/143

Bakker, A. (2004). *Design Research In Statistics Education: On Symbolizing And* Computer *Tools*. Utrecht, The Netherlands: CD Beta Press.

Budiman, H. (2016). Penggunaan Media Visual dalam Proses Pembelajaran. *Jurnal Pendidikan Islam, (7).* http://ejournal.radenintan.ac.id/index.php/tadzkiyyah/article/view/1501

Burhanudin, A. (2017). Pengembangan Media Pembelajaran Augmented Reality Pada Mata Pelajaran Dasar Elektronika. *(Skripsi Program Sarjana Ilmu Pendidikan Universitas Negeri Yogyakarta, Yogyakarta)*, 2–3.

Indarta, Y., Jalinus, N., Waskito, W., Samala, A. D., Riyanda, A. R., & Adi, N. H. (2022). Relevansi Kurikulum Merdeka Belajar dengan Model Pembelajaran Abad 21 dalam Perkembangan Era Society 5.0. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(2), 3011–3024. https://www.researchgate.net/publication/360842454_Relevansi_Kurikulum_Merdeka_Belajar_dengan_Model_Pembelajaran_Abad_21_dalam_Perkembangan_Era_Society_50

Kamelia, L. (2015). Perkembangan Teknologi Augmented Reality sebagai Media Pembelajaran Interaktif pada Mata Kuliah Kimia Dasar. *Noviembre 2018, IX(1), Vol.1*. https://journal.uinsgd.ac.id/index.php/istek/article/view/184

Karuni, D. W. (2021). Pengembangan Media Pembelajaran Augmented Reality pada Konsep Sistem Reproduksi Manusia. *Skripsi, iv.*

Khoirurrijal, Fadriati, Sofia, Makrufi, A. D., Gandi, S., Muin, A., Tajeri, Fakhrudin, A., Hamdani, Suprapno. (2022). *Pengembangan Kurikulum Merdeka*. Malang: CV. Literasi Nusantara Abadi.

Litanianda, Y., & Setyawan, M. B. (2017). Implementasi Augmented Reality pada Media Pembelajaran Sistem Rangka Manusia di SD Muhammadiyah Terpadu Ponorogo. *Seminar Nasional Dan Gelar Produk, SENASPRO 2017*, 411–417. http://research-report.umm.ac.id/index.php/research-report/article/view/1245

Mahnun, N. (2012). Media Pembelajaran (Kajian terhadap Langkah-langkah Pemilihan Media dan Implementasinya dalam Pembelajaran). *Jurnal Pemikiran Islam, Vol.37*. https://ejournal.uin-suska.ac.id/index.php/Anida/article/view/310

Mukti, F. D. (2019). Pengembangan Media Pembelajaran Augmented Reality (AR) di Kelas V Wahid Hasyim. *Elementary: Islamic Teacher Journal, Vol.7*. https://journal.iainkudus.ac.id/index.php/elementary/article/view/6351/0

Mustaqim, I. (2016). Pemanfaatan *Augmented Reality* Sebagai Media Pembelajaran. *Jurnal Pendidikan Teknologi Kejuruan*, 13(2). https://ejournal.undiksha.ac.id/index.php/JPTK/article/viewFile/8525/5566

Nasution, M. I. S. (2021). Pengembangan Bahan Ajar Sejarah Asia Timur Berbasisi Augmented Reality Dalam Meningkatkan Keterampilan Berpikir Kreatif. *Jurnal Pendidikan Sejarah*, 6(1). https://jurnal.unimed.ac.id/2012/index.php/ph/article/view/22655

Nusi, K., Laliyo, L. A. R., Suleman, N., Abdullah, R., Studi, P., Kimia, P., & Matematika, F. (2021). *HIDROLISIS GARAM Description of Students ' Conceptual Understanding of Salt Hydrolysis Material*. *12*(1), 118–127. https://www.researchgate.net/publication/351670911_DESKRIPSI_PEMAHAMAN_KONSEPTUAL_SISWA_PADA_MATERI_HIDROLISIS_GARAM

Plomp & Nieveen. (2013). Introduction to Educational Design Research: An Introduction. *Educational Design Research*, 11–50.

Qorimah, E. N., & Sutama, S. (2022). Studi Literatur: Media Augmented Reality (AR) Terhadap Hasil Belajar Kognitif. *Jurnal Basicedu*, *6*(2), 2055–2060. https://jbasic.org/index.php/basicedu/article/view/2348

Supriadi, Wildan, Siahaan, J., Muntari, Haris, M. (2023). Pengembangan Media Pembelajaran Kimia Berbasis Teknologi Augmented Reality (AR) untuk Melatih Model Mental Siswa. *Chemistry Education Practice, 6(1).*

Supriono, N., & Rozi, F. (2018). Pengembangan Media Pembelajaran Bentuk Molekul Kimia Menggunakan Augmented Reality Berbasis Android. *JIPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika)*, *3*(1), 53–61. https://jurnal.stkippgritulungagung.ac.id/index.php/jipi/article/view/652/0

Timbowo, D. (2016). Manfaat Penggunaan Smartphone Sebagai Media Komunikasi (Studi pada Mahasiswa Jurusan Ilmu Komunikasi Fakultas Ilmu Sosial dan Politik Universitas Sam Ratulangi). *E-Journal "Acta Diurna," V*(2), 1–13. https://ejournal.unsrat.ac.id/index.php/actadiurnakomunikasi/article/view/11719

Ummah, I., & Ariwibowo, M. R. (2020). Augmented Reality Sebagai Media Pendukung Pembelajaran Masa Pandemi Covid-19. Jurnal Ilmu Pengetahuan dan Teknologi, 7(1). https://jurnal.ustjogja.ac.id/index.php/sciencetech/article/view/8901

Vari, Y., & Bramastia, B. (2021). Pemanfaatan Augmented Reality Untuk Melatih Keterampilan Berpikir Abad 21 Di Pembelajaran Ipa. *INKUIRI: Jurnal Pendidikan IPA*, *10*(2), 132. https://jurnal.uns.ac.id/inkuiri/article/view/57256

Veronika, R., Nurtanto, M., Ikhsanudin, I., Abdillah, H., Kholifah, N. (2022). Studi Literatur: Augmented Reality pada Dunia Pendidikan sebagai Kecenderungan Belajar Abad XXI. *Vocational Education National Seminar (VENS), Vol.01*. https://jurnal.untirta.ac.id/index.php/VENS/article/view/15915/9154

Wijaya, E. Y., Sudjimat, D. A., & Nyoto, A. (2016). Transformasi Pendidikan Abad 21 Sebagai Tuntutan Pengembangan Sumber Daya Manusia Di Era Global. *Prosiding Seminar Nasional Pendidikan Matematika*, *V*(1). https://core.ac.uk/download/pdf/297841821.pdf

Wulandari, R., Widodo, A., & Rochintaniawati, D. (2020). Penggunaan Aplikasi Augmented Reality Untuk Memfasilitasi Penguasaan Konsep Dan Keterampilan Berpikir Kreatif Peserta Didik. *Jurnal Pendidikan Biologi*, *11*(2), 59. https://ejournal.upi.edu/index.php/asimilasi/article/view/25796

Zainil, M., & Helsa, Y. (2019). *Media Pembelajaran Matematika Menggunakan Augmented Reality Tipe Quick Response (QR CODE)*. Purwokerto: CV. IRDH.