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Development of KOIN Mobile Learning to Prevent Student Misconceptions on Chemical Bonding Material

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Abstract: Chemistry is a relatively tricky science; thus, it must be studied in depth to avoid misconceptions. These misconceptions can be caused by students themselves, teachers, textbooks, material context, and teaching methods. One way to prevent misconceptions is by using learning media that is easy for students to understand. Field facts indicate that chemistry teaching in high schools is still conducted conventionally, and only a few students understand the concepts of chemical bonding. Mobile learning is an interactive multimedia that can enhance students' learning motivation. This research aims to determine the feasibility of using KOIN m-learning to prevent student misconceptions about covalent and ionic bonds. The feasibility of m-learning is reviewed from two aspects: validity and practicality. This study employs the Research and Development (R&D) methodology, utilizing the development model proposed by Sukmadinata. The limited trial was conducted in class XI-MEDITEK of SMA Ta'miriyah Surabaya, with 15 students selected based on the most significant number of students who did not understand concepts in the pretest results. The research data shows that (1) KOIN m-learning is declared valid as indicated by the content validity mode of 4 with category valid and construct validity mode of 4 with category valid, (2) KOIN m-learning is declared practical as indicated by the average results of the student response questionnaire, supported by observations of student activities, of 97.04% with category highly practical, The results indicate that KOIN m-learning is feasible to be used to prevent student misconceptions about chemical bonding material.

Keywords: Chemical Bonding; M-Learning; Practicality; Preventing Misconceptions; Validity.

Introduction

Chemistry is one of the relatively complex subjects to learn. This is usually because many concepts in chemistry are invisible, even though their effects can be perceived. Chemistry also involves three levels of representation: (1) the macroscopic level, which involves things that can be observed with the senses; (2) the microscopic level, expressed in terms of species such as atoms, ions, and molecules; and (3) the symbolic level, represented in the form of formulas or models [1].

In studying chemistry, its abstract concepts must be deeply understood. However, if students misunderstand initial concepts, their knowledge of subsequent concepts will also be incorrect and can lead to misconceptions [2]. Misconceptions refer to students' perceptions developed from daily experiences that do not match accurate scientific principles. Misconceptions can hinder understanding of the material and harm students because students will have difficulty learning new concepts if previous concepts indicate misconceptions [3].

Factors that cause misconceptions include students, teachers, textbooks, material context, and teaching methods [4]. Students' understanding of a concept is divided into three categories, namely, understood the concept (U), did not understand the concept (DU), and misconception (Mi) [5].

Based on the pre-research carried out, the following results were obtained. In the ionic bond concept material, 10% of students indicated U, 31% of students DU, and 58% of students M. In the ionic bond formation material, 4% of students U, 50% of students DU, and 46% of students M. In the material on the properties of ionic compounds, 10% of students U, 46% of students DU, and 44% of students M. In the covalent bond concept material, 6% of students U, 46% of students DU, and 48% of students M. In the material on the formation of covalent bonds, 10% of students U, 60% of students DU, and 33% of students M. This shows that many students experience misconceptions about chemical bonding material.

One way to prevent misconceptions is by improving the delivery of concepts accurately and effectively, using learning media that do not trigger misconceptions. Learning media should engage students' interests and promote interactive learning. Multimedia is one type of learning media that can fulfil these requirements [6]. High school students are very familiar with smartphone technology [7]. One form of multimedia-based learning that leverages technology is mobile learning (m-learning). M-learning is a type of education that uses smartphones and tablets as the primary tools. The main advantage of m-learning is its flexibility in terms of time and location. With mobile learning-based educational media, students are expected to quickly learn and understand chemical bonding material anywhere and anytime [8].

In developing a learning media, it is necessary to know its suitability. The feasibility assessment criteria in this research are validity and practicality. This is done to

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get a quality product. In developmental research, validity includes both content validity and construct validity. Content validity entails assessing the product's indicators based on a robust theoretical foundation, with the underlying theory being extensively detailed and analyzed. In contrast, construct validity involves evaluating indicators that reflect internal consistency among the components. Practicality refers to how users find an intervention usable and favorable under typical conditions [9].

Therefore, an Android-based m-learning application called KOIN (Kovalen Ionik) was developed by leveraging technological advancements. This m-learning app can be downloaded and installed on smartphones. It presents material on covalent and ionic bonds engagingly and interactively. This research must be conducted so that students can understand the concept of chemical material correctly and not experience difficulties understanding higher concepts. The goal of developing this m-learning is to create valid content and construct validity tools, primarily focusing on preventing student misconceptions in the sub-material of covalent and ionic bonds. Additionally, this m-learning is designed to be practical and easy to use.

Research Methods

The design used in this research follows the steps outlined in the Research and Development (R&D) process by Sukmadinata, which has been modified from the ten-step Research and Development process by Borg and Gall. The research procedure is illustrated in Figure 1.

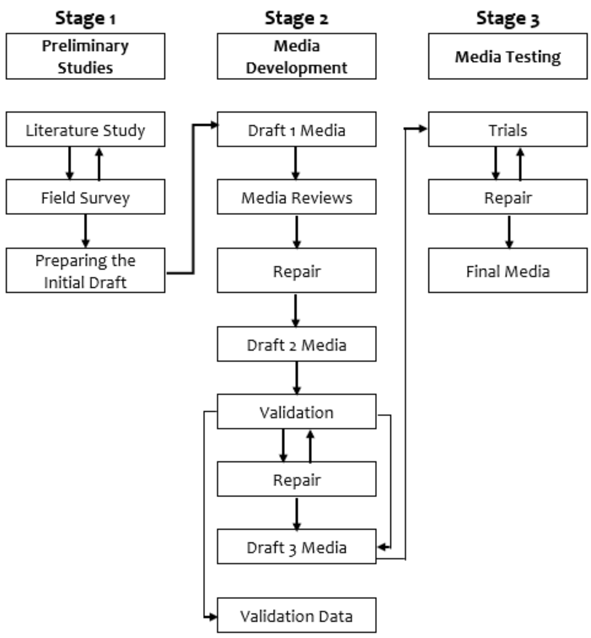


Figure 1. Research Procedure [10]

Based on Figure 1, there are 3 stages: the preliminary study stage, the media development stage, and the media testing stage. The preliminary study stage includes the literature study stage, field survey, and preparation of learning media drafts. The media development stage contains media review and validation. At the testing stage, a limited trial was carried out.

The trial in this study was conducted on a limited basis at SMA Ta'miriyah Surabaya during the second semester of the 2023/2024 academic year, involving 15 grade 11 students selected based on the most significant number of did not understand the concept in the pretest results.

The data from the m-learning review conducted by a chemistry lecturer included suggestions and comments regarding the m-learning. These suggestions were then reviewed and selected to determine which ones would be used to improve the m-learning.

Validity data were obtained from the validation sheet instrument filled out by two chemistry lecturers and one chemistry teacher for content and construct validity. The obtained data were in ordinal form, sohe score calculation used mode [11]. The mode score obtained was interpreted using the Linkert scale, as shown in Table 1. M-learning is said to be valid if the mode score ≥ 3.

Table 1. Likert Scale [12]

Value/Score	Statement
1	Invalid
2	Low Validity
3	Moderate validity
4	Valid
5	High validity

Practicality data was obtained from the student response questionnaire instrument supported by the student activity observation instrument. The student response questionnaire consisted of both positive and negative statements. Scoring was done according to the Guttman scale score based on Table 2.

Table 2. Guttman Scale [12]

Response	Answer	Value/Score
Negative	Yes	0
	No	1
Positive	Yes	1
	No	0

The data obtained were analyzed using the following formula to obtain the percentage of practicality.

$$\% \text{ practicality} = \frac{\Sigma \text{ score for each question}}{\text{Number of respondents}} \times 100\%$$

She then interpreted using the interpretation scale in Table 3. M-learning is said to be practical to highly practical if the percentage of practicality is ≥ 61%.

Table 3. Percentage of Practicality Criteria [12]

Percentage (%)	Criteria
0 - 20	Not Practical
21 – 40	Less practical
41 – 60	Moderately Practical
61 – 80	Practical
81 – 100	Highly Practical

Results and Discussion

The results of this study indicate that mobile learning is feasible for preventing students' misconceptions about chemical bonding material. Feasibility is assessed based on two aspects: validity and practicality. The development of this m-learning follows the research and development (R&D) method by Sukmadinata, which was adapted from Borg and Gall's ten steps of research and development. This R&D method consists of three stages: preliminary study, development, and testing.

Preliminary Study Stage

The preliminary study stage includes the literature study stage, field survey, and drafting learning media. A literature study was carried out to examine theories relevant to the research, the results of which are stated in the research background.

Field surveys were conducted to collect data regarding the implementation of learning in schools. The results obtained from the field survey were that chemistry learning at SMA Ta'miriyah Surabaya was still conventional. As many as 68.18% of students were uninterested and found it challenging to understand the material from the book without the teacher's explanation. In the ionic bond material, 9.03% of students indicated U, 42.36% of students DU, and 48.61% of students Mi. In the covalent bond material, 6.94% of students indicated U, 56.94% of students DU, and 36.11% of students Mi. This shows that many students experience misconceptions about chemical bonding material.

Misconceptions can cause students to experience learning difficulties [13] and be unable to connect existing concepts, affecting student learning outcomes [14]. Students will also be unable to achieve the expected learning objectives [15]. Misconceptions make students believe in the truth of a wrong concept. This can cause students to develop a pattern of continuous errors because the idea misunderstood at the beginning becomes the basis for understanding subsequent concepts [16]. Ultimately, if not immediately corrected, these conceptual errors will become an obstacle for students in the further learning process [17].

The selection of learning media dramatically affects the quality of learning and student learning achievement. Within the constructivist framework, m-learning provides a platform that supports active, collaborative, and individualized learning. In addition, m-learning can also attract students' interest by using new and exciting elements, which help clarify the delivery of material or information and reduce the risk of errors in understanding concepts. Based on the principles of information processing theory, m-learning can avoid cognitive load when learners have to absorb too much information at once. M-learning uses multimedia in the form of text, images, and videos to help clarify information. Media visualization becomes more structured. Therefore, m-learning can be used as a learning medium that makes it easier for learners to understand and remember content and improve their understanding of concepts. [18] . M-learning has several advantages: ow costs, time flexibility, place flexibility, learning speed flexibility, teaching standardization, teaching effectiveness, and distribution speed [8].

Based on the data gathered from the literature study and field survey, an initial draft of the m-learning application was created. The m-learning was developed using the Kodular website, with PowerPoint, Canva, and CapCut animations. An example of the m-learning interface at this stage is presented in Figure 2.

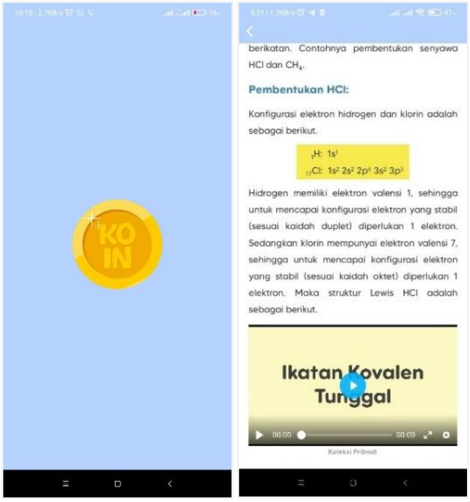


Figure 2. Example of the m-learning interface

The developed m-learning is named KOIN, which stands for Kovalen Ionik. This m-learning can be installed on Android gadgets with a minimum specification of Android 5.0. As the name suggests, this m-learning contains covalent and ionic bonding materials in text, images, audio, and video. Some exercises can test students' understanding. This m-learning prevents students from misconceptions about covalent and ionic bonding materials.

Images can visualize abstract concepts more concretely, while animations and videos provide an interactive visual experience [6]. Media equipped with questions and discussions can prevent misconceptions by giving students a more precise and detailed understanding of the studied concepts. Without interaction through practice questions, students' knowledge of almost correct concepts cannot be perfected [19].

Development Stage

Experts, including material and media experts, then reviewed the draft 1 of the m-learning. This process aims to develop m-learning that can be used as a learning medium to prevent misconceptions. The results of this study are improvements to the animation details, image descriptions in the animation, and the addition of some material related to the properties of covalent compounds.

Draft 2, revised results from draft 1, then validated. Two chemistry lecturers and one chemistry teacher tested the content and construct validity of m-learning. A validation assessment was performed using a validation sheet. Scoring was based on a Likert scale where the range of scores obtained was between 1-5. The data obtained during validation is ordinal, which cannot perform mathematical operations [11]. This study's minimum criteria for the mode value obtained was 3, a reasonably valid category. In addition, the validator can also provide suggestions if necessary.

Content validity includes the truth of the material concept in m-learning and the fulfillment of the requirements of m-learning learning to prevent misconceptions [20]. The content validity results are shown in Table 4. According to the data, KOIN m-learning received a content validity mode score 4 with category valid. This indicates that the m-learning developed is valid in terms of content validity.

Table 4. Content Validity Results

Objective	Aspect	Mode/ Category
The truth of the material concept	Description of the material	4/valid
	The structure of the materials	4/valid
	There are no mistakes in writing	4/valid
The requirements for m-learning to prevent misconceptions	Quiz menu	5/ highly valid
	Animation	4/valid

Construct validity includes the completeness of components, display quality, language use, and ease of use of m-learning [20]. The construct validity results are shown in Table 5. According to the data, KOIN m-learning received a construct validity mode score 4 with category valid. This indicates that the developed m-learning has been valid in terms of construct validity.

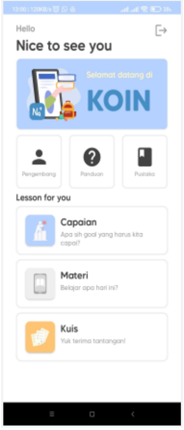
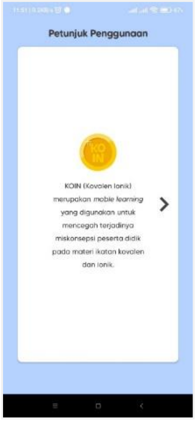
Table 5. Construct Validity Results

Objective	Rated aspect	Mode/ Category
Completeness of components	Text	4/valid
	Image	4/valid
	Audio	5/highly valid
	Video/animation	4/valid
Quality of display	Background	4/valid
	Font type	4/valid
	Font color	5/highly valid
	Graphics and layout settings	4/valid
Knowing the use of language in the material	The language	5/highly valid
	Do not use words that have ambiguous meanings	4/valid
Knowing the ease of using m-learning	Ease of use	4/valid
	Ease of reading text	4/valid
	The use of control buttons	5/highly valid
	Instructions	4/valid

Overall, based on both content validity and construct validity yielded a mode score of ≥ 3. This indicates that the developed m-learning is valid.

After the validation process, m-learning is revised according to suggestions and comments from validators. The specific details of the m-learning draft revisions are in Table 6, which outlines the changes made in response to the validators' feedback. As a result of this thorough review and revision process, Draft 3 of the m-learning platform has been produced.

Table 6. Revision Results after Validation

Before Revision	After Revision	Information
		I explained the abbreviation KOIN on the home menu, and the menu colors were made more colorful.
-		An explanation of KOIN m-learning was added to the user manual.
		Learning objectives are adjusted to higher cognitive levels.
		The quiz questions are adjusted to a higher cognitive level and made more colorful.

Testing Phase

M-learning that has been declared valid is then tested on a limited basis. The trial is conducted to collect data on the practicality of the developed m-learning. Data from the limited trial stage include student response questionnaires and student activity observation results.

The results of the response questionnaire are utilized to determine the practicality of KOIN m-learning as a preventative measure of misconceptions in chemical bonding material. The questionnaire contains 9 questions related to the quality of the presentation of the m-learning display, the clarity of how to use m-learning, and the level of student learning motivation after using m-learning [20]. The results of the questionnaire obtained are shown in Table 7.

Table 7. Student Response Questionnaire Results

Aspect	Percentage/ Criteria
Quality of display presentation	100.00%/ highly practical
Clarity on how to use	80.00%/ practical
Clarity of language	97.77%/ highly practical
Level of student learning motivation	100.00%/ highly practical

The results of this response questionnaire are supported by students' relevant activities for each aspect of the response questionnaire. The instrument is supported by a student activity observation sheet, which compares the questionnaire results with the observers to obtain accurate results. The observation results of these activities are shown in Table 8.

Table 8. Student Activity Observation Results

Aspect	Percentage
Quality of display presentation	100.00%
Clarity on how to use	97.50%
Clarity of language	96.65%
Level of student learning motivation	93.33%

Based on the data obtained, KOIN m-learning received an average questionnaire response score of 97.04% with category convenience. The results of the average percentage of student response questionnaires obtained were ≥ 61%. Therefore, it can be said that the m-learning developed is useful. In addition to validity and practicality, the effectiveness of learning media is essential to assess the extent to which the media successfully produces desired results [9].

Conclusion

Based on the results and discussion of the study, it was concluded that the KOIN m-learning was declared feasible to prevent student misconceptions about chemical bonding material. The conclusion was reviewed from two aspects of feasibility. (1) The developed m-learning was declared valid based on the content validity mode score of 4 with category valid and the construct validity mode score of 4 with category valid. (2) The developed m-learning was declared practical based on the average percentage of student response questionnaires, supported by the results of observations of student activities, of 97.04%, with the category highly practical.

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