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THE DEVELOPMENT OF BLENDED LEARNING-BASED DIGITAL TEACHING MATERIALS ON KINEMATICS FOR ISLAMIC PRIMARY SCHOOL PROSPECTIVE TEACHERS IN SCIENCE LEARNING

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ABSTRACT

Kinematics is one of fundamental materials in Basic Science Courses for Islamic Primary Schools Prospective Teacher. Kinematics often difficult for student because it needs schematic drawings and formula for motion. Thus, the kinematics teaching materials absolutely needed for Islamic Primary Schools Prospective Teacher. The current findings suggest that the environment in which Islamic Primary Schools Prospective Teachers learn has not been conducive to their growth and development. These initial observations indicate that certain factors may be hindering their progress. Therefore, digital teaching materials are needed that can facilitate the entire science learning process. The purpose of this research is to explicate the development process, along with the validation and comprehensibility of digital science teaching materials as learning media for prospective elementary school teachers in Islamic education. The Lee and Owens development model was used in the creation of this digital teaching material. The Lee Owens developmental model consist of assessment/analysis, need assessment, front-end analysis, design, development, implementation, and evaluation. A material validation questionnaire, media, and a student readability test were used in the questionnaire with Likert scale. The subject of this research are 24 students of Islamic Primary Schools Prospective Teacher in UIN Maulana Malik Ibrahim Malang. The material aspect of product validation showed an average result of 92.08%, while the media validation aspect scored 90.90%. The readability test for digital science teaching materials obtained a score of 83.2%. These findings suggest that digital science teaching materials are highly valid and suitable for use as learning media for prospective Islamic elementary school teachers. As a result, it is possible to conclude that digital science teaching materials are extremely valid and appropriate for use as learning media for prospective Islamic elementary school teachers.

Keywords: blended learning; digital teaching; islamic primary schools; prospective teachers; scaffolding; teaching materials

INTRODUCTION

Kinematics material is one of the materials taught in the Basic Science Concepts course for Islamic Higher Education (PTKIN) Islamic Primary School/ *Madrasah Ibtidaiyah* Teacher Education (PGMI) students. This material is generally taught at the beginning of the course because this material is the basis for subsequent science materials.[1]

[1] Andrei Craifaleanu, Cristian Dragomirescu, and Iolanda-Gabriela Craifaleanu, "Virtual Laboratory for the Study of Kinematics in Engineering Faculties," in *New Horizons in Web Based Learning: ICWL 2011 International Workshops, KMEL, ELSM, and SPeL, Hong Kong, December 8-10, 2011, ICWL 2012 International Workshops, KMEL, SciLearn, and CCSTED, Sinaia, Romania, September 2-4, 2012. Revised Selected Papers 11* (Springer, 2014), 191–200.

Kinematics material is a very fundamental material and is considered difficult by students.[2]

Without taking into account the reasons behind an object's motion, kinematics examines how it moves. When studying kinematics material, one uses formulas and schematic drawings to illustrate how objects move.[3] The initial observations on the Madrasah Ibtidaiyah Teacher Education students at State Islamic Religious Universities in East Java found that the science learning process has taken place through lectures and manual practicums.[4] The use of lecture-based learning and manual practicum in kinematics is considered ineffective due to limited illustrations between the schematic images taught and the actual phenomena.[5]

Furthermore, the availability of teaching materials related to kinematics among Madrasah Ibtidaiyah Teacher Education students is limited. A needs analysis on the PTKIN PGMI students in UIN Maulana Malik Ibrahim Malang, UIN KHAS Tulungagung, UIN Sunan Ampel Surabaya, and IAIN Kediri found that 45% of students used printed textbooks, and 41.3% of them only used student worksheets as kinematics teaching materials.[6] Moreover, there are no science teaching materials available that discuss kinematics in detail for PGMI students at UIN Maulana Malik Ibrahim Malang. Accordingly, teaching materials related to kinematics are needed to facilitate the student learning process.

Along with technological developments, the use of digital teaching materials in learning is modern and effective.[7] Over the last two decades, the use of digital-based

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[2] Bunga Dara Amin et al., "The Interpreting Ability on Science Kinematics Graphs of Senior High School Students in South Sulawesi, Indonesia," *Jurnal Pendidikan IPA Indonesia* 9, no. 2 (2020): 179–86; Muhammad Reyza Arief Taqwa and Lugy Rivaldo, "Kinematics Conceptual Understanding: Interpretation of Position Equations as A Function of Time," *Jurnal Pendidikan Sains* 6, no. 4 (2018): 120–27.

[3] R. Prada Núñez, AA Gamboa Suárez, and WR Avendaño Castro, "Difficulties in the Interpretation of Kinematics Graphs in Secondary Basic Education Students," in *Journal of Physics: Conference Series*, vol. 2159 (IOP Publishing, 2022), 012019.

[4] Rizki Amelia, "Need Analysis of Integrated Science Digital Teaching Materials with Blended Learning Models in the New Normal Era for PGMI Students throughout East Java," *Al Ibtida: Jurnal Pendidikan Guru MI* 10, no. 1 (2023): 29–41.

[5] Shahrul Kadri Ayop and M. Ismail, "Students' Understanding in Kinematics: Assessments, Conceptual Difficulties and Teaching Strategies," *International Journal of Academic Research in Business and Social Sciences* 9, no. 2 (2019): 1278–85.

[6] Amelia, "Need Analysis of Integrated Science Digital Teaching Materials with Blended Learning Models in the New Normal Era for PGMI Students throughout East Java."

[7] Rochman Hadi Mustofa and Henni Riyanti, "Perkembangan E-Learning Sebagai Inovasi Pembelajaran Di Era Digital," *Wahana Didaktika: Jurnal Ilmu Kependidikan* 17, no. 3 (2019): 379–91; Muhammad Irwan Padli Nasution, "Strategi Pembelajaran Efektif Berbasis Mobile Learning Pada Sekolah Dasar," *Jurnal Iqra* 10, no. 01 (2016).

learning has gained momentum in various fields, from mathematics to science.[8] Recently, many universities have used digital teaching materials in the learning process. This is because digital teaching materials provide low-cost solutions that can be adapted to the learning process and can be disseminated according to needs.[9] Thus, the use of digital teaching materials will greatly support the learning process in the higher education environment.

In the Islamic higher education context of East Java, the learning process occurs through blended learning approaches, with a higher proportion of face-to-face instruction than online learning. Blended learning refers to a pedagogical approach that combines face-to-face classroom instruction with online learning experiences.[10,11] The blended learning method creates a dynamic, interesting and effective learning environment for all students.[12,13] With blended learning, learning does not only take place in the classroom, but becomes endless learning that can optimize student learning potential.[14,15]

Blended learning-based digital teaching materials can be a suitable strategy for learning.[16,17] Digital teaching materials based on blended learning can be used as an alternative learning in the digital era.[18] The use of digital teaching materials based on

[8] Florence Gabriel et al., "Digital Education Strategies around the World: Practices and Policies," *Irish Educational Studies* 41, no. 1 (2022): 85–106.

[9] Michael B. Horn and Heather Staker, *Blended: Using Disruptive Innovation to Improve Schools* (John Wiley & Sons, 2017).

[10] Hien M. Vo, Chang Zhu, and Nguyet A. Diep, "The Effect of Blended Learning on Student Performance at Course-Level in Higher Education: A Meta-Analysis," *Studies in Educational Evaluation* 53 (2017): 17–28.

[11] Robin Castro, "Blended Learning in Higher Education: Trends and Capabilities," *Education and Information Technologies* 24, no. 4 (2019): 2523–46.

[12] Bokolo Anthony et al., "Blended Learning Adoption and Implementation in Higher Education: A Theoretical and Systematic Review," *Technology, Knowledge and Learning*, 2022, 1–48.

[13] I. Kadek Suartama, Punaji Setyosari, and Saida Ulfa, "Development of an Instructional Design Model for Mobile Blended Learning in Higher Education.," *International Journal of Emerging Technologies in Learning* 14, no. 16 (2019).

[14] Galina Abrosimova et al., "Blended Learning in University Education," *Humanities & Social Sciences Reviews* 7, no. 6 (2019): 06–10; Castro, "Blended Learning in Higher Education: Trends and Capabilities."

[15] Alejandro Armellini, Virgínia Teixeira Antunes, and Robert Howe, "Student Perspectives on Learning Experiences in a Higher Education Active Blended Learning Context," *TechTrends* 65, no. 4 (2021): 433–43.

[16] Adarsh Kumar et al., "Blended Learning Tools and Practices: A Comprehensive Analysis," *Ieee Access* 9 (2021): 85151–97.

[17] Hassan Abuhassna et al., "Strategies for Successful Blended Learning-A Bibliometric Analysis and Reviews.," *Int. J. Interact. Mob. Technol.* 16, no. 13 (2022): 66–80.

[18] Siti Masitoh, "Blended Learning Berwawasan Literasi Digital Suatu Upaya Meningkatkan Kualitas Pembelajaran Dan Membangun Generasi Emas 2045," *Proceedings of the ICECRS* 1, no. 3 (2018): v1i3. 1377-v1i3. 1377; I. Ketut Widiara, "Blended Learning Sebagai Alternatif Pembelajaran Di Era Digital," *Purwadita: Jurnal Agama Dan Budaya* 2, no. 2 (2018): 50–56.

blended learning can also increase digital literacy[19], learning outcomes[20], and learning independence.[21] Blended learning-based digital teaching materials are flexible and tend to be individualized.[22] This is because digital teaching materials based on blended learning can be studied by students wherever and whenever adjusted to their respective learning phases.[23]

Each student certainly has their own level of understanding and learning style. Scaffolding strategies can support and guide students' diverse learning processes.[24] Scaffolding provides temporary assistance in stages to enable the students to understand the material more deeply.[25] Scaffolding provides additional support for students who are struggling to remain motivated in studying.[26] Apart from that, scaffolding also helps students develop independent learning skills by gradually reducing the assistance provided.[27] Scaffolding can be attached to digital teaching materials, such as by equipping the developed teaching materials with the help menu. Islamic Primary Schools Prospective Teachers can use the help menu if they have difficulties in learning. Thus, digital teaching materials equipped with scaffolding will greatly facilitate students in the process of independent learning and understanding concepts.

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[19] Helena Anggraeni, "Penguatan Blended Learning Berbasis Literasi Digital Dalam Menghadapi Era Revolusi Industri 4.0," *Al-Idarah: Jurnal Kependidikan Islam* 9, no. 2 (2020): 190–203; Pidi Mohamad Setiadi, Dwi Alia, and Dadan Nugraha, "Pengembangan Bahan Ajar Digital Dalam Blended Learning Model Untuk Meningkatkan Literasi Digital Mahasiswa," *EDUKATIF: JURNAL ILMU PENDIDIKAN* 4, no. 3 (2022): 3353–60.

[20] Kevin Alexander Johannes Pangkerego, Luckie Sojow, and Hiskia Kamang Manggopa, "Pengaruh Model Blended Learning Terhadap Hasil Belajar Simulasi Dan Komunikasi Digital Siswa Kelas X SMK Negeri 1 Tomohon," *EduTIK: Jurnal Pendidikan Teknologi Informasi Dan Komunikasi* 1, no. 1 (2021): 55–68; Fendy Hardian Permana, "Pengembangan Buku Ajar Biologi Berbasis Blended Learning Sebagai Bekal Hidup Di Abad 21 Untuk Mahasiswa S1 Kimia FMIPA UM," in *Prosiding Seminar Nasional Pendidikan Biologi*, vol. 58, 2015, 50–61.

[21] Usman Usman, "Komunikasi Pendidikan Berbasis Blended Learning Dalam Membentuk Kemandirian Belajar," *Jurnal Jurnalisa* 4, no. 1 (2018).

[22] Kumar et al., "Blended Learning Tools and Practices: A Comprehensive Analysis."

[23] Thomas KF Chiu, "Digital Support for Student Engagement in Blended Learning Based on Self-Determination Theory," *Computers in Human Behavior* 124 (2021): 106909.

[24] Brigitta Erlita Tri Anggadewi, "Scaffolding: How It Works for Students with Learning Difficulties," in *The 2017 International Conference on Research in Education*, 2017, 210–18.

[25] Brian R. Belland, "Scaffolding: Definition, Current Debates, and Future Directions," *Handbook of Research on Educational Communications and Technology*, 2014, 505–18.

[26] Tayebeh Fani and Farid Ghaemi, "Implications of Vygotsky's Zone of Proximal Development (ZPD) in Teacher Education: ZPTD and Self-Scaffolding," *Procedia-Social and Behavioral Sciences* 29 (2011): 1549–54.

[27] Xun Ge and Bee Leng Chua, "The Role of Self-directed Learning in PBL: Implications for Learners and Scaffolding Design," *The Wiley Handbook of Problem-Based Learning*, 2019, 367–88.

Several previous studies have developed digital teaching materials related to kinematics.[28] Sinaga developed an e-book application used in mobile phones for kinematics material secondary schools.[29] Pratiwi used Virtual Laboratory Media on Motion Kinematics for physics students and used a quantitative approach.[30] Furthermore, Firdaus also developed a kinematics learning model using video and interface.[31]

However, there is still limited previous research that develops digital teaching materials based on blended learning accompanied by scaffolding, especially for Madrasah Ibtidaiyah Teacher Education students. Apart from that, there has been no previous research related to teaching materials for basic science concepts courses for Madrasah Ibtidaiyah Teacher Education students. Thus, this study aims to develop blended learning-based digital teaching materials on kinematics material for prospective Islamic Primary School / Madrasah Ibtidaiyah teachers.

RESEARCH METHODS

The development of e-scaffolding website media refers to the development model developed by Lee & Owens.[32] Researchers chose the Lee and Owens development model because it is suitable for multimedia-based development. This development model has five stages which are presented in Figure 1.

[28] Elarismoy Beporta Anusba et al., "Inovasi Modul Digital Berbasis POE Untuk Memfasilitasi Kemampuan Pemahaman Konsep Kinematika Siswa," *JURNAL PENDIDIKAN MIPA* 13, no. 3 (2023): 663–69; Kiar Vansa Febrianti, Fauzi Bakri, and Hadi Nasbey, "Pengembangan Modul Digital Fisika Berbasis Discovery Learning Pada Pokok Bahasan Kinematika Gerak Lurus," *WaPFi (Wahana Pendidikan Fisika)* 2, no. 2 (2017): 18–26; Sekar Arum Wulandari, Firmanul C. Wibowo, and Hadi Nasbey, "Pengembangan Interactive Digital Modul Physics (IDMP) Berbasis Model Physics Independent Learning (MPIL) Pada Konsep Kinematika Gerak Lurus," in *Prosiding Seminar Nasional Fisika*, vol. 2, 2023, 397–403.

[29] Parlindungan Sinaga, Amsor, and Febby Dwi Cahyanti, "Effectiveness of the New Generation E-Book Application for Mobile Phones in Improving the Conceptual Mastery of Kinematics," *International Journal of Mobile Learning and Organisation* 13, no. 2 (2019): 217–32.

[30] Maharani Rizky Pratiwi, Sri Purwaningsih, and Neneng Lestari, "Development of Learning Media Based on Virtual Laboratory on Straight Motion Kinematics Materials," *Jurnal Pendidikan Fisika Dan Teknologi* 9, no. 1 (2023): 36–42.

[31] T. Firdaus, W. Setiawan, and I. Hamidah, "The Kinematic Learning Model Using Video and Interfaces Analysis," in *Journal of Physics: Conference Series*, vol. 895 (IOP Publishing, 2017), 012108.

[32] William W. Lee and Diana L. Owens, *Multimedia-Based Instructional Design: Computer-Based Training, Web-Based Training, Distance Broadcast Training, Performance-Based Solutions* (John Wiley & Sons, 2004).

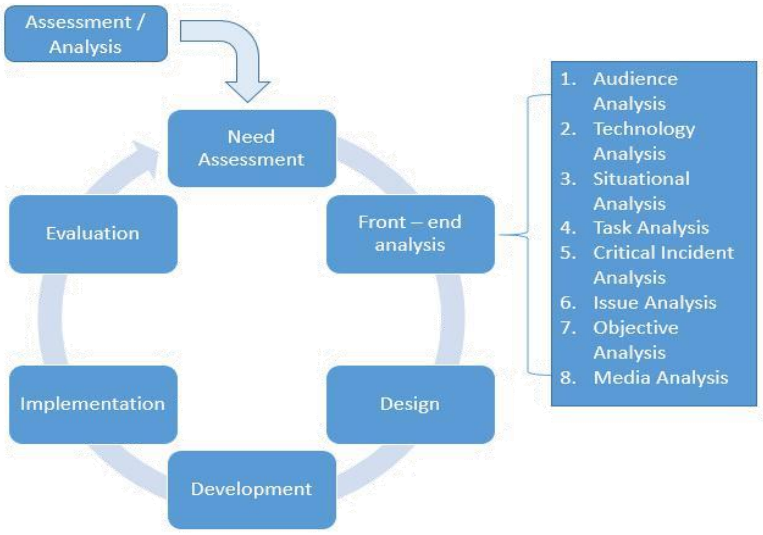

Figure 1
Lee Owen's Development Model[33]

The analysis stage was crucial to determine the subject's condition, the surrounding environment, and any hindrances to learning. This stage involved two types of analysis: need assessment and front-end analysis. In this study, need analysis became a reference for the process of developing learning media that suits students' conditions by observing the learning process with Islamic Primary Schools Teacher Education students and lecturers at East Java Islamic Higher Education, consisting of UIN Maulana Malik Ibrahim Malang, UIN KHAS Tulungagung, UIN Sunan Ampel Surabaya, IAIN Kediri, and IAIN Ponorogo. The need analysis is vital to create learning media precisely tailored to the students' conditions and to support blended learning in the East Java State Islamic Religious College environment.

At the design stage, a storyboard was created to determine the components that might be included in the teaching material. The storyboard was rigorously validated by an expert lecturer before being used to develop the product. The development stage involved two critical activities: production and post-production. The production stage was where learning media was developed, starting from material content to digital components and student worksheets included at each stage of e-scaffolding. The post-production stage was where the teaching materials' validity was tested by experts through material and media validation. Additionally, a readability test was conducted on students to assess their understanding and comfort with the developed learning media. The validity

[33] Lee and Owens.

and readability testing was part of the trials for the development of digital teaching materials for science education that integrate Scaffolding and Problem-Based Learning.

As part of the development process for digital teaching materials for science learning, trials were conducted by including validity and readability tests. To determine the feasibility of the media being developed, the validity test was divided into two parts: material validation and media validation. Expert lecturers and heads of Islamic Primary School prospective teachers study programs from Universitas Islam Negeri Maulana Malik Ibrahim Malang, UIN KHAS Tulungagung, UIN Sunan Ampel Surabaya, and IAIN Kediri validated the materials. In order to determine the level of understanding and comfort with the developed learning media, students from PGMI UIN UIN Malang, UIN KHAS Tulungagung, UIN Sunan Ampel Surabaya, and IAIN Kediri were subjected to readability tests. A questionnaire with an answer key was distributed to carry out both validity and readability testing. The validity criteria are presented in Table 1.[34]

Table 1
Interpretation Criteria for Average Analysis Scores

Percentage (%)	Criteria
0 – 20	Very weak/infeasible/invalid
21 – 40	Weak / Less worthy / less valid
41 – 60	Sufficient / Sufficiently Appropriate / Sufficiently Valid
61 – 80	Strong / Feasible / Valid
81 – 100	Very Strong / Very Feasible / Very Valid

Source: Personal Document

To test the validity of the teaching materials, media experts and material experts were involved in this study. The Media Experts were the lecturers of Islamic Primary Schools Teacher Education in UIN Maulana Malik Ibrahim Malang and UIN KHAS Tulungagung. The Material experts were the science lecturers of Islamic Primary Schools Teacher Education in UIN Maulana Malik Ibrahim Malang, UIN Sunan Ampel Surabaya, and IAIN Kediri. The validators filled out the questionnaire instrument. Then, the questionnaire data were analyzed using percentages.

[34] Suharsimi Arikunto, *Dasar-Dasar Evaluasi Pendidikan Edisi 3* (Bumi aksara, 2021).

RESULT AND DISCUSSION

Description of Development Product

The product of this development research is digital teaching materials for science learning (Scaffolding Integrated Problem Based Learning) which can be accessed at https://bit.ly/bahanajarmekanika. Digital teaching materials for science education contain material about motion, force, and Newton's laws. This web page consists of an introduction and contents sections which are described as follows.

Introduction Section

The introduction section covers a cover page and table of contents. The cover page is the initial page that appears when the digital teaching materials for science learning is first opened. The cover page includes the title of the teaching material, the UIN Malang logo, and the author's name. Meanwhile, on the table of contents page there are details of the material content hyperlinked to each part of the material content. The appearance of the cover page and table of contents page can be seen in Figure 2.

Figure 2
Introduction page
Source: Personal Document

Contents

After selecting the material, users will be directed to the content section. The content section encompasses the first page of the material, the problem context, the problem formulation, and the hypothesis, as well as Let's Explore, Let's Pay Attention,

Let's Evaluate, and Check Understanding. Each page in the contents segment is outlined as follows.

Initial page of material

The user will be taken to the first page of the material after choosing it from the table of contents. The learning objectives, keywords, and applications in MI/SD learning are described on this page. The goal of applying MI/SD learning is to aid students in understanding the grade level of the material that they will be studying. The material's first page is shown in Figure 3.

Problem Context and Problem Formulation

Students are given access to the problem context menu in the next section to help them better understand the material. To help students better understand the problems related to the material, this menu is accompanied by a problem formulation. While the problem formulation is embedded in a Google form that students can access directly within the course material, the problem context may be presented through animation or video. The problem formulation and context menu are shown in Figure 4.

Figure 3
Initial page of material

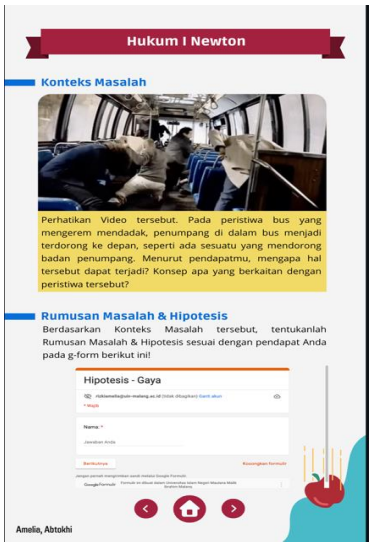

Figure 4
Problem Context Menu Page and Problem Formulation

Source: Personal Documents

Let's Explore

The Let's Explore section is the next menu in this teaching material. Let's look at a few things that can help students with virtual practicums, such as practicum objectives, implementation procedures, and outcomes. The context of the problem is presented

through a menu in the upcoming content section. Giving students the problem formulation and context helps them better prepare to study the material. Furthermore, it is anticipated that the problem formulation and context menu will help students comprehend the problems in relation to the content they are learning. The problem formulation is based on a Google form that is integrated into the instructional materials, and the problem context may be presented as a movie or animation. Students can complete it right in the instructional materials in this manner. The problem formulation and the problem context menu are displayed in Figure 4.

Let's Take a Closer Look

After students have finished carrying out the practicum, students are directed to pay close attention to the related material. In this menu, there is a brief explanation of the material and several examples of questions related to the material. The Let's Take a Closer Look menu display can be seen in Figure 6.

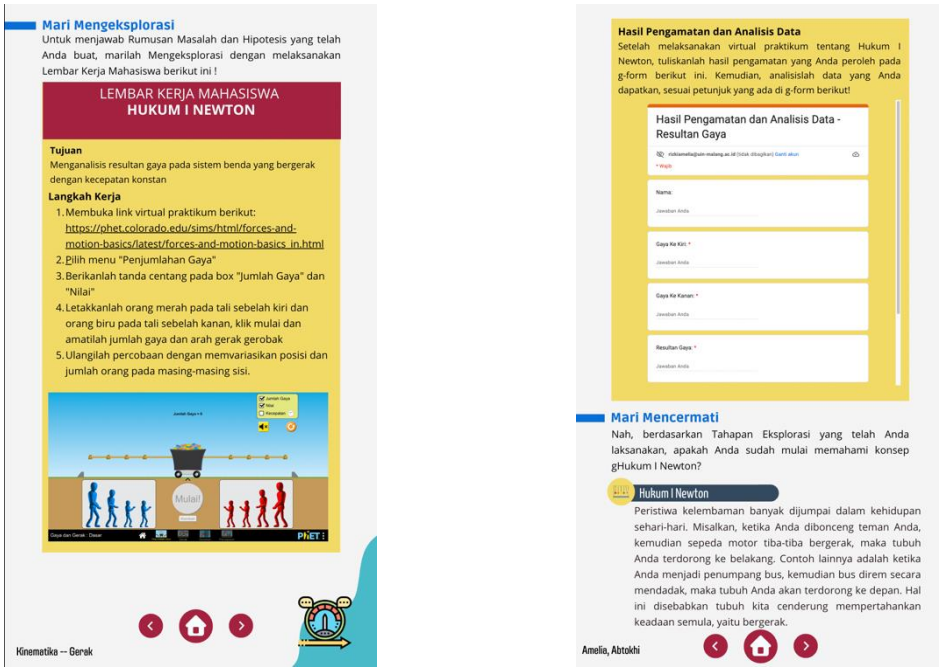

Figure 5
Let’s Explore Menu Display
Source: Personal Documents

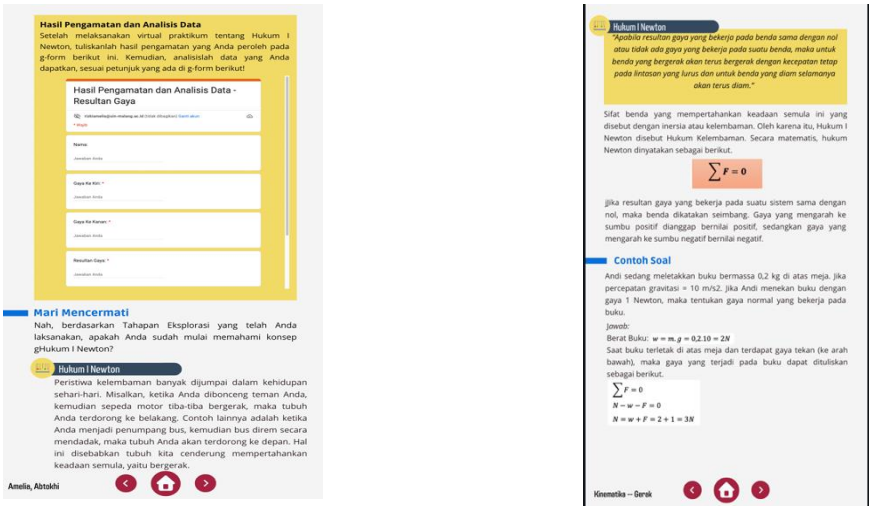

Figure 6
Let's Take a Closer Look
Source: Personal Documents

Let's Evaluate and Check Understanding

After students have looked at the concepts of material related to the Let's Observe menu, students can then decide whether to continue to the next menu on the Let's Evaluate menu. In this menu, there are checkmarks and cross hyperlinks. The tick mark will be connected to the next material, while the cross mark will be connected again at the beginning of the material.

Then, the last menu is an understanding check. This understanding check menu can be used by students to double-check their understanding of the material being studied. In this comprehension check, there is also an answer key, to make it easier for students to study independently.

Validity and Readability Test Results Data Analysis

Validation of digital teaching materials for science education was carried out from August to September by five lecturers from various State Islamic Religious Universities (PTKIN). The readability test was carried out in September 2022 involving 24 PGMI students from UIN Sunan Ampel Surabaya, UIN Sayyid Ali Rahmatullah Tulungagung, IAIN Kediri, and UIN Maulana Malik Ibrahim Malang. Data from validity and readability tests were obtained in the form of qualitative and quantitative data from questionnaires. Qualitative data were obtained from validators and students in the form of suggestions and comments. The quantitative data obtained is the average questionnaire score on a Likert scale ranging from 1 to 5. Following that, the questionnaire data was descriptively

analyzed using percentages of scores per question item. The quantitative data analysis results demonstrate the feasibility and readability of digital teaching materials for science education. The following are the results of validation and readability tests.

Analysis of Validation Results of digital teaching materials for science education

The present study conducted validation of digital teaching materials from multiple aspects, with the primary objective of determining their suitability for deployment. The validation process involved two distinct types of assessments, namely material validation and media validation. Material validation was performed to evaluate the content suitability, language appropriateness, and independent learning aspects. Content suitability was assessed based on several feasibility indicators, including the clarity of material details, alignment with learning outcomes, adherence to learning objectives, completeness, ease of understanding, ability to motivate learning, appropriateness to student level, and clarity of examples. The validation results indicated that the content of the digital teaching materials for science education had a very high degree of validity. The second aspect of material validation involved evaluating language appropriateness. The assessment included various indicators, such as easy-to-understand language, unambiguous sentences, compliance with Indonesian language rules, appropriateness to students' thinking level, and freedom from double meanings. The third aspect of material validation involved assessing independent learning aspects, including the material's ability to attract students' interest in learning and help them learn independently. The validation results of digital teaching materials for science education are presented in Table 2 for further analysis.

Table 2
Material Validation Results for Digital Teaching Materials for Science Education

No.	Aspect	Percentage	Criteria
1	Content Eligibility	89.58%	Very Valid
2	Use of Language	86.67%	Very Valid
3	Learn to be independent	100%	Very Valid
	Average	**92.08%**	**Very Valid**

Source: Personal Document

The second validity test is media validation. There are five aspects to be validated in the media validation, namely aspects of application introduction, user control, application appearance, end of application, and multimedia design principles. The results of media validation in the application introduction aspect consist of clarity of the title,

ease of the title in providing a general description of the application, clarity of the operation guide, and ease of the operation guide.

The second aspect of media validation is the user control aspect. The user control aspect consists of several indicators, including the accuracy of the control sequence, consistency of navigation button layout, and ease of use of buttons. The third aspect of media validation is the appearance of the application. In the aspect of application appearance, there are several indicators, including consistency of layout proportions, colors used, accuracy of background selection, consistency in use of colors, text and font types, and others.

The fourth aspect of media validation is the final aspect of the application. In the final aspect of the application, there are two indicators, namely confirmation of exit from the application and availability of the credit page. Meanwhile, the fourth aspect of media validation is multimedia design principles, including presenting material using more than one media, presenting using animation/video side by side, presenting material using interesting narratives, and many others. Furthermore, the overall details of the media validation results are presented in Table 3.

Table 3
Media Validation Results for Digital Teaching Materials for Science Education

No.	Aspect	Percentage	Criteria
1	Application Introduction	93.75%	Very Valid
2	User Control	97.22%	Very Valid
3	App View	89.91%	Very Valid
4	End of Application	83.35%	Very Valid
5	Multimedia Design Principles	90.28%	Very Valid
Average		**90.90%**	**Very Valid**

Source: Personal Document

Data Analysis of Readability Test Results for digital teaching materials (Scaffolding Integrated Problem Based Learning)

The purpose of the readability test is to assess students' capability to comprehend digital educational materials, with the aim of determining their suitability for use in the learning process. The readability test evaluates the complexity of the language, sentence structure, and overall readability of the materials. The objective to ensure that the students can comprehend the subject matter presented without undue difficulty, while still being challenged to learn and grow. The outcomes of the readability test indicate that the digital teaching materials for science education that are currently being developed

generate significant interest among students. This is mainly because of the inclusion of virtual practicums, which provide students with interactive and engaging learning experiences. These virtual practicums offer a hands-on approach to science education, allowing students to experiment and explore scientific concepts in a safe and controlled environment. The results of the readability test of digital teaching materials for science education are shown in Table 4.

Table 4
Readability Test Results for Digital Teaching Materials

No.	Aspect	Percentage	Criteria
1	The design of the digital teaching materials used is attractive	87.2%	Very Valid
2	Using digital teaching materials is very easy	84%	Very Valid
3	Videos in digital teaching materials support you to better master mechanics material	87.2%	Very Valid
4	Virtual practicum in this digital teaching material helps you to understand mechanics material	80%	Valid
5	The existence of digital teaching materials can provide motivation to study mechanical systems material	78.4%	Valid
6	The delivery of material in this digital teaching material is related to everyday life	82.4%	Very Valid
7	The material presented in this digital teaching material is easy for you to understand	81.6%	Very Valid
8	This digital learning media contains practice questions that can test your understanding of mechanics	85.6%	Very Valid
9	The presentation of material in this digital teaching material helps you to develop your problem-solving abilities	82.4%	Very Valid
10	The presentation of material in this digital teaching material helps you to develop your scientific reasoning abilities	85.6%	Very Valid
11	The shape, style and size of the letters used are simple and easy to read	80.8%	Very Valid
	Average	**83.2%**	**Very Valid**

Source: Personal Document

The results of the quantitative data description indicate that the readability test for the digital teaching materials for science education has produced a validation score of 83.2%. The study reveals that the digital materials designed for science education are highly suitable for learning activities, and they have the potential to significantly improve students' scientific reasoning and problem-solving abilities. The findings suggest that the materials are well-organized and informative, and can effectively engage students in the learning process. All in all, the outcomes of the study indicate that digital teaching materials for science education are a valuable resource that can contribute to the development of effective science education programs.

Science is an important aspect of the curriculum for UIN Maulana Malik Ibrahim Malang's Islamic Primary School Teacher Education program. To address this, digital science teaching materials have been designed using the Lee & Owens development model[35]. This model involves a thorough process of creating, implementing, and evaluating the digital materials to ensure their effectiveness and engagement. Experts in science education, instructional design, and digital media collaborated to create a comprehensive set of materials that cover a wide range of scientific topics. To ensure the validity and readability of the digital materials, a series of tests were conducted. The results showed that the materials are valid and appropriate for use as digital teaching materials in science learning. The development of digital teaching materials for science learning is a significant advancement in the Islamic Primary School Teacher Education Program at Universitas Islam Negeri Maulana Malik Ibrahim Malang. These materials provide learners with an engaging and comprehensive learning experience that can help them develop a solid understanding of scientific principles and concepts.

In the era of blended learning that has arised in the aftermath of the COVID-19 outbreak, digital science instructional materials have emerged as a critical tool for supporting independent learning among students.[36,37] These digital teaching materials have the capacity to enable students to study science concepts at any time and from any

[35] Lee and Owens, *Multimedia-Based Instructional Design: Computer-Based Training, Web-Based Training, Distance Broadcast Training, Performance-Based Solutions*.

[36] Sumitra Pokhrel and Roshan Chhetri, "A Literature Review on Impact of COVID-19 Pandemic on Teaching and Learning," *Higher Education for the Future* 8, no. 1 (2021): 133–41.

[37] Ghada Refaat El Said, "How Did the COVID-19 Pandemic Affect Higher Education Learning Experience? An Empirical Investigation of Learners' Academic Performance at a University in a Developing Country," *Advances in Human-Computer Interaction* 2021 (2021): 1–10.

location, and if they encounter any ambiguities, they can conveniently revisit the relevant materials. In this digital teaching materials equipped by help menu as scaffolding. This menu can help Islamic Primary Schools prospective teachers study independently. Scaffolding is a learning method that focuses on providing temporary support to learners during the learning process.[38] This support is provided gradually and reduced as the ability of students increases, so that they become more independent in learning.[39,40] Scaffolding in digital teaching materials can support independent learning[41], self-regulated learning[42,43], and learning motivation.[44,45]

This digital teaching material is designed for science education and utilizes a Problem-Based Learning (PBL) activity flow. The PBL approach is a student-centered method of teaching that encourages learners to engage in problem-solving activities. By using digital teaching materials based on the PBL method, students are more likely to think critically[46] and develop problem-solving skills.[47] The PBL approach requires students to actively participate in the learning process, which has been shown to increase their understanding of concepts.[48] By engaging in problem-solving activities, students can develop a deeper understanding of the subject matter and are better equipped to apply

[38] Belland, "Scaffolding: Definition, Current Debates, and Future Directions."

[39] Martha J. Larkin, "Providing Support for Student Independence through Scaffolded Instruction," *Teaching Exceptional Children* 34, no. 1 (2001): 30–34.

[40] Maria Zackariasson, "Encouraging Student Independence: Perspectives on Scaffolding in Higher Education Supervision," *Journal of Applied Research in Higher Education* 12, no. 3 (2020): 495–505.

[41] Ching-Huei Chen and Victor Law, "Scaffolding Individual and Collaborative Game-Based Learning in Learning Performance and Intrinsic Motivation," *Computers in Human Behavior* 55 (2016): 1201–12.

[42] Jennifer A. Jones, "Scaffolding Self-Regulated Learning through Student-Generated Quizzes," *Active Learning in Higher Education* 20, no. 2 (2019): 115–26.

[43] Tongguang Li et al., "Analytics of Self-Regulated Learning Scaffolding: Effects on Learning Processes," *Frontiers in Psychology* 14 (2023): 1206696.

[44] Belland, "Scaffolding: Definition, Current Debates, and Future Directions."

[45] Angelica Moè, Idit Katz, and Marianna Alesi, "Scaffolding for Motivation by Parents, and Child Homework Motivations and Emotions: Effects of a Training Programme," *British Journal of Educational Psychology* 88, no. 2 (2018): 323–44.

[46] Dwi Wahyu Agustina and Herlina Fitrihidajati, "Pengembangan Flipbook Berbasis Problem Based Learning (PBL) Pada Submateri Pencemaran Lingkungan Untuk Melatihkan Keterampilan Berpikir Kritis Peserta Didik Kelas X SMA," *Berkala Ilmiah Pendidikan Biologi (BioEdu)* 9, no. 2 (2020): 325–39.

[47] Setyoko Setyoko, Indriaty Indriaty, and Teuku Hadi Wibowo Atmaja, "Efektifitas Bahan Ajar Ekologi Hewan Berbasis Problem Based Learning Terhadap Kemampuan Berpikir Kritis Dan Pemecahan Masalah Mahasiswa Pendidikan Biologi," *BIOEDUKASI (Jurnal Pendidikan Biologi)* 10, no. 2 (2019): 133–39.

[48] Made Wisnu Adi Pramana, I. Nyoman Jampel, and Ketut Pudjawan, "Meningkatkan Hasil Belajar Biologi Melalui E-Modul Berbasis Problem Based Learning," *Jurnal Edutech Undiksha* 8, no. 2 (2020): 17–32.

their knowledge in real-world situations. In summary, the use of digital teaching materials based on the PBL approach can be an effective way to enhance science education and encourage student learning.

This digital teaching material for science education is designed to provide students with an interactive and engaging learning experience. The material includes a virtual lab that allows students to conduct practical work independently at any time and from any location. By using digital teaching materials based on virtual labs, students can achieve success in learning physics.[49,50] The virtual lab experiences and computer-based visualizations enable students to interact with scientific concepts that are often difficult to observe directly.[51,52,53] This makes learning more engaging and allows students to actively manipulate graphical visualizations of complex phenomena, enhancing their understanding of scientific concepts.[54]

Additionally, the virtual lab experiences and computer-based visualizations provide students with opportunities to plan, organize, and control their learning.[55] This empowers students to take ownership of their learning experience and become more independent learners. Furthermore, modeling and simulating laboratory experiments can assist students in overcoming cost, time, and security constraints.[56] This saves students time and money that would otherwise be spent on conducting physical experiments in a traditional laboratory setting.[57]

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[49] Susanne Walan, "Embracing Digital Technology in Science Classrooms—Secondary School Teachers' Enacted Teaching and Reflections on Practice," *Journal of Science Education and Technology* 29, no. 3 (2020): 431–41.

[50] Maria Zafeiropoulou et al., "Developing Physics Experiments Using Augmented Reality Game-Based Learning Approach: A Pilot Study in Primary School," *Computers* 10, no. 10 (2021): 126.

[51] Veljko Potkonjak et al., "Virtual Laboratories for Education in Science, Technology, and Engineering: A Review," *Computers & Education* 95 (2016): 309–27.

[52] Craifaleanu, Dragomirescu, and Craifaleanu, "Virtual Laboratory for the Study of Kinematics in Engineering Faculties."

[53] Jennifer L. Chiu, Crystal J. DeJaegher, and Jie Chao, "The Effects of Augmented Virtual Science Laboratories on Middle School Students' Understanding of Gas Properties," *Computers & Education* 85 (2015): 59–73.

[54] Abdullah Ambusaidi et al., "The Impact of Virtual Lab Learning Experiences on 9th Grade Students' Achievement and Their Attitudes towards Science and Learning by Virtual Lab," *Journal of Turkish Science Education* 15, no. 2 (2018): 13–29.

[55] Fitra Suci Arista and Heru Kuswanto, "Virtual Physics Laboratory Application Based on the Android Smartphone to Improve Learning Independence and Conceptual Understanding.," *International Journal of Instruction* 11, no. 1 (2018): 1–16.

[56] Lucília Domingues et al., "Virtual Laboratories in (Bio) Chemical Engineering Education," *Education for Chemical Engineers* 5, no. 2 (2010): e22–27.

[57] Ian Hawkins and Amy J. Phelps, "Virtual Laboratory vs. Traditional Laboratory: Which Is More Effective for Teaching Electrochemistry?," *Chemistry Education Research and Practice* 14, no. 4 (2013): 516–23.

Finally, students who have used this digital teaching material for science education and participated in virtual lab-based learning experiences have expressed positive feelings about their learning.[58,59] They found the virtual lab experiences to be engaging and interactive, which helped them to better understand scientific concepts and retain the knowledge they gained.[60] Overall the digital teaching materials about kinematics has positive impact for Islamic Primary Schools Prospective Teacher.

CONCLUSION

Digital teaching material products have been proven valid and suitable for use as teaching materials in science learning for prospective Madrasah Ibtidaiyah / Islamic Primary School teachers. The validity and readability tests results indicate valid scores, material validation of 92.08%, media validation of 90.90%, and readability test of 83.2%. The e-scaffolding feature in digital teaching materials also makes it very easy for students in the independent learning process. Furthermore, it is expected that this digital teaching material will also be developed for other science materials and can be disseminated to a wider audience.

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[59] Nadia Rahbek Dyrberg, Alexander H. Treusch, and Claudia Wiegand, "Virtual Laboratories in Science Education: Students' Motivation and Experiences in Two Tertiary Biology Courses," *Journal of Biological Education* 51, no. 4 (2017): 358–74.

[60] Gülsüm Aşıksoy and Didem Islek, "The Impact of the Virtual Laboratory on Students' Attitudes in a General Physics Laboratory.," *International Journal of Online Engineering* 13, no. 4 (2017).

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