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Development of a Microcontroller E-Module Based on Grove Beginner Kit for Arduino Informatics Subject

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Abstract: Lack of teaching materials, time limitations, and uninteresting materials are problems that need to be solved so that students can better understand learning at school. The researcher provides solutions to develop E-modules that can be accessed on the internet. This research aims to develop E-module based on a microcontroller based on the Grove Beginner Kit for Arduino as a teaching material for informatics subjects and to determine the feasibility of e-modules in Arduino microcontroller material class XI at SMA Negeri 10 Samarinda. This type of research is development using a 4-D model, consisting of Define, Design, Develop, and Disseminate. Studies show that the results of E-module tests by material experts result in an average percentage of 90%, with a very decent category. The average percentage of media expert assessments is 92%, and the E-modules are feasible to implement. Overall, the combined average of the due diligence by experts reached 91%, with the category of very feasible. The results of student responses were obtained with an average percentage of 81% with very feasible criteria. so it can be concluded that the Grove Beginner Kit-based microcontroller e-module for Arduino can be applied or disseminated at SMA Negeri 10 Samarinda. Further research is expected to be carried out on other development models such as the borg and gaal models or the R2D2 model (reflective, recursive design and development).

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Introduction

Education is very important to determine the future of a nation. Education can empower individuals to develop themselves and pursue a better life. Education is a deliberate and structured effort to create an environment and learning process where students can actively improve their abilities. This includes cultivating spiritual and religious strength, self-discipline, character, intelligence, moral values, and skills necessary for personal, social, and national progress. Therefore, it can be concluded that education significantly affects the progress of a nation (Syawal, 2021)

SMA Negeri 10 Samarinda is a school located in Samarinda City using information and communication technology-based learning. This information and communication technology-based learning is an educational approach using the help of information and communication technology into the learning process. This approach aims to utilize various information and communication technology tools and resources, such as computers, internet, mobile devices,

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learning software and other devices, in order to improve the effectiveness and efficiency of learning. SMA Negeri 10 Samarinda in the subject of informatics has been taught from class X compulsorily in all classes, while class XI and elective. The change of the 2013 curriculum to an independent curriculum will certainly affect various aspects. One of them is the readiness of teachers in the teaching process. Teaching materials are one of the teaching processes that need to be prepared by teachers.

While at school, the researcher found a problem, namely the lack of informatics teaching materials that were in accordance with the material taught, one of which was material about the Arduino microcontroller. Arduino is an open-source customizable electronic prototyping platform based on microcontrollers. The hardware and software are user-friendly, making it ideal for anyone interested in using a microcontroller in a practical and straightforward way (Fitria, 2021). Seeing the problems that occur, teaching materials that can be accessed anywhere and anytime are needed. Considering that in the classroom, teachers also experience limited time in preparing structured modules because of the many hours spent providing learning compared to the time spent developing modules or other teaching materials. Efforts that can be made to overcome these problems are to prepare e-modules that are in accordance with the condition of school facilities and infrastructure. E-modules integrate module-based educational content with computer technology to facilitate student access and support the learning process in the classroom (Marto, 2021). The development of E-modules must be in accordance with the rules for making printed modules referring to self-instructional teaching packages that contain one concept of learning materials (Yunus, 2019).

Relevant research as a reference is first, the development of Android-Based Mikrotik Installation E-Module in the subject of Network Infrastructure Administration at SMK (Mukhson & Untari, 2024), The results of this study state that the E-module is very effectively used as a learning medium for microtic installations. Second, Development of DBUS-based e-modules using book-creators to improve students' critical thinking skills (Rahayu & Ismawati, 2024), The result of the research is that E-modules using book creators can improve students' critical thinking skills and can be used for the learning process. Third, the Effectiveness of E-Module Interactive Learning Media Design (Jafnihirda et al., 2023), The result is that the development of E-modules using 4D models is effectively used as an English learning medium. With this relevant research, the researcher developed a microcontroller E-module as a learning medium to provide understanding to students as well as be able to practice simply.

The purpose of this research is to develop a grove-based microcontroller E-module beginner kit for informatics subjects. This is important to do considering that E-modules can provide wider information and there are visualizations so that students can understand and practice directly Step by Step programming Arduino using the Arduino IDE and a simple assembly process. The existence of e-modules also allows students to learn it at home independently. The Grove Beginner Kit for Arduino is a hardware package or kit designed to help beginners in the world of microcontroller programming using the Arduino platform. To create this e-module, the researcher uses Book creator as a medium for making e-modules. Book Creator is a platform used to access e-books or e-modules in the form of a website (Hartati et al., 2023). The platform is designed to make it easier for users, especially teachers and students, to create and access e-books or e-modules that can contain text, images, audio, video, and additional features (Juliana & Sulistyowati, 2023). So that by making e-modules using book creators, it can make it easier for students to learn and understand materials related to programming on Arduino microcontroller devices. E-modules have the advantage of being

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accessible anywhere and anytime with the help of smartphones and laptops that are generally owned by every student. The existence of e-modules as teaching materials is expected to help teachers in carrying out the teaching and learning process, especially in accordance with the implementation of information and communication technology learning carried out by SMA Negeri 10 Samarinda. This microcontroller e-module also contains C++ Language which is used for learning program practice. The programming language can be used to create a system according to the needs and uses of the sensors connecting to Arduino, it can be used in various fields, one of which is education (Fajri et al., 2024). This E-Module is very helpful for students and teachers in understanding learning about Arduino microcontrollers.

Research Method

This research was conducted at SMA Negeri 10 Samarinda, which is located on Jalan PM. Noor, East Sempaja, North Samarinda District, Samarinda City, East Kalimantan Province. The participants in this study are students from Class XI 7 and Class XI 8, with a total of 70 students 35 in Class XI 7 and 35 in Class XI 8. The focus of the research is on the teaching materials for the E-module Grove Beginner Kit for Arduino microcontroller. Researchers use research and development methods, which are research methods that aim to develop certain products and assess the feasibility of those products. The object developed by the researcher is the development of a microcontroller E-module based on the Grove Beginner Kit for Arduino as a teaching material that can be used in class XI informatics subjects at SMA Negeri 10 Samarinda. This research uses a development model based on the 4D development model. The 4D Development Model is a framework for creating various types of general learning media, suitable for developing various types of media and instructional materials (Arkadiantika et al., 2020). This development model has 4 stages, namely Define, Design, Develop, and Diseminate. This model is particularly suitable for research focused on creating educational tools, as it can help address learning challenges and can be used to develop educational resources (Fitria, 2021). The 4-D development model, consists of four stages used, including First, define, which is a development analysis involving the identification of product development requirements that are aligned with user needs, along with a research and development model that is appropriate for product manufacturing.

When creating instructional materials such as e-modules, the definition phase is carried out through three methods, namely Initial analysis, Student analysis, and Curriculum analysis (Adoe et al., 2022). In the initial analysis, the researcher examined the learning process in the classroom, the use of technological tools, and the teaching materials used, especially those that included microcontroller content. The initial analysis related to the learning process carried out in the classroom, the use of technological facilities and the teaching materials used, especially in the teaching materials containing microcontroller materials. The researcher conducted an interview with one of the informatics teachers there with 9 related questions to determine the basic problems faced in learning, especially in microcontroller materials.

Student analysis section, This activity is carried out to find out the views of students related to the learning process carried out by teachers in the classroom such as the use of methods and models carried out by teachers, the use of teaching materials, and the facilities used when the teacher teaches. This is also used to find out the needs of students in the *e-modules* developed. The researcher distributed a questionnaire using *a google form* containing 20 question items related to the learning process, the use of teaching materials, an understanding of microcontroller materials and the availability of teaching materials, as well

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as what needs are needed to develop *e-modules* to 70 students of SMA Negeri 10 Samarinda, namely class XI 7 as many as 35 people, and class XI 8 as many as 35 people. Then the researcher also conducted interviews with student representatives according to the questions in the student analysis questionnaire. In the curriculum analysis section, the researcher analyzed the curriculum used in schools through the previous two stages through interviews with informatics teachers and student analysis.

Second, the design involves three activities, including media selection, format selection, and initial design (Hariyanto et al., 2022). Media Selection The researcher uses Book Creator as a platform to access e-modules. This e-module is available on the official website and can be accessed on a variety of devices, including smartphones, laptops, and computers. Format Selection: At this stage, the researcher used Adobe Photoshop CC 2018 and Adobe Photoshop CS 6 to create the design of the e-module. The design of this e-module in this software researchers have determined the aspects of the color theme, paper dimensions, type and size of letters to be used when making the design. Initial Design, this stage carries out the initial preparation of the e-module product which refers to the design plan from the storyboard that has been made. This e-module has a 3-part structure consisting of the Initial Section, the Content Section, and the Final Section.

Development, to validate or evaluate the feasibility of product design. This process is carried out by experts in their respective fields. In addition, product testing is carried out on the actual target users. The development stage is the final form of learning media that is produced and has been revised by material experts and media experts through product validation, and product trials (Nardi Ardana, 2023). At this stage, after designing, a feasibility test is carried out on the product that has been developed. This feasibility test was carried out by 2 media expert validators and one material expert validator to find out the parts that are considered lacking and need to be improved. This feasibility test activity with material experts was carried out by one expert validator, namely an informatics subject teacher and the principal at SMA Negeri 10 Samarinda. Validator Media experts are lecturers who are in accordance with the field of media expertise.

The dissemination stage , distributing products made after conducting feasibility tests and product trials. The purpose of this stage is to distribute teaching materials from the e-modules that have been created in schools. This stage is the final stage after completing a feasibility study from experts and having tested the product. The assessment of the feasibility of the research is validated by media experts and subject matter experts. The instrument for material experts contains the suitability of the *e-module* which is reviewed from 3 aspects, namely the aspect of content eligibility, the aspect of presenting material containing *Self Instruction, Self Contained, Stand Alone, Adaptive, User Friendly* which is presented in table 1 (Gusrianto & Rahmi, 2022).

Table 1. Material Expert Assessment Grid

No	Aspects	Indicator	Item Number
1	Content eligibility	Compatibility with the curriculum	1,2
		Accuracy of examples with the material presented	3,4
		Suitability of images/videos to study the material	5
2		Self-study	6,7,8

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	Presentation of material	Complete	9
		Not relying on other media	10
		Adaptive	11
		Friendly to use	12,13,14
3	Language eligibility	Use of Language and Grammar	15,16,17
		Ease of reading the shape and size of the letters in the content of the e-module	18,19,20

Instruments for media experts can be reviewed from several aspects, namely media suitability, organization, attractiveness, font shape and size, as well as space and overall elements *of the e-module* presented in table 2 (Gusrianto & Rahmi, 2022)

Table 2. Media Rating Grid

No	Aspects	Indicator	Item Number
1	Media Suitability	Column format	1
		Use of images	2
		Use of *icons*	3
		Script preparation	4
		Text formatting	5, 6
2	organization	View table of contents	7
		Systematics or order of learning materials	8,9,10
		Arrangement and flow between chapters, between units, between paragraphs	11
3	Attraction	Compatibility of color combinations, images, illustrations, shapes and font sizes on the *cover*	12,13,14
		Providing pictures or illustrations in the content of *the e-module*	15
		Benefits of using *e-modules*	16,17,18,19
4	Font shapes and sizes	Ease of reading the shape and size of the letters in the content of *the e-module*	20,21,22
5	Overall Space and Elements E-Module	Whitespace	23
		Space between texts	24
		Every element of *the e-module* consistent.	25

The instrument for product trials is in the form of a questionnaire to see the response from students related to *the e-module* developed. This instrument is reviewed from several

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aspects, namely the material, graphics, and *E-Module* learning presented in Table 3 (Marisa & Hakim, 2020)

Table 3. Product Trial Grid

No	Aspects	Indicator	Item Number
1	Material	Relevant *e-module matter*	1,2,3,4
		Language in the delivery of material	5,6,7
		Practice questions or assignments	8,9,10
2	Graphics	E-Module *Cover Design*	11,12,13
		Use of Text	14,15,16,17
		Use of Images	18,19
		Color Composition	20,21
3	Learning *E-Module*	Use in learning activities	22,23
		Interest in *E-Modules*	24,25,26,27

The data collection process uses three methods namely observation, interviews, and questionnaires. Furthermore, the data analysis stage involves processing and presenting the collected data to assist the researcher in answering research questions. Data analysis is carried out by categorizing the data into grades and comments for improvement. The results are then used for revision and to assess the feasibility of the developed e-module product. The data is calculated using the following formula:

$$average\ score\ (\%) = \frac{Total\ Score}{\text{Maximum Score}}\ \text{X}\ 100\%$$ (Salsabella et al., 2023)

Further data analysis for feasibility tests and trials of products, materials and product designs developed are evaluated using 5 answer options based on the content of the questions. This data is used to determine the feasibility level of the final product. Assessment scores are presented in Table 1(Salsabella et al., 2023)

Table 4 Assessment Score for Answer Choices

Score	Answer Choices
5	Strongly agree
4	Agree
3	Simply Agree
2	Don't agree
1	Strongly Disagree

Furthermore, the scores from the feasibility test and the assessment of the product trial questionnaire are averaged and converted into questions to evaluate the feasibility of the developed product. To interpret scores as bias statements, see Table 2 (Salsabella et al., 2023)

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Table 5 feasibility criteria

Percentage (%)	Criteria
81%-100%	Very Worth It
61%-80%	Worthy
41%-60%	Decent Enough
21%-40%	Not Worth It
0%-20%	Very Inadequate

Based on the feasibility criteria table 2, the assessment of the feasibility test and trial of this e-module product is set with a minimum score of above 61%, namely "Feasible". If the results of the feasibility test and product trial assessment have an average percentage above 61%, then the product for the development of e-module teaching materials is "Good" to be used in learning.

Result and Discussion

This research develops e-module teaching materials on microcontroller materials and determines students' responses to the e-modules that have been developed. The data from the research and development of the e-module is described in the Define stage, namely first, Conducting the initial analysis that has been carried out is that SMA Negeri 10 Samarinda has used technology facilities such as projectors, labs, wifi, and other learning devices such as arduino microcontroller devices. In schools, there is still a lack of informatics teaching materials in accordance with the materials needed, such as teaching materials for microcontroller materials. When conducting practical demonstrations using microcontrollers, students are still difficult to understand what is being conveyed by teachers because of the lack of references in schools, and some of the references used by teachers are taken from several sources on the internet. Teachers also experience limited time in compiling ideal teaching materials, because teachers do not only teach in informatics subjects. The researcher proposed a solution by developing teaching materials in the form of e-modules that focus on microcontroller content. This e-module is intended to serve as a resource for students to improve their understanding of informatics subjects. The development of this e-module is also carried out as an innovation to support and improve the learning experience in the classroom.

Second, analyzing students, as many as 61% of students agree and 37% of students strongly agree that microcontroller material is difficult, and they do not understand microcontroller material well. The learning process in the classroom rarely uses electronic teaching materials compared to printed teaching materials based on the percentage obtained, which is around 86% of students who give the answer that teachers rarely use electronic teaching materials. Around 53% of students strongly agree and 44% of students agree that they prefer the use of electronic teaching materials compared to printed teaching materials. Students need a variety of teaching materials that are interesting and easy to understand based on percentage, namely as many as 60% of students strongly agree and 39% of students agree that interesting teaching materials can make them enthusiastic about learning. Based on needs, the researcher provides a solution, namely the development of electronic teaching materials with an easy-to-understand material explanation display starting from material presentation, writing systematics, the use of images, material explanation videos, audio that contains several materials and attractive designs. The presentation also uses the base of the grove beginner kit for Arduino device which they use in the learning process including hardware and software.

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Third, analyzing the curriculum, SMA Negeri 10 Samarinda has used an independent curriculum in the learning process. In this study, the researcher developed a microcontroller *e-module*, therefore the researcher must first know what are the microcontroller materials taught in the school, and know the microcontroller devices used in the school. Based on the Learning Objectives Flow which contains elements of computational thinking, computer systems, computer networks and the internet, programming algorithms, informatics social impact, and cross-field practices. The design stage has been carried out by starting to create a storyboard for the initial design of the e-module which is tested for feasibility by material experts and media experts. The following are the results of the design before and after it is revised based on input from material experts and media experts.

Figure 1. Changes in Suggested Design and Use of *E-Modules*

Figure 1 shows this page making design improvements which were initially plain, shapes were added to the sub-heading, then audio was added that also contained voices about suggestions and the use of *e-modules.* Figure 2 shows improving the spacing between texts and spacing of each text that is far apart to make it neater and easier to read.

Figure 2. Changes in Sentences That Are Still Distant

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Figure 3 Design changes in the summary section

Figure 3 shows that a specific page in each learning activity has a summary page. On the previous summary page, the sentence did not use left-right alignment, so that after the revision of the page in the summary in each learning activity it was left-right alignment.

Figure 4. Changes to Material Pages Containing Videos

Figure 4 shows the material page which was previously only a video, added audio to give a more minimalist impression so that there are not too many sentences piled up, then the correction of some images that were previously less interesting was replaced with other images to make the reader more comfortable when reading *the e-module*.

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Figure 5. Changing the design of the material page to audio

Figure 5 shows that on a certain page, there are also some materials that were previously sentences after being revised and converted into audio to make *the e-module* not too much writing so that *the e-module* can not only read the material, but can also be heard. The results of the assessment of subject matter experts by informatics teachers are presented in Figure 6.

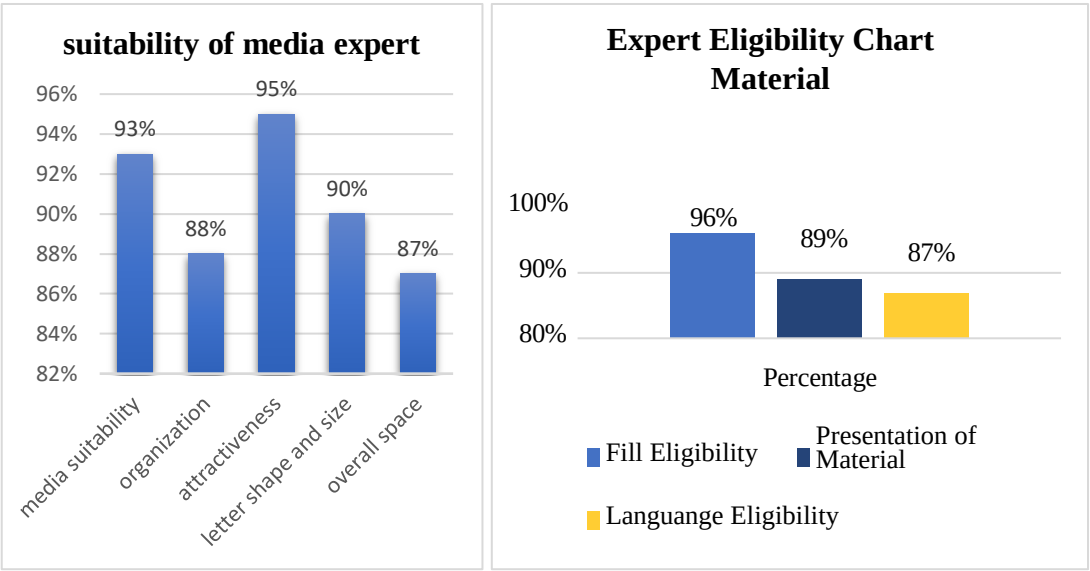

Figure 6. Qualification results by material experts and media experts

Based on the data in figure 6 of the feasibility test of media experts above, the percentage of media suitability aspects was obtained by 93%, the attractiveness aspect by 95%, organization by 88%, the shape and size of letters by 90%, and the space and overall *e-module* obtained by 87%. Based on table 5 on the percentage criteria obtained between 81%-100%, the E-module media is considered very feasible. For the assessment of material experts in terms of the feasibility of the content, the percentage was 96%, then the presentation of the material was 89%, and the feasibility was 87%. Based on table 5 on the percentage criteria obtained between 81%-100%, the material in the E-module is considered very feasible.

Test the product to 70 students to find out their response. The process of testing this product was carried out in the classroom, namely together with class XI 7 and class XI 8 at

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SMA Negeri 10 Samarinda. This trial is carried out with several initial stages, namely by first explaining the purpose and objectives of the researcher conducting a trial of this product, then continuing by explaining a little about the development that the researcher has made, after which explaining some components that can be used by students in *the e-module*. Furthermore, students are welcome to see the *e-modules* that have been developed, then after finishing the researcher distributes the questionnaire that has been made on *the google form* to the students.

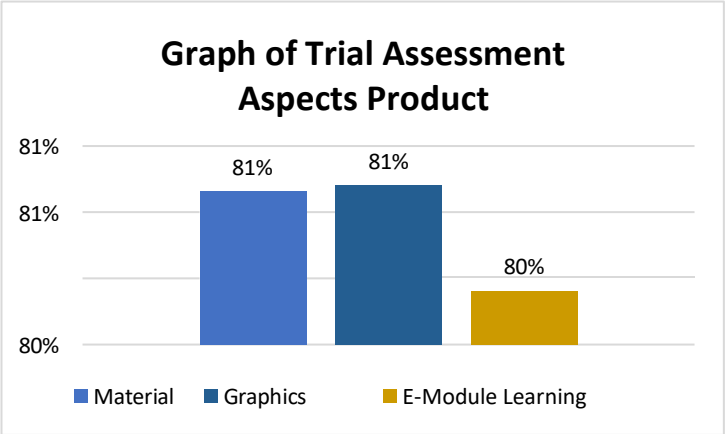

Figure 7. Product trials to students

The data in Figure 7 can be seen from the graph above for the material aspect obtained a result of 81%, the graphic aspect of 81% and the learning aspect of *the e-module* with a total of 80%. The average value of the percentage is 81% and is declared very decent. The Dissemination Stage is the final stage after completing a feasibility study from experts and testing the product. The E-module product that has been disseminated is presented in Figure 8.

Figure 8. Products that have been disseminated.

Conclusion

Based on the results and discussions, the development of a grove-based microcontroller *E-module beginner kit for arduino* based on a 4D model has been successfully developed and declared feasible for use in informatics learning at SMA Negeri 10 Samarinda. The assessment by material experts with a percentage of 90% of the criteria was very feasible, then the feasibility test from two media experts also obtained a percentage of 92% with very feasible

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criteria. From the two results, the average results were summed up and a percentage of 91% was obtained with very feasible criteria. The product trial was carried out to find out the response from students related to the development *of the e-module* that had been made, and the response from students was obtained by 81% with very feasible criteria. The e-module that has been developed with a 4D model can be used as a teaching material at SMA Negeri 10 Samarinda. This is in accordance with one of the research on the development of E-modules using a 4D model that is effectively used as an English learning medium (Jafnihirda et al., 2023)

Recommendation

Sing a device base other than *the Grove Beginner Kit for Arduino*. In addition, for the development of *the next e-module*, it is expected to be able to develop a *microcontroller e-module* using other development models such as the borg and gaal models or the R2D2 (reflective, recursive design and development) model. In terms of content, simulations can be used using software or hardware such as Raspberry Pi in order to enrich new information in the *e-module* to add insight to students.

References

Adoe, W., Amali, L. N., Salim, S., & Katili, M. R. (2022). *Pengembangan Video Animasi Menggunakan Model 4D Untuk Pembelajaran Anak Usia Dini*.

Arkadiantika, I., Ramansyah, W., Effindi, M. A., & Dellia, P. (2020). Pengembangan media pembelajaran virtual reality pada materi pengenalan termination dan splicing fiber optic. *Jurnal Dimensi Pendidikan Dan Pembelajaran*, *8*(1).

Fajri, R. M. A., Wahyudi, D. N., Ni'mah, E. S., Nugroho, F., Rahmeisi, N., Shaikh, S. S., Ashari, I., Fayyed, M. N. Al, & Putri, I. A. (2024). *Penerapan Pemrograman C++ dalam Pengembangan Alat Elektronik Sederhana untuk Mahasiswa Teknik Elektro* (Vol. 3, Issue 1). http://jurnalilmiah.org/journal/index.php/majemuk

Fitria, E. (2021). *Pengembangan buku elektronik materi indahnya kebersamaan dengan menggunakan book creator di kelas iv*.

Gusrianto, R., & Rahmi, U. (2022). Pengembangan E-Modul Pada Mata Pelajaran Informatika Berbasis Kurikulum Merdeka Belajar Untuk Kelas VII SMP. *Jurnal Bahana Manajemen Pendidikan*, *11*, 173–180. https://doi.org/10.24036/jbmp.v11i2

Hariyanto, B., MZ, I., SU, W., & Rindawati. (2022). 4D Model Learning Device Development Method of the Physical Geography Field Work Guidance Book. *MATEC Web of Conferences*, *372*, 05008. https://doi.org/10.1051/matecconf/202237205008

Hartati, Djangi, Muh. J., & Burhayati. (2023). Penggunaan Book Creator pada Model Discovery Learning untuk Meningkatkan Hasil Belajar Kimia Peserta Didik. *Jurnal Pemikiran Dan Pengembangan Pembelajaran*, *5*(3). https://www.ejournal-jp3.com/index.php/Pendidikan/article/view/784/697

Jafnihirda, L., Suparmi, Ambiyar, Rizal, F., & Eka Pratiwi, K. (2023). Efektivitas Perancangan Media Pembelajaran Interaktif E-Modul. *INNOVATIVE: Journal Of Social Science Research*, *3*(1), 227–239.

Juliana, I., & Sulistyowati, R. (2023). Pengembangan E-Modul Interaktif Berbasis Aplikasi Book Creator Mata Pelajaran Produk Kreatif dan Kewirausahaan Kelas Xi BDP SMK PGRI 13 Surabaya. *Jurnal Pendidikan Ekonomi (JUPE)*, *11*(3), 328–334. https://doi.org/10.26740/jupe.v11n3.p328

Januari 2025. Vol. 10 No. 1
E-ISSN: 2656-1417
P-ISSN: 2503-0602
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Marisa, U., & Hakim, A. R. (2020). Pengembangan E-Modul Berbasis Karakter Peduli Lingkungan di Masa Pandemi Covid-19. *Seminar Nasional PGSD UNIKAMA*, *4*, 323–330. https://conference.unikama.ac.id/artikel/index.php/pgsd/article/view/514

Marto, H. (2021). *Modul Elektronik*. https://penerbitpascasarjana.pps.ung.ac.id/

Mukhson, Muh. A., & Untari, R. S. (2024). Pengembangan E-Modul Instalasi Mikrotik Berbasis Android Pada Mata Pelajaran Administrasi Infrastruktur Jaringan Di SMK. *Indonesian Journal of Applied Technology*, *1*(1), 17. https://doi.org/10.47134/ijat.v1i1.3089

Nardi Ardana. (2023). Pengembangan Modul Elektronik pada Mata Pelajaran Teknik Pemesinan Bubut. *Jurnal Pembelajaran Inovatif*, *6*(2), 08–17. https://doi.org/10.21009/jpi.062.02

Rahayu, R., & Ismawati, R. (2024). Development of DBUS-Based E-Modules Using Book-Creators to Improve Students' Critical Thinking Skills. *JURNAL PENDIDIKAN IPA VETERAN*, *8*(1), 1–11. https://doi.org/10.31331/jipva.v8i1.2854

Salsabella, S., Iriani, T., & Saleh, R. (2023). *Pengembangan Bahan Ajar E-Modul Mata Kuliah Konsep Arsitektur Menggunakan Model 4D* (Vol. 5).

Syawal, I. (2021). Pengembangan Modul Pembelajaran Mikrokontroler Berbasis Online untuk Mahasiswa Teknik Elektro. *Jurnal Pendidikan Teknik Elektro*.

Yunus, Y. (2019). Validitas Media E- Modul Pemrograman Berorientasi Objek II Berbasis Problem Based Instruction. *CURRICULA: JOURNAL OF TEACHING AND LEARNING*, *4*(3), 154–163. https://doi.org/10.22216/jcc.2019.v4i3.3596

