Web-Based 21st-Century Skills-Oriented E-Module for Chemistry Teacher Candidates

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A R T I C L E   I N F O

A B S T R A K

Perkembangan sains dan teknologi membawa perubahan besar dalam dunia pendidikan. Pada proses pembelajaran di perguruan tinggi, seiring dengan kompleksnya permasalahan dalam kegiatan pembelajaran, kompetensi mahasiswa tidak lagi terbatas hanya pada penguasaan konten materi tetapi juga perlu memiliki kompetensi abad 21. Penelitian ini dilakukan untuk mengembangkan e-modul berorientasi abad 21 berbasis web untuk perkuliahan DDPMIPA yang valid dan mengetahui respon pengguna e-modul. Jenis penelitian ini yaitu pnegembangan dengan menggunakan model ADDIE. Metode pengumpulan data menggunakan kuesioer. Data penelitian diperoleh dengan menggunakan lembar validasi e-modul dan kuesioner respon pengguna. Uji validasi dilakukan oleh validator ahli materi dan validator ahli media. Uji coba dilakukan terhadap 3 orang mahasiswa dan uji coba terbatas dilakukan pada 15 orang mahasiswa. Data dianalisis dengan teknik analisis deskriptif kuantitatif dan deskriptif kualitatif. Berdasarkan hasil analisis data diketahui bahwa e-modul terkategori sangat valid (88,5%) pada aspek kelayakan isi, aspek kelayakan penyajian, aspek kebahasaan, dan aspek kelayakan media. Dari kuesioner respon pengguna juga diketahui bahwa e-modul yang memperoleh respon sangat baik dari pengguna (87,93%). Disimpulkan bahwa e-modul berorientasi keterampilan abad 21 menggunakan google sites yang dihasilkan sangat valid dan sangat baik untuk diterapkan dalam pembelajaran DDPMIPA.

A B S T R A K

The development of science and technology has brought major changes in the world of education. In the learning process in tertiary institutions, along with the complexity of the problems in learning activities, student competencies are no longer limited to mastery of material content but also need 21st-century competencies. This research was conducted to develop web-based 21st-century oriented e-modules for DDPMIPA lectures that validate and know the response of e-module users. This type of research is developed using the ADDIE model. The data collection method uses a questionnaire. Research data were obtained using e-module validation sheets and user response questionnaires. The material and media expert validators carried out the validation test. The trial was conducted on three students, and the limited trial was conducted on 15 students. Data were analyzed using quantitative descriptive and qualitative descriptive analysis techniques. Based on the results of data analysis, it is known that the e-module is categorized as very valid (88.5%) in terms of content feasibility, presentation feasibility aspects, linguistic aspects, and media eligibility aspects. The user response questionnaire also shows that the e-module gets very good user responses (87.93%). It was concluded that the resulting 21st-century skill-oriented e-modules using Google sites were valid and very good to apply in DDPMIPA learning.

1. INTRODUCTION

Education plays an important role in developing the knowledge, skills, attitudes, and values that enable a person to contribute to an inclusive and sustainable future (Angga et al., 2022; Husin & Yaswinda, 2021). Each individual needs to learn to form clear and directed goals, collaborate with others with different perspectives, find opportunities, and present solutions to big problems that may arise (Rosnaeni,

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2021; Sole & Anggraeni, 2018). Education should prepare young people for the world of work and equip students with the skills they need to become active, responsible, and actively involved citizens in overcoming the challenges of globalization (Pane & Dasopang, 2017; Sujana, 2019). The next generation of the nation will need a variety of skills, including cognitive and meta-cognitive skills (critical thinking, creative thinking, and self-regulation), social and emotional skills (empathy, self-efficacy, and collaboration), as well as practical and physical skills (e.g., using digital devices). Information and communication technology). Some of them are 21st-century skills or 4C skills, which include critical thinking and problem-solving, creativity and innovation, collaboration, and communication (Aldriani et al., 2021; Andrian & Rusman, 2019; Rahayu et al., 2022).

Critical thinking is reflective and logical thinking to decide what to believe or do (Agnafia, 2019; Anisa et al., 2021). Critical thinking skills are fundamental skills in solving a problem. These skills are important for students to have in finding the source of the problem and the right solution for the problem under study (Jamaluddin et al., 2020; Murdianingsih & Sumarno, 2022). Critical thinking skills can be instilled through various disciplines. Furthermore, creative thinking skills are the ability to apply new approaches and solve problems to become innovative (Elizabeth & Maria, 2018; Ferdiani & Pranyata, 2022). Students' creative thinking skills represent their ability to think about problems or challenges, discuss them with others, and receive feedback (Acesta, 2020; Handayani & Koeswanti, 2021). Furthermore, communication skills are skills to express new ideas, thoughts, knowledge, or information in written and oral forms. At the same time, collaboration skills are skills to work together effectively and efficiently that show respect for diverse teams, train fluency and willingness to make the necessary decisions to achieve common goals (Elendiana & Prasetyo, 2021; Medriati & Risdianto, 2020).

Implementing 4C skills in the education curriculum requires teachers to know this matter's provisions. The reality shows that not all students can properly apply the 4C thinking skills. The observations and interviews conducted with students of the chemistry education study program FKIP, University of Riau, show that students need to be more independent in gathering information about the material being discussed. Students tend to refer to invalid references, so lecturers must provide direction regarding material appropriate to the lecture topic. It indicates that students must properly apply 4C skills such as critical thinking, problem-solving, analysis, and decision-making. Students who master 21st-century skills enable them to find, acquire, and create more knowledge faster than others (Turhan & Demirci, 2021). The analysis of teaching materials also found that the teaching materials used were not explicitly oriented toward 4C skills. Other studies also found that student-teacher candidates tend to use cognitive skills at a high level. Other skills, such as independence, collaboration, and flexibility in solving problems, are only at an intermediate level, so teaching materials are needed for learning that integrates 21st-century skills (Ocampo, 2021).

One of the teaching materials that can be used as teaching materials is in the form of e-modules. A module can be defined as a facility for independent learning consisting of a series of learning units for certain competencies, which are arranged in a systematic and structured manner to be utilized by students along with operating guidelines for users to fulfill learning outcomes (Fauziah & Abdullah, 2022; Ferdiani & Pranyata, 2022). Modules can clarify and simplify the presentation of messages conveyed by lecturers (Maharcika et al., 2021; Yayang & Eldarni, 2019). Besides increasing cognitive achievement, using modules was also proven to increase the effectiveness of the learning process (Bhat et al., 2022; Sirisuthi & Chantarasombat, 2021). In the development process, the module can develop into an electronic module, commonly called an e-module. E-module is a digital-based non-printing teaching material that can be accessed anywhere and anytime via a computer, laptop, tablet, or smartphone (Muzijah et al., 2020; Qoridatullah et al., 2021). The use of e-module media allows students to learn independently and does not focus learning on educators so that students can develop their thinking skills independently (Novrianti, 2018; Santosa et al., 2019).

The use of e-modules in the learning process is a form of technological integration in the application of teaching materials. It can help maximize student involvement in the learning process. In addition, the presentation of web-based teaching materials also has advantages in terms of practicality. Google Sites are one of the applications from Google that can be used for website-based e-module development. The Google Sites platform enables teachers to provide teaching materials easily and can be accessed by students anytime and anywhere (Oktalia & Drajati, 2018). Web-based technology is believed to bridge the space between teachers and students (Singh & Thurman, 2019). Several studies have previously revealed that e-modules with a contextual approach to science subjects, especially in single and mixed object material, have met the criteria of being very feasible and interesting to use in the learning process (Widiastuti, 2021). The results of other studies reveal that e-modules based on problem-based learning models in network administration subjects in class twelfth computer and network engineering at SMK TI Bali Global Singaraja are very feasible to develop and use in the learning process (Santosa et al.,

2019). Further research revealed that the Interactive E-module assisted by the anyflip application on circle material was effectively used as a learning medium during online learning (Haeriyah & Pujiastuti, 2022).

Based on some of these research results, the e-module media has very good qualifications, so it is feasible to develop. In previous research, no study specifically discusses the development of web-based 21st-century skill-oriented e-modules for prospective chemistry teacher students. So this research is focused on the study to develop a web-based 21st-century-oriented e-module for valid DDPMIPA lectures and know the response of e-module users.

2. METHOD

This research is research and development (research and development). The development model applied is the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The initial stage was an analysis (analysis), an investigation of the scope of e-module development in the DDPMIPA course. In the activities carried out, identification, determination of focus, and analysis of problems related to learning implemented, student characteristics, learning materials, and learning technology are needed to develop e-modules. Next is the design stage. At this stage, the design of the e-module prototype is carried out by the needs analysis results carried out in the early stages. Activities at the design stage include preparing e-module components, presenting material, types of assignments, providing learning evaluations, and setting up e-module displays. In addition, at this stage, the preparation of validation instruments and e-module user response questionnaires was also carried out.

The third stage, development, was tested on e-modules developed by the validator and revised according to the suggestions from the validator. Limited implementation is carried out after the implementation of the one-to-one test. The results of the limited trial show that the user's response is a form of evaluation (evaluation) of the compiled e-module product. The scheme of the ADDIE development model can be seen in Figure 1.
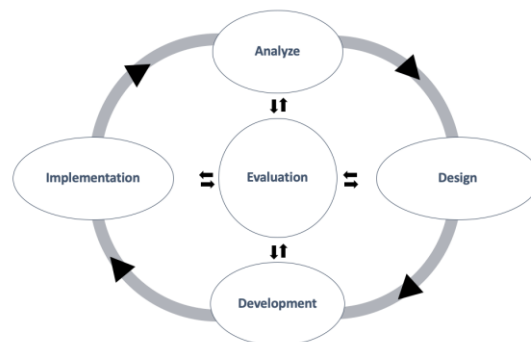

Figure 1. The ADDIE Model

The research was conducted in the chemistry education study program FKIP, University of Riau. The research subjects consisted of 1 material expert validator, one media expert validator, three students for one-on-one trials, and fifteen for limited trials. The students involved came from the chemistry education study program FKIP, University of Riau. Data collection in this development research was carried out using validation sheets and user response questionnaires. The validator uses the validation sheet to assess product feasibility from the described aspects. The description of the feasibility aspects of the e-module and the validation instrument grid can be seen in Table 1, and Table 2.

Table 1. Description of the Eligibility Aspects of the E-Module

	Description
Content Eligibility Aspects	The contained e-module regarding the scope of material is prepared by adjusting the Learning Outcomes of the DDPMIPA Course.
	The material presented uses relevant references and is by the development of science.
	The e-module contains all DDPMIPA lecture material which encourages students to study thoroughly.
Presentation Aspects	The e-module presentation structure includes titles, instructions for use, objectives, material descriptions, exercises, tasks/work steps, summaries, evaluations, glossaries,

	Description
	and references.
	The e-module learning activities are presented by integrating 21st-century skills (4C), which include: (1) critical thinking skills and problem-solving (critical thinking and problem-solving skills), (2) communication skills (communication skills), (3) creativity skills and innovation (creativity and innovation), and (4) collaboration skills (collaboration).
Linguistic Aspect	The language used in the e-module.
	E-modules use language that is adjusted to the level of the student's ability to make it easier to understand.
	The information and instructions contained in the e-module must be clear.
	The language used in the e-module must also be effective and efficient.
Media Feasibility Aspects	This aspect includes the ease of operation, the module's interactiveness of the e-module, the quality of the images and videos used, and the flexibility of using the e-module.
	As electronic-based teaching materials, e-modules should be flexible to use on various hardware devices to make it easier for users.

Table 2. E-Module Validation Instruments

No.	Aspect	Component	Number of Items
1	Content Eligibility	Appropriateness of learning outcomes	1
		Appropriateness of the content of the material	7
2	Eligibility of Presentation	Appropriateness of the e-module presentation structure	1
		Appropriateness of the sequence of learning activities	4
3	Language Eligibility	Conformity with the rules of the Indonesian language	3
		Language suitability with user capabilities	3
4	Media Eligibility	Ease of operation of the e-module	3
		Quality of e-module display	2

The data obtained were then analyzed with quantitative and qualitative descriptive analyses. The data obtained from the validation sheet and the e-module user response questionnaire are then interpreted in the criteria table as in Table 3, and Table 4.

Table 3. E-Module Validity Criteria

Percentage (%)	Interpretation
0 - 20	Invalid
21 – 40	Less valid
41 – 60	Valid Enough
61 – 80	Valid
81 – 100	Very Valid

Table 4. User Response Criteria

Percentage (%)	Interpretation
0 - 25	Not good
26 - 50	Less Good
51 – 75	Good
76 - 100	Very good

3. RESULT AND DISCUSSION

Results

This development research was conducted to produce a product in the form of a 21st-century skill-oriented electronic module using Google Sites that is valid for use in DDPMIPA courses for prospective chemistry teacher students. The series of contents in this e-module supports students in understanding DDPMIPA lecture material fully and encourages students to develop 21st-century skills, which include critical thinking and problem-solving skills, creativity and innovation, communication, and collaboration. Development research was carried out using the ADDIE model. This research and

development model consists of five stages: The first stage. This analysis stage shows problems in the learning process for the material Nature of MIPA and Learning Theory. In the learning process, students need help obtaining sources of information that are easy to understand and credible to support lectures on that material. In addition, the teaching materials used in lectures have yet to explicitly integrate the 4C skills to develop the potential of prospective chemistry teacher students. Therefore, a module is needed that can facilitate students in DDPMIPA lectures. Furthermore, the student needs analysis results also show that students need learning resources that are easy to understand and access. For this reason, the module was developed on a website using Google Sites to increase flexibility in teaching materials.

The second stage is the design stage, which is carried out by the needs analysis results at the initial stage. The format of the designed e-module consists of the front page, the scope of the e-module, instructions for using the e-module, learning achievement indicators, material descriptions, learning activities, exercises/tasks, summaries, feedback, and follow-up, evaluation, bibliography, and glossary. The third stage is the product development stage. The media that has been designed is then developed according to the design that has been made. The results of media development can be seen in Figure 2.
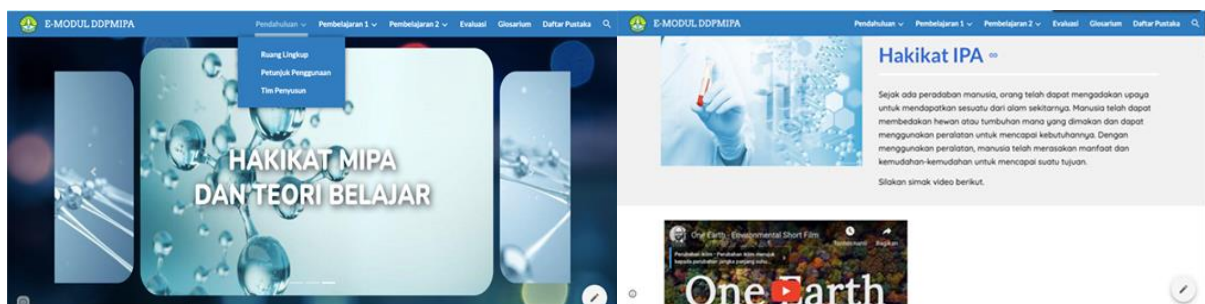

Figure 2. Display of E-Module

The media that has been developed is then tested for validity by the material expert validator and media expert. Validation is carried out to determine the feasibility of the developed e-module. Revisions were made to improve the results of the first stage of validation. Validation is carried out in two stages until the e-module product is deemed fit for DDPMIPA learning. The results of phase I and II validation are presented in Table 5.

Table 5. Validation Test Results

Rated aspect	First Stage Validation		Second Stage Validation	
	Percentage (%)	Category	Percentage (%)	Category
Content Eligibility Aspects	79.69	Valid	84.37	Very Valid
Presentation Aspects	75	Valid	90.00	Very Valid
Linguistic Aspect	85.42	Sangat Valid	89.58	Very Valid
Media Feasibility Aspects	81.2	Sangat Valid	90	Very Valid

After the validation test, the analysis then proceeds to product trials. The trial phase in this development research was carried out only with one-to-one and limited trials (small group trials). This one-on-one trial was conducted to determine the legibility of the product being developed. This one-on-one trial involved three students with different ability levels. From the test results, it is known that several things must be improved. Students are having difficulty filling in the tables available on the website. In the material description section, students also suggest that a shortcut button is provided on the web view to move to the next material page. Then the research continued to the small group trial stage or limited trials to small groups of students. This test obtained responses from 15 students who completed the user response questionnaire. Further, the results of the questionnaire can be seen in Table 6.

Table 6. The Results of the E-Modul User Response Questionnaire

Statement	Percentage (%)	Category
This E-Module makes me more enthusiastic about learning	96.67	Very good
The appearance and presentation of the E-Module as a whole are interesting and can add to my reading interest in DDPMIPA lectures	91.80	Very good

Statement	Percentage (%)	Category
The e-modules used are more interesting than the study materials that are usually used, so I am more enthusiastic when participating in learning	93.54	Very good
This DDPMIPA E-Module demands to dig up information myself so that it builds my knowledge	87.30	Very good
This e-module requires me always to be active so that learning is not only centered on the lecturer	92.19	Very good
Discourses and questions in the E-Module are related to everyday life	81.53	Very good
The directions and guidance given in this E-Module are clear and easy to understand	83.33	Very good
The language used in this E-Module is easy to understand, making it easier for me to understand DDPMIPA material	86.57	Very good
The videos in the E-Module make it easier for me to understand the nature of MIPA and science learning theory	79.411	Very good
Activities in the E-Module encourage practicing 4C skills	86.96	Very good
Average Percentage	**87.93%**	Very good

Discussion

E-Module is a form of presenting independent learning materials that are arranged systematically into certain learning units, which are presented in an electronic format, where each learning activity in it is connected with a link as navigation which makes students more interactive with the program, equipped with the presentation of tutorial videos, animations, and audio to enrich the learning experience (Azizah et al., 2022; Romayanti et al., 2020). E-modules are developed on a website basis to increase flexibility for students. Digital modules accessed via the website are proven to be more practical and flexible for users (Fauziah & Abdullah, 2022; Yayang & Eldarni, 2019). The results of the data analysis that has been carried out indicate that there are major findings in this study, including the first finding shows that in terms of content feasibility, the validation results show that the e-module obtained a score of 84.37% in a very valid category. It shows that the developed e-module is by the learning outcomes that have been determined. The developed e-module includes two learning materials: MIPA Nature and Learning Theory. Subject Learning Sub-Outcomes (Sub-CPMK) for MIPA Essence material is that students can understand the nature, concepts, principles of science education (science), and the objectives of PMIPA. Subject Learning Outcomes for Learning Theory material allow students to explain learning theory and its application in science education with independent, quality, measurable, and responsible performance. The e-module also contains learning materials with references relevant to learning outcomes so that students are encouraged to study thoroughly using the developed e-module (Ferdiani & Pranyata, 2022; Haeriyah & Pujiastuti, 2022).

The second finding shows that the validation results significantly increase after revision from the presentation feasibility aspect. The results of the first validation stage reached 75%, while a percentage of 90% was obtained after the second validation stage. E-module learning activities are presented by integrating 21st-century skills, which include critical thinking and problem-solving, communication, creativity and innovation, and collaboration. Critical thinking skills are integrated with criticizing the presentation of the material and issues given in the e-module. Problem-solving skills, integrated collaboration, creativity, and innovation are integrated into tasks in learning activities in e-modules (Maharcika et al., 2021; Yayang & Eldarni, 2019). In the e-module media developed by students, they are directed to analyze the appropriate learning theory to be applied according to the characteristics of the learning material. These activities will hone students' critical thinking skills (Andriyani & Saputra, 2020; Dharmono et al., 2019).

The third finding shows that in the language feasibility aspect, the final results of the validation show that the percentage achieved is 89.58%. The use of language in a medium must be adjusted to students' ability level so that it is easier to understand. Furthermore, the use of language in a media will determine the success of the media itself. Using appropriate language will help students understand media content well and avoid misconceptions (Fauziah & Abdullah, 2022; Ferdiani & Pranyata, 2022). In addition to using media design language, it is also one of the supporting factors for successful media development. An attractive design can increase student interest in the material presented (Novrianti, 2018; Santosa et al., 2019). In media, the ease of operating and accessing e-modules is an important thing that needs to be considered in developing digital teaching materials (Muzijah et al., 2020). It is intended that the e-module can increase the effectiveness of learning (Sirisuthi & Chantarasombat, 2021).

The fourth finding shows that the response data from users of the 21st Century Skills-oriented Learning E-Module using Google Sites for Basic MIPA Education Courses (DDMIPA) are in a very good category. Good user responses can be caused by Google Sites-based E-modules that can help students fulfill learning outcomes. Users can access Google Sites directly without downloading the application first (Liana et al., 2022; Megawati et al., 2022). Using Google Sites in learning can facilitate collaborative activities that allow students to complete assignments inside and outside the classroom. In addition, e-modules in learning can increase student engagement with material content and further activate student involvement in their learning process (Chauhan et al., 2019; Logan et al., 2021; Saputra & Nofrion, 2022). From these findings, e-modules oriented towards 21st-century skills using Google Sites can be used to facilitate the learning process in DDPMIPA courses.

The results obtained in this study are in line with the results of previous research, which also revealed that e-modules with a contextual approach to science subjects, especially in single and mixed object material, met the criteria of being very feasible and very interesting to use in the learning process (Widiastuti, 2021). The results of other studies reveal that e-modules based on problem-based learning models in network administration subjects in class twelfth computer and network engineering at SMK TI Bali Global Singaraja are very feasible to develop and use in the learning process (Santosa et al., 2019). Further research revealed that the Interactive E-module assisted by the anyflip application on circle material was effectively used as a learning medium during online learning (Haeriyah & Pujiastuti, 2022). Based on some of the results of these studies, the e-module media has very good qualifications, so it is very feasible to develop.

4. CONCLUSION

Based on the results of the research and development, it can be concluded that the ADDIE development model produced e-modules oriented towards 21st-century skills using Google sites for the Basics of MIPA Education (DDMIPA) course, which are very valid and very good to apply in learning.

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