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Physics Textbooks Feature Augmented Reality Technology-Based Media For Kinematics Material: Training 21st Century Skills For High School Students

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Abstract

Textbook as the main medium of learning are required to meet the needs of the 21st century. Textbook must facilitate the formation of 21st century skills. The necessary skills are Critical Thinking, Communication, Collaboration, and Creativity. This article describes the results of research on the development of a physics textbook at kinematic concept with augmented reality technology-based media. The physics textbook of this research is aimed at practicing the 21st century skills of high school students. The research method used is research and development with a Dick and Carey approach. A physics textbook at kinematic concept has been produced with stages to practice in 21st century skills. The components presented are: video based on augmented reality technology, data tables, graphs, pictures, mathematical analysis, verbal analysis for each subtopic presented. Learning is based on four pillars of education, namely: learning to know, learning to do, learning to be, and learning how to live together. The stages in the structure of the book being developed are concept maps, preliminary knowledge tests, theory by providing competency tests in each sub-chapter, summary, reflection, chapter competency tests, and learning activities that contain 4C components in practicing 21st century skills keterampilan. The results of this research and development textbook physics at kinematic concept have been validated by physics material experts, learning experts and textbook media experts. The expert gives a very decent assessment for all aspects that are assessed.

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INTRODUCTION

The educational process in the 21st century should build soft skills and hard skills optimally (Maulidah, 2019). Textbooks play an important role in the learning process. Textbooks are a major part of several educational systems that help to explain what is contained in the curriculum and can be a clear aid to educators in implementing learning. Textbooks are useful and easily accessible learning resources so that students and teachers can use them as needed (Mahmood, 2011). Student textbooks or textbooks are very many and varied available on the market and of course with different qualities (Adisendjaja, 2007). The outstanding book is still there are some shortcomings and not fully support students in learning, the existing books are also not designed for high-level thinking students in solving authentic problems in everyday life and connect it with society and the environment (Millah, 2012). In textbooks or textbooks are still found concepts that are less precise, misconceptions and require alternative conceptions (Adisendjaja, 2007). Textbooks have limitations such as, difficult to display motion in print media pages, if not designed properly can make students feel bored (Arsyad, 2011). The rapid development of technology so that it is also widely used to develop learning media, one of which is to develop Augmented Reality-based media learning (Sirakaya et al., 2018). Augmented reality is a variation of virtual reality (VR) (Sutherland, 2019). Augmented reality technology can combine two-dimensional virtual objects in the form of images and videos or three-dimensional objects (Chen et al., 2016). The use of augmented reality can develop students ' critical thinking skills, including cognitive ability to interpret, analyze, evaluate, explain something effectively (Mustami et al., 2019). Some of the advantages of textbooks with AR technology: enriching the reading experience so that it becomes more interactive and increases the ability to think (Dunse et al., 2018), visualize abstract physical concepts so that they become easier to understand (Vallera, 2019). This article describes the results of research and development of textbooks on kinematics materials equipped with media based on augmented reality technology. This textbook is presented contextually and multiple representations to shape science literacy in 21st century skills.

METHOD

1. Research design
   Research design the research and development of this physics textbook uses the Dick and Carey approach. The research stages include:
   1.1. Identify Instructional Goals
   The physics learning objectives developed in the textbook were identified from the 2013 revised curriculum of 2018. The abilities that learners must have include attitudes, knowledge, and skills.
   1.2. Conduct Instructional Analysis
   An analysis of the competence of physics subjects and basic competencies of physics concepts was carried out based on the 2013 curriculum revised in 2018. This analysis produces competency achievement indicators and material maps in accordance with basic competencies in physics subjects that train 21st century skills.
   1.3. Analyze Learners and Contexts
   Conduct an analysis of the relevance of the study of the material to the competence formed in the subject of physics. The analysis produces a prerequisite part, part of the material that needs to be given in regular learning and part of the deepening of the material for learners.
   1.4. Write Performance Objectives
   Identify the Cognitive, Affective and psychomotor skills that must be formed in the subject of physics according to the material on the chosen basic competence. Formulate specific learning objectives for each sub-subject presented in the textbook.

1.5. Develop Assesment Instruments
Develop achievement assessment instrument learning indicators that train the skills of the 21st century.The development of assessment instruments is based on competency achievement indicators and specific learning objectives formulated.

1.6. Develop Instructional Strategy
Strategize the exposure of the material in the textbook contextually, several representations to form the ability of science literacy in the competence of the 21st century. Learning strategies include; apperception, presentation of physics material contextually in several representations, simple practicum, summary, reflection direction and competency test.

1.7. Develop and Select Instructional Materials
Compile textbooks based on assessment instruments and learning strategies. Physics material in textbooks is presented contextually and multiple representations. For abstract material, a three dimensional medium is created that is integrated with augmented reality technology in books. The stages in the book also pay attention to the formation of 21st century competencies.

1.8. Design and Conduct Formative of Instruction
Compiled instruments and carry out formative evaluations to measure the feasibility of materials, media, and pedagogics by experts. Formative evaluation is carried out in order to obtain textbook products of physics subjects that are worthy of training the skills of the 21st century. There are three types of formative evaluations: individual tests (one-to-one), small group tests (small groups) and field tests (field evaluation).

1.9. Revise Textbook
Revision is based on formative evaluation. The part that according to the expert is not yet feasible needs to be revised until the expert concludes that the textbook product of Physics subjects equipped with augmented reality media is feasible to train 21st century skills.

2. Research Instruments
The assessment instrument used in this study is in the form of a questionnaire or questionnaire to test the feasibility of research results in the development of class x physics textbooks. Assessment instruments include a questionnaire on the feasibility of media, materials, and pedagogics.

3. Data is analyzed
Research data is the result of expert assessment of products using instruments in the form of questionnaires with continuum scale assessment 4.

TABLE 1. Interpretation of continuum scale assessment 4

No	Alternative Answer	Score
1.	Very Not Feasible	4
2.	Less Feasible	3
3.	Feasible	2
4.	Very Feasible	1

Based on the interpretation criteria score, it can be calculated and analyzed from the total score obtained by the following formulation:

$$percentage\ score\ (PS) = \frac{\sum earning\ score}{\sum maximum\ score} \times 100\%$$

To be able to find out the level of feasibility of the resulting product, grouping is carried out based on the average score. The feasibility interpretation group is calculated using the score range with the equation:

$$\text{RS} = \frac{maximum\ score - minimum\ score}{number\ of\ scale}$$

$$\text{RS} = \frac{4-1}{4} = 0.75$$

TABLE 2. Interpretation Score

Scale	Score Percentage	Interpretation
1 ≤ IS < 1.75	25% ≤ SP < 43.8%	Very Not Feasible
1.75 ≤ IS < 2.50	43.8% ≤ SP < 62.5%	Not Feasible
2.50 ≤ IS < 3.25	62.5% ≤ SP < 81.3%	Feasible
3.25 ≤ IS < 4.00	81.3% ≤ SP < 100%	Very Feasible

RESULTS AND DISCUSSION

This book is systematically compiled starting from concept maps, initial knowledge tests, theories by providing competency tests in each sub-chapter, summary, reflection, chapter competency tests, and learning activities containing 4C components in training 21st century skills. This book was developed to minimize the weakness of the book, namely that it cannot display motion or the book can only display two-dimensional media. Augmented reality technology is one of the alternatives that can support the quality of this book because it has the ability to visualize two-dimensional objects into three-dimensional objects. So, books can display media in the form of videos or animations assisted by augmented reality technology. Text book product physics and result.

1. Concept Map
   In this section, a concept map will be compiled as an outline of the arrangement of the material to be studied.

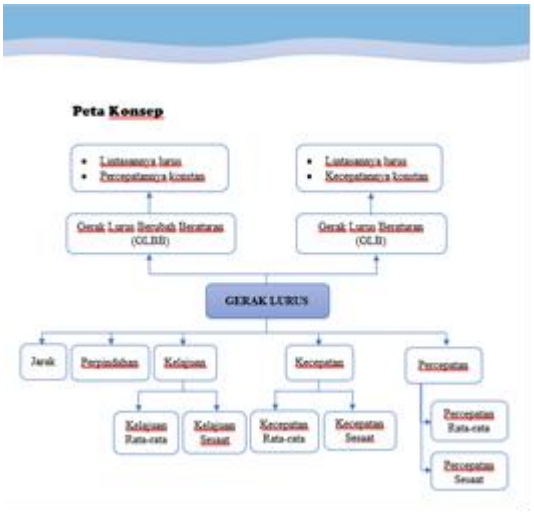

FIGURE 1. Straight Motion Concept Map

2. Initial knowledge test
   Before discussing the core material, a preliminary knowledge test is carried out with the aim of knowing the extent to which students master the related material beforehand.

FIGURE 2. Initial abilty test questions

3. Theory by providing competency tests in each sub-chapter
   Contains material exposure that will explain in detail about the topic of discussion studied.

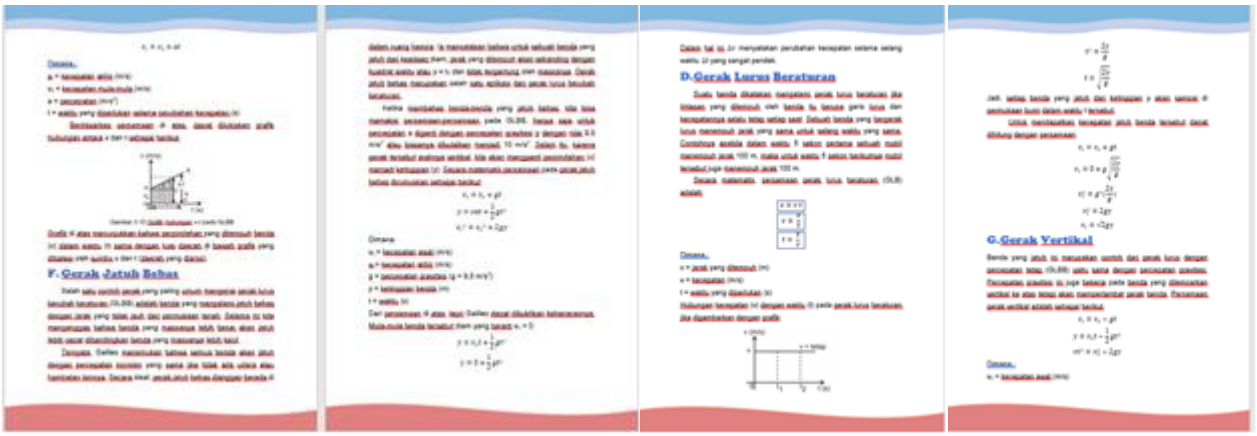

FIGURE 3. Material Exposure

4. Summary
   Contains a brief description that includes the entire material that has been studied.

FIGURE 4. Summary

5. Reflection
   The final learning activity is that students are asked to write down things or benefits obtained from studying the subject matter. And if students have difficulty in understanding the material, they can be consulted to the teacher through the reflection column.

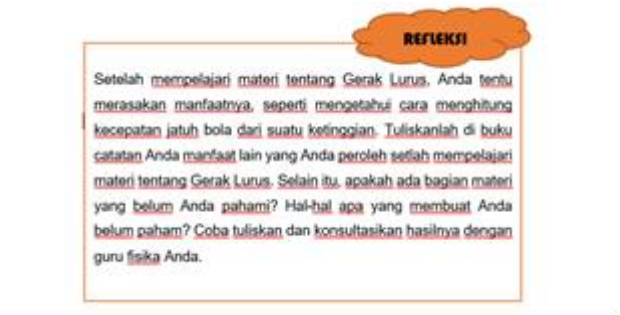

FIGURE 5. Reflection Column

6. Chapter Competency Test
   Contains enrichment questions aimed at testing students' understanding of the material that has been studied.

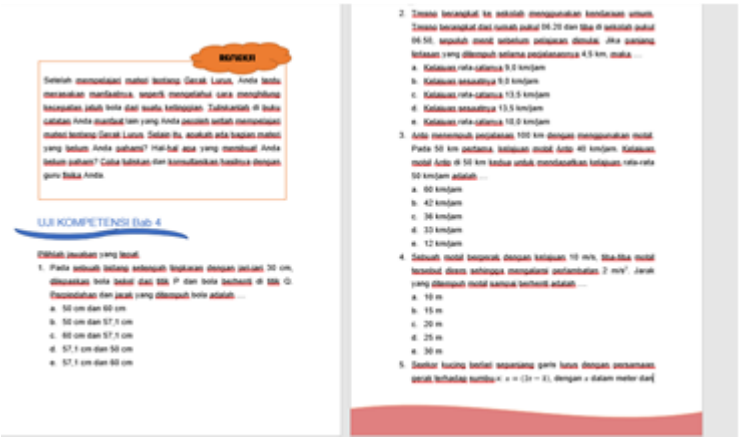

FIGURE 6. Competency test questions

7. Learning activities that contain the 4C component in training 21st century skills
   7.1. Critical Thinking

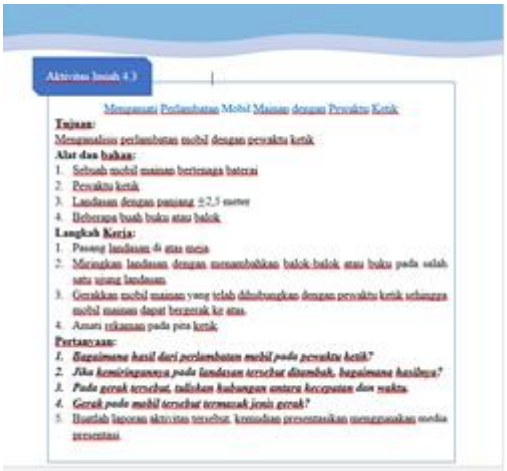

FIGURE 7. Activities For Critical Thinking Components

   7.2. Collaboration

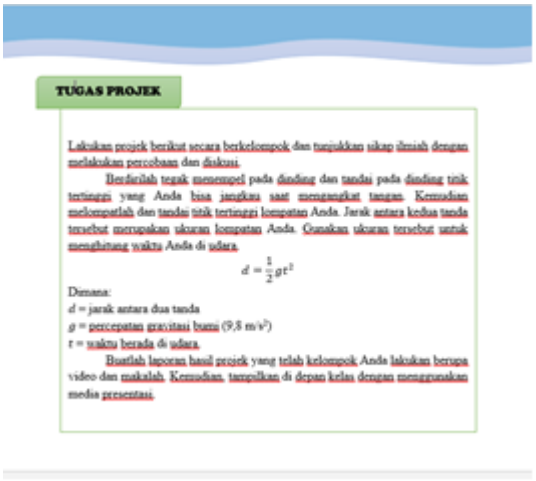

FIGURE 8. Activities for Collaboration Components

7.3. Communication

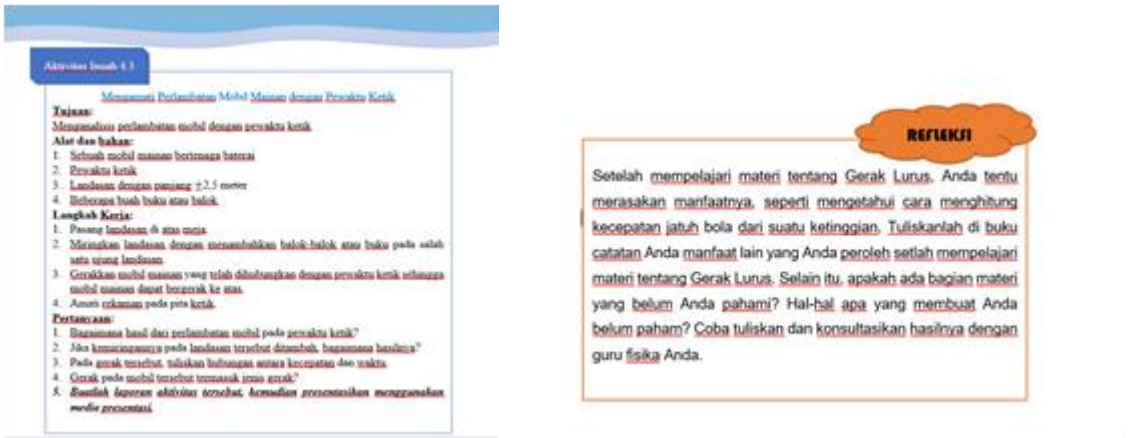

FIGURE 9. Activities for the Communication Components

7.4. Creativity

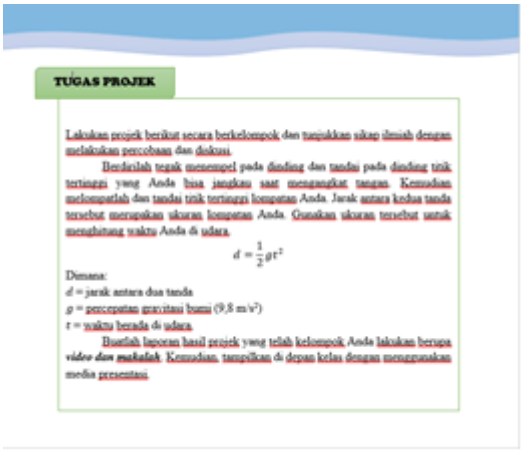

FIGURE 10. Activities for Creativity Components

Results of Formative Evaluation of Physics Textbooks Research Results

Based on the results of the formative evaluation of the book that has been carried out, the percentage of eligibility of media, materials, and products is obtained as follows:

TABLE 3. Textbook Media Eligibility with Augmented Reality

Aspects	Achievements
Elements of the Front-End Book	85%
Contents Section	87%
Final Part	86%
Aspects of Graphics	85%
Media Augmented Reality	89%

TABLE 4. Eligibility of Textbook Materials with Augmented Reality

Aspects	Achievements
Presentation of the material	84%
Representation of science in textbooks	88%
Media Augmented Reality	90%

TABLE 5. Textbook Learning Feasibility with Augmented Reality

Aspects	Achievements
Presentation of the material	87%
Use of illustrations	90%
21st Century Skills	86%

Discussion of Research Results

Based on the literature, currently there are still misconceptions found in some physics books. And also there are still many books that only practice hard skills or have not trained soft skills. The books in circulation have also not been designed for students to think at a high level in solving authentic problems in everyday life. As well as the weakness of books that cannot display three-dimensional objects is a problem that must be solved. With the rapid development of technology, so that the creation of augmented reality technology is expected to minimize the weakness of the book. Physics textbooks equipped with augmented reality-assisted media can display media in the form of videos or animations. With videos or animations, it is hoped that it can minimize misconceptions that occur during and can motivate students in interactive learning.

CONCLUSION

From the research and development carried out, a product was produced in the form of an odd semester class X physics textbook equipped with augmented reality, which aims to train the skills of 21st century high school students. The resulting product, namely physics textbooks, has been declared suitable for use by high school students based on media validation, material validation, and learning validation.

REFERENCES

Adisendjaja, Y. H., & Romlah, O. (2007). Analisis Buku Ajar Sains Berdasarkan Literasi Ilmiah Sebagai Dasar Untuk Memilih Buku Ajar Sains. *Seminar Nasional Pendidikan Biologi dan Biologi*, 1-8.

Arsyad, A. (2011). Media Pembelajaran. Jakarta: PT. Raja Grafindo.

Chen, P., et al. (2017). A Review of using Augmented Reality in Education from 2011 to 2016. *Innovations in smart learning*, 13-18.

Dunser, A., (2012). Creating Interactive Physics Education Books with Augmented Reality. *OZCHI'12*, 107-114.

Mahmood, K. (2011). Conformity to Quality Characteristics of Textbooks. *Journal of Research and Reflection in Education*, l(5), 170-190.

Maulidah, E. (2019). Character Building dan Keterampilan Abad 21 Dalam Pembelajaran di Era Revolusi Industri 4.0. *in Prosiding Seminar Nasional PGSD*.

Millah, E. S., Budipramana, & Isnawati. (2012). Pengembangan Buku Ajar Materi Bioteknologi di Kelas XII SMA IPIEMS Surabaya Berorientasi Sains, Teknologi, Lingkungan, dan Masyarakat (SETS). *BioEdu,* l(1), 19-24.

Mustami, M. K., et al. (2019). Validity, practicality, and effectiveness development of biology textbooks integrated with augmented reality on high school students. *Technology Enhanced Learning,* 187-200.

Sirakaya, M., et al. (2018). Tends in Educational Augmented Reality Studies: A Systematic Review. *Malaysian Online Journal of Educational Technology,* 6(2), 60-74.

Sutherland, J., et al. (2019). Applying modern virtual and augmented reality technologies to medical images and models. *Journal of Digital Imaging,* 32, 38-53.

Vallera, F. L. (2019). Durkheim Said What?: Creating Talking Textbooks With Augmented Reality and Project-Based Activities. *Journal of Research on Technology in Education,* 51(3), 290-310.