

Development of a Web-Based Interactive E-Module Application as an Innovative Biology Learning Media

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ABSTRACT

KEYWORDS:

*4D,
Interactive Science E-
Module,
Human excretory system,
Usability test.*

Today's rapid technological advances require teachers and students to be active and skilled in using technology. Teachers need more skills in creating educational materials, especially on the human excretory system, which needs visual aids for easier student comprehension. This research aims to determine the feasibility of interactive e-module learning media on human excretory system material and analyze student responses to the media developed. This research uses the Research & Development method by utilizing the 4D development design introduced by Thiagarajan, which consists of four stages: define, design, develop, and disseminate. The research subjects consisted of 25 class VIII students of SMP Muhammadiyah PK Kottabarat Surakarta. The research instrument used a questionnaire to assess the suitability of the E-module according to media experts and material experts, as well as a student response questionnaire to the E-modul, which was tested using a usability test. The research results show that. 1). According to media experts, the feasibility of the e-module is in the feasible category, with a score of 83.125%. 2). According to material experts, is in the very feasible category with a score of 81.9% and 3). The student's response received a score of 80.3 in the very good category. So the Interactive Science E-Module learning media is suitable for use as material for human excretory systems in class VIII of junior high school.

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1. INTRODUCTION

Today's rapid technological advances require teachers and students to be active and skilled in using technology. Technology has been widely used in education, including in creating learning media. The learning process requires a main element, namely learning resources in the form of teaching materials, such as books, modules, or student worksheets (Silalahi et al. 2022). However, students' interest in learning still needs to be improved because the learning resources used are dominated by text and images that are less attractive and do not provide students with a clear understanding (Saprudin et al. 2022). Conventional methods are still common in the learning process, and technology-based learning media have yet to be widely used (Dermawan and Fahmi 2020).

E-learning or electronic learning is an application of technology that utilizes existing electronic facilities to facilitate learning activities (Mahrawi et al. 2021). Learning media is a learning tool that can facilitate the learning process to achieve learning goals (Surata et al. 2020). Students' interest in learning can increase if learning media is good and appropriate (Hamid and Alberida 2021). Students need interactive media that is easy to use and can be accessed anywhere using a smartphone (Angraena and Arini 2021; Nurcahyanto et al. 2024).

One of the learning media that can be accessed using a smartphone is an electronic module or e-module. E-modules are digital teaching materials arranged systematically to help students

learn independently and increase learning motivation so that student learning outcomes also increase (Pramana et al. 2020). Interactive e-modules are modules that integrate text, graphics, audio, images, and video interactively, allowing users to interact with the content. This interaction triggers a response from the module, forming a dynamic relationship between the module and the user (Dewi and Lestari 2020). The use of interactive e-modules is one effort so that the learning process can run effectively and efficiently (Haka et al. 2021).

Some of the advantages of using interactive e-modules, according to Silalahi et al. (2022), are that they are equipped with various interactive features such as video, audio, and animation, have independent instructional properties, are adaptive, are flexible, and are designed with an interface that is easy to use and user friendly. Meanwhile, the disadvantage of interactive e-modules is that it takes quite a long time to prepare the material framework, design content, collect appropriate learning images and videos, and create layouts for e-modules (Bahri et al. 2021).

According to the observations made at SMP Muhammadiyah PK Kottabarat Surakarta, teachers found it difficult to teach excretory system material to class VIII students. This is because students need help understanding the processes of the excretory system just by reading material in books. Students are more interested in images and audio to understand the material better. Illustrations or images are needed that can be understood easily by students. Apart from that, learning media is also needed, and it can be accessed anytime and anywhere to make it easier for students to learn and repeat the material presented by the teacher. So, there is a need for interactive e-modules that are easy and flexible to use.

As in research, many e-modules have been developed Febrina et al. (2020) the web-based modules developed have received assessments from experts and have reached the very feasible category with several improvements based on suggestions from experts. However, this module could be more interactive because students can only see text and images, and audio and video are not used to help students understand the material. Based on this background, this research needs to be carried out to develop a website-based interactive e-module that can help students understand the excretory system material more easily. The objectives of this research are 1. To determine the feasibility and validity of a website-based interactive e-module on excretory material for class VIII SMP as a learning medium; 2. To determine students' responses to developing a website-based interactive e-module on excretory system material. With this website-based interactive e-module, learning objectives can be achieved, and student learning outcomes will increase.

2. MATERIALS AND METHODS

2.1. Design and procedures

This research was conducted at SMP Muhammadiyah PK Kottabarat Surakarta from December 2023 to February 2024. This research used the Research and Development (R&D) method with a 4D model consisting of Define, Design, Development, and Disseminate. According to research (Tanjung and Louise 2024; Ulum and Wiyatmo 2021). The flow of the interactive E-module development stages with the 4D model is presented in Figure 1.

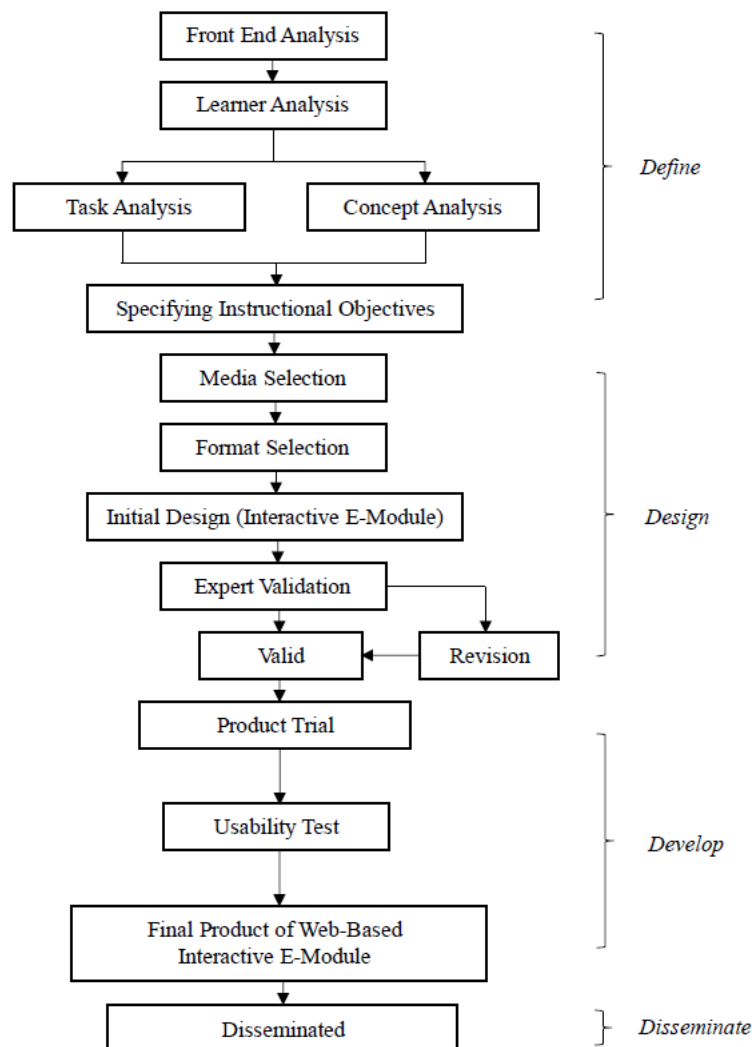


Figure 1. 4D Development Stage Flow

2.1.1. *Define*

The define stage is a pre-survey stage that identifies potential and learning problems and then seeks solutions to solve problems. This stage is carried out to analyze the objectives and limitations of the material to be developed on the device to be made.

2.1.2. *Design*

The design stage is where learning devices or media, such as e-modules and their supporting devices, are designed.

2.1.3. *Development*

The development stage produces a product in the form of an e-module, which is then validated and revised based on the validator's assessment. At this stage, limited trials were also carried out on several respondents, namely students, to determine students' responses to the developed media.

2.1.4. *Disseminate*

The dissemination stage aims to disseminate developed products to be used in learning.

2.2. Data Analysis

The data analysis technique used is qualitative. Qualitative analysis consists of media feasibility analysis, material feasibility analysis, and analysis of student responses to media use. The following are the data analysis techniques used in the validity test according to (Mahrawi et al. 2021).

2.2.1.1. *Qualitative data in the expert validity test assessment is converted into quantitative data by giving a value to the assessment results.*

Table 1. Eligibility Assessment Score

No	Value	Score
1	Very good (SB)	5
2	Good (B)	4
3	Enough (C)	3
4	Not Good (K)	2
5	Very Bad (SK)	1

2.2.1.2. *The score obtained will be summed up and then converted into a percentage with the following formula:*

$$\text{Result} = \frac{\text{Total score obtained}}{\text{Maximum score}} \times 100\%$$

2.2.1.3. *The determination of eligibility criteria is carried out based on the following Table 2:*

Table 2. Media Eligibility Criteria

No	Value	Interpretation
1	81% - 100%	Very worthy
2	61% - 80%	Proper
3	41% - 60%	Quite decent
4	21% - 40%	Not eligible
5	0% - 20%	Very unworthy

To test the feasibility and response of students to the developed media, a usability test was carried out referring to John Brooke's usability scale system. The assessment scores used are presented in the following Table 3.

Table 3. Usability Test Assessment Score

Answer	Score
Strongly disagree	1
Disagree	2
Undecided	3
Agree	4
Strongly Agree	5

The SUS (System Usability Scale) method has the following score calculation procedure: First, the respondent's score will be reduced by 1 for each odd question. Second, the final score, which was initially 5, will be reduced by the respondent's score for each even question. Then, the total scores from each respondent will be added up, and the results will be multiplied by 2.5 (Aisyah et al. 2021; Astari and Putra 2021). The eligibility criteria used are as follows.

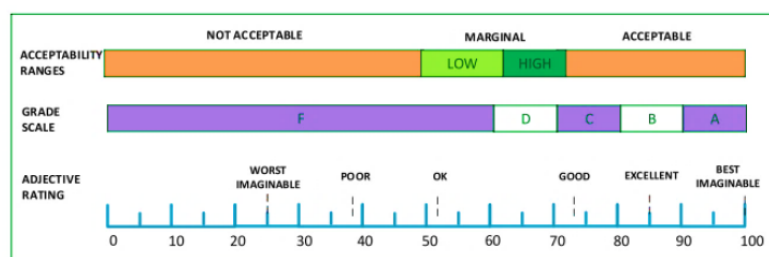


Figure 2. System Usability Scale Score Criteria (Brooke 2020; Sauro 2018).

The score on the System Usability Scale (SUS) can be divided into three criteria: Adjective, Grade, and Acceptable. In the Additive criteria, a score of 0-25 will be considered as Word Imaginable, 26-39 as Poor, 40-52 as OK, 53-73 as Good, 74-85 as Excellent, and 86-100 as Best Imaginable. In the Grade criteria, a score of 0-60 will be graded as F, 61-70 as D, 71-80 as C, 81-90 as B, and 91-100 as A. Meanwhile, in the Acceptable criterion, a score of 0-50 will be graded as Not Acceptable, 51-62 as Margin Low, 63-70 as Margin High, and 71-100 as Acceptable.

3. RESULTS AND DISCUSSION

3.1. Results

The development of website-based e-modules is carried out through four stages. The first stage is define; this stage includes analyzing the problem and finding solutions to the problem. After observation, it was found that the curriculum used in the school was the Independent Curriculum. However, implementing the curriculum needs to be more optimal due to teachers' limited teaching ability. Teachers are still adapting to the new curriculum and need help implementing it. One of the difficulties encountered is that in delivering excretory system material in grade VIII, students must learn independently, while the material studied could be clearer. Therefore, this e-module was developed to make it easier for teachers to deliver material and make it easier for students to understand the material.

The second stage is design; the design of the e-module is carried out, and materials and e-module feasibility assessment instruments are prepared. The third stage is development; at this stage, experts validate the feasibility of media and materials in the developed modules. After validation, expert suggestions and inputs are used as guidelines to revise the developed modules. Then, a limited trial or small-scale trial was carried out on several students. The last stage is dissemination; in this study, the product is distributed to grade VIII students at the school.

Media experts and material experts carried out validity testing. The media components assessed include software engineering, learning design, and content design. The results of the feasibility assessment from media experts are presented in Table 4 below.

Table 4. Media Expert Validation Results

Aspects	Media Expert 1			Media Expert 2		
	1	2	3	1	2	3
Score	24	15	30	22	14	28
Total Score	86,25%			80%		
Average grade	83.125%					

The result of validation from media experts is to get an average score of 83.125% which is included in the very feasible category. The graph of the validation results from media experts is presented in Figure 3 below.

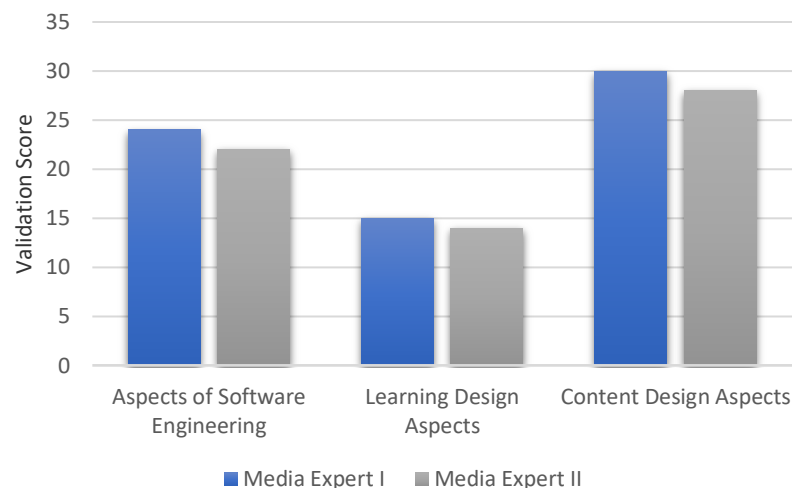


Figure 3. Graph of Media Expert Validation Results

The results of validation from material experts which include aspects of content, presentation, and language feasibility can be seen in Table 5.

Table 5. Material Expert Validation Results

Aspects	Subject matter expert 1			Subject matter expert 2		
	1	2	3	1	2	3
Score	24	17	15	29	17	16
Total Score	77.8%			86.1%		
Average grade	81.9%					

The validation results from the material experts were to get an average score of 81.9% which was included in the very feasible category. The graph of the validation results from the material experts is presented in Figure 4 below.

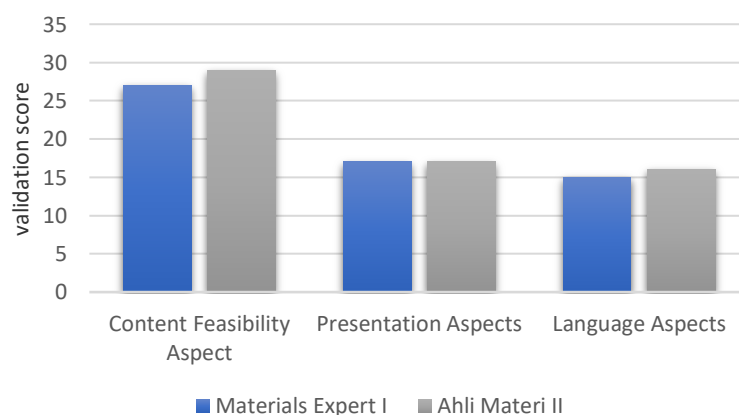


Figure 4. Graph of Material Expert Validation Results

3.1.1. Revised Draft 1

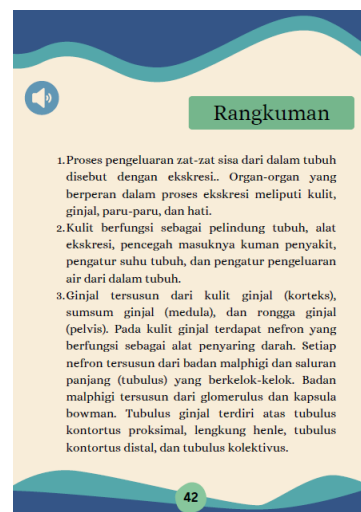
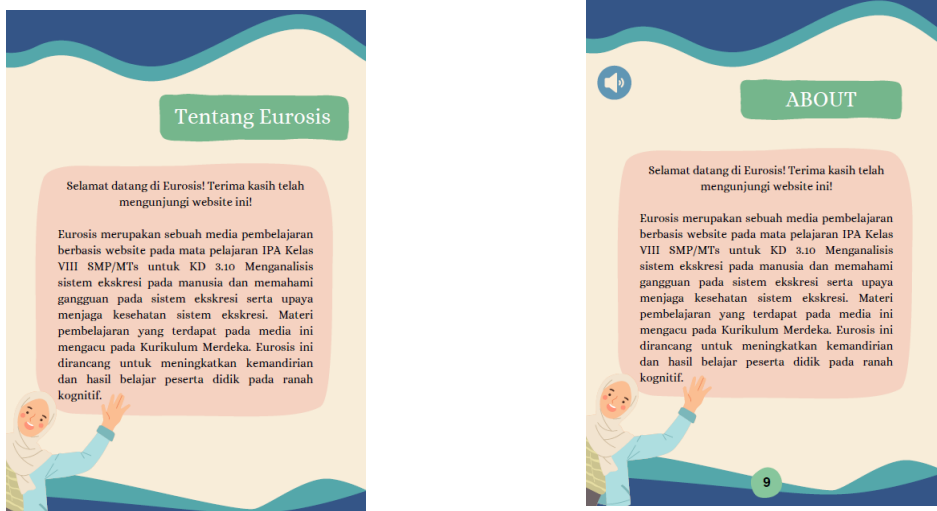
The revision is carried out based on the results of the assessment of experts which includes suggestions and inputs for improvement. The inputs and suggestions provided by the experts are contained in Table 6.

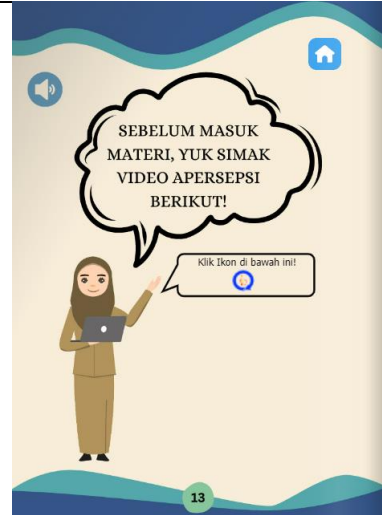
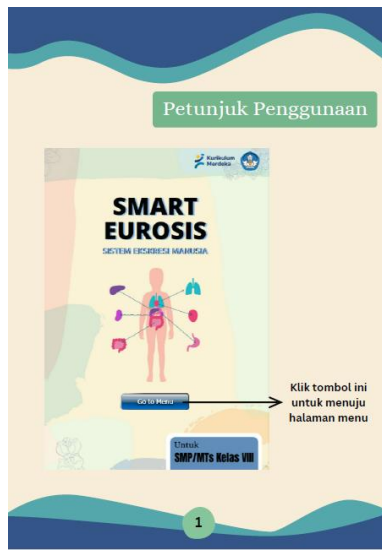
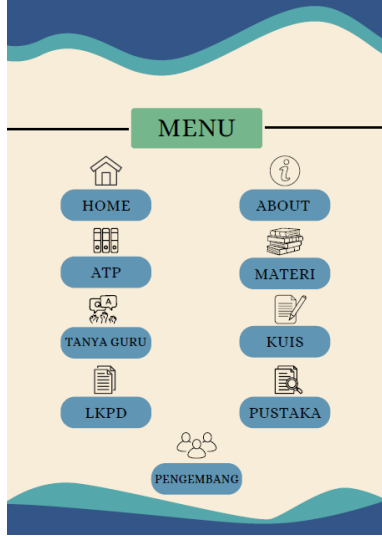
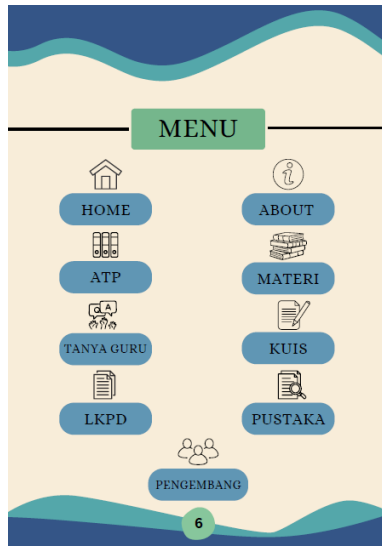
Table 6. Input and Suggestions from Validators



No.	Validator	Input and Suggestions
1.	Media Expert I	Add a summary to each important section. Add audio to important parts. Add a video component for material emphasis.
2.	Media Expert II	Added media usage instructions. Provide page numbers. The button icon is enlarged.
3.	Material Expert I	Learning outcomes are written according to the CP of the Independent Curriculum Phase D. Basic competencies are removed and replaced with learning objectives.

The revision of the e-module according to the suggestions and inputs of experts is presented in Table 7 below.

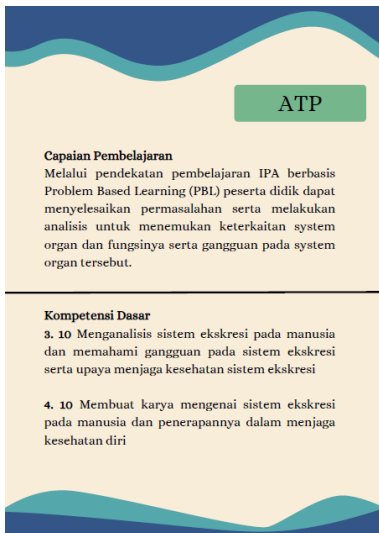
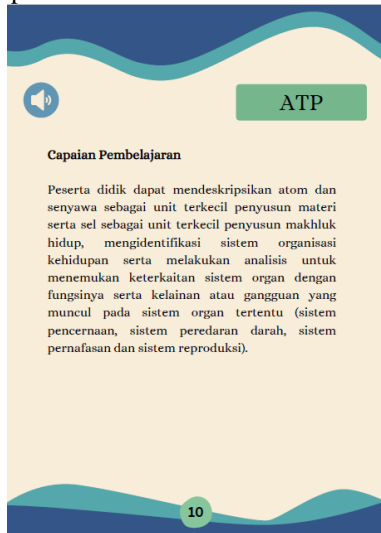
Table 7. Revision of E-module According to Validator Suggestions and Input

No.	Before the Revision	After the Revision
1.	Add a summary to each important section. No material summary	
2.	Add audio to important parts.	
3.	Add a video component for material emphasis.	

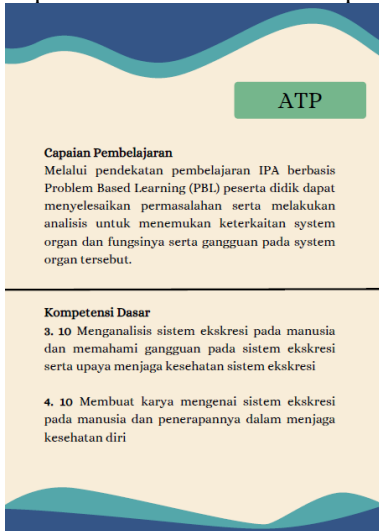
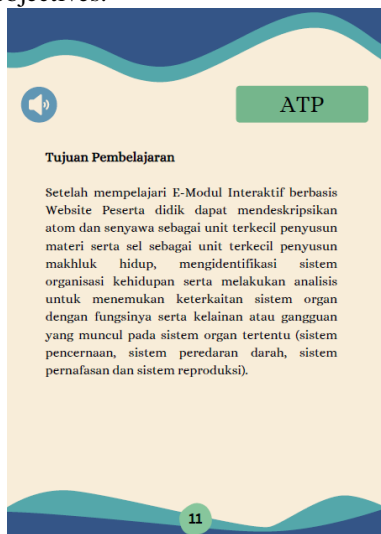
No.	Before the Revision	After the Revision
	No learning videos for material emphasis	
	Added media usage instructions.	
4.	No media usage instructions	
5.		
6.	Enlarge button icon.	

No.	Before the Revision	After the Revision
		

Learning outcomes are written according to the CP of the Independent Curriculum Phase D.

7.		
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Basic competencies are removed and replaced with learning objectives.

8.		
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The first revision was carried out after the media and learning instruments were validated by experts and practitioners before being tested on a limited basis. A limited trial was conducted at

Muhammadiyah Junior High School PK Kottabarat Surakarta for grade VIII students. During the limited trial phase, an analysis of students' responses was carried out to evaluate their responses to the modules that had been developed.

3.1.2. Small Scale Trials

Students' responses to learning media developed based on usability tests can be seen in Table 8.

Table 8. Results of Student Response Usability Test

Total score	Average Score
2007.5	80.3

The results of the usability test conducted on 25 respondents received an average score of 80.3 with the predicate excellent with a grade of B and included in the acceptable category. The graph of the usability test results of 25 respondents is presented in the following Figure 5.

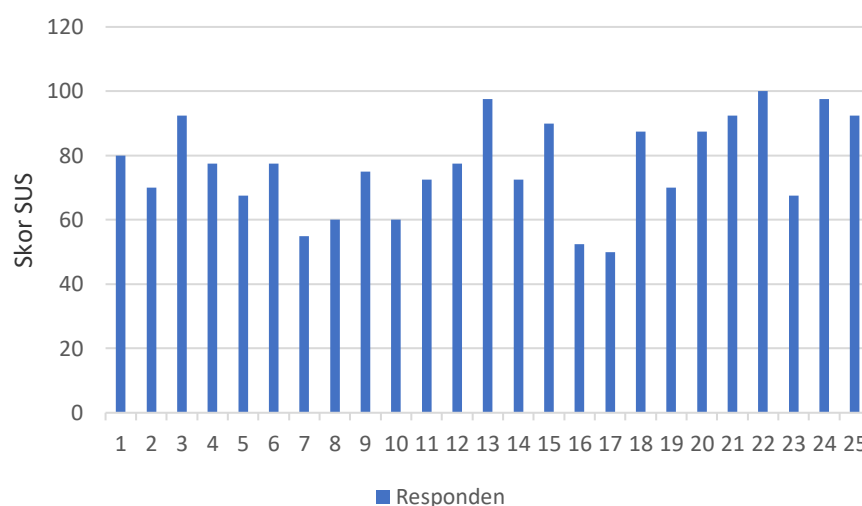


Figure 5. Usability Test Results Graph

The last stage is disseminating, in this study the product is distributed to grade VIII students at the school. The e-modules that have been developed are given to science teachers to be used as a learning medium, especially in the material of the Human Excretory System.

3.2. Discussion

3.2.1. Eligibility of Learning Media

The interactive e-modules that have been developed have been tested for validity by several experts. The feasibility test consists of media feasibility and material feasibility. The media feasibility test was carried out by a validator consisting of two expert lecturers. Meanwhile, the feasibility test of the material was carried out by validators consisting of expert lecturers and junior high school science teachers. The assessment is accompanied by suggestions and input from validators to be used as product revision material.

Based on the assessment of media experts, it was found that the results of the media feasibility test had a score of 86.25% from Media Expert I and a score from Media Expert II which was 80%. So that the average media feasibility score is 83.125% with a category that is very

suitable for use. Meanwhile, the results of the material feasibility test from Material Expert I were 77.8% and from Material Expert II was 86.1%. So the average score is 81.9% with a very decent category.

The indicators used in the assessment of media feasibility include aspects of software engineering, learning design, and content design. Meanwhile, the aspects of assessing the feasibility of the material include the feasibility of content, presentation, and language. The feasibility results of the interactive e-module media obtained are feasible or good. However, there are several suggestions and inputs from experts for the improvement of the media. The suggestions and inputs provided are very necessary so that the e-module products developed are really feasible to use and have a positive impact on students so that their learning outcomes increase. The integration of interactive e-modules in the learning process can stimulate students' active participation, increase their engagement levels, and improve academic achievement. The use of images and animations in interactive modules helps in the visualization of subject matter, facilitating understanding for module readers (Dewi and Lestari 2020).

Based on the results of validation by experts, suggestions and inputs related to the media and materials in the e-module were developed to be improved. The media design and some components in the e-module still need to be revised to make the media look better. The button size is too small so that it is not clearly visible. Instructions for using the e-module also need to be included so that e-module users do not have difficulties in operating the media. In addition, audio is also needed as a complement so that the understanding of the material is better.

In terms of material, there are several suggestions and inputs from experts, namely the need for a summary of the material to make it easier for students to understand. Then in the learning outcomes section, it needs to be adjusted to the curriculum used, namely the Independent Curriculum. Basic competencies also need to be eliminated because they are not in accordance with the curriculum used, replaced with learning objectives.

After validating and revising the media in accordance with the advice and input of experts, a limited trial was carried out to determine the feasibility of the media and the response of students to the media that had been developed. This trial was carried out by involving 25 students in grade VIII of Muhammadiyah Junior High School PK Kottabarat Surakarta as respondents.

3.2.2. *Students' responses to interactive e-modules*

The analysis of student responses to the developed products was carried out based on the System Usability Scale (SUS). The questionnaire given to students contains 10 questions. Based on the usability test conducted on 25 respondents, the SUS score was 80.3. In the adjective rating assessment, it is included in the excellent category because the score obtained is more than 80. The grade scale criteria are included in the B value and the acceptability scale criteria are included in the acceptable category.

The students' response to this interactive e-module is included in the good category. Students become easier to learn anywhere and can understand the material more easily. In a learning, good interaction between teachers and students is needed in order to achieve the expected learning goals. The interaction between teachers and students plays an important role because it helps teachers facilitate the student recall process. Through intertwined interactions, students can have a more immersive learning experience (Setyoningtyas et al. 2022). The newly developed digital module has the ability to display text, images, animations, and videos in electronic formats (Kimianti and Prasetyo 2019).

The main advantage of this e-module is its interactive nature that sets it apart from other media. The module is equipped with a variety of facilities, including image support that enriches the learning process. Its interactive capabilities allow users to easily browse content, display images, and take tests, which automatically provide feedback, thereby increasing students' motivation to learn. Thus, E-modules can be the best choice to improve students' understanding and their learning outcomes (Dermawan and Fahmi 2020).

4. CONCLUSIONS

Based on the results and discussions of the research that has been carried out, the following conclusions can be drawn: The website-based interactive E-module on the Human Excretory System material developed is included in the very feasible category according to media experts with an average score of 83.125%. The feasibility of the material in this module is included in the category of very feasible with an average score of 81.9%. Students' responses to the website-based interactive e-module on the Human Excretory System material were categorized as very good with a score of 80.3 with the predicate of excellent.

5. ACKNOWLEDGMENTS

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6. REFERENCES

- Aisyah, S., Saputra, E., Evrilyan Rozanda, N., and Khairil Ahsyar, T. 2021. Evaluasi Usability Website Dinas Pendidikan Provinsi Riau Menggunakan Metode System Usability Scale. *Jurnal Ilmiah Rekayasa dan Manajemen Sistem Informasi* 7(2): 125–132.
- Angraena, A., and Arini, W. 2021. Kevalidan dan Respon E-Modul Interaktif Berbasis Aplikasi Android pada Siswa Kelas XI SMA Negeri 4 Musi Rawas. *Silampari Jurnal Pendidikan Ilmu Fisika* 3(2): 158–171. DOI: 10.31540/sjipif.v3i2.1426
- Astari, I. A. G. R. W., and Putra, I. N. T. 2021. Analisis Sistem Informasi Kemdikbud pada SD Negeri 2 Dawan Klod Dengan System Usability Scale. *JIKO (Jurnal Informatika dan Komputer)* 4(1): 23–30. DOI: 10.33387/jiko
- Bahri, A., Arifin, A. N., and Abrar, A. 2021. Pengembangan E-Modul Biologi untuk Siswa Sma Kelas XII. *Seminar Nasional Hasil Penelitian “Penguatan Riset, Inovasi, dan Kreativitas Peneliti di Era Pandemi Covid-19”* 1276–1293.
- Brooke, J. 2020. SUS: A “Quick and Dirty” Usability Scale. *Usability Evaluation In Industry* (June): 207–212. DOI: 10.1201/9781498710411-35
- Dermawan, and Fahmi, R. 2020. Pengembangan E-Modul Berbasis Web Pada Mata Pelajaran Pembuatan Busana Industri. *Jurnal Pedagogi dan Pembelajaran* 3(3): 508–515.
- Dewi, M. S. A., and Lestari, N. A. P. 2020. E-Modul Interaktif Berbasis Proyek terhadap Hasil Belajar Siswa. *Jurnal Ilmiah Pendidikan dan Pembelajaran* 4(3): 433–441.
- Febrina, T., Leonard, L., and Astriani, M. M. 2020. Pengembangan Modul Elektronik Matematika Berbasis Web. *JKPM (Jurnal Kajian Pendidikan Matematika)* 6(1): 27. DOI: 10.30998/jkpm.v6i1.8141
- Haka, N. B., Majid, E., and Pahrudin, A. 2021. Pengembangan e-modul android berbasis metakognisi sebagai media pembelajaran biologi kelas XII SMA/MA. *Edu Sains Jurnal Pendidikan Sains & Matematika* 9(1): 71–83. DOI: 10.23971/eds.v9i1.2155
- Hamid, A., and Alberida, H. 2021. Pentingnya Mengembangkan E-Modul Interaktif Berbasis Flipbook di Sekolah Menengah Atas. *Edukatif: Jurnal Ilmu Pendidikan* 3(3): 911–918.
- Kimianti, F., and Prasetyo, Z. K. 2019. Pengembangan E-Modul Strategi Pembelajaran Sejarah dalam Upaya Peningkatan Literasi Digital Mahasiswa. *Criksetra: Jurnal Pendidikan Sejarah* 11(1): 84–96. DOI: 10.36706/jc.v11i1.16047
- Mahrawi, M., Usman, U., and Setiani, A. R. 2021. Pengembangan E-Modul Biologi sebagai Bahan Ajar pada Materi Sel. *Indonesian Journal of Mathematics and Natural Science Education* 2(2): 96–104. DOI: 10.35719/mass.v2i2.69
- Nurcahyanto, G., Yuliana, I., Risalam, N. M., Anggraini, E., and Laela, F. F. 2024. Development of Multimedia Interactive Science Learning Based on Cross Platform on Human Reproductive System Materials in The Ninth Grade of Junior High School. *QUANTUM: Jurnal Inovasi Pendidikan Sains* 15(1): 53–67.
- Pramana, M. W. A., Jampel, I. N., and Pudjawan, K. 2020. Meningkatkan Hasil Belajar Biologi Melalui E-Modul Berbasis Problem Based Learning. *Jurnal Edutech Undiksha* 8(2): 17. DOI: 10.23887/jeu.v8i2.28921
- Saprudin, S., Irfan Ahlak, Astuti Salim, Ade Hi Haerullah, Fatma Hamid, and Nurdin Abdul Rahman. 2022. Pengembangan e-Modul Interaktif Getaran dan Gelombang (eMIGG) untuk Pembelajaran IPA di SMP. *Jurnal Pendidikan Mipa* 12(1): 97–106. DOI: 10.37630/jpm.v12i1.549

- Sauro, J. 2018. 5 Ways to Interpret a SUS Score. *Measuring U* <<https://measuringu.com/interpret-sus-score/>>.
- Setyoningtyas, N. M., Astriani, D., and Qosyim, A. 2022. Efektivitas E-Modul Berbasis Pendekatan Deduktif Pada Materi Sistem Ekskresi Manusia Terhadap Peningkatan Hasil Belajar Siswa. *Pensa E-Jurnal : Pendidikan Sains* 10(1): 135–141.
- Silalahi, G. A., Silalahi, M. V., and Silaen, S. 2022. Pengembangan E-Modul Interaktif Berbasis Discovery Learning Pada Materi Ekosistem Kelas X Di Sma Swasta Kampus Nommensen Pematangsiantar. *Jurnal Ilmiah Multidisiplin* 1(06): 08–14. DOI: 10.56127/jukim.v1i06.309
- Surata, I. K., Sudiana, I. M., and Sudirgayasa, I. G. 2020. Meta-Analisis Media Pembelajaran Pada Pembelajaran Biologi. *Journal of Education Technology* 4(1): 22. DOI: 10.23887/jet.v4i1.24079
- Tanjung, A. K. P., and Louise, I. S. Y. 2024. Development of Student Worksheets with Discovery Learning Models Based on Augmented Reality in Chemical Bonding Materials to Increase Learning Motivation and Learning Outcomes. *Jurnal Penelitian Pendidikan IPA* 10(3): 1063–1074. DOI: 10.29303/jppipa.v10i3.6684
- Ulum, B., and Wiyatmo, Y. 2021. Pengembangan E-Modul Berbasis Web Fliphtml5 Untuk Meningkatkan Hasil Belajar Ranah Kognitif Pada Topik Momentum Dan Impluls Kelas X SMA Ditinjau Dari Minat, Kemampuan Awal, Dan Respon Pembelajaran. *Pendidikan Fisika* 8(2): 1–10.