Designing Interactive Electronic Module with Collaborative Team Work in Physics Learning

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Abstract

This study aims to determine the validity, practicality and effectiveness of interactive electronic modules (e-modules) with collaborative teamwork for physics learning. Design e-modules using the Flip PDF Professional application. This development uses the ADDIE development design (Analysis, Design, Development, Implementation and Evaluation). This research was conducted at senior high school in Purworejo. The test subjects were limited to class X2 with 5 students and a wide trial with 71 students in class X1 class X2. The research instruments used were validation sheets, collaboration skills questionnaires, learning module implementation sheets, collaboration skills observation sheets and student response questionnaires. Study data analysis techniques through validity test, and N-gain. The results of the study obtained: 1) material validation by expert validators obtained an average score of 3.72 in the "very good" category media experts obtained an average score of 3.63 in the "very good" category, so that it was declared very good. 2) the practicality of the media seen from the responses of the students obtained an average percentage of 93.7% in the "very practical" category. 3) the effectiveness of the e-module is seen from the increase in the results of the pre and post collaboration skills questionnaire, namely obtaining an N-gain of 0.68 in the "medium" category. For this reason, the development of interactive e-module with Collaborative Teamwork Learning for physics learning meets valid, practical and effective criteria, to improve students' collaboration skills in Class X senior high school.

Keywords: *Collaborative, Team work, e-Module, Interactive*

1. Introduction

Learning is defined as the process of creating an environment so that the learning process can occur so that it is able to change the behavior of students [1]. One of the educational science lessons that is applied in education science is physics learning. Learning physics is inseparable from mastering concepts, their application in solving physics problems, and conducting scientific research [2]. In learning physics students are not only required to understand the theories, concepts, and laws of physics, but are also expected to be able to understand how these physical phenomena can occur [3]. Physics learning has the goal of equipping students with knowledge, understanding, and skills in developing science and technology [4].

One of the abilities to develop science and technology is collaboration skills. Collaboration skills are a process in learning that is carried out by applying the principle of working together to balance differences of opinion, knowledge, playing a role in discussion by giving advice, listening, and supporting each other [5]. Collaboration skills are very important to be taught to students. Student collaboration skills can be applied in the learning process by using models, methods, media, methods, approaches, designs and other learning strategies [6]. One learning model that can be applied to improve collaboration skills is the collaborative teamwork learning model. The learning model of collaborative teamwork learning is a learning model that emphasizes the collaboration of students in groups [7]. That way the model is very suitable to be applied to improve students' collaboration skills.

Based on the results of interviews and direct observation with one of the physics teachers at SMA Negeri 5 Purworejo, information was obtained that there was still a lack of student collaboration skills because they were still using modules and textbooks with a teacher-centered learning model. The modules that are often used by students are mostly printed modules which tend to be informative, depict simple things and only contain practice questions. Even though some students have not been able to learn independently by using print modules so it is difficult to expand their knowledge. So that the development of an electronic module called e-module. Electronic modules (e-modules) are innovations that contribute to the learning process, where electronic modules can present material using a combination of media such as audio, text, images and video so as to motivate students to be further involved in the learning process [8]. Many applications support the creation of electronic modules (e-modules), including using the Flip PDF Professional application. Making teaching materials using this application because apart from containing writing, this application can also include video and audio, making learning an interesting and interactive learning medium to learn so it is not monotonous. This application is run online by utilizing the wi-fi facilities available at the school. So that students cannot be separated from using laptops, Android and iOS. Therefore, with the existence of an e-module using the Flip PDF Professional application it becomes teaching material for students so that it can be run through digital technology, especially laptops and smartphones. So that students are able to independently study the material being taught, it can even be used in any situation and place.

Based on this background, the researchers developed an interactive e-module with collaborative team work in physics learning. The results of the development of this interactive e-module are expected to help students learn collaboration skills and can be a source of reference for the learning process for teachers.

2. Methods

The interactive e-module research design in this study was adapted from the ADDIE model research and development (R&D) method [9]. The ADDIE model consists of 5 stages, namely: Analysis, Design, Development, Implementation, Evaluation. The Analysis includes an analysis of the characteristics of students and an analysis of media needs. In the Design Stage, the activities carried out are preparing materials, compiling maps of needs, and initial designs. Development stage, the activities carried out are instrument preparation, media testing, and limited testing. Implementation stage, the activities carried out are testing the area of the product being developed in one of senior high school at SMA Negeri 5 Purworejo.

The subjects of this study were grades X1 and X2 of senior high school in the even semester of the 2022/2023 academic year. The test subjects were limited to class X2 with 5 students and a wide trial with 71 students in class X1 class X2. Class selection is based on consideration of problem identification

regarding the lack of collaboration skills of class X students, and the rare availability of learning media in the form of electronic modules (e-modules).

Data was collected through: 1) observation, to see the implementation of teaching modules and student collaboration skills during learning using the e-module Collaborative Teamwork Learning assisted by Flip PDF Professional which was developed, 2) validation sheets, to determine the eligibility of the media, 3) questionnaire, to find out student responses and student collaboration skills before and after using the Collaborative Teamwork Learning e-module assisted by Flip PDF Professional on global warming material, 4) Documentation, used to support evidence of student activity while participating in learning activities.

Data analysis of the validity of the Collaborative Teamwork Learning e-module assisted by Flip PDF Professional includes material validation, media validation, collaboration skills questionnaire validation, teaching module implementation validation, collaboration skills observation sheet validation and student response questionnaire validation. Data validation results by expert validators, then tabulate the data obtained. Because the scoring already uses a scale of four, the data does not need to be changed to a scale of four. To facilitate the interpretation of the data, it is then converted to a qualitative criteria scale with reference to changing values in Table 1 [10].

Table 1. Reference for Changing the Value of Scale Four

Score Intervals	Interpretation
0,00-1,69	*Not good*
1,70-2,59	*Currently*
2,60-3,50	*Good*
3,51-4,00	*Very good*

To make it easier to compare scores, it is necessary to convert them into percentages, using equation 1 [10].

$$NP = \frac{R}{SM} \times 100\% \tag{1}$$

note: NP = expected percent value, R = raw score obtained, SM = ideal maximum score.

The practicality data analysis of the collaborative teamwork learning e-module assisted by Flip Pdf Professional includes student responses, implementation of teaching modules, and collaboration skills observation sheets. Student responses were analyzed by calculating the results of the completed response questionnaires. To facilitate calculations, the data is converted into percentage form according to equation 1. Then it is converted according to Table 2.

Table 2. Assessment Guidelines Criteria

Percentage (%)	Category
82- 100%	Very Practical
63 - 81%	Practical
44 - 62%	Less Practical
25 - 43%	Impractical

Assessment of data on the implementation of teaching modules and observation sheets for collaboration skills were filled in by two observers. To facilitate calculations, the data is converted into percentage form according to equation 1. Then it is converted according to Table 2. Calculating the Percentage Agreement (PA) value. Percentage Agreement is used to calculate the reliability of the results of the assessment of the implementation of learning that is carried out when observing the learning process. According to the Borich Percentage Agreement it can be determined by equation 2 [11].

$$Percentage\ Agreement\ (PA) = \left(1 - \frac{A-B}{A+B}\right) \times 100\%$$ (2)

note: PA = Percentage Agreement, A = The highest score from the observer, B = The lowest score of the observer.

A and B are the values given by the first and second raters with A>B. According to [12] an instrument is said to be reliable if the Percentage Agreement (PA) is more than one or equal to 75%. PA criteria reference as in Table 3 [12].

Table 3. PA Criteria Reference

Percentage (%)	Note
76- 100%	Reliable
51 - 75%	Reliable enough
26 - 50%	Less Reliable
0 - 25%	Not Reliable

Data from the questionnaire results of students' collaboration skills were analyzed based on indicators of success in improving students' collaboration skills. To find out the increase in results obtained, it is necessary to calculate the N-gain value using equation (3) according to Hake, Ricard R [13].
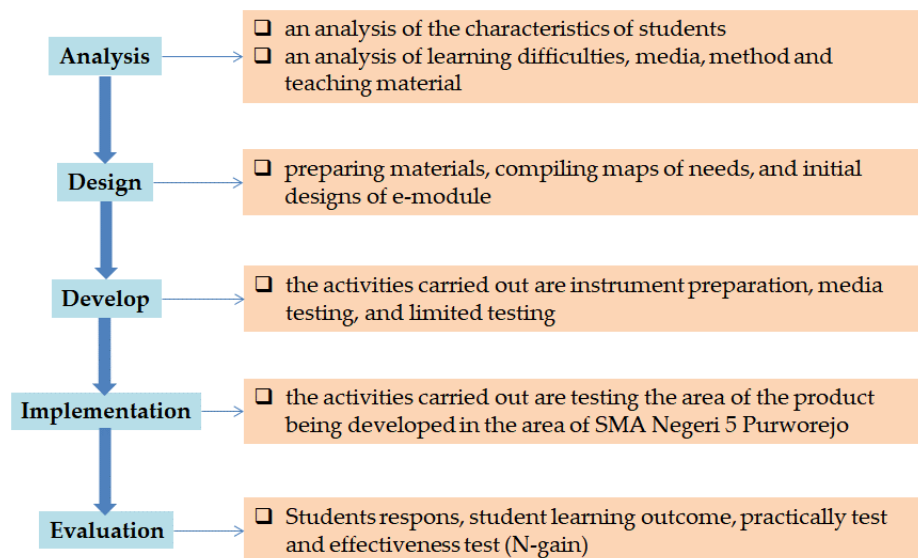
$$g = \frac{S_f - S_i}{100 - S_i}$$ (3)

note: g = Normalized gain, S_f = Post-test score, S_i = Pre-test score,

The results of the normalized gain calculation are then converted into the normalized gain classification according to Hake, Ricard R [13] with the criteria shown in Table 4. The stages of research procedure as seen in Figure 1.

Table 4. Criteria Normalized Gain

Criteria	Conclusion
0,70 < g <1,00	Tall
0,30 < g < 0,70	Currently
0,00 < g < 0,30	Low
g = 0,00	Stable
-1,00 < g < 0,00	Decrease

Analysis	❏ an analysis of the characteristics of students ❏ an analysis of learning difficulties, media, method and teaching material
Design	❏ preparing materials, compiling maps of needs, and initial designs of e-module
Develop	❏ the activities carried out are instrument preparation, media testing, and limited testing
Implementation	❏ the activities carried out are testing the area of the product being developed in the area of SMA Negeri 5 Purworejo
Evaluation	❏ Students respons, student learning outcome, practically test and effectiveness test (N-gain)

Figure 1. Research Procedure

3. Results and Discussion

The description of development interactive e-module that has been made as given as follow.

3.1. Analysis

The analysis of the characteristics of students, based on the results of interviews with physics teachers at SMAN 5 Purworejo, the characteristics of class X students in learning mostly tend to be individual and lack collaboration skills. This can be seen when the teacher gives group assignment material, only a small number of students work in groups while other students do not contribute to the task. In addition, learning activities using e-modules are still rarely used. In other studies also revealed that there are still many teaching materials that have not been integrated with impactful technology learning outcomes [14]. So that this is the basis for the preparation and development of the Collaborative Teamwork Learning e-module. This is in line with the results of Raharjo's research [15] which states that the learning process using modules can increase student motivation and students' understanding of physics concepts. From analysis of media needs we found that the things needed in developing collaborative teamwork learning e-modules are preparing global warming learning materials, designing appropriate e-modules Collaborative Teamwork Learning learning model and according to teaching modules.

3.2. Design

The results of this stage include the material to be loaded in the e-module, the arrangement of the map of needs, and the initial design. In making this interactive e-module, the material used is global warming. The sub material is about facts of environmental change, increase in atmospheric CO_2 levels behind the increase in earth's temperature, human activities causing environmental changes, and solutions to overcome global warming . The map of research need as seen at Figure 2.
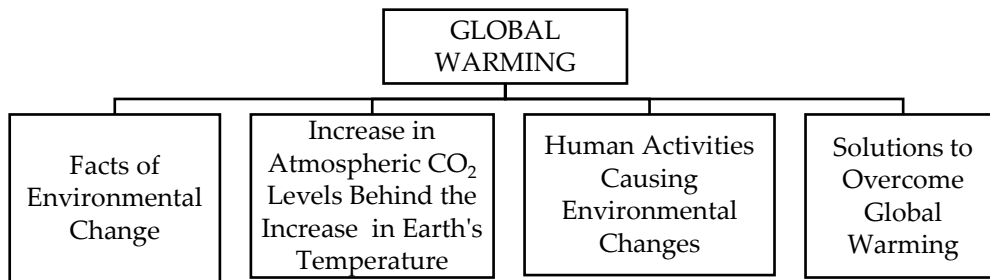
Figure 2. Map of Research Needs

At this stage, the initial design of the e-module is carried out. The initial design of the Collaborative Teamwork Learning e-module assisted by Flip PDF Professional is presented in Figure 3.

| (a) | (b) | (c) |

Figure 3. (a) Display of the e-Module Cover (b) Display of Introduction in Forming Stage, Display of Group Work

This e-module uses the collaborative teamwork learning model, each sub-material begins with an introduction related to the material followed by hypothetical questions, discussion of the material and ends with a conclusion sheet. As in the forming stage, namely instructions for forming groups of 4 students and given initial assignments containing questions about the material to be studied as seen in Figure 3(b).

3.3. Development

The development stage consists of evaluating the material expert validator and media expert. The draft that has been validated and has gone through the revision stage is tried out in schools. Limited trials were carried out involving class X students of SMAN 5 Purworejo. The trial results will be consideireid in the final product. At this stage media validation and trials were carried out. Table 5 shows the results of the validation of the collaborative teamwork learning e-module assisted by Flip PDF Professional which has been validated by 2 material expert validators, the score is then converted to a scale of four. The results of media validation on the content feasibility aspect obtained a value of 3.75 with a percentage of 93.75%.

Table 5. Results of Validation by Material Experts

No	Aspect	Score		Average	Percentage
		Expert I	Expert II		
1.	Content Eligibility	8	7	3.75	93.75%
2.	Collaborative Teamwork Learning	28	22	3.57	89.25%
3.	Language	12	11	3.83	95.75%
	Score Average			3.72	92.92%
	Category				Very Good

Aspects of collaborative teamwork learning obtained a value of 3.57 with a percentage of 89.25%. The linguistic aspect obtained a value of 3.83 with a percentage of 95.75%. All aspects scored 3.72 with a percentage of 92.92%, included in the very good category. Based on these data, the material expert validation classification listed in Table 5 can be concluded that the Collaborative Teamwork Learning e-module assisted by Flip PDF Professional which was developed based on an assessment of the feasibility aspects of content, Collaborative Teamwork learning and language, is appropriate for use in learning.

Table 6 shows the results of media validation on the aspect of ease of use obtained a value of 3.75 with a percentage of 93.75%. The design aspect obtained a value of 3.63 with a percentage of 90.75%. The media interaction aspect obtained a value of 3.50 with a percentage of 87.50%. All aspects got a score of 3.63 with a percentage of 90.67%, included in the very good category.

Table 7 shows the results of the collaboration skills questionnaire validation on the linguistic aspect obtained a value of 4.00 with a percentage of 100%. The content aspect obtained a value of 3.83 with a percentage of 95.75%. All aspects scored 3.92 with a percentage of 97.88%, included in the very good category. Based on these data, the classification of collaboration skills questionnaire validation is included in the very good category and is suitable for use in learning.

Table 6. Results of Validation by Media Experts

No	Aspect	Score		Score Average	Percentage
		Expert I	Expert II		
1.	Ease of Use	8	7	3.75	93.75%
2.	Design	16	13	3.63	90.75%
3.	Media Interaction	4	3	3.50	87.50%
	Score Average			3.63	90.67%
	Category				Very Good

Table 7. Collaboration Skills Questionaire Validation Results

No	Aspect	Score		Score Average	Percentage
		Expert I	Expert II		
1.	Language	8	8	4.00	100%
2.	Content	12	11	3.83	95.75%
	Score Average			3.92	97.88%
	Category				Very Good

The limited trial of the collaborative teamwork learning e-module assisted by Flip PDF was carried out in class X2 of SMA Negeri 5 Purworejo with a total of 5 students. Limited test data were obtained using a student response questionnaire. Researchers used the Collaborative Teamwork Learning e-module assisted by Flip PDF Professional to limited trial subjects. After students use the Collaborative Teamwork Learning e-module, students are asked to evaluate the learning media. Data on the results of student responses in the limited trials that have been implemented can be seen in Table 8.

Table 8. Limited Response Analysis Results

No	Student	Aspect			
		Convenience	Content	Language	Design
1	A	8	10	8	11
2	B	7	9	8	11
3	C	8	11	7	11
4	D	8	11	8	12
5	E	7	12	8	11
	Total score	38	53	39	56
	Max Score	40	60	40	60
	Percentage	95%	88.3%	97.5%	93.3%

Data from the results of the student response questionnaire showed that in the limited test on the of convenience, the percentage was 95%. The content aspect obtained a percentage of 88.3%. The language aspect obtained a percentage of 97.5%. The design aspect obtained a percentage of 93.8%. The overall percentage aspect is 93.7%, included in the very practical category. This shows that the student's assessment of the collaborative teamwork learning e-module assisted by Flip PDF Professional that was developed is feasible to use.

3.4. Implementation

The implementation stage aims to find out the responses of students as a whole, and to find out the improvement of students' collaboration skills using interactive e-module with Collaborative Teamwork Learning. The class used is X1 with 36 students and X2 with 35 students. The data in the extensive trial phase included data on the results of the pre and post questionnaires on students' collaboration skills. The pre-collaboration skills questionnaire was carried out by students before learning, while the post-questionnaire was carried out at the end of the lesson. The results of the students' collaboration skills obtained from the pre and post questionnaires are presented in Table 9.

Table 9. Pre-Post Questionnaire Data for Class X1 and X2 Collaboration Skills

Indicator	Score Average		gain	Category
	Pre	Post		
Contribution	47.3	79.1	0.60	Currently
Time management	52.5	88.7	0.76	Tall
Solution to problem	45.4	84.3	0.71	Tall
Work with other people	48.9	87.5	0.76	Tall
Investigation technique	43.3	81.7	0.68	Currently
Score Average	47	83.3	0.68	Currently

Based on Table 9 shows that the lowest changes occur in the contribution indicators and investigation techniques, increase. Collaboration skills on indicators contributing to making decisions for common goals are demonstrated improvement in score and N-gain value. This is because in the experimental class the material is given through Group work and discussion activities are more complex and thorough. Through providing the right content, teachers can improve student contribution and performance in discussion activities as well as can integrating contributions to members another [15], [16]. Meanwhile, the indicators of time management, problem solving, and working with others experienced high changes. Therefore, it can be said in general that the class average score before being given learning with interactive e-module with collaborative teamwork learning is 47. Meanwhile, the class average score after being given of 83.3. The N-gain value obtained is 0.68. This shows that there is an increase in students' collaboration skills, which are included in the medium category, because the N-gain value is < 0.7.

These results indicate that in class X1 and X2 the average post score is always higher. So that it can be interpreted that every learning in class X1 and X2 always occurs, but these changes in improvement are still in the moderate category, it does not rule out the possibility that there can still be an increase in collaboration skills. To find out whether there are differences in improving collaboration skills in each class, N-gain data analysis was carried out.

3.5. Evaluation

The stage is carried out to find out feedback on the interactive e-module with collaborative teamwork learning. Based on the data obtained from the development stage to implementation, the results show that this interactive e-module is feasible to use. In addition, product can improve students' collaboration skills. According to other research findings, with the help of e-modules, learning updates develop and current information is available, especially for mobile devices, which are thought to be effective in improving students' skills and cognitive characteristics as a new generation [17]. Collaborative activities can create conditions for students to discuss and exchange their opinions and provide an appropriate learning environment in exploring and encouraging investigative attitudes aimed at supporting knowledge development through collaborative activities.

4. Conclusion

The conclusions of the results of the development of interactive e-module with collaborative teiamwork for physics learning e-module to improve students' collaboration skills meets the validity criteria based on the validation results obtained from two expert validators obtaining scores with category "very good" so it is feasible to use in learning. This product fulfills the practicality criteria with teaching module implementation sheets, collaboration skills observation sheets and student response with the category "very practical." This interactive E-Module also fulfills the effective criteria based on the acquisition of pre and post collaboration skills questionnaire scores with a normalized gain of 0.68 which is included in the "medium" category, so that it meets the effective criteria.

References

[1] S. Hafizah, "Penggunaan dan pengembangan video dalam pembelajaran fisika," *Jurnal Pendidikan Fisika*, vol. 8, no. 2, pp. 225–240, 2020.

[2] A. D. Puspitasari, "Penerapan media pembelajaran fisika menggunakan modul cetak dan modul elektronik pada siswa SMA," *JPF (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar*, vol. 7, no. 1, pp. 17–25, 2019.

[3] C. E. Erlinawati, S. Bektiarso, and M. Maryani, "Model pembelajaran project based learning berbasis STEM pada pembelajaran fisika," *Fkip E-Proceeding*, vol. 4, no. 1, pp. 1–4, 2019.

[4] F. E. Priandono, S. Astutik, and S. Wahyuni, "Pengembangan media audio-visual berbasis kontekstual dalam pembelajaran fisika di SMA," *Jurnal Pembelajaran Fisika*, vol. 1, no. 3, pp. 247–253, 2021.

[5] H. F. Sunbanu, M. Mawardi, and K. W. Wardani, "Peningkatan Keterampilan Kolaborasi Siswa Menggunakan Model Pembelajaran Kooperatif Two Stay Two Stray Di Sekolah Dasar," *Jurnal Basicedu*, vol. 3, no. 4, pp. 2037–2041, 2019.

[6] Q. A'yun, "Analisis tingkat literasi digital dan keterampilan kolaborasi siswa dalam pembelajaran IPA Kelas VII Secara Daring," *Jurnal Didaktika Pendidikan Dasar*, vol. 5, no. 1, pp. 271–290, 2021.

[7] A. Safitri, E. Suyanto, and I. Wahyudi, "Pengembangan Lembar Kerja Peserta Didik Berbasis Collaborative Teamwork Learning Pada Materi Fluida Dinamis Sma Kelas Xi," *Jurnal Pendidikan Fisika*, vol. 7, no. 1, pp. 81–92, 2019.

[8] A. Tazkiyah, S. Sulur, and S. Fawaiz, "Pengembangan modul elektronik dengan feedback berbasis android materi suhu dan kalor untuk siswa SMA/MA," *Jurnal Pendidikan Fisika Dan Teknologi*, vol. 6, no. 1, pp. 31–38, 2020.

[9] J. P. Tegeh, *Model Penelitian Pengembangan*. Jakarta: 2014, 2014.

[10] Purwanto, *Prinsip-Prinsip dan Teknik Evaluasi Pengajaran*. Bandung: 2012, 2012.

[11] D. E. Rahmawati and G. Trimulyono, "Validitas instrumen penilaian Higher Order Thinking Skills (HOTS) pada materi keanekaragaman hayati," *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, vol. 11, no. 1, pp. 138–147, 2022.

[12] Trianto, *Mendesain Model Pembelajaran Inovatif-progresif*. Jakarta: 2009, 2009.

[13] Y. Rizqiyani, N. Anriani, and A. S. Pamungkas, "Pengembangan e-modul berbantu kodular pada smarthphone untuk meningkatkan kemampuan literasi matematis siswa SMP," *Jurnal Cendekia: Jurnal Pendidikan Matematika*, vol. 6, no. 1, pp. 954–969, 2022.

[14] A. H. Ngurahrai, S. D. Fatmaryanti, and N. Nurhidayati, "Pengembangan Media Pembelajaran Fisika Berbasis Mobile Learning Untuk Meningkatkan Kemampuan Berpikir Kritis Peserta Didik," *Radiasi: Jurnal Berkala Pendidikan Fisika*, vol. 12, no. 2, pp. 76–83, 2019.

[15] R. Fahmi, H. Tusa'diah, P. Aswirna, and A. Sabri, "Pengembangan Keterampilan Kolaborasi Melalui Penerapan Modul Interaktif Berbasis TTI," *Natural Science: Jurnal Penelitian Bidang IPA dan Pendidikan IPA*, vol. 6, no. 2, pp. 2477–6181, 2020.

[16] M. R. N. Cholis and D. Yulianti, "Pembelajaran Fisika Berbasis Science Technology Engineering And Mathematics (STEM) Untuk Mengembangkan Keterampilan Kolaborasi," *Unnes Physics Education Journal*, vol. 9, no. 3, pp. 249–255, 2020.

[17] D. Darmaji, D. A. Kurniawan, A. Astalini, W. Kurniawan, K. Anwar, and A. Lumbantoruan, "Students' perceptions of electronic's module in physics practicum," *Journal of Education and Learning (EduLearn)*, vol. 13, no. 2, pp. 288–294, 2019, doi: 10.11591/edulearn.v13i2.13005.