Development of Interactive Multimedia-Based Learning Media in Basic Electronics Courses

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Abstract. This research aims to develop interactive multimedia-based learning media for basic electronics courses. The present study employs the Borg and Gall research paradigm, which was previously condensed into five stages by the Puslitjaknov Team in 2008. This study progresses through the following stages: product analysis, initial product development, expert validation and revision, small-scale field trials, and product revision. The final stage includes the final product and large-scale trials. Research data is derived from validation data from experts and data from small-scale and large-scale trials to assess the feasibility and ease of use of the research product being developed. The results of the validity analysis revealed that the overall average assessment from experts was 89.55%, considered as the "very feasible" category. Consequently, it can be concluded that this interactive multimedia is appropriate for basic electronics learning.

Keywords: Learning Media, Interactive Multimedia, Basic Electronics

1 Introduction

Contemporary advancements in technology and information (ICT) have a significant impact on the education field, particularly in the learning process. The impact of ICT has resulted in several transformations in the learning process, including the ability to undertake normally classroom-based learning anywhere and at any time, learning that is usually from paper has changed to an online system, the facilities used are usually physical-based and have become network-based facilities,[1] One of the influences of ICT developments can also be seen from the rapid development of ICT-based learning media. Integration of multimedia in education is highly feasible with the implementation of information and communication technology (ICT). Educators must make effective and prudent use of ICT advancements in learning media, because choosing and using the right media will have an impact and influence on achieving learning goals. Using appropriate

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learning media can also help in presenting messages, overcoming passive attitudes of students, overcoming limitations of space, time and also students' sensory data, [2]. Therefore, it is very essential to utilize ICT in developing learning media with the aim of improving the quality and quality of learning. as explained in research, [3]–[5] that there are several potential benefits in providing adaptive learning with technology.

ICT-based learning media that is currently being developed by researchers in the field of education is interactive multimedia-based learning media. This interactive multimedia is an innovative media that can realize active learning and is also interesting for students, [6]-[7] Additionally, their investigation demonstrated that interactive multimedia systems can enhance academic performance. This aligns with the research findings of [8], which indicate that multimedia has the potential to enhance learning as an effective learning technology significantly. The use of multimedia in learning is an alternative in optimizing the learning process, because using multimedia can enable the use of media such as text. , video, images, audio and animation which in operation are integrated into one form of learning media which is outfitted with a user-operated controller. Multimedia is a compilation of a variety of media—including text, images (vector or bitmap), graphics, sound, animation, video, and interaction—that have been compiled into digital files (computerized) and are employed to communicate messages to students., [9]. Multimedia is also defined as the utilization of computers to generate and integrate text, aural graphics, and moving images (video and animation) through the integration of link tools that facilitate user navigation, interaction, creation, and communication in a face-to-face context, offline context, as well as online contexts,[10]. Therefore, using interactive multimedia in learning can be a very useful innovation, especially for students in terms of increasing students' understanding and activeness in the learning process. [11].

It is very necessary to develop learning media in the learning process with the aim of improving student learning outcomes in order to generate graduates of high quality. This is also necessary for all forms of education, including the basic electronics courses in the Electrical Engineering Education study program, UNIMED. In this study program, Basic Electronics is a mandatory course. This course consists of 2 credits which are theoretical courses that discuss and introduce the characteristics, working principles, and analysis and calculations of electronic components. This course provides electrical engineering education students with an initial understanding of electronics. From the results of a survey conducted on PTE students taking basic electronics courses for the 2023/2024 academic year, regarding the learning media used in lectures, data was obtained that the media applied was unable to stimulate student interest and improve their motivation to learn. The results of the questionnaire administered to students indicate that only 23.78% found the media utilized engaging and capable of enhancing their motivation to participate in learning. The majority of students, over 70%, believe that the current media is uninteresting, seems monotonous and cannot attract students' interest in learning. The same thing was also found from the results of observations, where the media used in this course was still conventional media such as whiteboards and standard power points. This is one of the factors contributing to students' inadequate comprehension of the material. This is why it is important to implement innovations and modifications in the learning process. One such innovation is the developing of interactive multimedia-based learning media. The

goal of this media is to enhance student engagement and motivation in the learning process, thereby enhancing students' comprehension of the material.

The media development carried out in this basic electronics course is according to the findings of a survey administered to students regarding their media requirements during the study of basic electronics courses. This survey was carried out by distributing questionnaires to students regarding the types of media needed for learning. Data regarding learning media needs is provided to students taking basic electronics courses in 2023/2024 which consist of 3 classes with a total of 72 students. According to the questionnaire results, it was found that 83% of students agreed that the media needed for development was interactive multimedia, the use of which could support active and independent learning that was not limited by space and time to access the learning material. Therefore, researchers intend to develop interactive multimedia in the form of flipbook media, which is a form of learning media. The ultimate goal is to enhance student learning outcomes by fostering student interest and motivation in the learning process through the development of interactive multimedia..

This development research is reinforced by similar research conducted by [6], where the research results indicate that the multimedia developed is appropriate for use in the learning of building construction, as well as research from [12] that is, the multimedia developed has a positive impact and can improve learning outcomes. student. And research from [13] they were determined that the interactive multimedia developed is highly appropriate for use and can pique the interest of students in learning, thereby facilitating their comprehension of the material. Therefore, in this research, learning multimedia will be developed with the title Development of Interactive Multimedia Based Learning Media in Basic Electronics Courses.

1.1 Learning Media

Media refers to intermediaries or mediums in plural form, namely as a means of communication. Everything that conveys information from the information source to those who receive the information is called media. [14] In this way the media becomes an intermediary between the source and recipient of information. Media is a means and source of communication. [15], [16] says that media is a means or device that functions as an intermediary or channel in the communication process between the communicator and the communican. According to [17], media is also called "props that help the process of demonstrating something". So from the definition of media above, it can be argued that the media serves as a connection between the source and the recipient of the information. The information will be more easily comprehensible if the recipient and source share the same level of experience and knowledge.

Messages in a medium can be understood by the recipient if the recipient of the message also understands the language being conveyed.

Rusman (2011) [18], explains that edia is an instrument that is utilized in all forms of learning activities to reach learning objectives. The media in question can be print and non-print media. In

the sense stated by Rusman, It is restricted that the media utilized for educational purposes is in the sense of physical facilities. However, Smaldino does not restrict it to physical and non-physical means; rather, it encompasses all entities that serve as intermediaries in the transmission of information from the source to the recipient.The process of learning is a communication procedure. The learning process is comprised of five communication components: learners (communicators), learning materials, learning media, learners (communicants), and learning objectives). So, learning media is any medium that can be employed to transmit messages (learning materials) in order to stimulate students' interest, stimulate their thoughts, and evoke emotions during learning activities, thereby facilitating the attainment of learning objectives.

Learning media are a variety of learning aids that can be employed during the learning process. which aims to increase effectiveness and efficiency in achieving a learning goal [19]. So, learning media can be defined as any learning facility that can convey messages or serve as intermediaries in the learning process. Learning media can take the form of tools, methods, and techniques that enhance the effectiveness of communication and interaction between students and lecturers. Lecturers may employ a variety of instruments to communicate their teaching messages to students through sight and hearing, thereby preventing verbalism, which is still feasible when visual aids are employed. The function of media in the educational process is to increase students' learning experiences. There are numerous categories into which learning media can be divided, including: audio media, visual media, audiovisual media, various media (whiteboards and display boards), three-dimensional media, dramatization technique media, community learning resources, programmed learning, computers. Teaching materials are one available media for facilitating the learning process, [20]

1.2 Multimedia

The term "multimedia" was initially introduced in the early 1990s through mass media. In the realms of entertainment, publishing, communications, marketing, advertising, and business, the term is employed to amalgamate digital and analog technologies. Multimedia is a term that combines the words "multi" (meaning "many") and "media" (meaning "medium" in its plural form). The term "multi" is derived from the Latin word "nouns," which means "various." In contrast, the term "media" originates from the Latin word "medium," which denotes an intermediary or an object that is employed to transport or distribute something. The "American Traditional Electronic Dictionary" defines the term "medium" as a device for the dissemination and presentation of information. This multimedia-based is a compilation of a variety of media, including text, images, graphics, sound, animation, video, and interactions, that have been organized into digital files to enhance the presentation of the information, [21].

Students are highly inclined to employ multimedia in their educational pursuits.. The most commonly used multimedia components are text, video, audio, animation or interactivity. Multimedia will be very popular as a learning medium, For this reason, multimedia should not be viewed solely from each component, as the benefits will be significantly enhanced if these

components are unified.. Multimedia will help students become more active and creative in the learning process, as well as enable educators to become facilitators and make it easier for students to learn rather than giving orders or instructions to students. In its use, multimedia utilizes various media combined to produce a medium that can maximize the five senses as much as possible. Multimedia is a medium that involves various senses in a learning process, [22]

1.3 Interactive-Multimedia

Interactive multimedia is multimedia that is non-linear in nature, but students are given the option to select from a menu. When studying a topic of discussion, students have the option of selecting the first topic to study in order to direct the message and to encourage the students to make choices that will benefit their learning process. Interactive multimedia is distinguished by the presence of a controller, which is typically referred to as a Graphical User Interface (GUI). This controller may take the form of icons, buttons, scrolls, or other elements. Interactive multimedia is accessible to all individuals, regardless of their location, at any time and in any location, thereby fostering the belief that the learning process is not restricted to formal education and can last a lifetime., [21]. People generally believe that multimedia aids in the learning process, as it presents information and can be combined with computer assistance based on multimedia applications. Information presented through multimedia may be more engaging and recent than information presented through traditional lecture methods in the context of learning. The presentation of multimedia-based information has the potential to enhance the learning rate of students and allow them to manage their learning pace, [23]

1.4 Basic Electronics Course

Basic Electronics is a compulsory course in the Electrical Engineering Education study program at UNIMED. This course consists of 2 credits which are theoretical courses that discuss and introduce the characteristics, working principles, and analysis and calculations of electronic components. This course provides electrical engineering education students with an initial understanding of electronics. This course is also an initial foundation for students in understanding electronic circuits. [24]. Learning outcomes in basic electronics courses are that students are able to apply basic electronics knowledge that is relevant to the engineering field to obtain in-depth and comprehensive engineering studies by showing an attitude of responsibility independently, of quality and measurability. The sub-study of learning outcomes for this course is that students are able to analyze components, characteristics of component types, component functions, condition of electronic components.

Based on the learning outcomes described above, it can be seen that the basic electronics course abilities resulting from the student learning process consist of several levels, namely cognitive, affective and psychomotor. Student cognitive behavior is behavior that is the result of the thinking process, for example students are expected to be able to know, understand, apply, synthesize, evaluate, create or create subject matter. Student psychomotor behavior is behavior that is produced

as a result of body movements, for example imitating and manipulating. Consequently, it is envisaged that students can use the lecture materials in a practical and accurate manner concerning their physical capabilities. Affective behavior is behavior that occurs when a person makes choices or decisions in interacting with the environment in the form of feelings or attitudes, for example response, appreciation, assessment and organization.

2. Research Method

This research is classified as research and development (R&D). As stated by [25] Development research focuses on the development and validation of educational products. The Borg and Gall development model was employed in this investigation, and it was simplified by Puslitjaknov in 2008 [26] into five stages, conducting an analysis of the product, developing the initial product, expert validation and revision, small-scale field trials and product revision, and the final stage, which includes large-scale trials and final products. This research selected the Borg and Gall model due to its systematic approach, which aligns with the research's objectives. This research will be conducted at the Department of Electrical Engineering Education, Faculty of Engineering, Medan State University. There are the following phases of research:

2.1 Analysis of products to be developed

The research product to be developed is analyzed at this stage. The analysis was carried out through preliminary research (pre-survey) to collect information from literature reviews, classroom observations and relevant research studies. From the results of this preliminary research, problems found in learning can be identified. Furthermore, from identifying problems, needs can be identified which will become the basis for developing learning media. After identifying needs, it is continued with planning such as identifying and defining skills, formulating objectives, determining the sequence and steps for product development, planning expert tests, small-scale and large-scale tests that will be conducted.

2.2 Develop initial product

This activity aims to develop an initial product (prototype) in the form of preparing a draft or concept for the product to be developed. This product development includes preparing learning materials, reference books and supporting devices for designing media devices to be developed.

2.3 Expert validation and revision

At this stage, initial field trials are carried out, where the trials carried out are in the form of expert judgments. This initial stage of testing was carried out on 2-4 experts. Data or information collection at this stage is carried out through interviews, discussions and also questionnaires. Furthermore, the data collected through this stage is analyzed where the results of the data analysis from this initial

stage test will be used as a reference or basis for improving the initial product draft that has been produced.

2.4 Small scale field trials and product revisions

The research product has gone through the revision stage based on the results of expert testing, then a small-scale field trial is carried out consisting of 3-8 subjects who come from users of the product being developed. Trials are carried out to see the ease or practicality of using the product, users' views and assessments of the product being developed. From the test results, the data collected is then analyzed in order to determine the shortcomings of the product produced. Next, revisions are made to the product being developed based on the conclusions or findings obtained from the small-scale trial stages that have been carried out.

2.5 Large scale field trials and final product

The next stage is large-scale trials. Where research products that have gone through revisions at the small-scale trial stage are then tested on users, with more subjects, consisting of 30-50 research subjects. During this large-scale field trial, researchers collected data about user opinions and assessments of the product being developed. From the data collected at this stage, data analysis is then carried out which becomes the basis for improving the final research product. Furthermore, the final product is revised according to suggestions and data findings and the final product developed can be implemented by users, disseminated for use in learning.

Data Collection and Analysis Techniques

The data collection technique in this research is observation and distribution of questionnaires. Observations were carried out to analyze development needs as well as to analyze and obtain data on problems that occurred in learning which served as the basis for carrying out this development research. A questionnaire was distributed to experts (lecturers) and students in basic electronics courses to determine the feasibility and ease of use of the product being developed.

The data analysis technique used in this research is descriptive data analysis technique, namely by describing the feasibility and level of ease of the product being developed. In collecting qualitative data in the form of statements or categories of not good, not good, quite good, good and very good it will be converted into quantitative data which has a scale of 1 to 5. The results are subsequently averaged and utilized to evaluate the quality of the developed learning media. According to Suprijono, (2011:318) [27], the assessment of the interactive multimedia being developed will be converted into grades using a five-point scale, namely in accordance with the Likert scale, and the assessment criteria will be analyzed descriptively using the formula:

$$\text{Value} = \frac{Total\ zscores\ obtained}{Total\ Scores\ dor\ all\ item}\ x\ 100\ \% \qquad (1)$$

Furthermore, the value obtained from the average results above will be given a qualitative interpretation with the following interval criteria:

$$\text{Interval} = \frac{100}{total\ score}\ x\ 100\ \% \quad (2)$$

The value criteria for qualitative data analysis can be seen in the following table:

Table 1. Feasiblity criteria interactive multimedia.

Percentage value (%)	Criteria of Feasiblity
80 < X ≤ 100	Very high
60 < X ≤ 80	high
40 < X ≤ 60	currently
20 < X ≤ 40	low
0 ≤ X ≤ 20	Veru low

3. Result and Discussion

The development of interactive multimedia-based learning media in basic electronics courses was developed through 5 stages in accordance with the development model from Borg and Gall which has been simplified into 5 stages [26]. At the evaluation stage of this progress report, the development stage reached has only reached the third stage. The following is a description of each stage of interactive multimedia development that has been implemented:

1. Analysis of the product to be developed

At this stage, data is obtained in the form of the results of identifying problems found in learning as well as from preliminary research (pre-survey in the form of class observations, literature reviews and also relevant research studies. These results are used as a basis for developing interactive multimedia that will be developed. From the research results In the form of a survey and classroom observations, several problems were found which were the basis for developing interactive multimedia. Some of the problems were that the learning media used in basic electronics courses were not able to attract students' interest and increase their motivation in learning with the results of distributing a questionnaire where more than 70% of students thought that the media currently used was less interesting, seemed monotonous and was also unable to increase students' interest in learning. From the results of observations, it was found that the media currently used was still conventional media such as blackboards and standard power point. From the results of interviews regarding learning materials with students, it was found that this was also one of the causes of students' lack of understanding of the learning materials.

At this stage, a survey was also carried out on students regarding the need for media development in basic electronics learning. This survey was carried out by distributing questionnaires.

Questionnaires were distributed to students taking basic electronics courses in 3 classes with a total of 72 students. From the results of the questionnaire that was distributed, data was obtained that 83% of students agreed that the media needed for development was interactive multimedia. Interactive multimedia is more often chosen by students because its use can support students using active learning methods and independent learning which is not limited to the classroom.

According to problem's identification in this research, the learning media will be developed in the form of interactive multimedia, which in the design of this media can combine various types of learning media such as visual media, audio media and audiovisual media. By utilizing various forms of media in developing interactive multimedia, it can also facilitate student learning styles such as visual, auditory and kinesthetic learning styles. With various types of media and learning styles that students can utilize through interactive multimedia, it is hoped that it can increase students' understanding of basic electronics learning. This is reinforced by research from [12], that multimedia that has been developed can have a positive impact in the form of increasing student learning outcomes in learning.

2. Develop initial product

At this stage, the research team carries out initial design of the interactive multimedia that will be developed. Based on the analysis of material requirements, this interactive multimedia was developed on various electronic components such as resistors, capacitors, inductors and diodes. The material discussed focuses on the characteristics, types and working principles of components in electronic circuits. The material presented is also equipped with an analysis of the size of the electronic components in the circuit where the analysis is carried out manually and also simulated using the Multisim application. This interactive multimedia is also equipped with discussion of material regarding the introduction of the Multisim application for analyzing electronic circuits and is equipped with a video tutorial on using the Multisin application in analyzing electronic circuits.

This interactive multimedia design uses several media design applications so that the multimedia display developed becomes more attractive. Meanwhile, in designing the design, the writing team used several assets in the form of images, audio and video from several websites that could be utilized. And to design the background and appearance, the writing team used the Canva application. To combine all the assets that have been designed, the writing team uses the help of a professional PDF flip application in providing interaction on each designed multimedia page. The initial stages of developing interactive multimedia can be seen in the following picture:

Fig. 1. Interactive Multimedia home page display

Fig. 2. Menu and Sub Menu Display for Each Material

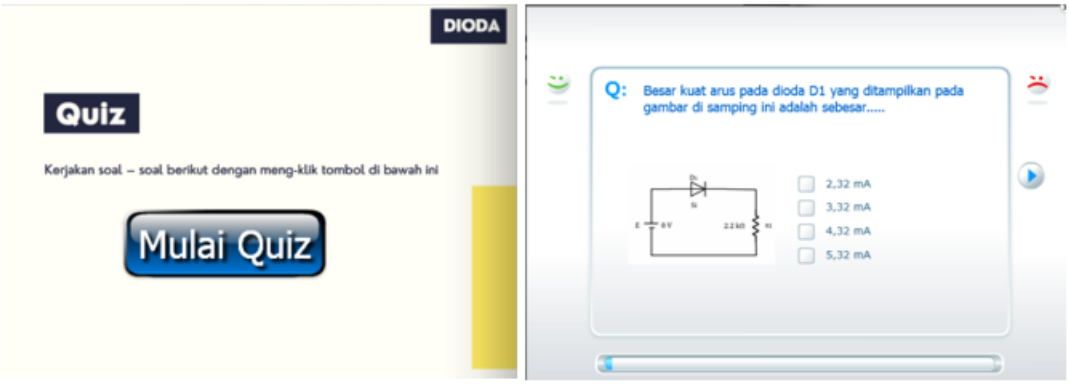

Fig. 3. Interactive Quiz menu display

3. Expert validation and revision

This stage is the initial stage in testing research products. This stage is in the form of a trial stage to see the validity of the interactive multimedia being developed. This validity test stage was carried out on experts consisting of lecturers who were material experts and also learning media experts. Material validation tests were carried out on two lecturers who taught basic electronics courses, and media validation tests were carried out on two lecturers who were experts in learning media. Material validation is carried out on three aspects, namely the content quality aspect, the learning quality aspect and the feasibility aspect of presentation, while the media validation is carried out on three aspects, namely: the learning aspect, the programming aspect and the media display aspect.

This table illustrates the outcomes of the material expert's evaluation of the interactive multimedia that is currently being developed::

Table 2. Material Expert Validation Results

Material Aspects	Content Quality (%)	Learning Quality (%)	Presentation Quality (%)	Mean Score (%)	Category
Exprert 1	92	86.67	92.5	90.39	**Very Feasible**
Expert 2	95	83.33	87.5	88.61	**Very Feasible**
Mean Score	**93.5**	**85**	**90**	**89.5**	**Very Feasible**

In Table 2 above, the validation results from the first material expert show that the average assessment from the content quality aspect is 92%, from the learning quality aspect it is 86.67% and from the presentation quality aspect it is 92.5%. From the average assessment of the material from all aspects by the first material expert, the average assessment was 90.39%, where the material validity category of the interactive multimedia being developed was in the "very appropriate" category. From the assessment of material aspects by material expert 2, the average assessment of

the content quality aspect was 95%, the learning quality aspect was 83.33% and the presentation quality aspect was 87.5%. From the average assessment of the material from all aspects by material expert one, the average assessment was 88.61%, where the material validity category of the interactive multimedia being developed was in the "very appropriate" category. Furthermore, the average assessment from the two material experts obtained an average assessment of 89.5%, where from the results of the assessments by the two material experts, the validity of the material from the learning multimedia developed was in the "very feasible" category. The results of analysis and data processing from material experts on the interactive multimedia developed can be seen in the following graph:

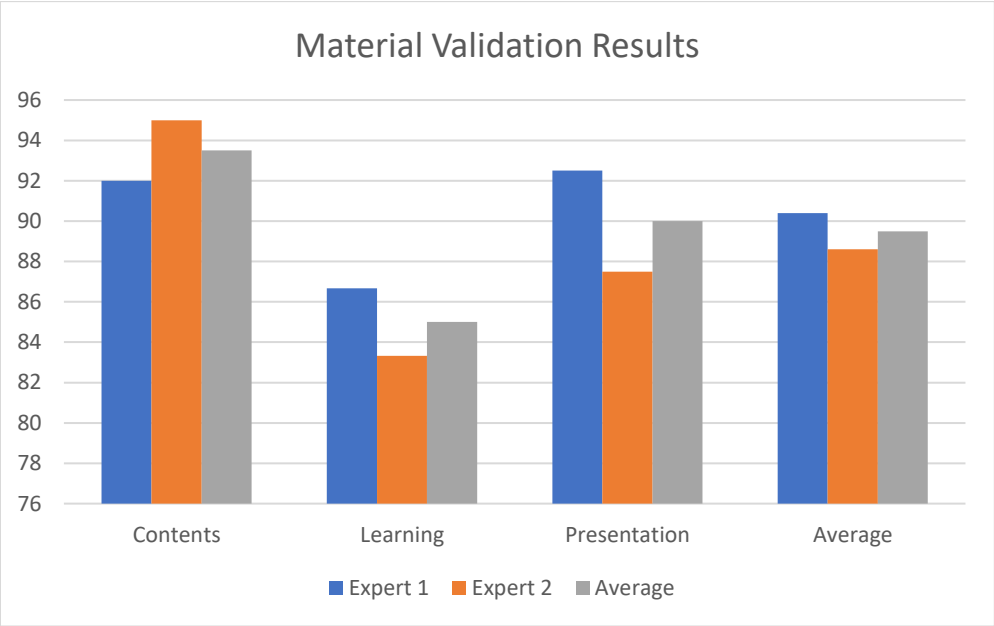

Fig. 4. Graphic of Validation Results from Material Experts

This table illustrates the outcomes of the media expert's evaluation of the interactive multimedia that is currently being developed:

Table 3. Media Expert Validation Results

Media Aspects	Learning (%)	Programming (%)	Media Display (%)	Mean Score (%)	Category
Exprert 1	86.67	93.6	86	88.76	**Very Feasible**
Expert 2	93.33	88	90	90.44	**Very Feasible**
Mean Score	**90**	**90.8**	**88**	**89.6**	**Very Feasible**

In Table 3 above, the validation results from the first media expert showed that the average assessment from the learning aspect was 86.67%, from the programming aspect 93.6% and from the media display aspect it was 86%. From the average media assessment of all aspects by the first media expert, the average assessment was 88.76%, where the media validity category of the interactive multimedia being developed was in the "very feasible" category. From the media aspect assessment by the second media expert, the average assessment obtained from the learning aspect was 93.33%, from the programming aspect 88% and from the media display aspect it was 90%. From the average media assessment of all aspects by the second media expert, the average assessment was 90.44%, where the media validity category of the interactive multimedia being developed was in the "very feasible" category. Furthermore, the average assessment from the two media experts obtained an average assessment of 89.6%, where from the results of the assessments by the two media experts, the validity of the learning multimedia developed was in the "very feasible" category. The results of analysis and data processing from material experts on the interactive multimedia developed can be seen in the following graph:

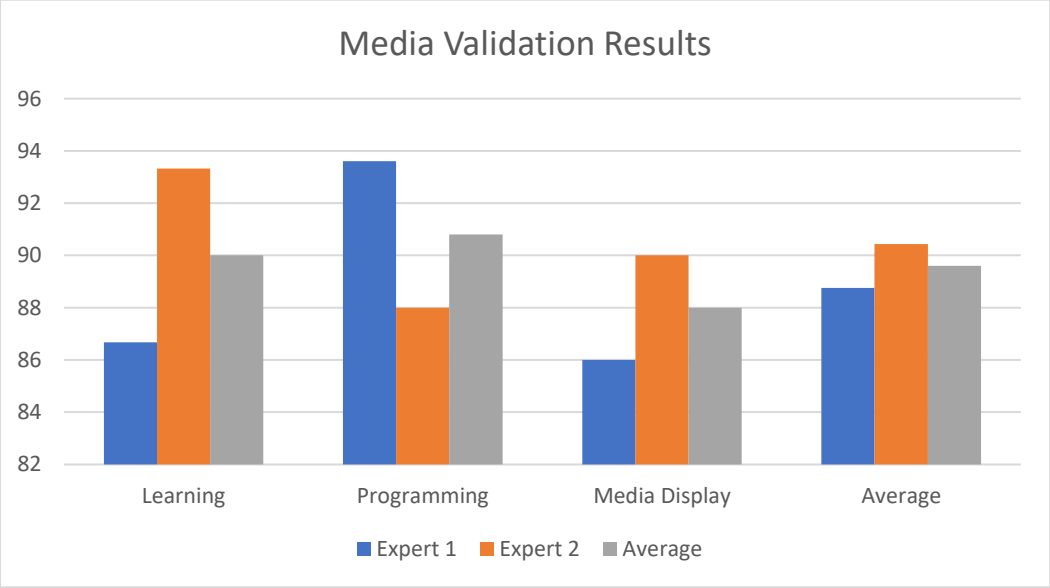

Fig. 5. Graphic of Validation Results from Media Experts

From the overall assessment results from four material and learning media experts on the interactive multimedia being developed, data was that the average assessment result from all media and material experts obtained was 89.55%, where the results of this assessment were in the "very feasible" categories. So it can be concluded that the developed interactive multimedia is feasible for use in

learning and is feasible to be continued to the user testing stage of the developed interactive multimedia. At this stage, discussions were also held with material experts and learning media experts regarding learning multimedia, so that several suggestions and input were obtained for improving the interactive multimedia being developed. Suggestions and input from experts are followed up by revising the interactive multimedia and then this interactive multimedia can be used in the testing phase for interactive multimedia users in learning.

4. Conclusion

It is possible to infer that the results of the research conducted thus far indicate that the interactive multimedia developed has a final assessment in terms of material of 89.6% which is in the "very feasible" category. In terms of media, the final assessment was 89.5% which was in the "very appropriate" category. So from the results of the validity analysis of this interactive multimedia, the overall average assessment from experts is 89.55%, which is in the "very feasible" category and from the results of this validity analysis, In conclusion, this interactive multimedia-based learning medium is highly appropriate for the instruction of basic electronics.. This is also in line with research from [24], [28], [29] that the multimedia-based interactive media produced has gone through the validity testing stage with experts and is in the valid category. so it is suitable for use in learning.

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