

DEVELOPMENT OF AN E-MODULE BASED ON LOCAL WISDOM ETHNOASTRONOMY IN THE DIGITAL ERA TO STRENGTHEN THE PEDAGOGICAL COMPETENCE OF SOCIAL STUDIES TEACHERS

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Abstract

This research aims purposes to design and develop a digital-based e-module with ethnoastronomy content for junior high school students. We used a Design-Based Research (DBS) approach with four steps: needs analysis, design planning, development, and reflection on results of use. We used questionnaires, field notes, literature studies, and documentation for social studies teachers. The results showed that the preparation of e-modules refers to the applicable curriculum and pays attention to the analysis of learning needs. E-module design is very good as interactive teaching material, concrete, implementable, characteristic practical, and economical, making it easier for students to understand. The enthusiasm of social studies teachers in improving pedagogical technology competence following the demands of independent, adaptive, and contextual professional teacher competence supports the successful use of e-modules. The research implications increase the variety of interactive teaching materials and easy access for students in learning.

Keywords: E-module, Ethnoastronomy, Local wisdom, Pedagogical competence, Social studies teachers.

1. Introduction

Digital technology develops along with the growth of human culture without restrictions on physical activity [1-7]. Digital technology is information technology that predominantly uses computers and internet networks with the principles of automation and sophisticated computerization. Technological developments influence cultural progress which develops linearly in all aspects of human life. One of which is the educational aspect [8]. The development of the digital era has brought about significant changes in the world of education. One of which is how teachers can utilize technology as a learning resource.

In the educational aspect, teacher is one of the key points for the successful teaching and learning process. They must develop creative and innovative learning, taking advantage of increasingly rapid technological developments, especially in developing learning materials that have many concepts, and meanings and are closely related to the social life of society. That is why much research focuses on teachers to improve the teaching and learning process [9] (see Table 1). Several references in Table 1 are from literature [10-26]. In this digital era, teachers must have the motivation to utilize technology, one of which is by using information and communication media in developing teaching materials, namely by switching to e-modules or electronic books.

In this situation, e-modules are very appropriate to use as an electronic-based teaching material development which encourages students to have motivation and interest in learning independently with attractive features. Many reports regarding the use of electronic-based media for supporting the teaching and learning process [27-31]. Unfortunately, there is still not much research regarding e-modules in social studies learning. Therefore, this research aims to be able to present effective, efficient, and interactive teaching material references.

This research aims to design and develop digital-based e-modules in learning. The character of social studies learning includes aspects of knowledge, attitudes, and skills as a whole with the support of the use of a variety of interactive teaching materials. To fulfil these prerequisites, it is essential to design interactive teaching materials that encourage students' motivation to learn actively and creatively. Thus, they have complete competence. E-module teaching materials must meet the criteria of being interesting and practical. The novelty of this research is (i) developing a digital-based e-module containing ethnoastronomical values that have not yet been widely researched. This research will be an innovative development of interesting interactive teaching materials; (ii) offering e-module components that increase student activity in Social Studies learning to improve the quality of learning; and (iii) presenting e-module features that are easy to access both online and offline. Thus, they can be widely useful. Finally, this study adds new information and insight for improving the teaching and learning process, especially in social studies, as reported elsewhere [32].

2. Literature Review

2.1. Digital-based electronic module (E-module)

E-modules are part of electronic-based e-learning, namely learning media that utilize information technology with various electronic devices [33, 34]. E-module designs can be computer-based, gadget devices, or internet-based [35]. The e-module component consists of various interactive images, text, and illustration features that can help students understand the material. These illustrations help

students' imaginative powers come alive compared to reading a collection of texts. The use of E-Modules uses the paperless principle. Thus, it is practical to read [36]. E-modules provide solutions that cover four aspects, namely scientific context, process, content, and attitudes [37]. The E-module design in digital form consists of text, images, or both containing digital electronic material along with simulations that are suitable for use in learning [38].

Table 1. Previous research published in 2024 relating to teachers for improving the teaching and learning process.

No.	Title	Ref
1	Potential biodiversity from ethnozoology of Enggano Island: Utilization, a quantitative analysis, list of animals conserved by local people, and application of research findings empowering species literacy in biology student teachers	[10]
2	An investigation into the conditions of ICT application at the teacher education	[11]
3	Teachers' perspectives on interpreting services	[12]
4	Authentic assessment tools: Implication to enhancement of learning among undergraduate science student-teachers	[13]
5	Teachers' job satisfaction and its perceived influence on secondary school student's academic performance	[14]
6	Analysing the relationship between the sense of efficacy and technological pedagogical content knowledge of teachers	[13]
7	Difficulty of science pre-service teachers in their major courses (physics, biology, chemistry, earth science)	[16]
8	Examining the role of biology teachers' beliefs, motivations, and self-reported practices in constructing curves for biology class	[17]
9	Competency level in information and communications technology (ICT) of teachers: Basis for a technological, pedagogical and content knowledge (TPACK) readiness training program	[18]
10	Primary teachers' mathematics anxiety and mathematics teaching anxiety as predictors of students' performance in mathematics	[19]
11	Primary school teachers' competence level in the early identification of gifted children	[20]
12	Parents' and teachers' perception of indicators for the choice of marriage partner among hearing-impaired adults	[21]
13	Quality of life among secondary school teachers in Kwara State: Implication for counselling	[22]
14	Sustainability of performance of teacher-awardees' instructional competence and teaching effectiveness	[23]
15	Teachers' knowledge and use of multiple disciplinary measures in curbing pupils' antisocial behaviour	[24]
16	Health-related factors and teaching performance of physical education teachers amidst COVID-19 pandemic	[25]
17	Teachers 21 st century skills special program in sports curriculum	[26]

Initially, printed modules were developed as learning media, but often the preparation of printed teaching materials was less interesting and less motivating, and the material was difficult to understand [39]. As technology develops, modules are transformed into electronic form, these electronic modules are then referred to as e-modules. Interactive e-module packaging pays attention to the composition of text, images, graphics, audio, animation, and video which are useful for learning activities. E-modules are a learning resource that utilizes the use of computers or

supporting gadgets. Multimedia features as a complementary component of e-modules can enrich the reading experience for students [40]. With these features, e-modules become independent and flexible learning materials without regard to reading time and place [41]. Interactive e-modules can be the best alternative that contributes to increasing students' interest in reading as well as overall understanding based on direct practice. Thus, they can increase students' learning activities. In this situation, the development of electronic-based teaching materials or e-modules can encourage students to have motivation and interest in learning independently with attractive, effective, efficient, and interactive features.

The preparation of E-Modules is important to anticipate problems in learning [42], namely the limited availability of diverse learning materials, the tendency for teacher-centred learning, limited and less contextual teaching materials, many students become objects of information, learning focuses on memorizing, and students' desire to explore and analyse teaching materials is limited. Therefore, the preparation of E-Modules as learning materials stimulates students to be self-instructed, self-contained, stand-alone, adaptive, and user friendly which describes learning materials along with students' practical activities [43]. This allows the E-Module to become a source of independent learning with complete learning instructions and independent activities [44].

E-modules provide advantages in the learning process. They can increase knowledge of teaching material content, and stimulate students to think, behave, and develop to master complete skills [45]. Another benefit of e-modules is that they are alternative sources and efficient learning media with minimum facilities [46]. As one of the technologies in the field of education, e-modules are an innovation that gives birth to procedures for solving learning problems in the form of good and effective information technology-based learning resource development designs. Just as changes in learning patterns after the pandemic have led to changes in the intensive use of technology, these changes in patterns have caused various problems such as inequality in providing material to students [47-49]. Therefore, the existence of e-modules is the right solution as learning material that complements reading references for students who have difficulty understanding subjects.

The existence of an e-module design in learning must meet ideal criteria, of course by paying attention to the procedures for preparing e-modules according to the rules. The e-module must have a Specification component for the e-module section consisting of a title/cover page, introduction, main content, and conclusion [50]. The introductory component includes a foreword, table of contents, competency achievements, and instructions for use. The main content includes material, independent activities, and quizzes. The closing component contains a reference list, glossary, and author profile. The material design in the e-module must meet the criteria of appropriateness (suitability of the material with the applicable curriculum), accuracy (accuracy of material coverage), currency (correctness and up-to-dateness), and clarity (clear and systematic material) [40]. In terms of appearance, the e-module needs to pay attention to aspects of screen presentation (attractive presentation and layout) and design (attractive display of graphics and images). In more detail, the e-module component structure is in Fig.1.

Figure 1 shows the ideal e-module must contain complete introductory, core, and complementary components. The introductory component contains a cover, e-module profile/identity, instructions for use, and a concept map. The core components contain Learning Outcomes, learning objectives, teaching materials,

independent activities, evaluation sheets, quizzes, and reflections. The complementary components include a bibliography, glossary, and author profile. Teachers can add other components according to their needs and creativity. Writing systematics must meet the readability aspect which affects the quality of the e-module. similar to textbooks in general, but there are different aspects, especially in the aspect of independent activities and achieving goals on each topic through quizzes and student reflections.

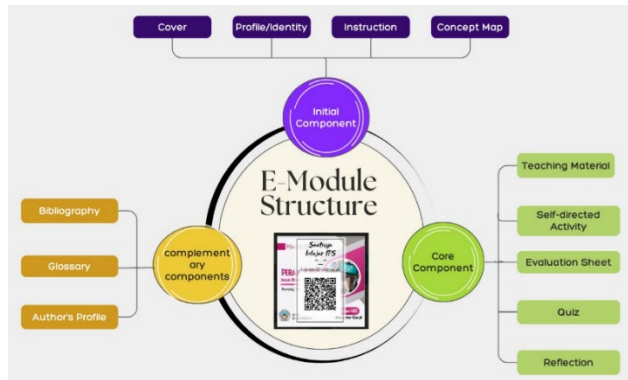


Fig. 1. E-module component structure.

Apart from fulfilling the complete component structure, also pay attention to the interactive e-module design rules on Fig. 2. It presents the criteria for an interactive e-module, including that the material must be contextual by presenting current problems at the beginning of the discussion, the material is then linked to the material content on that topic. Next, in presenting material and independent activities, it is necessary to insert emancipatory questions including 5W 1 H to stimulate students' critical thinking power. Complete the e-module with interactive media in the form of QR codes, YouTube links, word wall, or other digital platforms to provide interactive content. Independent activities are characteristic of e-modules in the form of digital LKPD, quizzes, and collaborative discussions that facilitate students being actively involved in understanding the material practically. Finally, complete the e-module with a reflection that shows whether the student's understanding is in line with the initial learning objectives or still needs improvement.

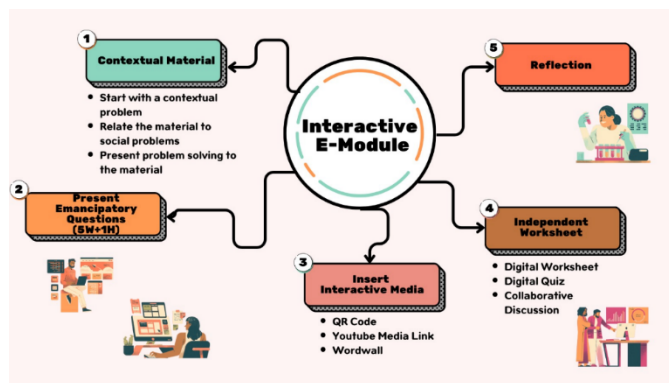


Fig. 2. Interactive e-module design.

2.2. E-modules as interactive teaching materials in social studies learning

Teaching materials are tools that help learning activities as a systematic collection of material both written and unwritten [51]. Teaching materials are available from the government and private publishers in the form of printed and non-printed teaching materials. However, ideally, teachers should be able to compose their teaching materials to suit specific school needs. The implementation of teaching materials needs to have unique characteristics for the audience in a particular learning process. Apart from that, the preparation of the content of teaching materials needs to be specific to achieve certain goals of a certain audience. Systematic delivery must be following the characteristics of students and subjects [52].

Teaching materials are a core component of the curriculum which consists of various forms of messages, concepts, principles/rules, procedures, and problems as content or materials as student learning materials in the learning process [53]. Teaching materials are a set of learning tools that contain learning materials, learning methods, methods, and learning evaluations to achieve learning objectives following the needs and characteristics of teaching materials both written and unwritten [54]. Teaching materials have an important role in learning activities; therefore, their existence can be varied. Types of digital-based teaching materials include audio, video, text, models, PowerPoint slides, and e-modules which have five important components for participants including learning instructions, competency achievement, supporting information, exercises, and evaluation [55].

Teaching materials are important to support learning activities to be carried out well. Teaching materials help teachers and students to present material, information, and studies in detail and demonstrate complete competence. There are two types of teaching materials, namely printed teaching materials which function as print-out learning materials, and non-printed/digital teaching materials in the form of video, audio, and computer-based electronic texts [56]. E-Modules are an example of a form of computer and Android-based digital teaching materials. The steps for preparing digital-based teaching materials include data collection, analysing students' teaching material needs, analysing competencies to achieve learning goals and objectives, preparing teacher guidance for student activities, and finally maintaining the digital-based teaching material platform.

2.3. Ethnoastronomy as E-module content in social studies learning

Ethnoastronomy is the study of the relationship between astronomy and past cultural societies. Etymologically, ethnoastronomy is a combination of two words, namely ethnology, and astronomy, which have the meaning of a science that examines the cultural elements of an ethnic group or community inhabiting an area to obtain the evolutionary process of human cultural history [57]. In cultural studies, Indonesia has used astrology to determine day and night, the mythology of the sky and the ebb and flow of seawater, the flowering and fertilization periods of plants, the migration and breeding of animals, planting times, means of worship, the calendar and navigation. One example of ethnoastronomy in the Bajo Wuring Tribe is that constellations for navigation in sailing have for generations become a culture for the Bajo Tribe as sailors [58].



In social studies subjects it is related to human understanding of cosmology, the concept of time and calendar, the movement of the moon, the direction of the sun, and the motion of stars [59]. The values of ethnoastronomy local wisdom that have been passed down from generation to generation in the community are important study materials in social science learning. The material in the textbook can be further explored by raising the local wisdom of the surrounding area so that learning can be more meaningful. Students not only understand the material on patterns of human adaptation to nature but also find realistic examples in the environment such as the example of the story of *nini anteh* in the Sundanese tribe, Indonesia. In detail, the ethnoastronomy content mapping is listed in Table 2. Some images of the table are available at the link <https://x.com/infoAstronomy/status/682535429552275457> which was retrieved on July 2024.

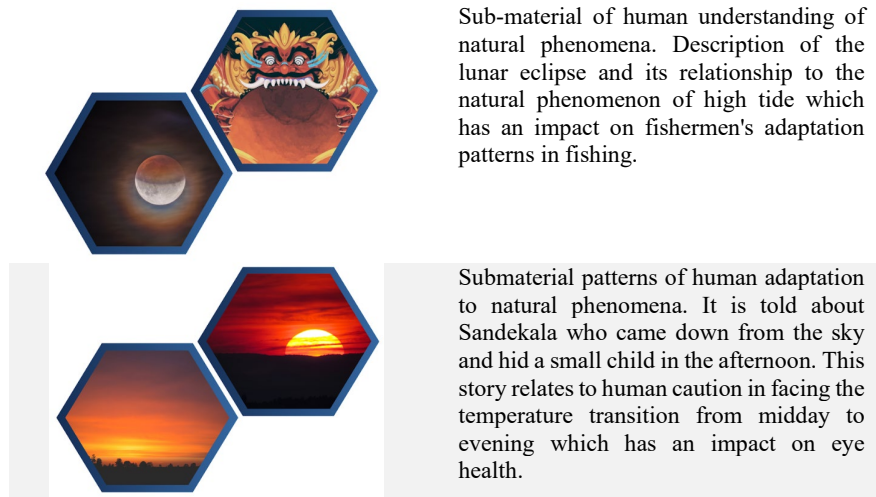
2.4. Competency of social studies teachers in developing E-modules

Teacher competency has the meaning of a mandate in the Teacher and Lecturer Law which relates to a set of authority, knowledge, and abilities in carrying out professional duties [60]. Teachers are professional educators with the main task of educating, teaching, guiding, directing, training, assessing, and evaluating participants. Thus, they have four competencies, namely pedagogical, professional, personal, and social competencies [61].

Teacher competencies related to e-module development are pedagogical competencies as listed in Fig. 3, which is the ability of an educator to manage student learning which includes the ability to understand students, the ability to make learning plans, the ability to carry out learning, the ability to evaluate learning outcomes [62]. Teachers with their professional abilities as educators play an important role in organizing the learning process [63].

Table 2. Example of ethnoastronomy study of Sundanese local wisdom as material content in E-modules.

Ethnoastronomy Content in Digital-Based E-Modules	Explanation
	<p>The sub-material is getting to know nature and the surrounding environment, explaining the folklore of Nini Anteh who lives on the moon with her cat. This story represents the local community's understanding of the natural environment and its surroundings, especially the existence of the earth, moon, and planets in the universe.</p>
	<p>The sub-material on preserving natural resources presents an interpretation of prey regulations based on the phenomenon of the appearance of stars as a reference for dates and accuracy in managing season-based agriculture. Thus, the use of nature is following the sky map (star lore).</p>



Teachers' pedagogic competence can be developed with direct experience in developing e-modules. Teachers must understand the applicable curriculum as a reference in developing e-modules. It is important for teachers to have the ability to map learning objectives elaborated with material descriptions and learner activities. The selection of interactive media is highly dependent on the teacher's skills in operating digital technology. Teachers must also be creative in choosing varied learner activities that foster student learning motivation.

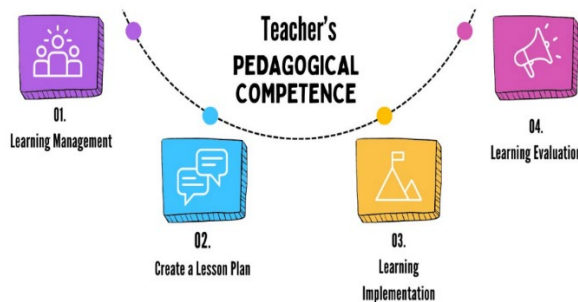


Fig. 3. Teacher pedagogical competence in developing e-modules.

2.5. Previous research on E-module development in learning

The development of digital-based E-Modules appeared in several previous studies, especially those related to learning. In more detail, previous research regarding e-modules is in Table 3.

3. Methodology

This research used the Design-Based Research (DBR) approach to understand goal achievement, research problem solving, nature, and data analysis. In this research, DBR was adapted to produce digital-based e-module products which consist of 4 steps, namely analysis, design planning, development, and reflection on results of

use. This step is shown in Fig. 4. In the analysis step, researchers identified needs of teachers regarding the e-modules needed at school. Based on the needs analysis, the initial design of the e-module was developed at the planning and design development stage. Finally, the successful use of e-modules is collected at the reflection stage.

The subject of this research involved social studies teachers who were gathered in Social Studies teacher deliberations in Kabupaten Bandung and Kabupaten Bandung Barat, Indonesia, including several schools: SMPN 2 Cileunyi, SMPN 1 Cicalengka, SMPN 1 Ibum, and SMP Plus Ar-Rahmat, SMPN 1 Padalarang, SMPN 4 Padalarang, and SMPN 1 Parongpong. Researchers collaborated with social studies teachers at the research location to collect data. The selection of the research site was based on the representativeness of the e-module product model trial sample. The distribution of locations and research subjects is listed in Fig. 5.

The research instruments include a questionnaire to analyse field needs for product trials, field notes (Field Notes) to collect qualitative data during the research process, a literature review of journals related to e-modules and ethnoastronomy and Focus Group Discussions (FGD) to collect direct input from social studies teachers involved in the research.

Table 3. Previous research.

No.	Title	Research result	Ref
1	Development of e-module for introduction to educational technology at Muhammadiyah University of Makassar	E-Modules teaching materials by using the flipbook application are effective and practical in supporting students to understand the content.	[64]
2	The usage effectivity of project-based interactive e-module in improving students' achievement	The use of project-based interactive e-modules in digital simulation learning can improve student achievement.	[65]
3	Usefulness of e-module based on experiential learning in physics learning	The development of e-modules based on direct experience is very useful in learning physics	[66]
4	E-module based project learning for teaching speaking	The e-module project in language learning can improve students' creativity, activity, and ability in speaking	[67]
5	Electronic module development with project based learning in web programming courses	The development of e-modules in web programming courses with project-based learning models can be applied well, students give very good responses.	[68]
6	Electronic module (e-module) as innovative learning media to increase knowledge among nursing students	E-modules have been proven effective in improving knowledge, the content of e-modules should be updated by combining with moral values.	[69]
7	Development of character-based e-module design to improve elementary school students' experiences	Character-based e-modules are suitable for use as a learning tool that helps students develop character.	[70]

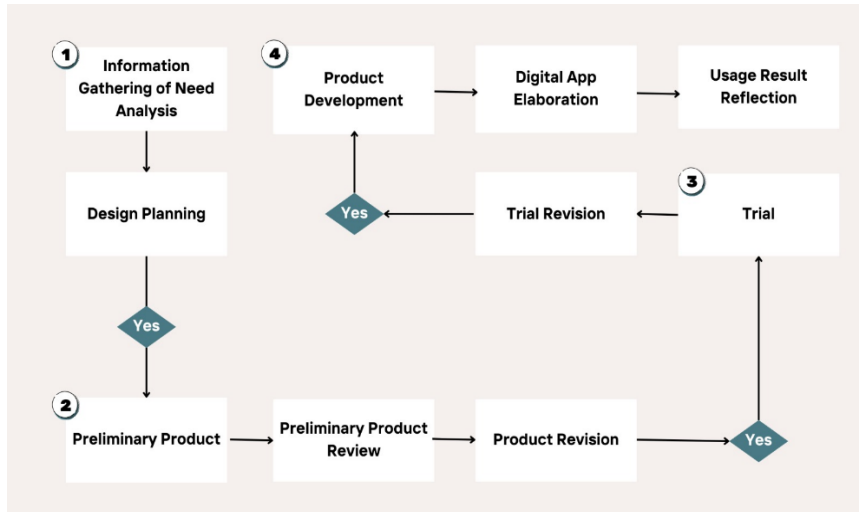


Fig. 4. Design-based research (DBR) steps.

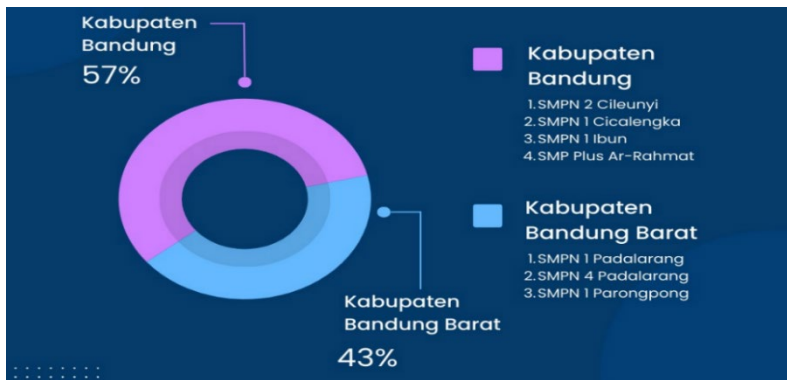


Fig. 5. Location and research subjects.

4. Results and Discussion

4.1. Analysis of digital-based E-module development needs

The results of the needs analysis show that there are two important aspects. Based on Table 4, teachers have strong expectations for the e-module design with certain criteria. The design of e-module material must be deeper, more concrete, and implementable, and make it easier for students to understand the material independently to help teachers in presenting learning activities. Apart from that, the content of student activities must be able to accommodate fun, active, varied, dynamic learning, following student characteristics and making students more enthusiastic about learning. The anticipated obstacles in designing e-modules are related to the availability of infrastructure. Thus, the preparation of e-modules must pay attention to practical aspects and be easily accessible both online and offline. Apart from that, teachers must receive competency training in preparing e-modules on an ongoing basis.

Table 4. Analysis of the need for digital-based E-modules for social studies teachers.

Aspect	Results Description
Benefit analysis	<p>Make it easier for students to understand and absorb material</p> <p>Stimulate learning activities that are fun, varied, and dynamic, and make students more enthusiastic</p> <p>Assist teachers in presenting learning material independently</p> <p>Contains content that stimulates teachers and students to use technology</p> <p>Stimulate students to be able to explore material more deeply, concretely, and applicable in everyday life</p> <p>Providing teaching materials that facilitate active and non-monotonous learning activities</p> <p>Presenting alternative material delivery in a style that suits the diverse characteristics of students</p>
Obstacles and Anticipation	<p>The availability of supporting capacity for school facilities and internet networks means that e-modules must be practically accessible online and offline</p> <p>The process of creating an e-module requires quite lengthy steps and requires preparation of the teacher's time availability</p> <p>Teachers need special training to prepare E-modules</p> <p>It is necessary to select activities that are relevant to the social studies learning material in the E-Module</p>

4.2. Digital-based E-module conceptual model with ethnoastronomy content

The digital-based e-module design model with ethnoastronomy content at the preliminary product stage is the introduction, core and complementary components in digital form. Initial components include a cover, e-module profile/identity, and instructions for use. In detail, the following e-module cover criteria are listed in Fig. 6. The cover should be designed with an attractive design, informative title, author's name, title, year, and e-module publishing agency.

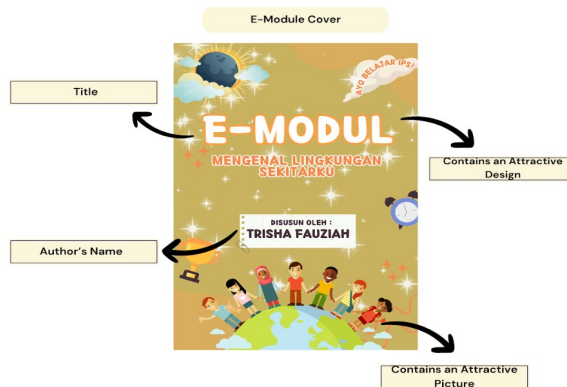


Fig. 6. E-module cover design.

Another initial component contains the e-module profile/identity along with instructions for use, and a concept map is listed in Figs. 7 and 8. The e-module profile/identity contains the e-module title, author, author's agency, year of preparation, editor (if any), and ISBN (if any). The instructions for use contain

descriptions of the e-module components and how to use them. The contents are in the form of descriptions and instructions which serve as a guide for readers. The concept map contains a presentation of important concepts in the e-module sub-chapters based on mapping learning outcomes and learning objectives.



Fig. 7. Profile/identity design and usage instructions.

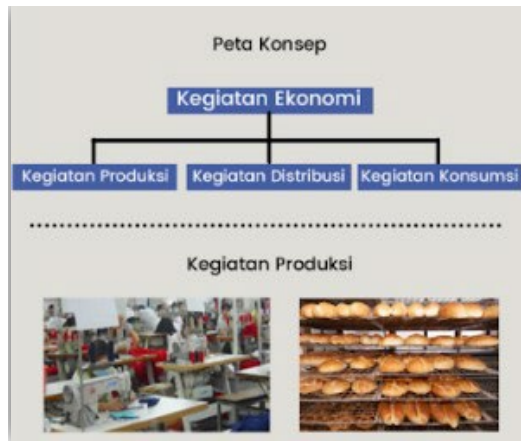


Fig. 8. Mind map design.

The design of the core components of the e-module are teaching material and student activities. Teaching material containing descriptions of social studies material that integrates textbook material with contextual issues, inserting 5W 1H emancipatory questions (see Fig. 9) Thus, the material is interactive with students who read. In presenting the material, students also include independent activities (see Fig. 10). Thus, they not only understand the material but also gain direct experience.

Components that are no less important in the core components are evaluation sheets, quizzes, and reflections, shown in Fig. 11. The form of evaluation can be in the form of tests or non-tests that measure learning achievement, apart from that, insert variations of quizzes as formative test material for students' understanding of sub-chapters. Variations in assessment are an important component as a criterion for achieving learning objectives. Tests measure the knowledge aspect of learners in understanding the material. Meanwhile, non-tests facilitate the assessment of attitudes and skills, which can include performance, projects, and portfolios.

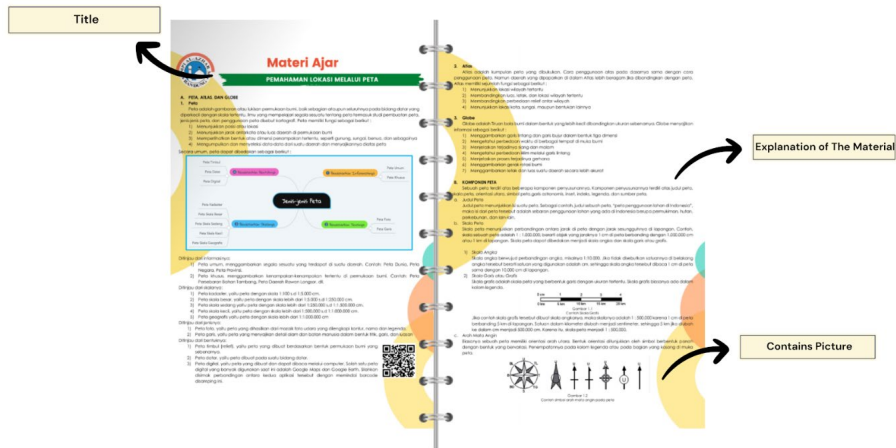


Fig. 9. Teaching material design.



Fig. 10. Design student activity materials.

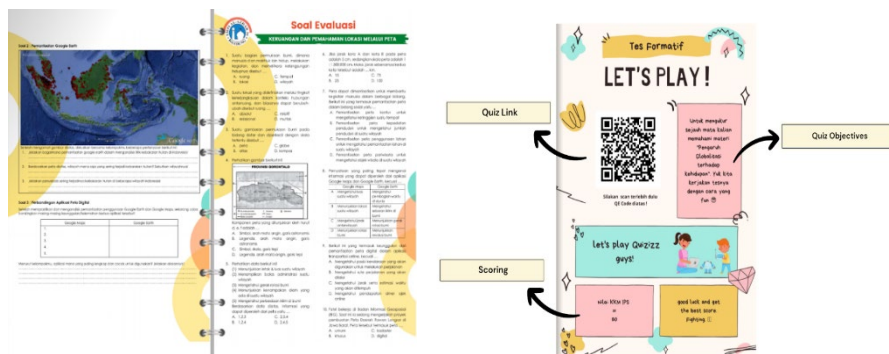


Fig. 11. Design evaluation sheets, quizzes, and reflections.

The last core component in Fig. 12, includes reflection as a differentiator between e-modules and regular textbooks. In reflection, students are stimulated to present their learning experiences after studying the e-module as well as reflect on the student's achievement of learning objectives. Learners reflect on the achievement of learning outcomes after reading e-modules and carrying out independent activities. Reflection is in the form of self-description of material that has been understood and material that is difficult. Through reflection, learning outcomes can be measured.

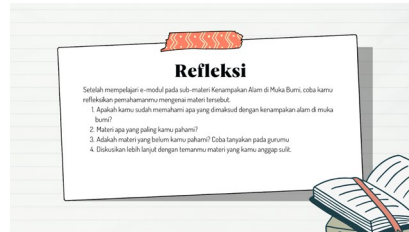


Fig. 12. Learning reflection design.

The supplementary component is shown in Fig. 13, containing a bibliography and glossary. The bibliography is a reference used to compile e-modules in the form of books, journals, research, mass media news, and information from the internet. In addition, the glossary contains difficult terms and their meanings that provide information on understanding the difficult terms.

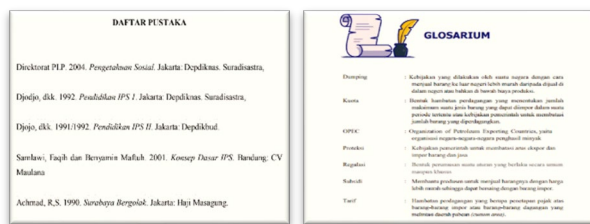


Fig. 13. Design bibliography and glossary.

The final component as a complement is the author's profile as shown in Fig.14. The author's history is required to provide information on the author's credibility. E-modules are prepared by teachers; therefore the author's history can strengthen the profile of the teacher's work in preparing teaching materials. The author's history component consists of presenting a curriculum vitae, work history, work results, and achievements (if any).

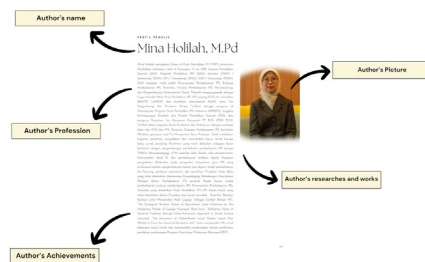


Fig. 14. Curriculum vitae design.

4.3. Validation of development results of E-Modules containing ethnoastronomy in social studies learning

The e-module product design was validated by experts consisting of three social studies education lecturers and three social studies teachers as users (Table 5).

Table 5. Results of digital-based E-module product design validation.

No.	Assessment Aspects	Validation Results (N=6)			
		Strongly agree (%)	Agree (%)	Don't agree (%)	Strongly Disagree (%)
1	E-Module makes it easier for teachers to teach	75	25	0	0
2	E-Modules can stimulate learning for students to think critically	55	40	5	0
3	E-Modules are appropriate for use in learning	60	30	10	0
4	The size and type of E-module letters in learning media are easy to read	50	50	0	0
5	E-Modules present clear and directed learning objectives	50	40	10	0
6	The level of conformity between images and material in the e-module	40	60	0	0
7	The use of e-modules can make students enthusiastic in social studies learning	55	45	0	0
8	The material in the e-module is complete	57	43	0	0
9	The description of the material in the e-module is easy to understand	50	50	0	0
10	Completeness of e-module systematics	55	45	0	0
11	The e-Module meets the creative and dynamic criteria	56	44	0	0
12	The use of e-modules regarding social studies material makes it easy for students to understand the material	68	32	0	0
13	The use of e-modules on social studies material allows students to focus and pay attention when studying	50	50	0	0
14	The existing pictures/charts provide further explanation of the material	50	20	20	0
15	E-Module is equipped with questions	50	40	10	0
Average Score		54.7	40.6	3.9	0

The results of quantitative data validation are listed in Table 5. The validation results show that most of the digital-based e-module components are rated as very good. The useful aspects of e-modules are appropriate for learning, can make it easier for teachers to teach, and stimulate students to think critically. The preparation of the complete e-module has fulfilled all aspects of the introductory, core, and supplementary components. The material design is complete, systematic, and easy to understand, as well as students' independent practical activities which

are also equipped with questions. Graphic presentation and layout are quite related to the presentation of images, charts, and font sizes that are proportional and attractive. Aspects that are considered lacking lie in mapping relevant learning objectives with the material, adding pictures and charts which then become material for improving the final e-module product.

4.4. Reflection on the results of using E-modules containing ethnoastronomy in social studies learning

Implementation of the final e-module product has been carried out in Kabupaten Bandung and Kabupaten Bandung Barat, Indonesia. Based on this implementation, the reflection data are listed in Table 5. The reflection results show that teachers appreciate the e-module model offered. The e-module has met the criteria of ideal components in a full, systematic structure, easy-to-understand material mapping, and contains learner activities, quizzes, and reflections.

Table 5. Reflection on the results of using E-modules.

No.	Aspect	Information
1	Completeness of e-module components	The e-module has fulfilled all components from the introduction, core, and supplementary
2	Systematic design of e-modules	The preparation of e-modules is systematic and easy to understand
3	Formulation of learning objectives	Learning objectives are clear, contained in the material description, and measurable in the evaluation tool
4	Material content mapping	Material content mapping has included essential material from the curriculum with contextual material
5	Retention of material	The material is easy to understand, in-depth, and concrete to everyday life
6	Student Activities	E-modules contain varied activities for students to be independent and active
7	Interactive media presentation	Interactive media has appeared in e-modules in the form of QR codes, YouTube links, and other digital applications
8	Quizzes and Assessments	The e-module contains quizzes and assessments that include tests and non-tests
9	Student reflection	Reflections are at the end of the sub-chapter

4.5. Discussion

E-modules are electronic teaching materials (electronic-based e-learning) [33-35] that have the characteristics of utilizing good electronic devices based on computers, gadgets and the internet with various image, text and interactive illustration features. The benefits of preparing e-modules include helping students understand the material, fostering imagination and experience in real contexts, flexible use online/offline, used independently, and increasing interest in reading with interesting features [41]. in providing material that can be accessed using the paperless principle [36].

E-modules are important to overcome the problem of the lack of variety of learning materials in schools, learning activities tend to be teacher-centred, learning

materials are less contextual and focus on memorization, and the lack of student motivation to explore the material independently [42]. The e-module as an interactive teaching material must contain the core component. The core components of the curriculum consist of various forms of messages, concepts, principles/rules, procedures, and problems in interactive features with students [53].

The ideal teaching module structure must contain the requirements of self-instruction, be self-contained, stand-alone, adaptive, and user-friendly, and have independent learning instructions and activities [43, 44]. The ideal e-module model must be supported by good teacher competence, especially pedagogical competence, namely the ability of an educator to design learning materials [62]. The teacher's competence in preparing e-modules includes designing learning objectives, mapping material, selecting relevant media, mapping variations in students' independent activities, formulating assessment forms, and designing illustrations.

The study of ethnoastronomical values becomes study content related to the main material of the social studies curriculum. The e-module material contains patterns of human interaction with nature including cosmology, the concept of time and calendar, the movement of the moon, the direction of the sun, and the motion of stars [59]. Social studies material that can be related to ethnoastronomy studies includes material about getting to know nature and the surrounding environment, preserving natural resources, human understanding of natural phenomena, and patterns of human adaptation to natural phenomena.

We recommend digital-based e-modules and ethnoastronomy content that strengthen students' character in understanding the local culture of the local community. Through user-friendly features, e-modules become learning materials that are easy to use. The interactive e-module structure stimulates students' independent learning motivation and help teachers develop pedagogical competence in creating teaching materials. Based on the background of this problem, in general, the research problem is how to develop digital-based e-modules as interactive teaching materials in social studies learning. This paper also adds new information in the education, as reported elsewhere [71, 72].

5. Conclusion

The development of digital-based e-modules in Social Studies learning is appropriate based on an analysis of field needs for ideal e-module components and anticipating limited infrastructure in schools.

The pre-production stage shows that the e-module has fulfilled all aspects of the introductory, core, and supplementary components in a concrete, implementable manner and makes it easier for students to understand.

The E-module modelling design is considered very good and has the characteristics of teaching materials that present fun, active, varied, dynamic material, following student characteristics and creating, paying attention to practical aspects.

The final reflection shows that the use of e-modules is appropriate in Social Studies learning as an interesting variation of interactive learning materials. Research arguments show that digital-based e-modules are effective as interactive teaching materials that stimulate students to actively learn independently, think critically, and gain practical experience.

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