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Design of Augmented Reality Integrated Learning Applications on Acid and Base Subject Material for F Phase Students

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Abstract
The aim of this research is to create integrated augmented reality learning media in the form of an application that focuses on the acid base material in the F phase or senior high school phase. Along with the development of the world of education, various kinds of new learning media have emerged. One of the interesting technologies that can currently be developed on Android is Augmented Reality (AR). Augmented Reality is considered one of the most advanced technologies in virtual reality research and is effective as a learning medium, especially chemistry. Augemented Reality is a technology that combines the real world with a computer-generated virtual world so that the boundaries between the two worlds are very minimal. Because of its advantages, AR can be used to create learning applications that can support the teaching and learning process. One lesson that can utilize this technology is chemistry learning about acids and bases. This application was created with Blender 3D software to create 3D acid base objects, Easy AR and Unity 3D to build applications. This media design was adopted by the Plomp development media. Where the design of this media is in accordance with the needs of schools which expect learning media to contain animation and be guided by questions that can guide students in discovering concepts. It is hoped that this learning application can be used at school and outside school as a support in learning chemistry, especially acids and bases.

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INTRODUCTION

According to the Ministry of Education and Culture of the Republic of Indonesia, chemistry is grouped into science and technology which has developed competencies that require students to have factual, conceptual, procedural and metacognitive knowledge in learning natural sciences (Putri & Muhtadi, 2018) . Chemistry is the study of matter which includes the properties of matter, changes in matter, and the energy associated with these changes. Material in chemistry is studied by observing the properties and characteristics of each substance (Silberberg, 2013). This causes most chemical concepts to be abstract because they involve understanding that cannot be observed directly with the human senses (Wirya et al., 2009). According to Bowen & Bunce, students' ability to represent chemical problems and translate them into macroscopic, submicroscopic and symbolic representations is very necessary to understand chemistry learning concepts. Learning materials with three levels of representation and a high level of conceptual difficulty are acids and bases. This is because understanding the concept of acids and bases requires integration with other concepts both those that have been taught and those that will be taught in the future (Azizah et al, 2022).

Based on research by Atika & Latisma (2022), the level of student learning difficulty with a percentage of 77.2% in indicator 1, namely analysis of solution properties based on acid-base theory according to Arrhenius, Bronsted-Lowry and Lewis, is included in the high learning difficulty category. Based on data analysis and discussions carried out by Azizah et al (2022), learning difficulties occur in all acid-base concepts. One way to help students is to utilize technology-based learning media which is currently developing . According to *Azhar* (2015:19) States that use of learning media in the learning process teach can awaken desires and interests new , give rise to motivational and stimulating activity Study even give effect psychological for student (Burhanudin et al, 2017) . Learning media has an influence on students' cognitive learning outcomes (Tanjung, 2015)

Choosing the right learning media will attract students' interest in learning and be able to make students active in learning (Rosma et al., 2019) . The development of learning media based on information and communication technology is currently increasingly developing and has become a necessity that must be mastered by teachers and students (Zahwa & Syafi'i, 2022). So technology has a very important role in the field of education, such as the emergence of digital media which is used as a learning medium and the learning process can be carried out via the internet (Indarta et al, 2021). Information and communication technology in the world of education can be utilized by educators to create effective, creative and educational learning media. 21st century learning requires educators to be able to develop various technology-based learning media. One of the results of technological developments that is widely used in the 21st century is smartphones with the Android operating system (Abdul Majir, 2019).

Based on teacher interviews distributed across three school namely at State Senior High School (SMAN) 3 Padang, SMAN 7 Padang and Senior High School (SMA) Pembangunan UNP. Teacher at three school the use two type of learning media that is printed module and Ms. Office Power Point base media. Instructional Media with using an Android- based application yet There is used . Whereas Smartphone with system Android operation is one of them results development lots of technology used in the 21st century (Khairini & Yogica, 2021). According to data reported from goodstats.id, the Ministry of Communication and Information (Kemenkominfo) stated that the use of smartphones has reached 167 million people with a percentage of 89% of the total population of Indonesia. The phenomenon of many smartphone users provides a great opportunity for the development of technology that is useful in the field of education. Mobile technology, such as gadgets, offers opportunities to facilitate student-centered learning (Chen & Tsai, 2021). One technology that can be utilized in the education sector which can improve the learning experience is Augmented Reality (Mustaqim, 2016).

Based on research conducted by Nachairit & Srisawasdi (2016). Entitled "Using Augmented Reality Cars For Chemistry Learning Of Acid-Base Titration: Correlation Between Motivation And Perception" Research results This show influence motivation to chemistry to perception students to learn in environment based augmented reality learning inquiry that motivation student to chemistry own impact Partial to perception they towards mobile augmented reality. There is two dimensions namely significant Flow and Enjoyment related with Intrinsic Motivation, Career Motivation and Self Determination. It means , feeling pleasure and perception student to channel experience Study depends on feelings Study science for himself himself , and as tool to achieve objective . With Thus , we can use AR for participants who have effect positive and negative (Nachairit & Srisawasdi , 2016).

Augmented Reality has the potential to be used as a learning medium, because it can make the learning process more interesting and clear. Currently, almost all teachers and students

have gadgets, so there are no significant obstacles in using Augmented Reality as a learning medium (Ismayani, 2020). The use of Augmented Reality technology in education has several advantages over traditional teaching methods. Augmented Reality provides a more immersive and interactive learning experience (Turkan et al., 2017). This allows students to observe visualizations of abstract concepts that are present in real environments. Augmented Reality technology can increase student engagement and motivation so that it can make learning more fun and effective (Sarkar et al., 2020).

Augmented Reality technology provides a more personalized learning experience, allowing students to learn at their own pace and with more focus (Köse & Güner-Yildiz, 2021). Augmented Reality can display more interesting visuals with three-dimensional objects that seem to exist in a real environment. Augmented Reality technology can display animated objects in three dimensions along with audio from the material (Pramono, 2018). It is hoped that the combination of the virtual world and the real world can create a more effective and efficient learning process. Learning media that uses Augmented Reality technology can improve students' understanding because three-dimensional objects, text, images, video and audio can be displayed simultaneously directly (Abdoli-Sejzi, 2015).

According to Salawati & Indrawati (2015), students will more easily understand a lesson if it contains animated images that can stimulate student creativity. Currently, many educational institutions and organizations have adopted Augmented Reality technology to improve the teaching and learning process. Augmented Reality is used in various subjects, including science to create a more interesting and interactive learning experience (Yildirim, 2020). Based on the opportunity to combine technology with Augmented Reality, research was conducted with the aim of designing a prototype of an interactive learning application using Augmented Reality to increase student understanding and enrich the learning experience. As in research by Supriono & Rozi (2018) which states that augmented reality in chemistry subjects are suitable for use in schools and increase students' interest in learning.

METHOD

This researcher using educational design research (EDR). EDR is systematic with the aim of designing, developing and implementing educational interventions. This research follows the plomp model, originally proposed by Tjeerd Plomp, which consists of three distinct stages: initial investigation, prototype development or formation, and assessment stage (Plomp, 2013) . However study This only until two stages, namely the initial research and the research stage type prototypic formation .

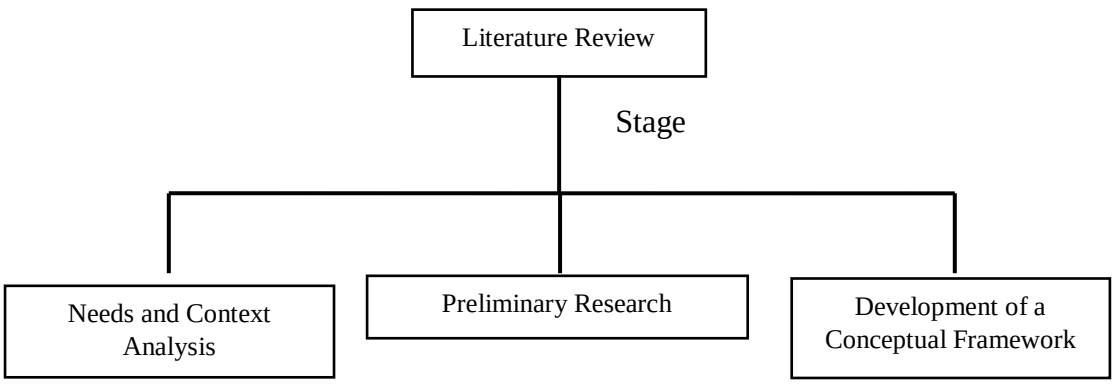


Figure 1 . Preliminary research stages

A needs analysis was carried out by interviewing three chemistry teachers in different schools to find out a picture of the problems experienced by teachers and students regarding acid-base material and the implementation of the chemistry learning process. In chemistry learning, learning media is needed to support chemistry learning. However, in reality there are still few learning media available, especially regarding acid-base material. Context analysis is an analysis of the curriculum and syllabus. This analysis is carried out to identify, detail and systematically compile the scope of learning outcomes, learning materials and media that will be developed. In the first step, an analysis is carried out of the learning outcomes that students must have in accordance with the demands of the independent curriculum. This analysis was carried out on F phase (senior high school phase) for acid base material.

Literature Review In this step, sources and sources related to research activities are sought. Books, journals, or online sources can be sources and references. In this step, the media is identified, detailed and explained along with the main concepts being studied, so that these concepts take the form of a concept analysis as an easy map.

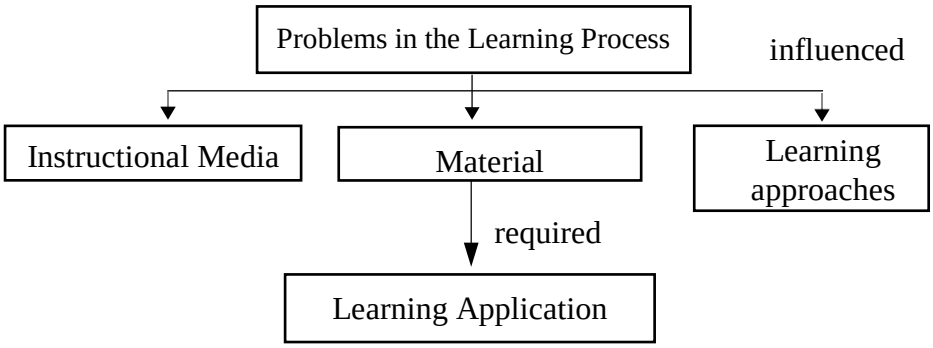


Figure 2 . Framework Conceptual

Needs and context analysis, as well as a comprehensive literature survey, provided the basis for developing a conceptual framework. In this research, the researcher collected the context of thinking by connecting the problems obtained from needs analysis and context analysis with a literature survey as a reference. Based on these results, it will later become the basis for designing learning media for chemistry learning material in F phase.

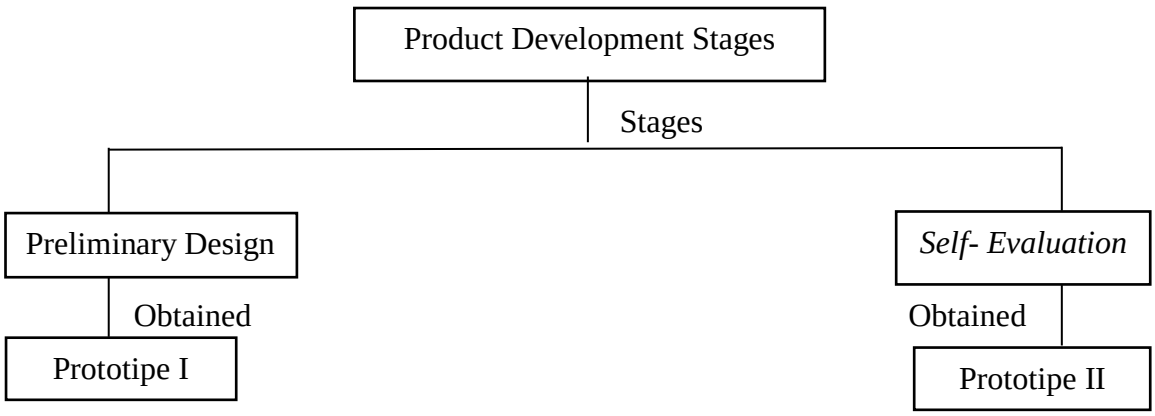


Figure 3 . Stages of Product Formation

Initial product design is based on preliminary research. At this stage the application begins to be designed starting from the software engine used, the appearance of the application, and the

systematics of the application program. This design is made in the form of a flowchart which is the result of a prototype.

The self-evaluation stage on prototype I was carried out by checking the components of prototype I with a checklist containing the required product components. After carrying out a checklist on the learning media design, if there are still parts that are missing then revisions are carried out to produce prototype II.

RESULTS AND DISCUSSION

Application design using the Plomp development model in this research aims to produce a prototype II to find out whether the application design can function fully according to design based on the results of preliminary research analysis.

Needs and Context Analysis

The goal of this analysis is to deeply understand user needs and the context in which the augmented reality application will be used. By understanding user needs and context of use, developers can design and develop augmented reality applications that are more relevant, functional, and engaging for users. Data was obtained through distributing questionnaires to students and 3 chemistry teachers from SMAN 3 Padang, SMAN 7 Padang, and SMA Pembangunan UNP as well as 99 students from these 3 schools. One of The results of the questionnaire for the three schools can be seen in Appendix 1.

According to the Ministry of Education and Culture of the Republic of Indonesia, chemistry is grouped into science and technology which has developed competencies that require students to have factual, conceptual, procedural and metacognitive knowledge in learning natural sciences (Putri & Muhtadi, 2018). According to Bowen & Bunce, students' ability to represent chemical problems and translate them into macroscopic, submicroscopic and symbolic representations is very necessary to understand chemistry learning concepts. Learning materials with three levels of representation and a high level of conceptual difficulty are acids and bases. This is because understanding the concept of acids and bases requires integration with other concepts both those that have been taught and those that will be taught in the future (Azizah et al, 2022). This is in line with data obtained from 99 stage F students for the 2022/2023 academic year, that 79.6% of them experienced difficulties in understanding the concepts contained in the acid-base material.

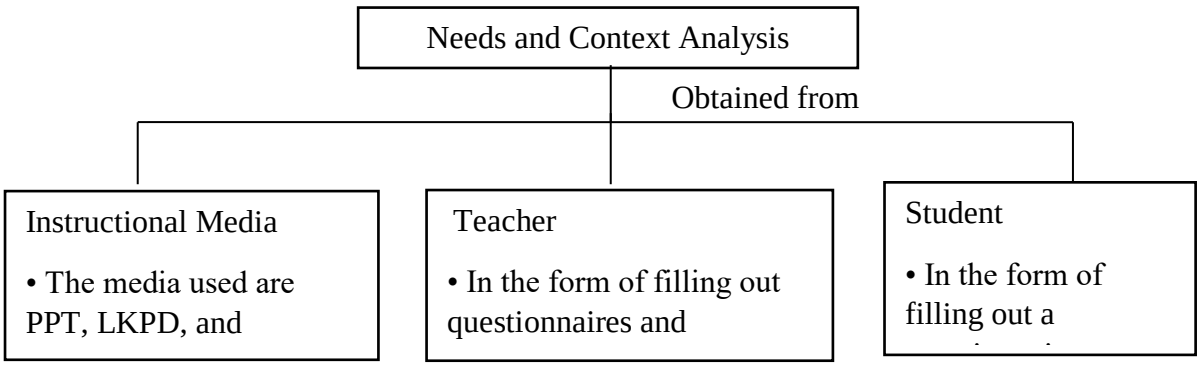


Figure 4 . Needs and Context Analysis

One of the causes of students' low understanding of concepts is that teachers rarely use media that can present images containing abstract concepts well in learning activities. The use of

visual media is more interesting for students in learning because visuals have a greater influence on the ease of understanding the material (Safitri & Sa'dudin, 2019). Based on a questionnaire distributed to 3 teachers, 100% of teachers used PPT, module and LKPD media in the acid-base learning process, where the media contained more text and images that were less clear. According to Siirtola et al (2014), media that can support presentations is at least accompanied by clear image visualization and concise description of the text. The use of media with explanatory text that is not concise and visualization of images that are not clear causes students to tend to prefer to memorize each material in the media presented and write it back in their notebooks before taking daily tests (Appendix 2).

Choosing the right learning media will attract students' interest in learning and make students more active in learning. Three teachers stated that the media used in acid-base learning activities did not attract students' attention, so students were less active during the acid-base learning process. This shows that the choice of media used in the acid-base learning process is not appropriate to support student-centered learning activities. Mobile technology offers opportunities to support student-centered teaching and learning activities (Chen & Tsai, 2021). Based on the questionnaire distributed, 100% of students use personal devices at school to support the learning process at school. Even though gadgets have been used in acid-base learning activities, in fact most students use these gadgets for online games and interactions on social media.

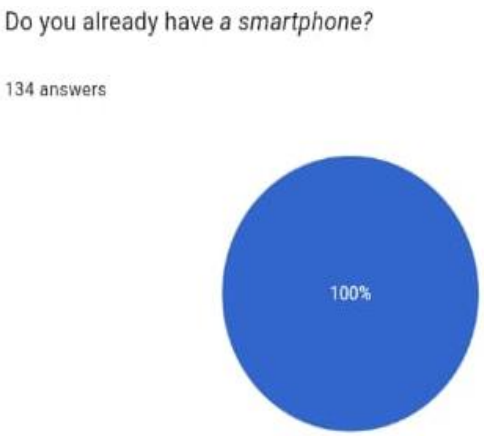


Figure 5. Percentage students who have smartphones

The high use of gadgets among students can be used as technology-based media that can guide students in discovering concepts to support learning both at school and outside school. One technology that utilizes student-oriented learning devices is learning media in the form of applications that are integrated with Augmented Reality.

Literature Review

The literature review aims to find and understand sources related to the development activities carried out. The literature review was carried out by looking for references related to learning media design activities in the form of interactive applications using Augmented Reality technology on acid-base material. Study Relevant past _ with study This including :

Research conducted by FS Irwansyah , YM Yusuf, Farida, MA Ramdhani (2018). Entitled "Augmented Reality (AR) Technology on The Android Operating System in Chemistry Learning" Via study based design , has succeed developed A product in the form of learning media AR- based on the Android system . Learning media test results AR based on the concept geometry molecule in a way whole has fulfil condition Enough worth using _ as

source Study with percentage 70.83-92.50%. This result show that learning media AR- based on the Android system has the potential to be applied to learning chemistry especially regarding material geometry molecule (Irwansyah et al, 2018) .

Learning with Augmented Reality media can increase students' interest in learning and students' understanding of concepts. This is supported by research by Nachairit & Srisawasdi (2016) whose research results show that the use of Augmented Reality provides positive results for students to increase student enthusiasm. Augmented Reality media in chemistry learning can improve students' 4C abilities (Critical Thinking, Creative Thinking, Collaboration and Communication).

conceptual framework

The theoretical framework was prepared based on the results of needs and context analysis as well as literature review. The conceptual framework is given in Figure 6.

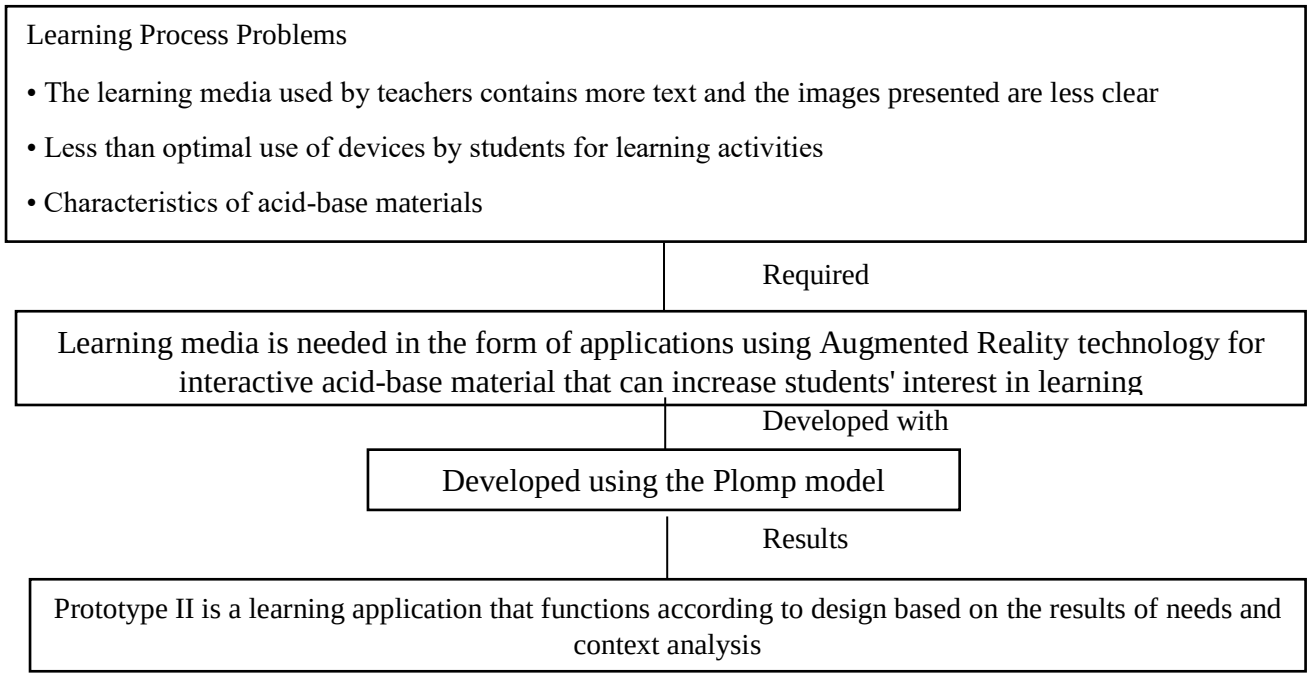


Figure 6 . Conceptual framework

Initial design

The initial stage of product development in this research is application design. This augmented reality integrated application is designed using a combination of several software. Unity 3D software is used as an application creation studio. Blender software is used to design the required three-dimensional objects and their animations. EasyAR is used as a provider of Augmented reality creation features connected to Unity 3D. Adobe Illustrator is used to create designs from markers or target images that will be scanned on AR cameras and other visual design needs for application displays. The target image is designed like a flashcard by providing some important information about the three-dimensional object that will appear. The flow diagram of implementation activities is presented in Figure 7.

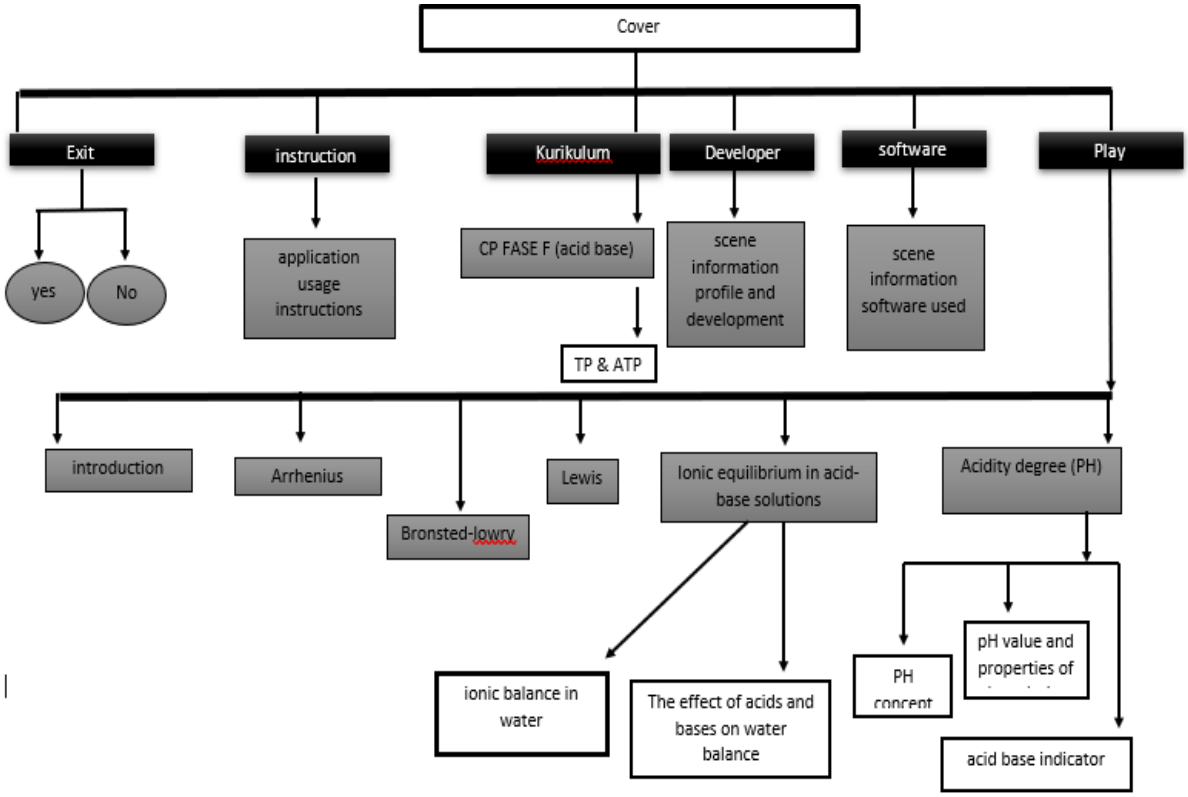
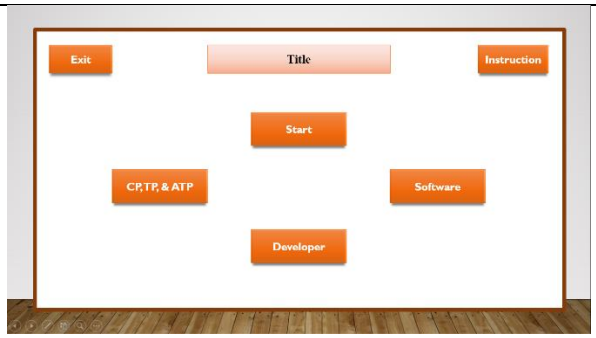
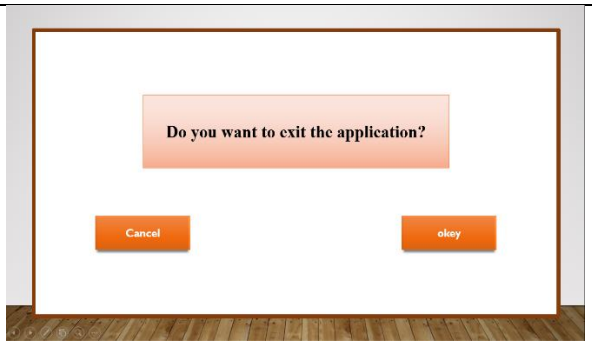
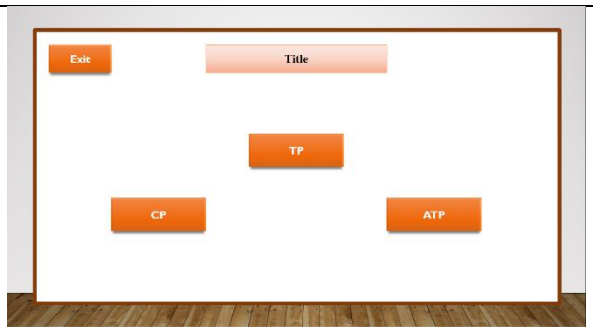


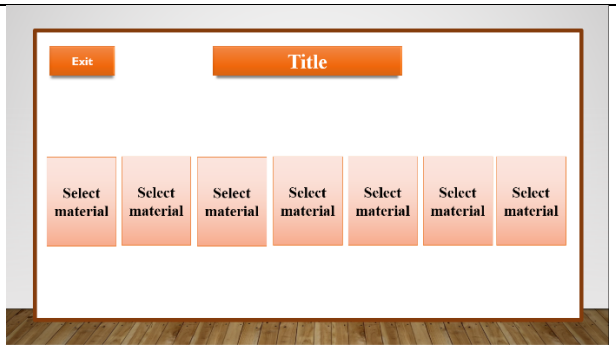
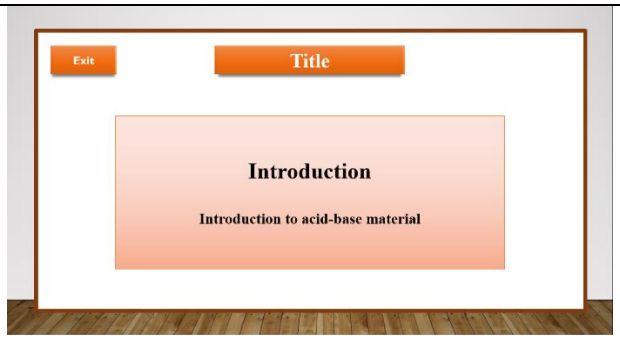
Figure 7. Application flow diagram

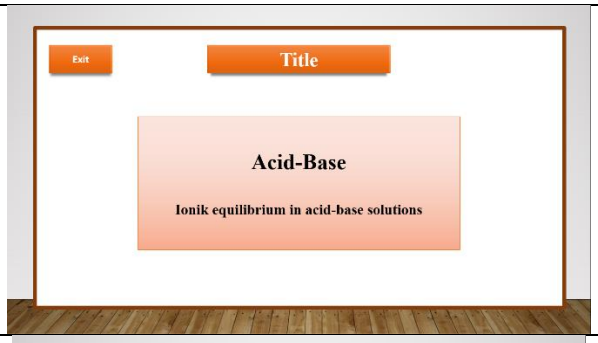
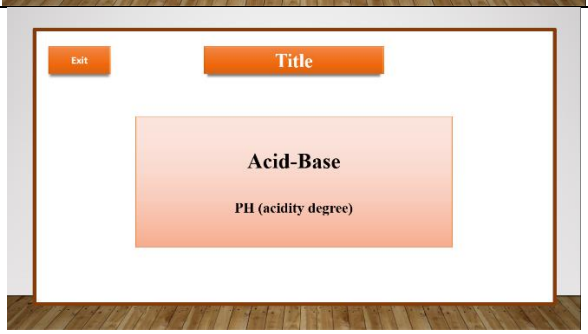
Flowcharts help plan, develop, test, identify problems, and document application workflows efficiently. Apart from the flowchart, in the initial planning an application storyboard is also designed. Application storyboards aim to visualize concepts, organize storylines, identify design needs, facilitate team collaboration, and serve as reference documents in application development. The application storyboard is given in Table 1.

Table 1. Application Storyboard

Page	Appearance	Information
Cover		cp tp & atp , turn, exit, software , instructions and developer.

Go out		If the user clicks the yes button then the application will exit, and if the user clicks the no button it will return to the cover.
CP, TP, & ATP		This scene contains cp, tp and atp. Exit button to return to cover.
Instruction		Contains instructions for using the application, exit button to return to cover .
device soft		Contains information about what software was used to develop the application, and an exit button to return to the cover.
developer		Contains application developer profile information and an exit button to return to cover .

Play		Contains a selection of materials that can be selected by the user, exit button to return to the cover.
Introduction		acidic basic material (videos & quizzes). Exit button to return to the material selection scene.
Ingredients 1		Contains acid-base material regarding Arrhenius theory (images, animations, and videos as well as quizzes), AR to view 3D objects and an exit button to return to the scene to select material.
Ingredient 2		Contains acid-base material regarding Bronsted-Lowry theory (images, animations and videos as well as quizzes), AR to view 3D objects and an exit button to return to the scene to select material.
Ingredient 3		Contains acid-base material regarding Lewis's theory (images, animations, and videos as well as quizzes), AR to view 3D objects and exit button to return to scene, select material.

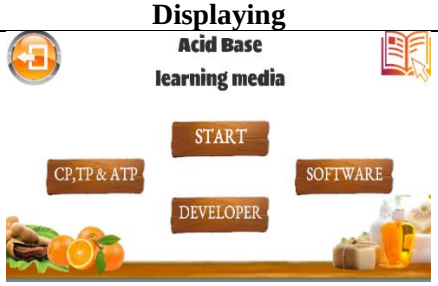
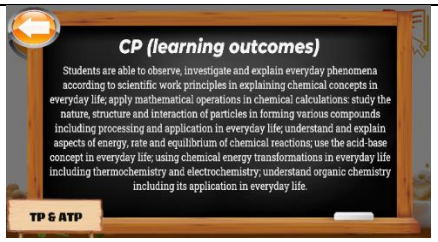
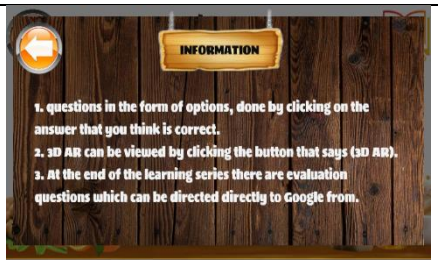
Material 4		Contains acid-base material regarding acid-base internal ion balance solutions (images, animations, and videos as well as quizzes), and an exit button to return to the scene to select material.
Material 5		Contains acid-base material regarding degrees of PH similarity (images, animations, and videos as well as quizzes), and an exit button to return to the scene to select material
Evaluation		For evaluation questions, users click the Google Forms link. Exit button to return to the selected material.

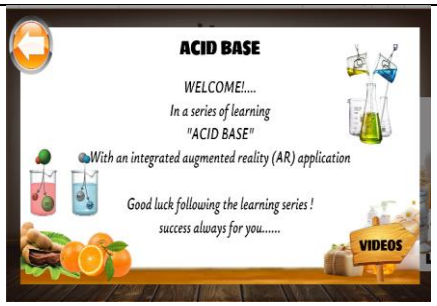
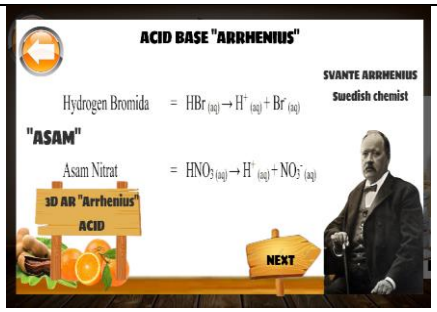
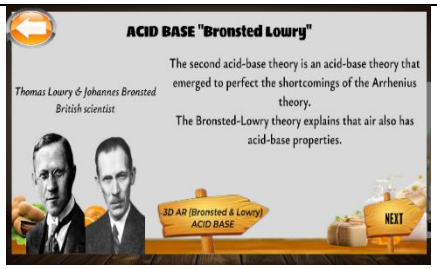
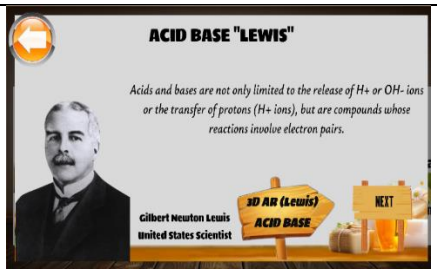
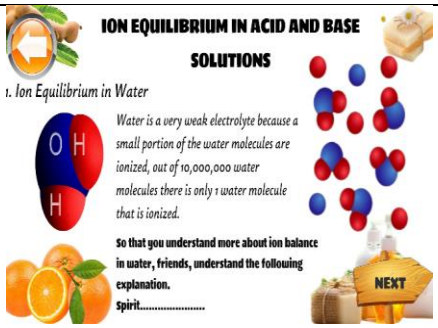
Self evaluation

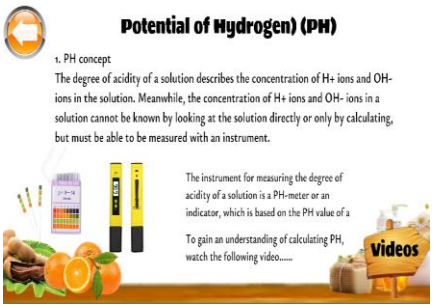
Self-Evaluation is carried out after realizing the design needed to create an integrated Augmented Reality application on acid-base materials. Self-evaluation is carried out after realizing the design needed to create an integrated Augmented Reality application on acid-base materials. Self-evaluation is carried out using a check-list method to see the completeness of prototype I. Prototype I which passes the self-evaluation stage will become prototype II of the product being developed. Application functions are designed based on the results of analysis in initial research according to user needs, where in general the application contains material, AR pages and quizzes.

Previous research by Supriono & Rozi (2018) stated that applications with Augmented Reality were successfully built, could run well from the aspect of functional suitability and stated that students' interest in learning could increase due to the existence of learning applications assisted by Augmented Reality media. However, learning applications are not yet equipped with an interactive learning process where the application does not guide students in discovering concepts. Therefore, in this research a learning application was designed which is equipped with material that guides students to discover concepts using prompting and quiz methods as well as direct observation of 3D objects without the need for markers. This application was developed using the Plomp development model. In developing Plomp, self-evaluation was carried out using a checklist instrument. The results of the self-evaluation are presented in Table 2.

Table 2. *Self Evaluation* Results

No	Page	Information	Displaying	Conclusion
1.	Cover	The cover page displays successfully with an exit button at the top left to exit the application, and another button for the next menu .		Succeed
2	Cp, Tp & atp	The curriculum page successfully displays CP, TP, and ATP as well as an exit button to exit the application		Succeed
3.	software	On the successfully displayed software page , the exit button returns to cover.		Succeed
4.	Instruction	On the success instruction page displayed, the exit button returns to the cover.		Succeed
5.	developer	On a successfully displayed developer page , the exit button returns to cover.		Succeed
6.	beginning	On the Play page there is a selection of materials that the user can select, and exit to return to the cover		Succeed

7.	Introduction	On the introductory page there is an explanation of the basic acid material (images, videos and quizzes). Exit button to return to the options menu		Succeed
8.	Ingredients 1	After the introductory page is complete the user can continue to material page 1, on this page there are resources material base about theory arrhenius , camera button to view 3D objects and exit to return to the material selection page.		Succeed
9.	Ingredient 2	basic material regarding Bronsted Lowry's theory , a camera button to view 3D objects and exit to return to the material selection page.		Succeed
10.	Ingredient 3	After the material on page 2 is complete, the user can continue to material on page 3, on this page there is material on acids and bases about theory Lewis , camera button to view 3D objects and exit to return to the material selection page.		Succeed
11.	Material 4	After material on page 3 is complete, users can continue to material page 4, on this page there is acid-base material regarding acid-base internal ion balance solutions , and exit to return to the material selection page.		Succeed

12.	Material 5	After the material on page 4 is complete, the user can continue to the material on page 5 , on this page there is material about acids and bases . degree of pH equivalence , and exit to return to the selected ingredient page.		Succeed
1 3 .	Evaluation	After the material on page 4 is complete, the user can continue to the evaluation page, on this page the user can test his understanding of the material presented by clicking Google from. Exit button to return to the material selection menu .		Succeed

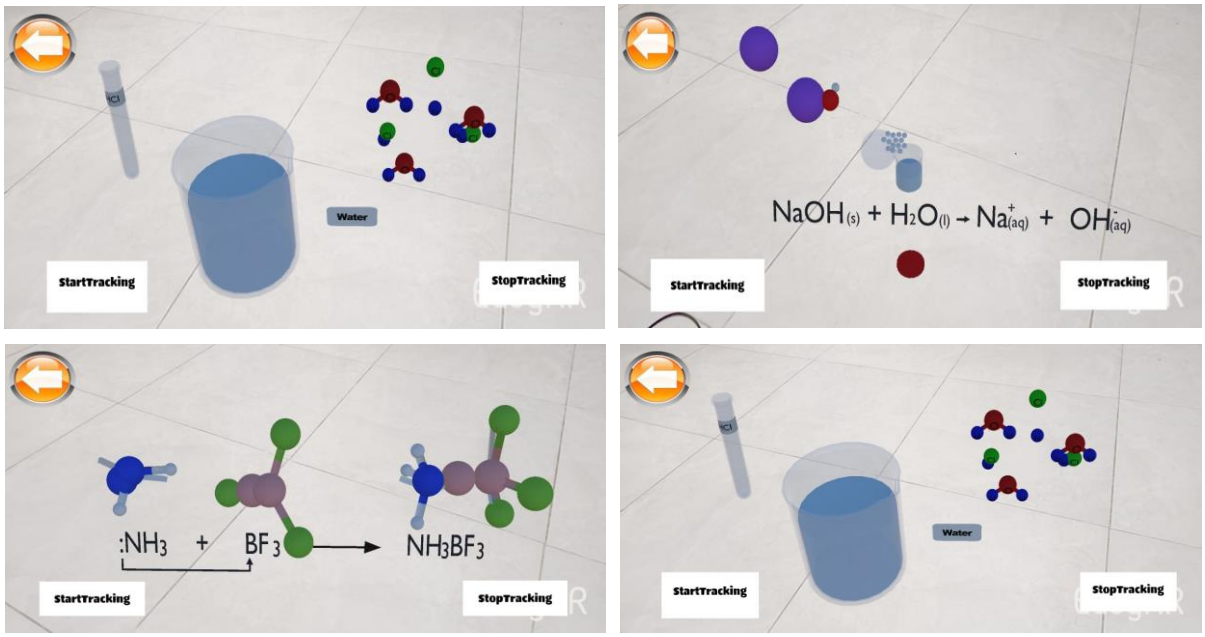


Figure 8. 3D AR produced

The designed application is equipped with existing research designs by providing a main menu which is equipped with several sub menus, namely curriculum, instructions, application, and main to continue on the material selection page. On the material selection page there are several sub-materials. The material displayed is oriented towards student processes where students discover concepts independently by carrying out each programmed process complete with quizzes and observations through 3D objects in Augmented Reality without the need for markers.

CONCLUSION

Based on initial research data and the product formation stage, it can be concluded that the learning application design using the Plomp development model produced a Prototype II that conformed to the design based on the results of the analysis in the initial research as successful as expected. This application is a solution as a learning medium that can help users better understand acid-base material through discovering concepts using augmented reality and testing each sub-material. It is hoped that this application prototype can be continued to produce an interesting learning application using Augmented Reality on acid-base material that can be used in schools and outside of school to support chemistry learning.

RECOMMENDATION

Recommendations based on the research results, it is hoped that this application prototype can be continued so as to produce an interesting learning application using Augmented Reality on acid-base material which can be used in school and outside school as a support for chemistry learning, especially acid-base. basic material.

BIBLIOGRAPHY

Abdoli-Sejzi, A. (2015). Augmented Reality Dan Lingkungan Pembelajaran Virtual. Jurnal Penelitian Ilmu Terapan, 11(8), 1–5.

Abdul Majir. (2019). Blended Learning Dalam Pengembangan Pembelajaran Suatu Tuntutan Guna Memperoleh Keterampilan Abad Ke-21. *Sebatik Jurusan PGSD, FKIP, Universitas Katolik Indonesia Santu Paulus Ruteng.* , 359–366.

Atika & Latisma. (2022). Deskripsi Kesulitan Belajar Kimia Siswa pada Materi Asam Basa Kelas XI IPA di SMA Negeri 7 Padang. *Entalpi Pendidikan Kimia*, 18–26.

Azizah dkk. (2022). Analisis Miskonsepsi Dengan Tes Diagnostik Two-Tier Multiple Choice Dan In-Depth Interview Pada Materi Asam Basa. *Jurnal Pendidikan Kimia, Program Studi Pendidikan Kimia, Universitas Sebelas Maret*, *11*(2), 168–177. https://jurnal.uns.ac.id/jpkim

Chen, C.-H., & Tsai, C.-C. (2021). In-Service Teachers' Conceptions of Mobile Techonology-Integrated Instruction: Tendency Towards Student-Centered Learning. *Computers & Education, 104224*, 170.

Indarta dkk. (2021). 21st Century Skills: TVET dan Tantangan Abad 21. *Edukatif: Jurnal Ilmu Pendidikan, 3*(6), 4340–4348.

Irwansyah dkk. (2018). Augmented Reality (AR) Technology on the Android Operating System in Chemistry Learning. *IOP Conference Series: Materials Science and Engineering*, *288*(1), 0–7. https://doi.org/10.1088/1757-899X/288/1/012068

Ismayani, A. (2020). Membuat Sendiri Aplikasi Augmented Reality. Jakarta: Elex Media Komputindo

Khairini & Yogica. (2021). Pengembangan Media Pembelajaran Interaktif Berbentuk Android Packaging Kit (APK) Pada Materi Virus. *Jurnal Penelitian Dan Pengembangan Pendidikan*, *5*(3), 406–413. https://ejournal.undiksha.ac.id/index.php/JJL/index%0APengembangan

Köse, H., & Güner-Yildiz, N. (2021). Augmented reality (AR) as a learning material in

special needs education. *Education and Information Technologies*, *26*(2), 1921–1936. https://doi.org/10.1007/s10639-020- 10326-w

Mustaqim, I. (2016). Pemanfaatan Augmented Reality Sebagai Media Pembelajaran. Jurnal Pendidikan teknologi dan kejuruan , 13(2), 174-183.

Nachairit & Srisawasdi. (2016). Using Mobile Augmented Reality For Chemistry Learning Of Acid-Base Titration: Correlation Between Motivation And Perception. *Researchgate: Khon Kaen University, Khon Kaen, Thailand, February*. https://www.researchgate.net/publication/294670016%0AUsing

Plomp & Nieveen. (2007). *An Introduction to Educational Design Research* (Tjeerd Plomp & Nienke Nieveen (ed.); Edisi 1). Proceedings of the seminar conducted at the East China Normal University, Shanghai (PR China), November 23-26, 2007.

Plomp & Nieveen. (2013). *Educational design research* (Tjeerd Plomp & Nienke Nieveen (ed.)).

Pramono, H. D. (2018). Penerapan Teknologi Augmented Reality Pada Game Pengenalan Hewan Berdasarkan Jenis Makanannya Berbasis Mobile. J-INTECH, 6(01), 166–172.

Putri & Muhtadi. (2018). Pengembangan Multimedia Pembelajaran Interaktif Kimia Berbasis Android Menggunakan Prinsip Mayer Pada Materi Laju Reaksi. *IPTPI: Jurnal Inovasi Teknologi Pendidikan*, *5*(1), 38–47. http://journal.uny.ac.id/index.php/jitp

Rosma Aryani, P., Akhlis, I., Subali Jurusan Fisika, B., & Matematika dan Ilmu Pengetahuan Alam, F. (2019). Penerapan Model Pembelajaran Inkuiri Terbimbing Berbentuk Augmented Reality pada Peserta Didik untuk Meningkatkan Minat dan Pemahaman Konsep IPA. *Unnes Physics EducationJournal Terakreditasi SINTA,8*(2). http://journal.unnes.ac.id/sju/index.php/upej

Safitri, E., & Sa'dudin, I. (2019). The Use of Visual Media in Maharatah Al-Kalam Learning. *Jurnal Al Bayan: Jurnal Jurusan Pendidikan Bahasa Arab, 11*(1), 72-89.

Salawati, T., & Indrawati, N. D. (2015). Tahap Analisis Untuk Pengembangan "Asetaro" Komik Pendidikan Kesehatan UNTUK Anak Tentang Bahaya Merokok. Prosiding Seminar Nasional & Internasional

Sarkar, P., Kadam, K., & Pillai, J. S. (2020). Learners' Approaches, Motivation and Patterns of Problem-Solving on Lines and Angles in Geometry Using Augmented Reality. *Smart Learning Environments*, *7*(1). https://doi.org/10.1186/s40561-020-00124-9

Siirtola, H., Saily, T., Nevalainen, T., & Raiha, K.-J. (2014). Text Variation Explorer: Towards Interactive Visualization Tools For Corpus Linguistics. *Internasional Journal of Corpus Linguistics*, *19*(3), 417-429.

Silberberg, M. S. (Martin S. (2013). *Principles of General Chemistry* (Third).

McGraw-Hill.

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).

Tanjung, S. (2015). Pengaruh Media Pembelajaran dan Gaya Kognitif terhadap Hasil Belajar Sejarah. *Paramita*, *25*(2).

Turkan, Y., Radkowski, R., Karabulut-Ilgu, A., Behzadan, A. H., & Chen, A. (2017). Mobile Augmented Reality for Teaching Structural Analysis. *Advanced Engineering*

Informatics,*34*,90–100. https://doi.org/10.1016/j.aei.2017.09.005

Wirya, W., Suyanto, E., & Suyadi, G. (2009). Identifikasi Masalah Kesulitan dalam Pembelajaran Kimia SMA Kelas X di Provinsi Lampung. *Journal Pendidikan MIPA (JPMIPA)*, *10*(2), 9–18.

Yildirim, F. S. (2020). The Effect of the Augmented Reality Applications in Science Class on Students' Cognitive and Affective Learning. *Journal of Education in Science, Environment and Health*, *6*(4).

Zahwa & Syafi'i. (2022). Pemilihan Pengembangan Media Pembelajaran Berbasis Teknologi Informasi. *Equilibrium: Jurnal Pendidikan Dan Ekonomi*, *19*(01), 61–78. https://journal.uniku.ac.id/index.php/Equilibrium

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https://e-journal.undikma.ac.id/index.php/hydrogen/index

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Appendix 1. Sample of the Teacher Questionnaire Results

QUESTION SHEET

A. Instruction Charging Questionnaire

- It is hoped that Mr/ Mrs read and answer all question with thorough without something was missed .
- Give sign tick (√) on the answer according to Mr/ Ms appropriate .

B. Teacher Identity

Teacher's name : Laksminawati Yunaz
School Name : SMA Construction of UNP laboratory

C. Item Question

No.	Question
1.	Curriculum what are you father/ mother using in learning acid base in the year teaching this / next ? ☐ K13 ☐ Independent Curriculum √
2.	Are you Mr/ Mrs using learning media in learning Acid Base ? ☐ Yes √ ☐ No
3	What media do you use, sir/ madam ? use it on the material Acid Base ? ☐ Text √ ☐ Visual ☐ Audio ☐ Moving objects (video, animation) ☐ Engineer (model)
4.	What form of media that Mr/ Mrs present the material Acid Base ? ☐ Book print √ ☐ E- module ☐ Print Module ☐ E-LKPD ☐ LKPD √ ☐ Web- based system ☐ Power point (PPT) √ ☐ Android/ iOS / *mobile learning application* √ ☐ Etc *(write):* ...
5.	Based on answer No. 4, what just the type of media available in the teaching materials ? ☐ Image √ ☐ Model √ ☐ Animation ☐ Videos
6 .	Representation What That's all you have , sir/ madam use it on the material Acid Base ? ☐ Macroscopic √ ☐ Microscopic ☐ Symbolic √
7.	How are you sir/ madam ? give description to concepts in the material Acid Base ? ☐ Describe draft linked to the board write √ ☐ Displaying picture draft linked to powerpoint √ ☐ Provide related videos description draft related ☐ .....
8.	What is learning media The acid and base that Mr/ Mrs use Already can displays form three dimensions from existing concepts ? _ ☐ Already ☐ Not enough ☐ Not yet √
9.	Is the media on the material sir / madam use can interesting attention participant educate ? ☐ Already interesting attention participant educate √ ☐ Not enough interesting attention participant educate ☐ No interesting attention participant educate
10.	How interest Study participant educate in learning Acid Base ? ☐ X < 25% ☐ 25 % ≤ X ≤ 50% ☐ 50 % ≤ X ≤ 75% √ ☐ X ≥ 75%
11 .	How liveliness participant educate in learning Acid Base ? ☐ < ¼ participants educate active ☐ ≥ $\frac{1}{2}$ participant educate active √ ☐ ¼ – 1/3 participants educate active ☐ No some are active
12.	How understanding participant learn (results study) participants educate in material Acid Base ? *(scale divide by 4!)* ☐ < ¼ participants educate reach completion that has been done set ☐ 1/3 – ¼ participants educate reach completion that has been done set ☐ < 1/3 participants educate reach completion that has been done set ☐ ≥ $\frac{1}{2}$ participant educate reach completion that has been done set √ ☐ *No There is* participant students who achieve completion that has been done set
13.	How media characteristics or teaching materials that Mr/ Mrs need in learning Acid Base ? a. In terms of media type , have ☐ Image √ ☐ Model √ ☐ Videos √ ☐ Animation √ b. In terms of representation chemistry , has : ☐ Representation macroscopic √ ☐ Representation submicroscopic √ ☐ Representation symbolic √ c. In terms of practicality ☐ Can used Where just and when just √ ☐ Easy used √ ☐ Easy accessed
14 .	Are you Mr/ Mrs give permission participant educate use gadget For support learning moment needed ? ☐ Yes √ ☐ No

Augmented Reality

Technology *Augmented reality* is visual technology that combines object or virtual world to in real world view in real time. Camera as the ' eyes ' of AR technology takes picture from the marker in a way ongoing , processing and then produce virtual interactions that appear on a real- world display good on screen or head mounted display (HMD). A combination of the virtual world and the real world This hopefully it can bring a deeper learning process _ effective and efficient .

15.	Are you Mr/ Mrs Already know Augmented Reality technology before ? ☐ Already ☐ Not yet √
16.	Are you Mr/ Mrs Once using learning media Augmented Reality based on material Acid Base ? ☐ Once ☐ Never √
17.	Are you Mr/ Mrs interested use technology *Augmented Reality* as a learning medium Atomic Structure ? ☐ Interested √ ☐ Not interested

I say Thank You to those of you who have to spare the time For answer question in accordance with circumstances Actually .

Padang, 01 June 2023

Respondent

(Laksminawati yunaz)

Appendix 2. Recapitulation Teacher Questionnaire

Recapitulation Answer Teacher questionnaire _ _

TEACHER IDENTITY	
Teacher name	**School**
1. Zulvadianty , S.Pd	SMAN 3 Padang
2. Ernawati , S.Pd	SMAN 7 Padang
3. Laksminawati Yunaz	Padang Development High School

No	Question	Teacher's Answer		
		SMAN 3	SMAN 7	PB High School
1.	Curriculum what are you father/ mother using in learning acid base in the year teaching this / next ? ☐K13 ☐ Independent Curriculum	☐ Independent Curriculum	☐ Independent Curriculum	☐ Independent Curriculum
2.	Are you Mr/ Mrs using learning media in learning Acid Base ? ☐ Yes ☐ No	☐ Yes	☐ *Yes*	☐ Yes
3.	What media do you use, sir/ madam ? use it on the material Acid Base ? ☐ Text ☐Audio ☐ Engineer (model) ☐Visuals	☐ Text ☐Visuals ☐ Object moving (video, animation)	☐ Text ☐Visuals	☐ Text
	☐ Object moving (video, animation)			
4.	What form of media that Mr/ Mrs present the material Acid Base ? ☐ Books print ☐Print Module ☐LKPD ☐Power point (PPT) ☐E- module ☐E-LKPD ☐Web - based system ☐Android/ iOS / mobile learning application ☐ Etc (write down): ……	☐ Books print ☐Print Module ☐Power point (PPT)	☐Print Module ☐Power point (PPT)	☐ Books print ☐LKPD ☐Android/ iOS/ mobile learning application
5.	Based on answer No. 4, what just the type of media available in the teaching materials ? ☐Image ☐ Animation ☐Models ☐Videos	☐Image ☐Videos	☐Image ☐Models	☐Image ☐Models
6.	Representation What That's all you have , sir/ madam use it on the material Acid Base ? ☐ Macroscopic ☐ Microscopic ☐ Symbolic	☐ Macroscopic ☐ Microscopic ☐ Symbolic	☐ Macroscopic ☐ Symbolic	☐ Macroscopic ☐ Symbolic
7.	How are you sir/ madam ? give description to concepts in Acid Base material ? ☐ Describe draft linked to the board write ☐ Displays picture draft linked to powerpoint ☐ Provide related videos description draft related ☐ ….	☐ Describe draft linked to the board write ☐ Displays picture draft linked to powerpoint	☐ Describe draft linked to the board write ☐ Displays picture draft linked to powerpoint	☐ Describe draft linked to the board write ☐ Displays picture draft linked to powerpoint
8.	What is learning media The acid and base that Mr/ Mrs use Already can displays form three dimensions from existing concepts ? _ ☐ Already ☐ Not enough ☐ Not yet	☐ Already	☐Not yet	☐Not yet
9.	Is the media on the material sir / madam use can interesting attention participant educate ? ☐ Already interesting attention participant educate ☐ Not enough interesting attention participant educate ☐ No interesting attention participant educate	☐ Already interesting attention participant educate	☐ Not enough interesting attention participant educate	☐ Already interesting attention participant educate
10.	How interest Study participant educate in learning Acid Base ? ☐ X < 25% ☐ 25 % ≤ X ≤ 50% ☐ 50 % ≤ X ≤ 75% ☐ X > 75%	☐ X ≥ 75%	☐ 25 % ≤ X ≤ 50%	☐ 50 % ≤ X ≤ 75%
11.	How liveliness participant educate in learning Acid Base ? ☐ < ¼ participants educate active ☐ ≥ $\frac{1}{2}$active students	☐ ≥ $\frac{1}{2}$active students	☐ ≥ $\frac{1}{2}$active students	☐ ≥ $\frac{1}{2}$active students
	☐ ¼ – 1/3 participants educate active ☐ No some are active			
12.	How understanding participant learn (results study) participants educate in material Acid Base ? *(scale divide by 4!)* ☐ < ¼ participants educate reach completion that has been done set ☐ 1/3 – ¼ participants educate reach completion that has been done set ☐ < 1/3 participants educate reach completion that has been done set ☐ ≥ $\frac{1}{2}$students achieve the specified mastery ☐ *No There is* participant students who achieve completion that has been done set	☐ ≥ $\frac{1}{2}$students achieve the specified mastery	☐ ≥ $\frac{1}{2}$students achieve the specified mastery	☐ ≥ $\frac{1}{2}$students achieve the specified mastery
13.	How media characteristics or teaching materials that Mr/ Mrs need in learning Acids and Bases? a.From facet media type , have ☐Image ☐Videos ☐Models ☐ Animation b. From facet representation chemistry , has : ☐ Representation macroscopic , ☐ Representation submicroscopic ☐ Representation symbolic c. From facet practicality ☐ Got it used Where just and when just ☐ Easy used ☐ Easy accessed	a.From facet media type , have ☐Image b. From facet representation chemistry , has : ☐ Representation macroscopic , ☐ Representation submicroscopic ☐ Representation symbolic c. From facet practicality	a.From facet media type , have ☐Image ☐Models b. From facet representation chemistry , has : ☐ Representation macroscopic , ☐ Representation submicroscopic ☐ Representation symbolic c. From facet practicality	a.From facet media type , have ☐Image ☐Videos ☐Models ☐ Animation b. From facet representation chemistry , has : ☐ Representation macroscopic , ☐ Representation submicroscopic
		☐ Got it used Where just and when just ☐ Easy used ☐ Easy accessed	☐ Got it used Where just and when just ☐ Easy used ☐ Easy accessed	☐ Representation symbolic c. From facet practicality ☐ Got it used Where just and when just ☐ Easy used ☐ Easy accessed
14.	Are you Mr/ Mrs give permission participant educate use gadget For support learning moment needed ? ☐ Yes ☐ No	☐ Yes	☐ Yes	☐ Yes
15.	Are you Mr/ Mrs Already know Augmented Reality technology before ? ☐ Already ☐ Not yet	☐ Not yet	☐ Not yet	☐ Not yet
16.	Are you Mr/ Mrs Once using learning media Augmented Reality based on material Acid Base ? ☐ Once ☐ Never	☐ Never	☐ Never	☐ Never
17.	Are you Mr/ Mrs interested use technology *Augmented Reality* as a learning medium Atomic Structure ? ☐ Interested ☐ Not interested	☐ Interested	☐ Interested	☐ Interested