

## Needs Analysis For Development Application Of An Augmented Reality-Integrated E-Module On Magnetic Induction

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### Abstract

The purpose of this study was to provide empirical data for the development of an integrated Augmented Reality (AR) physics learning e-module application focusing on the topic of Magnetic Induction among senior high school students from the perspective of physics teachers in Bandung city. Using a quantitative approach, 32 physics teachers from Bandung city completed a needs assessment questionnaire. In terms of learning conditions, Magnetic Induction was identified as the most difficult topic for students to understand, mentioned by teachers 53.1% (understanding basic concepts), 56.3% (visualization of abstract material concepts), 62.5% (solving application problems), and 46.9% (lack of student interest in learning). Current teaching methods and materials (21.9%) are less effective in supporting student understanding, 50% still use textbooks, Both teachers and students expressed a strong preference for e-module applications that integrate AR to visualize abstract concepts, increase engagement, and provide clear explanations, practical activities, and learning evaluations. Although the potential of AR is recognized, it has not been optimally utilized because there is currently no integration with physics e-modules. This study highlights the urgent need for the importance of AR-based e-module applications to create more engaging, interactive, contextual, relevant learning experiences and improve learning outcomes, especially on complex topics such as magnetic induction.

**Keywords :** Augmented Reality (AR) · e-Module · Magnetic Induction · Physics Education · Needs Analysis

### INTRODUCTION

The rapid development of technology in the Industrial Revolution 4.0 era demands innovation in the world of education. Advances in educational technology have opened up enormous opportunities to improve the teaching and learning process, especially in subjects that have complex and abstract concepts such as physics. Physics, one of the science subjects in Junior High Schools (SMA) in Indonesia, requires an understanding of concepts and experiments that are often considered by many students (Handhika et al., 2015; Setyani et al., 2017).

One of the physics topics studied in grade 12 high school is Magnetic Induction. This topic is known to be complex, especially because of its abstract spatial concept and is not easy to visualize (Cai et al., 2017; Lemmer et al., 2020; Ürek & Çoramık, 2021). Studies have shown that students have difficulty understanding magnetic fields due to the abstract nature of this subject and the lack of adequate visualization in traditional teaching methods (Li & Singh, 2017; Neset Demirci, 2006).

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Research conducted by Hafi and Supardiyono (2018) stated that 78.2% of students had difficulty understanding physics concepts because learning was only delivered with textbooks and working on questions containing formulas. This is related to the opinion of Septarini & Kholiq (2021) who stated that Physics is considered a difficult subject for students, including for vocational school, high school and MA students. This situation makes it difficult for students to understand the physics material being taught and forms a mindset that physics learning only struggles with formulas. Physics material is material that is correlated with everyday life, so teachers are expected to be able to explain physics concepts in schools into real forms (Astuti, et al. 2017). In addition, the lack of information and communication technology (ICT) in textbooks to support visualization. Current textbooks are only able to provide two-dimensional images, which are less effective in helping students understand abstract content. It is hoped that more interactive 3D visualizations, such as those offered by augmented reality (AR) technology, can overcome this problem.

Augmented Reality (AR) technology offers an innovative solution to enhance interactive and contextual learning experiences. With the ability to combine the real and digital worlds, AR enables more engaging and interactive visualization of physics concepts. In the context of magnetic induction material, AR-based e-module applications can help students understand Faraday's law, magnetic fields, and magnetic flux through virtual simulations and experiments. Several studies have shown the effectiveness of AR technology in enhancing science learning. For example, research by Cheng et al. (2017) found that the use of AR in physics learning can improve students' conceptual understanding and learning motivation. In addition, research by Putri et al. (2020) showed that AR-based e-modules can help students overcome misconceptions in electricity and magnetism. Another study by Bacca et al. (2018) identified that the use of AR in physics learning can increase student engagement by up to 30% higher than traditional methods. By integrating AR into learning e-module applications, students can experience significantly increased visual interactions, which in turn can improve their understanding of complex and abstract concepts (Dünser et al., 2012; Farhani Isty et al., 2021; Permana et al., 2023).

Magnetic induction is one of the materials in physics that is abstract and difficult to understand if only using a conventional approach. According to Sari and Aminah (2021), many students have difficulty understanding the relationship between changes in magnetic flux and the resulting electromotive force (EMF), because this concept cannot be observed directly. Therefore, learning media are needed that are able to present a visual representation of the physics phenomenon.

The use of digital-based e-modules is an effective alternative in supporting the learning process. E-modules not only provide materials in text form, but can also be equipped with animations, simulations, and interactivity that strengthen students' understanding (Rahmawati & Prasetyo, 2020). The integration of Augmented Reality into e-modules adds added value by providing real visualizations of these abstract concepts. Research by Dewi, Lestari, and Nugroho (2022) shows that the use of AR in physics learning can increase students' learning motivation and help master concepts through more meaningful learning experiences. In addition, technology-based learning media such as AR are also in line with the 21st century learning approach that emphasizes critical thinking, collaborative, and problem-solving skills. As stated by Putra and Handayani (2023), AR-based learning provides opportunities for



students to explore concepts independently and actively, thereby increasing their involvement in the learning process.

Because students still experience difficulty understanding the concept of magnetic induction due to its abstract nature, the lack of technology-based interactive media, and despite the existence of digital-based e-modules, integration with Augmented Reality (AR) is still rarely used in physics materials, particularly magnetic induction, this study was conducted to analyze the need to develop an AR e-module application that can help improve student conceptual mastery and learning motivation.

The research questions in this section are:

- (1) What are students' and teachers' needs for AR e-modules on magnetic induction?
- (2) What are the desired product specifications to support learning?

## METHOD

The study used a descriptive survey with a validated questionnaire instrument. The respondents of this study were 32 physics teachers in the city of Bandung, consisting of 16 female teachers and 16 male teachers. This number of respondents was selected according to the limitations of the research class population, and methodologically it can still represent the analysis needs because this study is a needs analysis, not for broad generalization. The research instrument used a questionnaire in the form of a Google Form with the title "Analysis of the Needs for Developing an Integrated Augmented Reality E-Module Application on Magnetic Induction Material", which was distributed to physics teachers spread across high schools in Bandung.

## RESULT AND DISCUSSION

The data obtained from this study include data on the condition of learning magnetic induction material, views on technology-based learning media, expectations and needs for developing learning media, and challenges in using learning media. Based on the data obtained from the questionnaire results, the results and discussions are as follows:

### Conditions Learning Material Induction Magnetic

To see the conditions of learning magnetic induction materials in the field, the formulation of the problem explored in this questionnaire is

1.1. Do your students usually have difficulty in understanding Magnetic Induction material?

**Table 1.** Percentage of students' difficulties in understanding magnetic induction material

No.	Category	Amount	Percentage (%)
1	Very often	3	9.4
2	Often	15	46.9
3	Sometimes	13	40.6
4	Seldom	2	6.3
5	Never	0	0

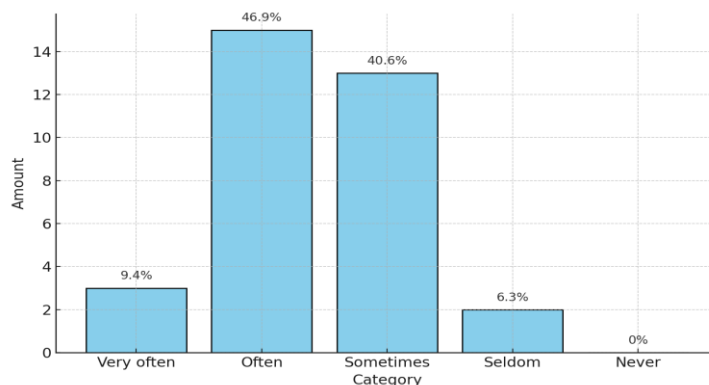


Figure 1. Difficulty student in understand induction magnetic

Based on the data presented in table 1 and figure 1, from 32 respondents of physics teachers in Bandung city related to students' difficulties in understanding magnetic induction material, 9.4% were in the "Very Often" category, 46.9% were in the "Often" category, 40.6% were in the "Sometimes" category, 6.3% were in the "Rarely" category, and 0% were in the "Never" category. It can be concluded that overall, students still have difficulties in understanding magnetic induction material.

1.2. What just difficulty main student in learn material Induction Magnetic? ( maybe) choose more from One)

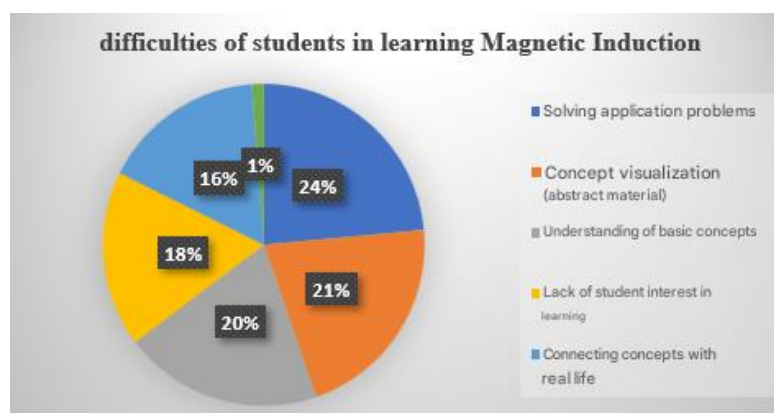


Figure 2. Difficulty main student in learn material induction magnetic

Based on the data in Figure 2 above, students experience difficulty main as big as 20% in understanding draft base, 16% in connect draft with life real, 24% in finish question application, 18% interest Study student less, 21% in visualize draft nature abstract, and as big as 1% difficulty other.

1.3. What media do you usually use? For teach material Induction Magnetic?

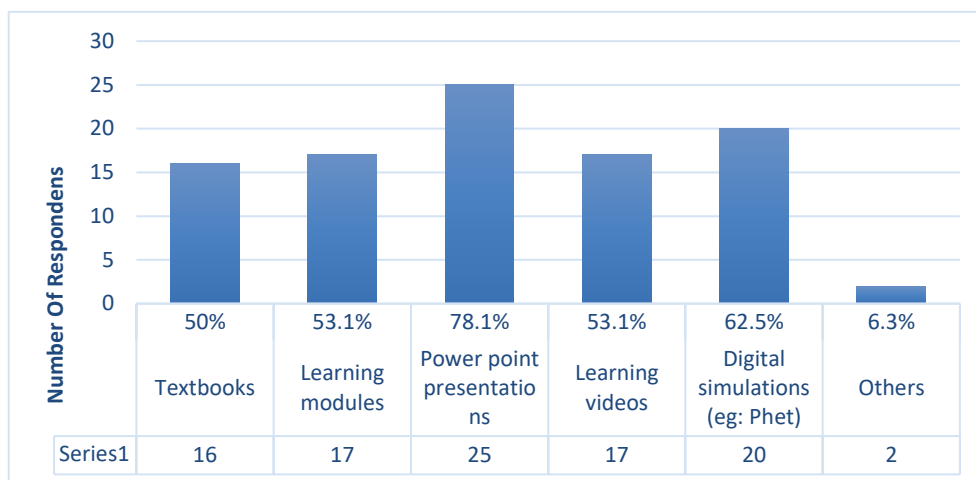


Figure 3 . The media used by teachers teach induction magnetic

Based on Figure 3, media that is often used by teachers in teach induction magnetic is as big as 50 % Books text , 55.10 % Learning modules , 78.10 % Power point presentations , 53.10 % Learning videos , 62.50 % Phet digital simulations , and 6.30 % others . In conclusion, the media that are often used used is power point.

1.4. What media do you use? Already effective For increase understanding students on the material induction magnetic?

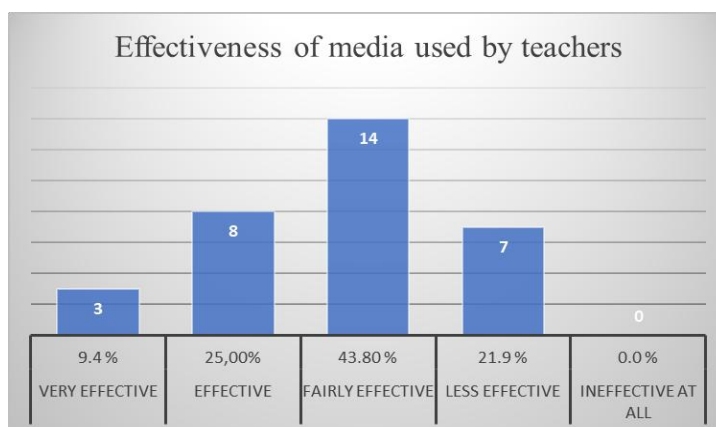


Figure 4. Effectiveness of media used by teachers

Based on image 4 above , from aspect the effectiveness of the media used by teachers turns out to be in a way general Still in category Enough effective (43.80 %) , effective (25 %) , not enough effective ( 21.9 %) , and very effective ( 9.40% ). This means that the media used during This especially (power point) still not yet maximum.

## Views towards Learning Media Based on Technology

### 2.1. Have you ever using learning media based on Augmented Reality (AR) in teach physics?

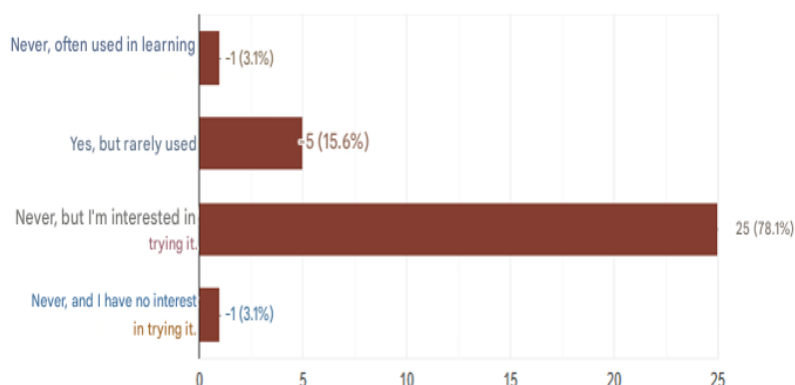


Figure 5 . Use of learning media based on Augmented Reality

Based on Figure 5 above, in particular general teachers do not once using Augmented Reality based media but very interested to try it (78.1 %). Opinion Respondent other there are those who have , but seldom using AR (15.6 %), there are also those who have use by 3.1 % in learning , the rest as much as 3.1 % did not Once use even No interested The same once . See condition This possibility Lots obstacles faced by teachers in using this Augmented Reality media , which resulted in some teachers not being able to interested in this AR media . One of them limitations time , and teacher competence in prepare and create this AR- based media .

### 2.2. If not , are you interested? For try learning media based on Augmented Reality (AR)?

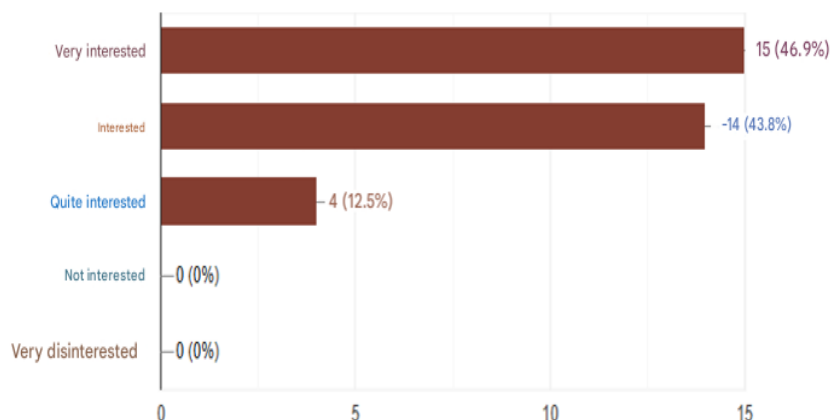


Figure 6 . Interest respondents in learning AR based

Based on Figure 6 above, as many as 48.4 % are very interested For try learning media based on Augmented Reality (AR), 41.9 % category interested , and 12.9 % category Enough interested. This is can concluded enthusiasm respondents are very positive to learning based on Augmented Reality (AR).

2.3. In your opinion, can AR-based media help student understand draft Induction Magnetic with more Good?

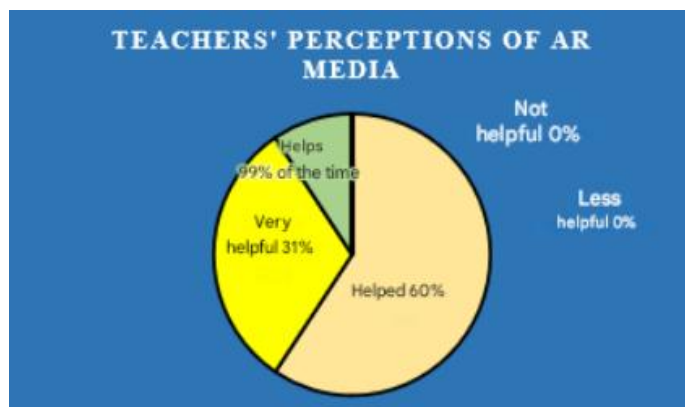


Figure 7. Teachers perceptions of AR media

Based on Figure 7 above, AR-based media is very helpful (31%), helpful (60%), and sufficient help as big as 99%. Can concluded the existence of AR-based media can help student in understand material induction magnetic.

### Hopes and Needs Development of Learning Media

3.1. What just the features you expect from Learning media applications AR based for Induction Magnetic?

Table 2. Expected features from AR based media application

No	Features in AR Media	Amount	Percentage
1	Interactive simulation of physics concepts	31	96.9 %
2	Visual explanation through animation	28	87.5 %
3	Practice questions with discussion	20	62.5 %
4	Experiment demonstration video	27	84.4 %
5	Other	0	0%

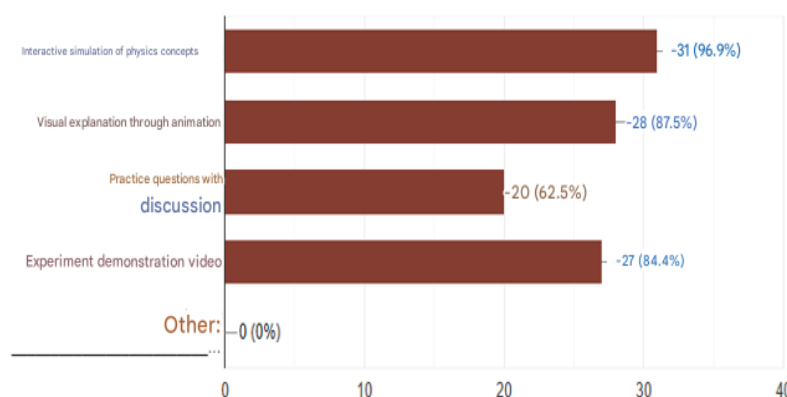


Figure 8. Expected features from AR based media application

From figure 8 above, the expected features from Respondent is in the form of simulation interactive draft physics (96.9 %), Visual explanation through animation by 87.5 % , demonstration and experiment videos ( 84.4 %), and practice questions with discussion by 62.5 % . Can concluded expected features the respondents are in the form of simulation interactive draft physics.

3.2. In your opinion, what is the learning media? AR based can also increase motivation Study student?

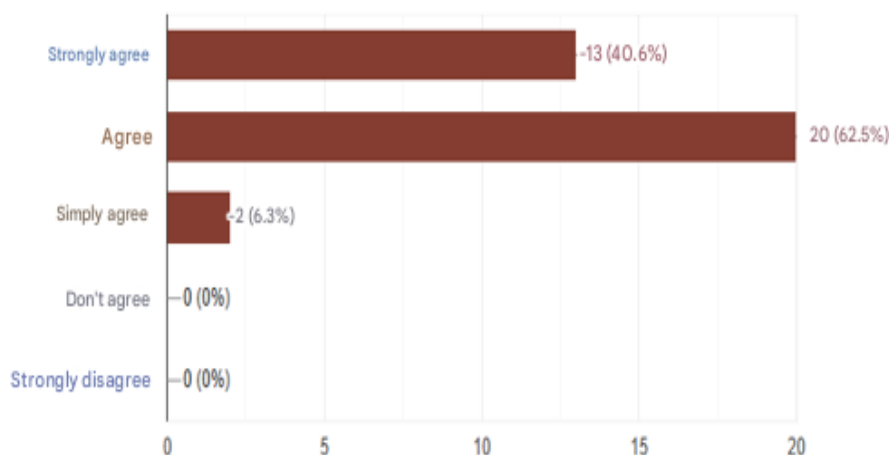


Figure 9. Learning media AR based can increase Motivation Study student

From Figure 9 above, it shows that 62.5 % of respondents " agree " with learning media. AR based can increase motivation Study students , 40.6 % of respondents stated that they strongly agree , and the rest stating " enough " namely by 6.3 % . In matter this, in a way general Respondent stating learning media AR based can increase motivation Study student .

### Challenges in Use of Learning Media

Although enthusiasm to technology high , respondents also identified a number of challenges in using AR Media . Teachers experience limitations facilities (68.80%) such as availability AR -enabled devices in schools , the lack of time For prepare media (71.90% ) , lack of teacher training (50%), and lack of understanding student against media based technology (18.80 %), and the rest answer other by 3.10 % . Apart from That another challenge is time additional required For integrate technology This in activity teaching and learning. Here challenge problems faced by teachers in the field in using media based technology For learning physics like table 3 and the following figure 10 This

Table 3. Challenges in use of AR media

No	Challenge	Number of Respondents	Percentage
1	Lack of time to prepare media	23	71.90 %
2	Limited facilities (e.g. technological devices)	22	68.80 %
3	Lack of training for teachers	16	50%
4	Students' lack of understanding of technology-based media	6	18.80%
5	Other	1	3.10 %

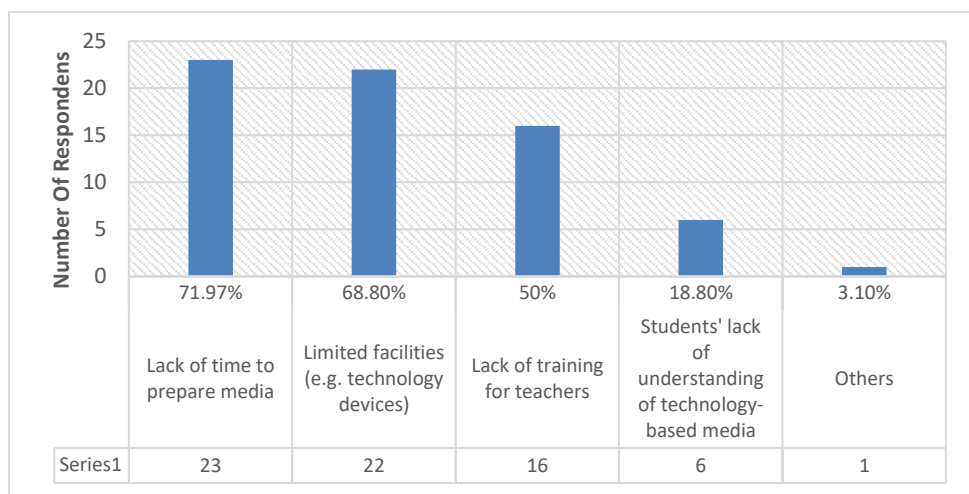


Figure 10 . Challenges in use of AR media

Studies have shown that students have difficulty understanding magnetic fields due to the abstract nature of the subject and the lack of adequate visualization in traditional teaching methods (Li & Singh, 2017; Neset Demirci, 2006). This is in line with studies showing that students have difficulty understanding magnetic fields due to the abstract nature of the subject and the lack of adequate visualization in traditional teaching methods (Li & Singh, 2017; Neset Demirci, 2006).

## CONCLUSION

Based on the results of a preliminary study conducted on 32 physics teachers, important information was obtained regarding the challenges and needs in using technology-based media in physics learning, especially in magnetic induction material. The majority of teachers (71.9%) stated that they experienced obstacles in terms of time constraints to prepare learning media. In addition, as many as 68.8% of teachers stated that limited facilities, such as technological devices, were the main obstacle in integrating technology-based media in the classroom.

Lack of training for teachers was also a significant factor mentioned by 50% of respondents, indicating the need for teacher competency development in the use of learning technology. Meanwhile, 18.8% of teachers stated that students do not yet understand technology-based media well, indicating the need for the right approach and user-friendly interface in media development.

These findings reinforce the urgency of developing an integrated Augmented Reality (AR) magnetic induction e-module application that not only supports the visualization of abstract physics concepts, but is also designed to be easily accessible, efficient in its use, and accompanied by adequate training and usage guides for teachers and students. AR-based e-modules are expected to be an innovative solution to improve students' mastery of concepts and learning motivation in magnetic induction materials, while reducing the burden of media preparation from teachers. In conclusion, based on the direct research questions above, the following are:

1. The needs analysis shows that students and teachers require an AR e-module on magnetic induction to improve conceptual understanding and learning motivation.

2. The desired product specifications include interactive features, AR-based 3D visualization, ease of use on Android smartphones, and integration of interactive practice questions.

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## REFERENCES

- Astuti , IAD, Bhakti, YB, & Prasetya , R. (2021). *Four Tier-Magnetic Diagnostic Test (4T-MDT): Instrument Magnetic Field Evaluation For Identifying Misconception Students* . JIPFRI ( Journal Physics Education Innovation and Research Scientific ) , 5(2), 110–115. <https://doi.org/10.30599/jipfri.v5i2.1205> .
- Azuma, R., Baillot , Y., Behringer, R., Feiner , S., Julier , S., & MacIntyre , B. (2001). *Recent Advances in Augmented Reality*. Computer Graphics and Applications, IEEE, 21(6), 34–47. <https://doi.org/http://dx.doi.org/10.1109/38.963459> .
- Billinghurst , M., & Dünser , A. (2012). *Augmented reality in the classroom*. Computers, 45(7), 56–63. <https://doi.org/10.1109/MC.2012.111> .
- Cai, S., Chiang, F.K., Sun, Y., Lin, C., & Lee, J.J. (2017). *Applications of augmented reality-based natural interactive learning in magnetic field instruction*. *Interactive Learning Environments*, 25(6), 778–791. <https://doi.org/10.1080/10494820.2016.1181094> .
- Chasteen, S. V., & Pollock, S. J. (2009). *A research based approach to assessing student learning issues in upper-division electricity & magnetism*. AIP Conference Proceedings, 1179, 7–10. <https://doi.org/10.1063/1.3266759> .
- Sari, RP, Kusuma, D., & Haryanto, T. (2021). *The Use of Augmented Reality Media in Learning Physics For Increase Understanding Draft Students* . Journal of Science Education , 9(2), 134-142.
- Wibowo, B., & Pratama , RD (2019). *Development of Augmented Reality Media on Material Induction Magnetic* . Indonesian Journal of Physics Education , 7(3), 89-99.
- Hidayat , R., Hasanah, U., & Syafrina , D. (2020). *Visualization of Magnetic Field Lines with Augmented Reality*. Journal Innovation Learning Physics , 6(2), 123-130.
- Lestari, S., Permana , H., & Putri, MR (2021). *Development AR Application for Faraday's Law*. Journal Educational Technology , 13(1), 34-44.
- Mayer, R.E. (2001). *Multimedia Learning* . Cambridge University Press.
- Prastyo , D., Nugroho, A., & Suryani, T. (2018). *The Influence of 3D Visualization Media on Motivation Study Students* . Journal Educational Technology , 6(1), 78-85.
- Mubarok , A., & Wibowo, S. (2020). *The Use of Augmented Reality in Learning Interactive* . Journal Technology Information and Education , 13(2), 111-121.
- Indra Septian Suprayogi , Andreas Handjoko Permana, Siswoyo (2020). *Development of Android-Based E-Modules for High School Students on Electromagnetic Induction Material with a Scientific Approach*. Proceedings of the National Physics Seminar. Jakarta State University.
- Ahmad Maqruf . (2024). *Application of Project-Based Laboratory Model to Improve Cognitive Ability and Creative Thinking Skills of High School Students on Temperature and Heat Material*. S2 thesis, Indonesian University of Education.
- Tetri Sabrina. (2023). *Development of Augmented Reality-Assisted E-Modules on Temperature and Heat Material (Emarks) on Learning Outcomes and Intrinsic Motivation of Students*. Thesis. Indonesian University of Education.
- Azuma, R.T. (1997). A Survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments* , 6(4), 355-385.



- Chang, KE, Chang, CT, Hou, HT, Sung, YT, Chao, HL, & Lee, CM (2014). *Development and Behavioral Pattern Analysis of a Mobile Guide System with Augmented Reality for Painting Appreciation Instruction in an Art Museum*. *Computers & Education* , 71, 185-197.
- Schutt, R., & Linehan, M. (2016). *The Art of Storyboarding* . Focal Press.
- Sadiku, MNO, & Musa, SM (2017). *Education and Augmented Reality*. *International Journal of Advanced Research in Computer Science and Software Engineering* , 7(6), 1-5.
- Schutt, R., & Linehan, M. (2016). *The Art of Storyboarding* . Focal Press.
- Sadiku, MNO, & Musa, SM (2017). *Education and Augmented Reality*. *International Journal of Advanced Research in Computer Science and Software Engineering* , 7(6), 1-5.
- Sun, J.C., Ye, S., Yu, S.Y., & Chiu, TKF (2023). *Effects of Wearable Hybrid AR/VR Learning Material on High School Students' Situational Interest, Engagement, and Learning Performance: the Case of a Physics Laboratory Learning Environment*. *Journal of Science Education and Technology*. <https://doi.org/10.1007/s10956-022-10001-4>
- Ürek , H., & Çoramık , M. (2021). *A Cross Sectional Survey about Students' Agreement Rates on Non-Scientific Ideas concerning the Concept of Magnetism*. *Journal of Turkish Science Education*, 18(2), 218–232. <https://doi.org/10.36681/tused.2021.61>
- Ziden , A.A., Ziden , AAA, & Ifedayo , A.E. (2022). *Effectiveness of Augmented Reality (AR) on Students' Achievement and Motivation in Learning Science*. *Eurasian Journal of Mathematics, Science and Technology Education*, 18(4). <https://doi.org/10.29333/ejmste/11923>
- Chang, KE, Chang, CT, Hou, HT, & Sung, YT (2014). *Development of a Mobile Guide System with Augmented Reality*. *Computers & Education* , 71, 185-197.
- Venny H. , Siti N . B. A ., and Shahrul K . B. A. (2025). *The Development of Magnetic Field Learning Module Integrated with Augmented Reality (AR) for Senior High School: A Need Analysis*. <https://doi.org/10.15575/jotalp.v10i1.40684>
- Maison, Hidayat , Kurniawan, DA, Yolviansyah , F., Sandra, RO, & Iqbal, M. (2022). *Students' Misconceptions: Viewed from Students' Perceptions on Magnetic Field Learning*. *Indonesian Journal of Education*, 11(3), 492–500. <https://doi.org/10.23887/jpiundiksha.v11i3.43752>
- Nakamura, H., & Mizuno, Y. (2022). *Development of Augmented-Reality-Based Magnetic Field Visualization System as an Educational Tool*. *Sensors (Basel, Switzerland)*, 22(20), 1–13.
- Farhani Isty , M., Nor, M., & Sahal , M. (2021). *The Development of Mobile Augmented Reality Based Science Learning Media on Earth Layer Materials and Disasters in Class VII Junior High School*. *Journal Geliga Sains: Journal of Physics Education* , 9(1), 60. <https://doi.org/10.31258/jgs.9.1.60-69>
- Faridi , H., Tuli, N., Mantri, A., Singh, G., & Gargrish , S. (2021). *A framework using augmented reality to improve critical thinking abilities and learning gains of the students in Physics*. *Computer Applications in Engineering Education*, 29(1), 258–273. <https://doi.org/10.1002/cae.22342>
- Gilbert, J. . (2008). *Visualization: An emergent field of practice and inquiry in science education*. In *Visualization: Theory and Practice in Science Education* (pp. 3–24). Springer.
- Florian Lyrath, Carsten Stechert\* , Syed Imad-Uddin Ahmed. (2023). *Application of Augmented Reality (AR) in the Laboratory for Experimental Physics*. Peer review under the responsibility of the scientific committee of the 33rd CIRP Design Conference 10.1016/j.procir.2023.03.089
- Maričić O, Ivkov-Džigurski A, Stojšić I, Cvjetičanin S, Ivanović-Bibić L. *Multimedia teaching effectiveness in natural science teaching*. *Geographica Pannonica* 2020;24:147–56. <https://doi.org/10.5937/gp24-23357>.
- Sung, Ma, Choi, Hong. *Real-Time Augmented Reality Physics Simulator for Education*. *Applied Sciences* 2019;9:4019. <https://doi.org/10.3390/app9194019>.
- Chen Y, Wang Q, Chen H, Song X, Tang H, Tian M. *An overview of augmented reality technology*. *J Phys Conf Ser* 2019;1237:22082. <https://doi.org/10.1088/1742-6596/1237/2/022082>.

- Maulana FI, Al-Abdillah BI, Pandango RRA, Djafar APM, Permana F. *Introduction to Sumba's traditional typical woven fabric motifs based on augmented reality technology*. Indonesian Journal of Electrical Engineering and Computer Science 2022;29:509. <https://doi.org/10.11591/ijeecs.v29.i1.pp509-517>.
- Nincarean Eh Phon D, Zainal Abidin AF, Ab Razak MF, Kasim S, Basori AH, Sutikno T. *Augmented reality: effect on conceptual change of scientific*. Bulletin of Electrical Engineering and Informatics 2019;8:1537–44. <https://doi.org/10.11591/eei.v8i4.1625>.
- Stolzenberger C, Wolf N, Trefzger T. *Technology deployment in physics lessons: Understanding optics better with Augmented Reality*. J Phys Conf Ser 2021;1929:012037. <https://doi.org/10.1088/1742-6596/1929/1/012037>.
- Huang K, Wang C, Wang S, Liu R, Chen G, Li X. *An Efficient, Platform-Independent Map Rendering Framework for Mobile Augmented Reality*. ISPRS Int J Geoinf 2021;10:593. <https://doi.org/10.3390/ijgi10090593>.