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Innovation in the Development of Android-Based Digital Teaching Materials on Coloid System Materials

Lolita A.M. Parera, Jasman, I Gusti M. N. Budiana, Sudirman, Kasimir Sarifudin and Eka C. G. Kerihi
Department of Chemistry Education, Universitas Nusa Cendana, Kupang, Indonesia

Abstract: Research has been carried out with the title Innovation Development of Android-Based Digital Teaching Materials on Colloid Systems Material. The purpose of this study was to develop an android-based digital teaching material colloidal system and to determine the level of validation of android-based digital teaching materials. The development of this digital teaching material uses the Borg and Gall research model. The development procedure includes 4 stages, namely: (1) Preliminary study, (2) Development, (3) Field Test, (4) Final Product Dissemination. At the development stage, the products that have been developed are then assessed by three experts, namely instrument experts, material experts and media experts. Furthermore, the field test phase is divided into two, namely limited field test and product feasibility test. In a limited field test, products that have been assessed by material experts and media experts are then revised and reassessed by peer reviewers in this case high school chemistry teacher. While on the product feasibility test, the results of the peer reviewers' revisions that were revised by the developer were then assessed by reviewers. The results of the expert's assessment of the questionnaire included the very good and feasible categories used in the field. The results of the assessment of material experts and the media on the feasibility of this digital teaching material have a very good category with the percentage of safety ideals respectively 92.67% and 93.016%. In the limited field testing stage by peer reviewers on digital teaching materials, scores were obtained with very good categories and overall ideal percentage of 89.86%. During the product feasibility test by the reviewer, the assessment results were included in the excellent category and the overall ideal percentage was 91.94%. Based on expert judgment, peer reviewers and reviewers of android-based digital teaching materials on colloidal system material are very suitable to be used as supporting chemical learning.

Keywords: Development, Digital Learning Materials, Android, Colloid Systems.

INTRODUCTION

In today's digital era, science and technology are developing rapidly. This development has the impact of being more open and spreading information and knowledge from and to all over the world, breaking the boundaries of distance, place, space and time. The reality in human life in this digital era will always be related to technology. Technology is essentially a process to get added value from the product it produces so that it is useful. Technology has influenced and changed people in their daily lives, so that if you are 'technologically stuttering' now, it will be too late to master information, and you will also be left behind to get various opportunities for advancement (Herman, Silalahi and Sinaga, 2022). Mastery of technology is a benchmark and indicator of a nation's progress. Technology will continue to move like ocean currents that continue to run in the midst of human life. So there is no other choice but to master and control technology properly and correctly in order to provide maximum benefits. One of the great benefits of technology that currently must be properly developed is in the field of education.

Education has an important role in efforts to develop human resources and determine the progress of a nation. Reforms in the field of education will have an impact on attitudes, behavior and values of individuals and society. If education in a nation increases, then human resources will also increase, so as to give birth to a highly qualified generation in today's modern era. To achieve progress in the world of education, the right strategy is needed. Made, (2011) argues that the use of strategies in learning activities is necessary to facilitate the learning process so as to achieve optimal results. Appropriate use of technology in the teaching and learning process will improve learning outcomes optimally.

Information and communication technology has been widely used in the teaching and learning process but not all schools are able to apply it properly to the subjects taught in schools (Herman, *et al.*, 2022). One of them is chemistry subject. Chemistry subject is a branch of Natural Sciences and is a basic science that plays an important role, both in everyday life and in the development of science and technology. But in reality, there are still many problems, namely learning chemistry is a subject that is not liked and seems too abstract for students. One material that is considered abstract is colloid system material.

In the 2013 curriculum, colloid system material is one of the XI MIA Chemistry subject matter. Colloidal system material is material that is difficult to teach and difficult for students to understand. Colloid system material contains material that sometimes requires the help of special media to visualize the properties and

***Corresponding Author:** Lolita A.M. Parera

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processes of colloid formation. In addition, there are various types of colloids and their application in everyday life which are not possible to practice or demonstrate directly because they are dangerous and expensive. The location of learning colloidal system material which is at the end of the semester also makes this material sometimes not delivered directly but only through textbooks. The textbooks that have been provided by the school are not sufficient to describe the process of forming colloids concretely, so visualization is one way that can be done to concretize something abstract.

Based on the results of the Educational Quality Mapping Research (PPMP) in 2011 from several lecturers (Holiwarni, 2012) showed that the factors causing students not to master competence for chemistry subjects included teachers not using media in the learning process, whether natural or artificial let alone learning media that are IT. As a result, chemistry becomes a boring and difficult subject to understand. This research also found the cause of not using media in learning because teachers were not able to design and develop their own learning media while in the field learning media were not yet available that were in accordance with the learning objectives to be achieved.

Efforts to meet demands and overcome problems that arise in learning chemistry are the need for a digital container that can foster student interest and raise awareness of the need to study chemistry. The help of teaching materials with digital media and easy to understand is urgently needed, both in the form of text, images, video, audio and animation. The use of digital teaching materials with Android intermediary media can be used as an alternative to solving some of these problems. Based on the above, an innovative development of Android-based digital teaching materials is developed as an innovative alternative to chemistry learning. This Android-based digital teaching material is a learning teaching material that combines text, graphics, sound, animation and video. This teaching material program can offer interesting and interactive new ways for students to use in learning colloidal system material.

The application of learning technology in accordance with current technological advancements is utilizing Android-based mobile devices (smartphones) in the process of teaching and learning activities. Smartphones are goods that are no longer foreign to students at various levels of education. The majority of students already use smartphones. The fact that is happening now is that students no longer care about the teacher or the situation in the classroom but prefer to spend a lot of time with their smartphone for chatting, playing games and other things that they find more interesting. Therefore, a new breakthrough is needed to attract students' attention from these things. Smartphones that are currently developing are already using an operating system that supports application development. The operating system in question is the Android operating system. This operating system opens up great opportunities for application developers to innovate to develop attractive applications. One of them is the development of this Android-based digital teaching material in order to reduce or even eliminate the habit of using smartphones in the world of education that is not optimal.

Android is a Linux-based operating system designed for touch-screen mobile devices such as smartphones and is open source. What is meant by open source is an operating system with an open system that allows users to develop it openly. This provides a great opportunity for application developers and application makers. The development of Android is very rapid, as evidenced in October 2012 there are around 700,000 applications that have been provided by Android. The survey also shows that Android is the most popular platform for developers and is used by 71% of mobile application developers from April to May 2018. This has contributed to the development of Android, so that Android is the most widely used smartphone operating system in the world.

The software used in the development of Android-based digital teaching materials is Adobe Flash CS6 action script 3.0. This program has many functions, such as making object animations, making presentations, animations, games, supporting web page animations, so that it can be used for making animated films. Action script is a programming language that contains commands to run objects, animations or whatever is created in the layer. In making this teaching material, action script 3.0 is used specifically for mobile platform use. This software already contains the AIR for Android item so that developers can easily publish this application to Android phones.

In the world of education, the use of Android smartphones as learning media is considered more helpful because they are thin, light and can be carried anywhere. Besides being able to create

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easy and fun learning, this Android-based digital teaching material is able to answer the concept of learning anytime and anywhere because it has high flexibility and ease of access. Students can also search for themselves and directly experience the learning process. Learning in question is in the form of learning that is carried out realistically and concretely. Technology-based learning activities can be realized, one of which is by making digital teaching materials.

The use of mobile phones in the field of education in Indonesia, especially for independent student learning is still very minimal, even though students cannot be separated from mobile phones every day. The development of Android-based chemistry learning media can be an alternative to independent learning media that is more attractive, more practical, more economical and can be used by users or students anywhere and anytime. Seeing the usefulness and needs of learning media in the chemistry learning process, especially colloidal system material in high school, research is needed to produce teaching materials that suit the needs of students.

Some research that supports the development of digital teaching materials is carried out by Irawan and Sukarna, (2013). The results of the research conducted previously showed that all aspects of the assessment, namely aspects of the material and questions, language, implementation, audio-visual display, software engineering based on the assessment of the reviewer including in very good category. The results of research by Sari, *et al*., (2013) show that the digital teaching materials being developed are of good quality and are suitable for use in the learning process and are effective in improving student learning outcomes. Danusaputra, (2015) conducted research on "Development of Android-based Learning Multimedia on hydrocarbon compound material as a chemistry learning medium" and the results showed that Android-based interactive teaching materials were included in the very good category (SB) with an ideal percentage of 91.33% and feasible to use. as a medium in chemistry learning activities. From the studies that have been carried out, Android-based chemistry learning materials have received very good responses from teachers and students.

RESEARCH METHODS

This innovation in developing digital teaching materials uses a modified Borg and Gall research model. The development procedure includes 4 stages: (1) Preliminary study, (2) Development, (3) Field testing, (4) Dissemination of the final product. At the development stage, the products that have been developed are then assessed by three experts, namely instrument experts, material experts and media experts. Furthermore, the field test phase is divided into two, namely limited field tests and product feasibility tests. In the limited field test, the products that have been assessed by material experts and media experts are then revised and re-assessed by the peer reviewers, while in the product feasibility test, the results of the assessments from the peer reviewers which have been revised by the developer are then assessed by the reviewers.

The object in the development of this teaching material is the quality (appropriateness) of Android-based digital teaching material products on colloidal system material as chemistry learning materials in terms of the assessment of material aspects and questions, linguistics, applicability, audio-visual display and software engineering. Product assessment is carried out by the reviewer by including the assessment instrument and its elaboration.

The instrument is a tool used by researchers to collect data by measuring (Munawaroh, 2012). The assessment instruments in this study consisted of questionnaires or questionnaires, discussions and consultations for material experts, media experts and peer reviewers (3 chemistry teachers) and a questionnaire in the form of a checklist with a Linkert scale for reviewers. The quality assessment questionnaire in the form of a checklist was validated logically and theoretically by consulting the supervisor.

Questionnaire sheets for material experts are used to obtain data regarding the feasibility of content, presentation, and language. Questionnaire sheets for media experts are used to obtain data on graphic feasibility. Questionnaire sheets for subject teachers to obtain input after product revision from experts. Questionnaire sheets for students are used to obtain data about the feasibility of teaching materials from students as product users, in order to evaluate the product resulting from the development

Data analysis used in development research can be carried out with the following techniques:
1. Calculate the average score for each aspect of the criteria assessed

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2. Changing the average score in the form of qualitative data into a quantitative value with an ideal assessment category.
3. The average score data for each aspect and all aspects obtained are then calculated with the ideal percentage

RESULTS AND DISCUSSION

This innovative research on the development of digital teaching materials is operated using an Android mobile phone and developed using Adobe Flash CS6 software. Research on the development of interactive teaching materials was carried out by adapting and modifying the flow or steps of the Borg & gall. The adaptations and modifications made are simplifying the 10 stages of Borg & Gall into four stages that have covered all stages in the development of Borg & gall. The simplified steps include (1) preliminary study, (2) development, (3) field testing, and (4) dissemination of the final product. these four stages are carried out systematically in order to obtain the results of the feasibility of the product being developed.

As for the results of the innovation of Android-based digital teaching materials on the subject matter of the colloid system that has been developed, the researcher can explain as follows:

Cover Media

The cover or main page of this digital teaching material contains the colloidal system material title, target users for class XI SMA/MA, start button, music on/off button, exit button and media identity, namely Android-based digital teaching materials. The cover display of this Android-based digital teaching material can be seen in Figure 1.

Figure 1: Cover of Android-based digital teaching materials

In the appearance of this main page, the developer uses a theme that is not too flashy. The background color used is white with slightly opaque chemical images accompanied by animated lines and boxes. In addition, there are musical instruments that can be turned on or off depending on the user's taste.

Menus

On the menu page there are buttons including competency buttons, material buttons, evaluation question buttons, instructions buttons and profile buttons. Then the buttons on the main menu are made using hyperlinks with the aim that the user can directly open the desired page by pressing the button. The main menu display can be seen in Figure 2.

Figure 2: Main menu display

In the main menu view of this teaching material, the developer designed a background with a dominant blue color, with several chemical images and accompanied by musical instruments. Explanation of each menu is as follows:

Competency Menu

This competency menu contains basic competencies (KD) and competency achievement indicators. The purpose of making this competency button is so that before studying the learning material, students know what will be learned and

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the goals to be achieved. After students open the competency page display, basic competencies and achievement indicators from the colloidal system material will appear as shown in Figure 3.

Figure 3: Display of KD and Indicators on Digital Teaching Materials

Material Menu

The material menu was designed by the developer with the aim that students can open the material page view in teaching materials. After students open the material menu, there are several sub-menus that contain an outline of the material that has been designed into buttons so that users can directly enter the material they want by pressing directly on the sub-material. The submaterial consists of understanding the colloid system, types of colloids, properties of colloids, making colloids and a summary of the material. The submenu display can be seen in Figure 4.

Figure 4: Display of the Material Submenu

Evaluation Question Menu

The evaluation question menu was designed by the developer with the aim that students can open the evaluation question page for colloidal system material in digital teaching materials. After the user opens the evaluation question menu, an initial display of the evaluation question page will appear which consists of an explanation of the colloidal system material evaluation question and the next button. In the initial appearance of the evaluation question page, there is a next button. When the user presses the next button, the next page will appear. This page contains a welcome sentence to the interactive quiz, fields to fill in the student's name and also the student's absence number. In addition, there is a start button to start the evaluation question quiz. After the student fills in the name and attendance number, press the start button to start the quiz. This colloidal system evaluation question consists of 20 multiple choice question numbers. In each number in this evaluation question, there is already a column of points and results for each question. If the question is answered correctly, then immediately get one point and the result statement is correct. Conversely, if the answer is wrong, the point is zero, and the result statement is wrong. The correct points will add up to the end of the evaluation questions. And in the last part of this evaluation question, these points will be calculated along with the student's name and absent number. The evaluation menu display can be seen in Figure 5.

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Figure 5: Display of the Evaluation Question Menu: a. The initial display of the evaluation menu; b. Appearance Personal identity; c. Display of Evaluation Questions; d. Final Appearance of Evaluation Questions

Help Menu

This instruction menu is designed so that users can understand the function of the buttons contained in digital teaching materials so that students can easily operate this Android-based digital teaching material. The display of the instruction page for using the buttons is as shown in Figure 6.

Figure 6: Instructions for Using Buttons

On the user manual page, there is an explanation of the functions of the buttons, including competency buttons, materials, evaluation questions, instructions, profiles, sound on, sound off, animation, menu, next page, back page, click and exit. The following is an explanation of each button in the teaching materials (competency, material, evaluation questions, instructions and profile buttons have been explained on the menu button).

Results of Storage of Android-Based Digital Teaching Materials

The entire contents of the Android-based colloid system digital teaching materials were made with the Adobe Flash CS6 Action Script 3.0 program and then published with AIR for Android in the program options. After that, the next step is to install the application that has been published to the Android phone. If the user wants to send or move the application to another cellphone, then the user can send using the SHAREit and Bluetooth applications. The delivery method is carried out like an application in general on an Android cellphone.

Validation Results

Innovation research on the development of android-based teaching materials on colloidal system material is as follows:

Instrument Validation

The results of the validation carried out by instrument experts showed that the questionnaires that would be given to each validator were very good so that these questionnaires could be used to assess Android-based digital teaching materials.

Material Validation

Based on the results of the material expert's assessment of Android-based digital teaching materials on the colloid system material, it can be seen that the overall percentage is 92.67%. This percentage shows that the teaching material product is in a very good category and can be used without revision. This high percentage is because the materials contained in these teaching materials

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have been adjusted to the current 2013 curriculum standards.

Table 1: Results of Material Expert Assessment

Aspect	Indicator	Average	Ideal percentage
Content Eligibility	Suitability of material with KI and KD	9,33	93,33%
	Conformity with learning objectives	5	100%
	Learning objectives are easy to understand	9,67	96,67%
	Material accuracy	18	90%
	The significance of learning materials	14,67	97,78%
	Total	56,67	95,56%
Penyajian	Material presentation techniques	10	100%
	Presentation support	15,67	78,33%
	Feasibility and suitability of evaluation and test questions	22,33	89,33%
	Total	47,9	89,22%
Kebahasaan	straightforward	10	100%
	Communicative (dialogical and interactive)	14,33	95,56%
	Suitability with the level of development of students	10	100%
	Total	34,33	98,52%
	Total Number	139	92,67%

Based on Table 1., the results of the percentage of assessment for each aspect obtained are the content feasibility aspect of 95.56%, the presentation aspect of 89.22% and the linguistic aspect of 98.52%. In the aspect of content feasibility, the percentage obtained is in the very good category, namely 95.56%. The acquisition of this value can be seen from the digital teaching materials that have been developed, where these digital teaching materials are developed according to each indicator in the aspect of content feasibility. These indicators include the suitability of the material with KI and KD in the curriculum used, suitability with learning objectives, accuracy of the material and the meaningfulness of the learning material. The teaching materials developed include all of these indicators because they are categorized as very good based on expert judgment. In the aspect of presentation, the percentage obtained is in the very good category, namely 89.22%. This percentage is seen from the relationship between the development of teaching materials and the indicators in this aspect. Indicators in this aspect include material presentation techniques, presentation support, feasibility and suitability of evaluation test questions and feedback. Although this aspect is categorized as very good, the percentage obtained is the lowest among the three aspects. This is because there are indicators that get the lowest percentage, namely indicators supporting the presentation with a percentage of 78.33%. This low percentage is because one of the assessment indicator items in the questionnaire, namely giving rewards for correct answers and reinforcement for wrong answers, is not yet available in digital teaching material media. This became material for improvement during revision I.

Revisions to the assessment section were carried out by providing rewards for correct answers to evaluation questions and reinforcement for incorrect answers to evaluation questions so as not to discourage students. Giving rewards and reinforcement is more emphasized on evaluation questions because in the teaching materials assessed by the validator, there is no reward or reinforcement in the evaluation questions. To fix this, the developer provides rewards and reinforcement in the form of sound or sound for each answer option for the correct evaluation questions and answers to the wrong evaluation questions in order to provide motivation for students. In addition, the developer also added motivational words at the end of the evaluation questions.

In the third aspect, namely the linguistic aspect, the percentage obtained is categorized as very good, namely 98.52%. This can be seen from the development of teaching materials that are in accordance with the assessment indicators in this aspect, namely the language used is straightforward, communicative (dialogical and interactive) and in accordance with the ability level of students. The average result of material validation as a whole from the three validators is 139 with a percentage of 92.67% and is in the very good category. This percentage is obtained based on an assessment of the teaching materials, especially the material aspect, where most of the

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contents of these digital teaching materials have followed the existing assessment indicators. Based on these results, this teaching material is feasible to try out.

Media Validation

Media validation is carried out with the aim of knowing the opinions of experts about the media being developed so that it can be perfected according to the opinions of experts and is suitable for use in the field. The aspect that is assessed is the graphical aspect. The ideal average and percentage for each indicator from the aspect of media assessment can be seen in Table 2.

Table 2: Results of Media Expert Assessment

Aspect	Indicator	Average	Ideal percentage
Graphic	changeable	9,67	96,67%
	Illustration	13,67	91,11%
	Color composition	9,33	93,33%
	Selection of font type and size	9,67	96,67%
	Modify margins	4,67	93,33%
	Animated icon	4,67	93,33%
	Image and animation feasibility	14	93,33%
	Use of music and sound	8,67	86,67%
	Ease of using media	14	93,33%
	Text readability	4.67	93,33%
	Program presentation	4,67	93,33%
	Total	97,67	93,016%

Based on Table 2, the results of the percentage assessment on the graphical aspect are 93.016%. This aspect is included in the very good category. In this aspect, there are indicators that assist the validator in assessing this digital teaching material with the percentage of each indicator which can be seen in Table 2.

The percentage obtained in this graphical aspect is in the very good category because most of the development of digital teaching materials has followed assessment indicators. The relationship between teaching materials and indicators includes the use of illustrations, color composition in teaching materials that are not too flashy, selection of type and size of letters that can be read by the user, modification of margins or stage boundaries, use of images and animations that are not too busy, and ease of use. media. Even though this aspect is categorized as very good, there is an indicator that has the lowest percentage, namely the indicator of the use of music and sound. with a percentage of 86.67%. This low percentage is due to the use of music as a backsound in this teaching material which makes noise and distracts users, but this can be overcome by pressing the sound off button.

The average media validation result as a whole from the three validators is 97.67 with a percentage of 93.016% and is in the very good category. This percentage is obtained based on an assessment of teaching materials, especially the media aspect, where most of the contents of these digital teaching materials have followed the existing assessment indicators. Based on these results, this teaching material is feasible to try out. After knowing the results of the material expert's assessment, the material from this teaching material needs to be revised based on input and suggestions from experts. These suggestions are very useful for developers in order to improve the graphical aspects of digital teaching materials. In general, experts say that the products that have been made are very good. The advice given by experts is that apart from using musical instruments, developers should use sound. This input is then applied to quiz questions, where each answer to a quiz question is given a vote as a reward for correct answers and reinforcement for wrong answers. Also another input is to adjust the background image so that it is not too crowded. This input has been followed up by the developer according to the input by adjusting the contrast in the background.

Field Test

The field test was carried out in 2 steps, namely the limited field test and the feasibility test. The results of the field test, namely Android-based digital teaching materials, are in the very good category and are suitable for use without revision. The percentage results from student responses are as follows:

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Table 3: Product Assessment Results in Limited Field Tests

Evaluation Aspects	Average	Ideal Percentage
Material and questions	33,67	84,17%
language	13,67	91,11%
Audio and visual display	23,67	94,67%
Device engineering	41,33	91,85%
Total	112,33	89,86%

Table 4: Product Assessment Results on Product Feasibility Test

Evaluation Aspects	Average	Ideal Percentage
Display Quality	11,17	93,05%
Material Presentation	10,9	90,83%
Total	22,07	91,94%

Based on Table 3, the results of the percentage of assessment for each aspect obtained were material aspects and questions 84.17%, language aspects 91.11%, audio and visual display aspects 94.67% and equipment engineering aspects 91.85%. These four aspects are included in the very good category. In terms of material and questions, the percentage obtained is in the very good category, namely 84.17%. This percentage is seen from the relationship between the development of teaching materials and the indicators in this aspect. Indicators in this aspect include material presentation techniques and evaluation test questions. In the linguistic aspect, the percentage obtained is categorized as very good, namely 91.11%. This can be seen from the development of teaching materials that are in accordance with the assessment indicators in this aspect, namely the language used is straightforward, communicative (dialogical and interactive) and in accordance with the ability level of students. In the aspect of audio-visual display, the percentage obtained is in the very good category, namely 94.67%. The acquisition of this value can be seen from the digital teaching materials that have been developed, where these digital teaching materials are developed according to each indicator in the aspect of content feasibility. These indicators relate to the selection of images, colors and animations.

Digital teaching materials that cover all of these indicators have been developed as well as possible so that they are categorized as very good based on the peer reviewer's assessment. In the aspect of device engineering, the percentage obtained is categorized as very good, namely 91.85%. This can be seen from the development of teaching materials that are in accordance with the assessment indicators in this aspect, namely the suitability of selecting letters, the ease and fluency of using software, and the level of interactivity. The average overall assessment result is 111.33 with a percentage of 89.86% and is in the very good category. Based on these results, this digital teaching material is feasible to be tested.

Based on Table 4, the percentage on the display quality aspect is 93.05%. The results of this percentage include very good category. While in the aspect of presentation of the material, the percentage obtained is 90.83%. It also shows very good criteria. The percentage gain with this very good category is in accordance with the digital teaching materials being developed. Where the teaching materials have been revised based on the assessment of previous experts. The percentage in this very good category is because most of the contents of digital teaching materials are in accordance with the existing assessment indicators. The overall assessment results are 22.07 with a percentage of 91.94% and are in the very good category and are very suitable for use.

CONCLUSION

Based on the results and discussion, it can be concluded as follows:

The results of the development of Android-based digital teaching materials on colloid system material consisting of covers, menu views, competencies, material (definition of the colloid system, types of colloid systems, properties of colloids, making colloids, summaries and references), evaluation questions, user manual and developer profile. This teaching material product also contains audio, images, and learning supporting videos that can hone students' skills in understanding colloidal system material anywhere and anytime using an Android mobile phone.

Based on the results of the validator's assessment, this Android-based digital teaching material is included in the very good category and is feasible to be tested in the field with a percentage of all

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aspects, namely 92.67% for material experts and 95.24% for media experts. There are two trials, namely limited field tests and product feasibility tests. In the limited field test, the percentage obtained was 89.86% and the percentage for product due diligence was 91.94%. This shows the feasibility of this Android-based digital teaching material included in the very good category.

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