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The Potential for The Development of Augmented Reality Media to Increase Student Understanding of Earthquake Material

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Abstract: Along with the development of technology, the use of smartphones in teaching and learning activities has become one of the most influential innovations in the world of Education, especially in physics learning. Learning media is needed to make it easier for students to understand physics concepts, but media that can visualize abstract concepts clearly have not been developed much. As an alternative media, Augmented Reality was chosen as a solution to this problem. This type of research is descriptive qualitative and aims to describe the potential for the development of augmented reality media to increase students' understanding of earthquake material. Data collection techniques using questionnaires. The questionnaire was made using G-Form containing six question items, each of which required a response in the form of a checklist or description in each item answer column according to the respondent's opinion. The questionnaire was distributed online to respondents who were students of Universitas Pendidikan Ganesha and Universitas Terbuka. The sample was randomly selected as many as 206 students who had attended the lecture wave. Research conclusions can be drawn after analysis of questionnaires filled out by respondents. Based on data analysis, it can be understood that the media / learning resources on wave material so far used by lecturers are powerpoint (PPT) with a percentage of 14%, the media used so far is considered by students to be less attractive 22%, the obstacles encountered by students are at most visualizing wave forms 27%, the media that students consider appropriate for wave material is through visualization / illustration with a maximum percentage of 61%, so that AR media is considered to have the potential to make wave material interesting and easy to understand.

Keywords: Augmented Reality, Earthquakes, Learning Media, Waves

INTRODUCTION

Education plays an important role in developing humans holistically both in aspects of knowledge, skills, and attitudes to prepare humans to become individuals who are able to provide benefits and contribute sustainably (Salsabila et al., 2021; Zaripova et al., 2021). Technology is the result of the development of science, which occurs in the world of education. Therefore, it is appropriate for education itself to also utilize technology to help the implementation of learning (Lazar, 2015; Lestari, 2018). Digital technology has now begun to be used in educational institutions as a means to support learning, either as an information tool (ie as a means of accessing information) or as a learning tool (ie as a means of supporting learning activities and assignments) (Teräs, 2022).

The trend of change and innovation in the world of education will continue to occur and develop in entering the 21st century today. These changes include: easier to find learning resources, more options for using and utilizing ICT, the increasing role of media and multi-media in learning activities (Gul et al., 2017; Tarabini, 2016). The trend of change and innovation, has very broad implications in the world of education, namely changes in renewal programs and learning technology, changes in learning and learning programs using experimental methods, more control of learning to students, increasing IQ (intlelligence quontient) balanced with EQ (emotional qoutient), and SQ (spiritual qoutient) coaching, and demanding the integration of ICT in learning activities (Budiman, 2017; Jaffer et al., 2007). With the rapid development of science and technology, the emergence of multimedia

technology and its application to teaching, displaying audio, visual, and animation effects brings its own color in teaching activities and sets a favorable platform for reform and exploration of teaching models in the new era (Little & Green, 2009; Suhardiana, 2019). In its implementation, online learning certainly cannot be separated from the role of technology. Technology can facilitate all needs in the teaching and learning process. Along with the development of the technological era is growing, currently many platforms that can help implement online learning such as e-learing, Google Clasroom, Edmodo, Moodle, Learning houses, and even platforms in the form of video conferencing have been increasingly including Google meet, Zoom, and Visco Webex (Hanifah Salsabila et al., 2020).

According to data from the Central Statistics Agency (BPS), 67.88% of Indonesians aged 5 years and over already own a mobile phone or mobile phone in 2022. This percentage increased compared to 2021 which was still 65.87%, as well as being the highest record in the last decade. As for nationally, in 2022, the percentage of male residents aged 5 years and over whose *mobile phones* reached 72.76%, while women only 62.91%. The percentage of male residents aged 5 years and over who access the internet is also more, namely 69.39%, while women are only 63.53% (Akraman & Priyadi, 2018). The most internet users (by accessing gadgets) in Indonesia are people in the age group of 15-19 years. While the second largest number of users is the age group of 20-24 years and children with the age group of 5-9 years are also classified as internet users. So that data obtained from 171.17 million users who use the internet and shows that teenagers or young people use the internet the most (Irfan et al., 2020). With reference to the high use of smartphones among children and adolescents, it is expected that the use of smartphones is not only a means of entertainment but also to support learning activities.

Physics learning is one of the subsystems that does not escape the current of change caused by the presence of very intrusive technology: With all its attributes, technology becomes inevitable in the learning system in the classroom. Various possibilities are offered by technology to improve the quality of physics learning in the classroom. Among them are (1) improvement and development of teachers' professional abilities, (2) as a learning resource in learning, (3) as a learning interaction tool. and (4) as a learning platform, including changes in learning paradigms caused by the use of technology in learning (Gok, 2011; Siahaan, 2012). Physics material is material related to everyday life, so teachers are required to be able to explain the concept in real form. Pressure material is one of the materials that seems abstract to students, many students have not been able to transfer the material in concrete form. So in the end many students are lazy to learn physics because there are too many formulas for its application. If only by using the lecture method will make students become bored and bored. There must be other methods used by teachers to change the mindset of students (Astuti et al., 2017; Drigas & Kontopoulou, 2016)

Along with the development of technology, the use of smartphones in teaching and learning activities has become one of the most influential innovations in the world of education. Smartphones have great potential to expand access to educational resources, increase student engagement, and provide a more interactive approach to learning (Marto, 2021). Smartphones provide instant access to a variety of learning resources such as digital books, online learning materials, journals, and learning videos. This allows students and teachers to access up-to-date and diverse information relevant to the subjects they are studying (Kaimara et al., 2019). Students can quickly search for the information or definitions they need during lessons by using the search engine on their smartphones. It helps in solving problems or finding answers quickly. The use of images, videos, and animations on smartphones can make lessons more interactive and facilitate the understanding of abstract concepts (Vakil, 2019). Teachers can design learning experiences tailored to the individual needs of students. This allows each student to learn in the way that is most effective for them (Kibona & Rugina, 2015).

The use of technology as a medium for learning Physics to make it easier for both teachers and students to manage, convey information and make different learning experiences (Andari, 2020). Previous research has shown that various media have been used to teach earthquake material. Research conducted by Isroqmi (2015) shows that the use of MS power point to teach earthquake material where the advantages of MS Power Point software are

hyperlink facilities. With this facility, a slide can be connected to other slides, or it can also connect with other software / files that will be accessed and can even be connected to open a website address (Isroqmi, 2015). In addition, Herijanto (2012) using interactive Cd media to teach earthquake material received a positive response from students, but teachers still had difficulty in making interactive Cd (Herijanto, 2012). Furthermore, Dwikusuma & Bachtri (2015) used the module as a teaching medium for earthquake material, showing that the module received good criteria and was suitable for use in the teaching and learning process on earthquake material (Dwikusuma & Bachri, 2015). However, the media used is still rigid and does not describe the concept of physics, especially abstract concepts.

For example, in the phenomenon of earthquakes. An earthquake is a violent tremor that spreads to the earth's surface caused by disturbances in the lithosphere. This vibration occurs in the skin layer with a thickness of 100 km due to the accumulation of energy released by the layer of the earth's skin itself (Sasma & Fauzi, 2020). The tremors propagate in all directions as seismic waves that propagate from the epicenter through the interior to the Earth's surface. The relationship between earthquake material and waves can be seen in the phenomenon during the earthquake process. During tectonic earthquakes, there is a jolt in the hypocenter that circulates seismic waves that spread in all directions. The spread of these seismic waves will cause small tears in the Earth's crust below the surface along the fault plane. These small tears are called fractures or cracks. In fault planes, new fractures will be visible after rock deformation shifts. When the rock deformation shifts between the two plates, there are tears along the fault plane and form a path. This tearing occurs due to the rigid and inelastic structure of the rock (Salditch et al., 2020; Siska, 2019).

Augmented Reality (AR) is one of the media developed to support learning activities. AR is a technology that combines the real world with digital or virtual elements (Lytridis et al., 2018). In the context of learning, AR has become a valuable tool for enhancing the learning experience. AR allows students to actively interact with learning content. They can touch, move, and explore virtual objects that appear in the physical environment resulting in deeper learning and a more enjoyable learning experience (Abdinejad et al., 2021). With AR, abstract concepts can be visualized clearly. For example, in science lessons, students can see molecular structures in three dimensions or see simulations of historical events in the context in which they occurred. The use of AR in learning often increases student motivation and engagement. This interactive and engaging technology can make the learning process more interesting and entertaining (Cai et al., 2021; Sural, 2018)

Learning earthquake material is an important aspect in understanding and preparing for natural hazards that can occur in various regions of the world. Education and public awareness are key in reducing earthquake risk. There needs to be an effort to teach people how to identify risk areas and what to do when an earthquake occurs (Bansal & Joshi, 2014). The use of smartphones as a learning tool for earthquake material is a very useful innovation. With the rapid growth of smartphone users it has become effective and accessible to many people. Smartphone apps can provide interactive simulations of how earthquakes occur and how they impact buildings and the environment (Makhrus et al., 2022). Users can access a variety of resources learning about earthquakes online through their smartphones. It includes articles, videos, presentations, and other learning materials. The use of smartphones in earthquake material learning not only makes the material more accessible to individuals, but also allows for more interactive, relevant, and up-to-date learning. This can play a role in increasing public awareness and preparation for earthquake hazards, which in turn can reduce the negative impact of earthquake events (Arista & Kuswanto, 2018; Suryanda et al., 2019). Seeing the urgency of this problem, the author is interested in conducting research related to the potential development of AR media.

METHODS

This type of research is descriptive and aims to describe the potential development of augmented reality media to increase students' understanding of earthquake material. The research procedures carried out are as follows: (1) preparation of questionnaires, (2) distribution of questionnaires to respondents, (3) analysis of answers given by respondents, (4) drawing conclusions. Data collection techniques using questionnaires. The questionnaire was made

using G-Form containing six question items, each of which required a response in the form of a checklist or description in each item answer column according to the respondent's opinion. A summary of the question points on the questionnaire used in this study is presented in table 1 below.

Table 1. Instrument Question Item

Number of questions	Question Focus
1	Student responses related to the media/learning resources used by lecturers in the wave material
2	Student responses related to the weaknesses of the media/learning resources used by lecturers in the wave material
3	Student responses related to the obstacles they encountered in studying wave material
4	Student responses to the right medium to study the wave
5	Student responses to the potential of AR as a learning medium for wave material
6	Student feedback on smartphone-based apps to study waves

The questionnaire was distributed online to respondents who were students of Universitas Pendidikan Ganesha and Universitas Terbuka. The sample was randomly selected as many as 206 students who had attended the lecture wave. Research conclusions can be drawn after analysis of questionnaires filled out by respondents.

FINDINGS AND DISCUSSION

Findings

Wave matter is one of the physics materials that has abstract concepts so it requires media to teach it to students. The following is presented student responses about wave lectures related to the media / learning resources used by lecturers so far.

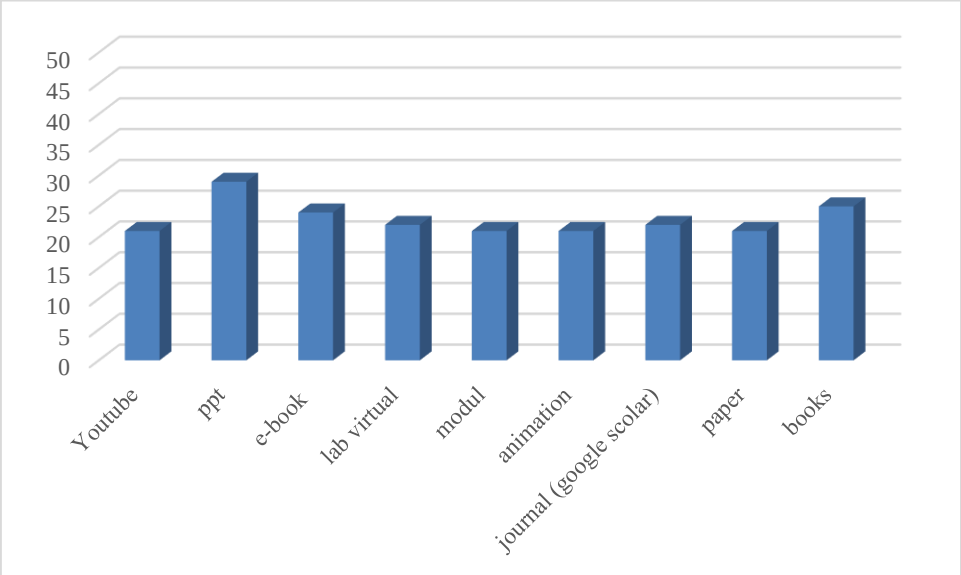


Figure 1. Student responses related to teaching media for wave material

Based on figure 1, it can be seen that the media that are widely used by lecturers as media / learning resources on wave material are powerpoint (PPT) with a percentage of 14% (29 people), followed by books 12% (25 people), e-books 12% (25 people), articles in journals or browsing goole scholar 11% (22 people), and virtual labor 10% (21 people). The rest use papers, teaching modules and animations. Furthermore, students are asked to provide opinions related to teaching media that have been used by lecturers in teaching wave material. The following is a description of student opinions related to teaching media that have been used by lecturers in teaching wave material.

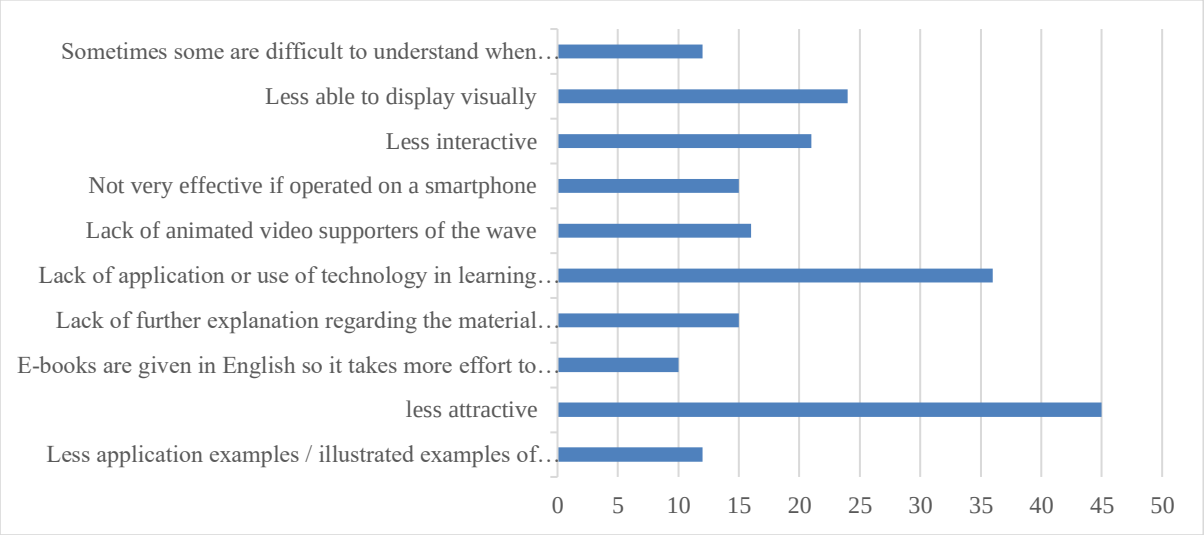


Figure 2. Description of student opinions about wave teaching materials

Based on figure 2, it can be understood that the weaknesses of the media used by lecturers so far according to student perceptions include less attractive with a maximum percentage of 22% (45 people), lack of application or use of technology in learning that supports the learning process, especially in wave material 17% (36 people), less visual display 12% (24 people), less interactive 10% (21 people) and lack of animated video supporters from the wave 7% (15 people). The rest lack application examples / illustrated examples of wave theory and e-books given in English so that it is difficult to understand. The obstacles encountered by students during wave lectures can affect student learning motivation. Therefore, it is necessary to know the obstacles that students encounter while studying wave material. The following is presented a description of student obstacles while studying wave material.

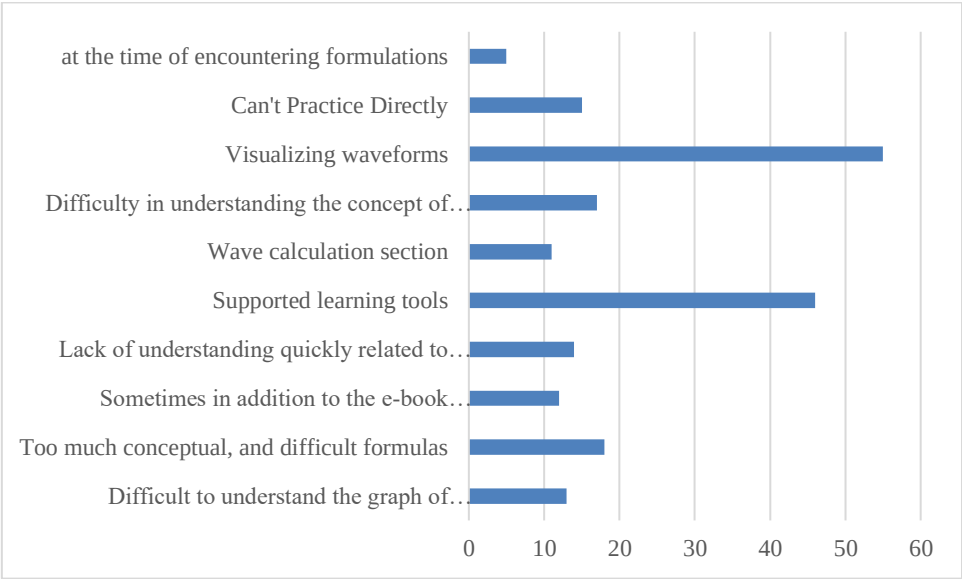


Figure 3. Description of student constraints in studying wave material

Based on the picture, it can be understood that the obstacles that students often encounter in studying waves include visualizing waveforms 27% (55 people), learning tools that support with a percentage of 22% (46 people), difficulty in understanding the concept of material about waves 7% (14 people), the rest are difficulties when meeting formulations and difficulty understanding graphs. Furthermore, students were asked to expresstheir opinions about what kind of media can make it easier for them to understand wave material. The following is

presented student responses regarding what kind of media questions are appropriate to use to teach wave material.

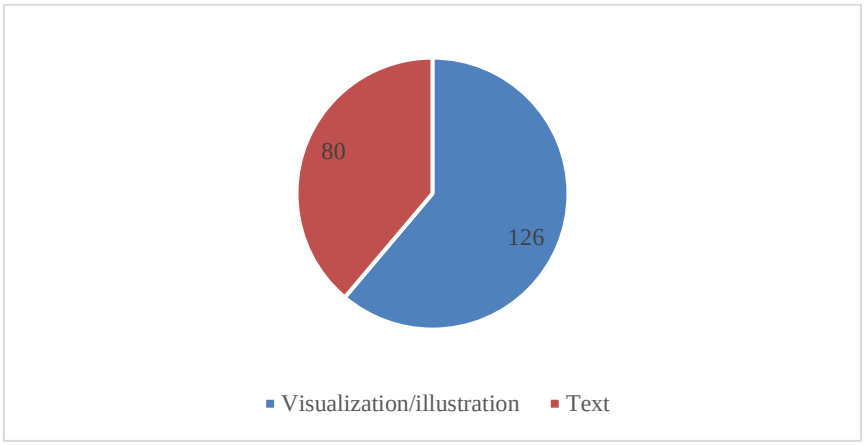


Figure 4. Student response about their expectations if they want to learn material about the earthquake

Based on figure 4, according to students, the right media to study waves, especially earthquake phenomena, include through visualization / illustration with a maximum percentage of 61% (126 people), the rest through text with a percentage of 31% (80 people). Augmented Reality-based media is one of the popular learning media that aims to visualize material. AR media is flexible and can be operated on smartphones. Students are asked to give their opinions regarding the potential of AR media to be developed as a learning medium, especially for learning material about waves and earthquakes. The following is a description of student opinions related to this question.

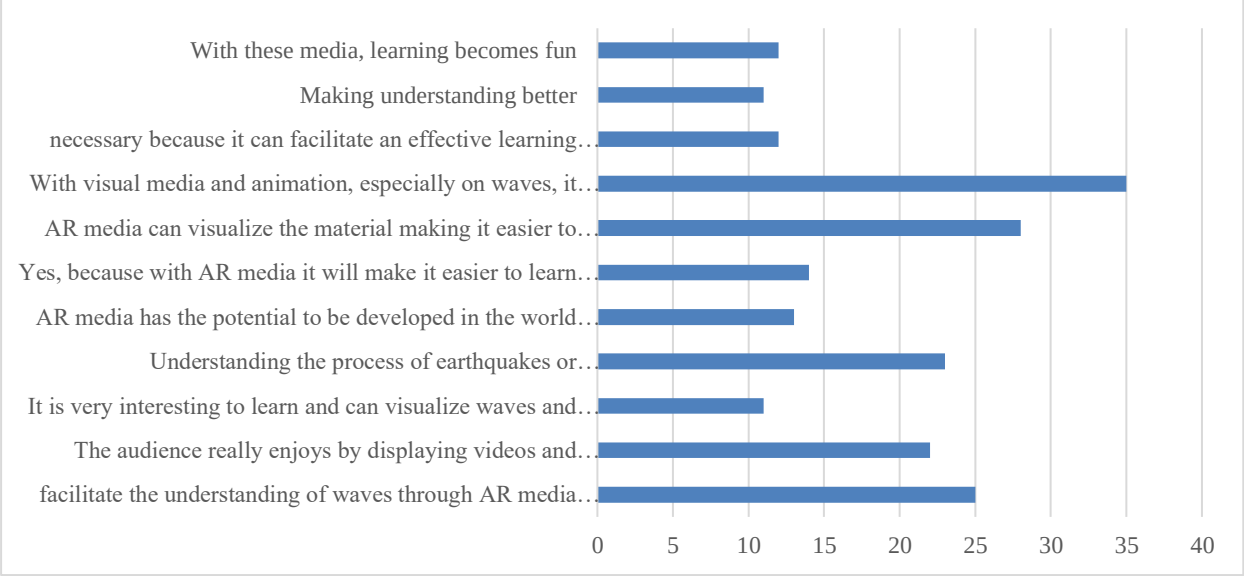


Figure 5. Description of student opinions related to the potential of AR as a teaching medium for waves and earthquakes

Based on figure 5, it can be understood that AR has the potential to be developed as a learning medium, especially to learn material about waves and earthquakes. The percentage of students who stated that visual and animation media, especially on waves, would be easy to understand and analyze by 17% (35 people), AR media can visualize material making it easier to learn material 14% (28 people), facilitate understanding waves through AR media so that it is more real, learning is not monotonous 12% (25 people), the audience really enjoys displaying

video and audio so that it can be understood and remembered easily 11% (22 people), the rest makes learning fun and attracts interest in learning. Students give their opinions regarding what questions must be in an application if a smartphone-based application is made that is useful for increasing student understanding of earthquakes. The following is a description of student opinions.

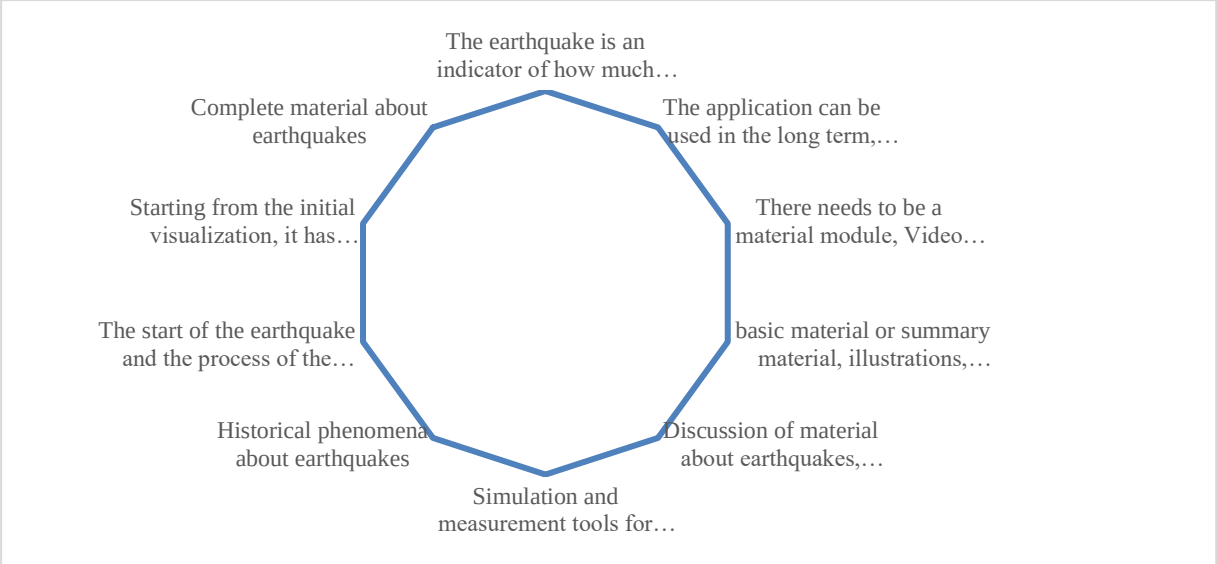
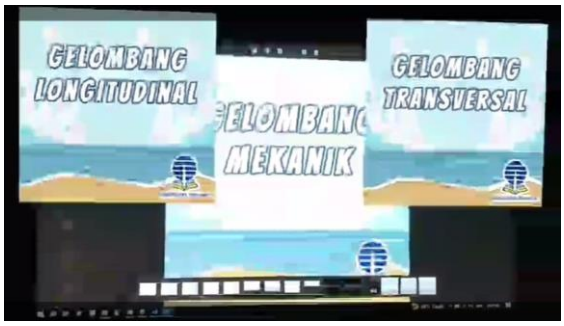


Figure 6. Description of student opinions related to what should be in the application media to teach wave and earthquake material

Based on figure 6, it can be understood that students need media used to teach earthquake material, can visualize earthquake phenomena in the form of simulations along with conoths and illustrations. In addition, the application used must also be practical so that it does not make it difficult for students when using it. The questions and exercises provided are accompanied by discussions so that students can learn the parts they don't understand.

The use of Augmented Reality (AR) in teaching material about earthquakes has great potential to increase student understanding and engagement. AR allows college students to see earthquakes and related phenomena in a realistic way. They can see earthquake simulations, tectonic plate movements, and their impacts directly through the device, making for a better understanding of how earthquakes occur (Li, 2020; Pegrum, 2021). The following is presented the display of AR media that has been developed.

Discussion



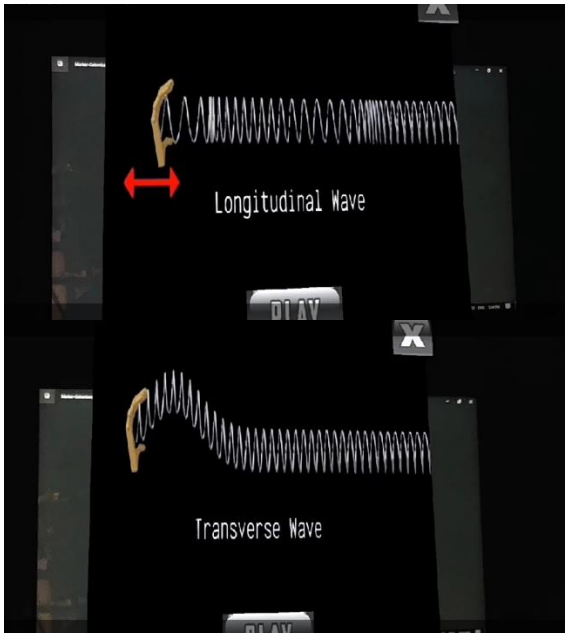


Figure 7. AR media display of developed wave and earthquake matter

Through AR media, students can investigate the appearance and geological processes associated with earthquakes, such as folds, faults, directly so that they canexplore independently, which allows them to learn more actively. Students can choose additional content, dig deeper into topics of interest and create more customized learning experiences according to their interests (Rahmatullah et al., 2021; Yilmaz, 2021). The developed AR media will be available on the playstore, making it easier for students to download it with lightweight storage and no need for a data package. AR media on the Play Store can generally be downloaded easily by users through their Android devices. Does not require expensive or complex enhancements (Aydoğdu &; Kelpšiene, 2021).

Visualization media makes it easy for students to study earthquakes. Visualization allows students to clearly see how earthquakes occur, including the movement of tectonic plates, earthquake focus, and faults. This helps them understand the geology and science behind earthquakes better (Ambarwulan &; Muliyati, 2016; Panigrahi et al., 2018). Visualization media can create realistic earthquake simulations. Students can see and feel how earthquake shocks affect building structures, the environment, and human life. This gave them an in-depth experience of the impact of the earthquake (Astra et al., 2015). Through visualization, students can understand mitigation efforts made to reduce the impact of earthquakes, such as the construction of earthquake-resistant buildings, early warning systems, and evacuation plans (Sadeghi, 2019).

AR makes it easier for students to see abstract or complex concepts in a more visual and tangible form. It helps students to understand difficult concepts in an easier and clearer way (Karakus et al., 2019; Yau et al., 2020). AR allows students to interact with virtual objects in the real world. Students can rotate, examine, or change the object to gain a deeper understanding of a particular topic (Kuit &; Osman, 2021). Through AR, students can learn through hands-on experiences, helping them understand context and concepts better. AR allows students to become active in the learning process (Aydoğdu &; Kelpšiene, 2021). Students can take the initiative to investigate, find out, and hone critical skills while interacting with AR elements. This encourages deeper learning.

CONCLUSION

Based on data analysis, it can be understood that the media / learning resources on wave material so far used by lecturers are powerpoint (PPT) with a percentage of 14%, the media used so far is considered by students to be less attractive 22%, the obstacles encountered by students are at most visualizing wave forms 27%, the media that students consider appropriate for wave material is through visualization / illustration with a maximum percentage of 61%, so that AR media is considered to have the

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