



Development of E-Module Based on Contextual Teaching and Learning on Human Mobility Material to Improve Science Literacy Abilities of Class XI Students

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Abstract

The latest PISA score results in 2022 state that the scientific literacy abilities of students in Indonesia are in the low category. Based on the results of a questionnaire analyzing the needs for teaching materials at SMA Teuku Umar Semarang, the teaching materials implemented had not yet trained scientific literacy in the aspects of content, process and context. The aim of this research is to develop an electronic module (E-module) based on Contextual Teaching and Learning (CTL) on human mobility material that is feasible, practical and effective to improve students' scientific literacy skills. The research design used is Research and Development using the 4D (Four-D) model stages, including: Define, Design, Development, and Dissemination. Data collection tools include product feasibility questionnaires, product practicality questionnaires, and multiple choice test instruments. Based on the research results, the e-module was declared very feasible with a percentage score of 96.2% by material experts and 97.9% by media experts. In the practicality test, it was stated that it was very practical with the percentage of scores obtained based on teacher responses, namely 87% and the percentage of scores from students of 89%. In the effectiveness test, it was declared effective in improving scientific literacy skills with a percentage of 94.83% of students who obtained N-Gain scores in the medium and high categories.

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INTRODUCTION

Education is a forum that can provide provisions for students so they can optimize their potential in the future. Mantiri (2019) states that one of the important aspects of a nation's progress is determined by the quality of human resources, therefore the important role of education in realizing the quality of human resources requires professional competence from a teacher in order to form superior students who are able to master the field. which he will pursue. In the current era of globalization, progress in education is characterized by the presence of science and technology as demands in responding to the challenges of 21st century development (Wijaya et al., 2016).

The Merdeka Curriculum at several formal school levels currently in use is a learning rights policy that is flexible and tailored to needs so that it encourages students to develop and master their knowledge in preparation for later entering the world of work (Suryaman, 2020). Basically, the independent curriculum is oriented towards 21st century learning which involves the active role and independence of students in learning (Pertiwi et al., 2022). The implementation of the independent curriculum also leads to the implementation of the learning process to develop students' literacy and realize learning that is able to develop soft skills or character through strengthening the Pancasila student profile.

Quoting from The Organization for Economic Co-operation and Development (OECD), the latest PISA score results which were announced in 2022, Indonesia found that the level of scientific literacy was still in the low category with a score of 383 points. Indonesia is ranked 64th out of 81 countries classified as PISA participants. The PISA ranking obtained by Indonesia in 2022 shows an increase in position 6 compared to before, but based on these results it is certainly not satisfactory because the points obtained have decreased by 13 points where the score obtained in 2018 was 396 (OECD, 2023). Therefore, a decrease in the score indicates students' low scientific literacy abilities, so this is a problem that requires attention to appropriate improvement and evaluation strategies to resolve the problem of students' scientific literacy achievements in Indonesia.

The quality of students' scientific literacy is influenced by the implementation of the learning process in the classroom. The implementation of learning activities can be said to be effective and efficient if the teaching materials used are able to support learning objectives according to the curriculum implemented and adapted to the challenges of 21st century needs (Puspitarini et al., 2019). Therefore, the role of teachers as providers of learning tools and facilities in the form of teaching materials is very necessary. Teachers who act as facilitators and determinants of the success of a learning process are required to integrate it with 21st century education so that interactive teaching materials that are able to train students' scientific literacy skills are very necessary at this time.

One of the teaching materials that can support the interactive learning process and is able to practice scientific literacy skills is teaching materials in the form of Electronic Modules (E-modules). Nikat and Sumanik (2021) stated that e-modules are an electronic learning media based on Information and Communication Technology (ICT). ICT media is a tool to support the learning process which is able to provide interactive learning stimuli between students and teachers so that it becomes a means to develop scientific literacy and make students more ready to learn and improve their understanding of science (Aripin & Ikrom, 2022).

The application of teaching materials oriented towards training scientific literacy is still a problem for some teachers. Based on the results of interviews conducted with biology subject teachers at Teuku Umar High School Semarang, information was obtained that the teaching materials were monotonous because they predominantly used handbooks in the form of Student Worksheets and PowerPoint soft files. Teaching materials in the form of e-modules have never been developed and applied to support the learning process. The implementation of scientific literacy has not been carried out due to the lack of supporting teaching materials, such as the characteristics of teaching materials that are less interactive, the use of opaque paper in the handbooks used, and teaching materials that do not train high-level thinking skills, which is a potential cause of low interest in literacy. Students are always accustomed to understanding learning material by carrying out reading literacy which only aims at developing the theories in the handbook. Based on

information from the interview results, it shows the need for innovative teaching materials in the form of e-modules that are able to hone students' scientific literacy skills.

Human mobility material combines the nervous system and the movement system. This material is new material in the Merdeka Curriculum taught at Teuku Umar High School Semarang. Human mobility material has contextual material characteristics because it involves the body system. Through the application of CTL which is oriented towards learning syntax to practice scientific literacy in teaching materials, students are expected to be able to improve their thinking skills in finding material or scientific issues through their own experiences and based on real life situations, thereby creating meaningful and fully involved learning. The active role of students in the Independent Curriculum can be realized. Material packaged in module form allows students to discover important concepts of the material, broaden their insight, and increase their interest in learning (Sukmawati et al., 2020). Therefore, the development of CTL-based e-modules in learning human mobility material is needed to support students in practicing their scientific literacy skills.

RESEARCH METHOD

This research was conducted at SMA Teuku Umar Semarang in the even semester of the 2023/2024 academic year. The population of this study were all class XI students at SMA Teuku Umar Semarang. The sampling technique is Purposive Sampling with consideration of the same teachers in the sample class. The research sample used was 2 classes, namely class XI MIPA 1 and XI MIPA 2. Data collection in this research includes analysis of field problems through interviews, analysis of teaching material needs through questionnaires, product feasibility through material and media validation questionnaires, product practicality through teacher and student response questionnaires, and product effectiveness through large-scale testing through scientific literacy test instruments by research sample class students.

The test decision is based on the objectives of this research, namely: (1) The e-module is declared feasible if the percentage of feasibility test results for product materials and media is in the range of 61% - 100% with a note that after revision or without revision, (2) E-modules are declared practical if the percentage of teacher and student responses is in the range of 61% - 100%, provided that after revision or without revision, (3) E-modules are declared effective in improving scientific literacy skills if > 90% of students obtain N-Gain scores in the medium and high categories.

RESULTS AND DISCUSSION

This development research consists of 4 stages, namely define, design, development, and dissemination. The define stage is an analysis of potential problems related to the achievement of students' scientific literacy skills, the design stage is the process of designing supporting components for content and product design, the development stage is the process of testing the feasibility, practicality and effectiveness of the product, and the dissemination stage is the product distribution stage.

Define Stage

The results of PISA achievements in the field of students' scientific literacy are one of the educational problems in Indonesia that need to be solved. Researchers have defined problems in the field, namely through interviews with biology teachers at Teuku Umar High School, Semarang. Based on the results of interviews with biology subject teachers, information was obtained that students' interest in reading literacy was still low based on the teacher's analysis when guiding classroom learning. Low literacy skills in reading and interpreting reading are one of the obstacles for students in studying science. This low literacy interest is influenced by the implementation of teaching materials. The characteristics of the teaching materials at SMA Teuku Umar Semarang are that they are less interactive and dominated by Student Worksheet Handbooks which have the characteristics of opaque paper and are dominated by text. Apart from that, teachers also apply power point files (PPT) in learning which only contain material content for developing students' basic theory so they have not yet trained high-level thinking skills.

Design Stage

At this stage an initial design (prototype) is carried out which consists of the stage of preparing material tailored to learning competencies, supporting components for the presentation of the e-module, and graphic design of the e-module. At the preparation stage, the material and components of the e-module were prepared using the help of Microsoft Office Word, while the graphic design was developed using the help of a website-based application (Canva). Graphic designs for e-module products that have been developed include covers, cover pages, foreword, table of contents, list of images, list of tables, material anatomy, instructions for using e-modules, material competencies, stages of CTL learning syntax, material maps, material introduction , material framework design, summary, learning evaluation, self-assessment, reflection sheet, glossary, bibliography, and author biography. The product that has been designed is then packaged based on the media that has been determined, namely through the help of the flip pdf corporate edition application with the output product format in the form of a link that can be accessed via smartphone or computer.

Development Stage

The aim of product development in this research is to develop a CTL-based electronic module on human mobility material that is feasible, practical, and effective for improving students' scientific literacy skills.

(1) E-Module Appropriateness

The assessment of the feasibility of the e-module product was carried out by two validators who are experts in the field of learning materials and media. The feasibility of the e-module product is validated through a product feasibility questionnaire instrument which consists of aspects of content appropriateness, presentation appropriateness and linguistic appropriateness for material expert validators. Meanwhile, the assessment of product suitability by media expert validators is related to graphics which consists of aspects of assessing the suitability of size, cover design and e-module content design.

The validity test by material experts aims to prove the suitability of CTL-based e-module product content on human mobility material. The validation results of the CTL-based e-module on human mobility material by material experts are presented in Table 1.

Table 1. Material Expert Validation Results

Aspects	Score	Max. Score	Percentage (%)
Feasibility of Presentation	61	64	95,3
Content Eligibility	39	40	97,5
Linguistic Feasibility	50	52	96,2
Average Percentage of Validation by Material Experts			96,2
Category			Very Feasible

Based on analysis of validity test data by material experts, the results showed that the presentation, material content (content) and language contained in CTL-based e-modules were very suitable for use in biology learning on human mobility material. This can be seen from the percentage of validity test results showing 96.2% which is included in the very feasible category.

The results of the assessment of the e-module presentation aspect show a percentage of 95.3% which is in the very feasible category. A proper presentation indicates that the e-module can be applied as a teaching material that is able to train scientific literacy. This is because the presentation of e-modules is equipped with learning components that integrate aspects of scientific literacy, such as activities in analyzing scientific knowledge through presenting case studies or problems, stimulating thinking and investigation processes through presenting practical activities, and stimulating the ability to solve problems contextually through presentations. material facts and questions that must be answered by students.

The results of the assessment of the feasibility aspect of the content/material showed a percentage of 97.5% which was in the very feasible category. This indicates that the material in the e-module has met the competency standards according to the curriculum applied and the information sources can be studied by students accurately without any misconceptions or distorted information. Apart from that, the material

description also contains CTL learning syntax and is adapted to current events according to students' daily lives so that they are able to practice scientific literacy skills.

The results of the assessment of the language appropriateness aspect show a percentage of 96.2% which is in the very appropriate category. E-modules have fulfilled the category as teaching materials with a language that is very worthy of being studied by students because researchers present language that is communicative, dialogical, light, straightforward and conceptual without ignoring the rules of good and correct Indonesian so that it is able to make it easier for students to digest the material in learning and increasing students' interest in reading literacy.

The assessment of the feasibility of e-modules is not only on the material aspect, but also on the media aspect which is assessed by media expert validators. The validity test by media experts aims to prove the feasibility of the product related to CTL-based e-module graphics on human mobility material. The validation results of the CTL-based e-module on human mobility material by media experts are presented in Table 2.

Table 2. Media Expert Validation Results

Aspects	Score	Max. Score	Percentage (%)
Size Eligibility	4	4	100
Cover Design Feasibility	51	52	98,1
Feasibility of Content Design	39	40	97,5
Average Percentage of Validation by Media Experts			97,9
Category			Very Feasible

Based on analysis of validity test data by media experts, the results showed that the graphics of CTL-based e-modules were very feasible with a percentage showing 97.9%. The results of the assessment of the e-module size aspect show a percentage of 100% which is in the very feasible category.

The results of the assessment of the cover design aspect show a percentage of 98.1% which is in the very feasible category. The e-module has fulfilled the category as teaching material with a very decent cover appearance because it is arranged attractively and aims to clarify the function of the e-module. The results of the assessment of the content/material design aspect show a percentage of 97.9% which is in the very feasible category. E-modules have fulfilled the category as teaching materials with very appropriate content/material graphics because the layout of the material is arranged clearly, consistently and proportionally. Apart from that, the presentation of the material is also adjusted to the level of education of students in the use of letters and letter variations that are not excessive.

(2) E-Module Practicality

The e-module practicality assessment involved biology teachers and students at Teuku Umar High School Semarang. The practicality assessment of CTL-based e-modules on human mobility material was carried out by 88 students after participating in learning activities using CTL-based e-modules on human mobility material, including 30 Class XII MIPA students (on a small scale) and 58 participants. Class XI MIPA students (on a large scale).

The results of teachers' and students' responses to the practicality of CTL-based e-modules on human mobility material are presented in Table 3 and Table 4.

Table 3. Results of Teacher Responses to Practicality

Aspects	Score	Max. Score	Percentage (%)
Ease of Understanding the Material	30	32	93,8
Language	21	24	87,5
Ease of Use	12	12	100
Graphics	24	32	75
Average Percentage of Practicality by Teachers			87
Category			Very Practical

Table 4. Results of Student Responses to Practicality

Aspects	Score		Max. Score	Percentage (%)
	Small Scale	Large Scale		
Ease of Understanding the Material	841	1660	2816	88,8
Language	610	1241	2112	87,6
Ease of Use	329	641	1056	91,9
Graphics	835	1678	2816	89,2
Average Percentage of Practicality by Students				89
Category				Very Practical

Based on the assessment results, it shows that the average percentage of practicality scores from teachers and students respectively is 87% and 89% in the very practical category, thus indicating that the e-module has met the characteristics of a good teaching material and is able to support the learning process, namely is self-instructional, self contained, stand alone, adaptive, and user friendly (Laraphaty et al., 2021).

The results of assessments by teachers and students regarding the ease of understanding the material show percentages of 93.8% and 88.8% respectively, which are in the very practical category. This is because the e-module contains clear CTL learning process flow instructions (self-instruction) so that it opens up space for them to build their own knowledge, of course supported by the teacher's role as a facilitator who guides students in discovering concepts in learning. The presentation of the material is also structured clearly by separating sub-chapters of the material (self contained) with complete (stand alone) sources of information on important concepts of the material, making it easier to support the learning process. Apart from that, the content/material components presented are also considered to be adaptive, such as in inquiry learning activities which facilitate students to analyze current events or phenomena in the world of science.

The assessment of the practicality of the e-module in the linguistic aspect received a percentage from teachers of 87.5%, while students obtained a percentage of 87.6%, both of which were in the very practical category. This indicates that the use of language and grammar in the e-module is appropriate to the level of development of students, namely using language that is light, standard and communicative so that it can motivate and make it easier to learn the material clearly.

The assessment of the practicality of e-modules in the aspect of ease of use obtained percentages from teachers and students respectively, namely 100% and 91.9%, both of which were in the very practical category. Based on this assessment, it indicates that the e-module can be accessed easily via the internet (user friendly). Apart from that, the use of e-modules is also accompanied by features that function to make it easier for students to access e-modules, such as hyperlink and barcode scan features that students can use to open wider learning sites via the internet.

The assessment of the practicality of the e-module in the graphic aspect obtained a percentage from teachers of 75% and a percentage of 89.2% from students, which was in the practical and very practical categories. Based on this assessment, it indicates that the graphics in the e-module are able to support the practical presentation of learning.

(3) E-Module Effectiveness

The effectiveness test was carried out on a large scale with a total of 58 students consisting of 28 students from Class XI MIPA 1 and 30 students from Class N-Gain is analyzed from pre-test and post-test scores. The results of the N-Gain test for students using CTL-based e-modules on human mobility material are presented in Table 5.

Table 5. Student N-Gain Results After Using E-Module

Recapitulation of Student N-Gain Test Results			
N-Gain	Frequency	Percentage (%)	Category
$g > 0,7$	44	75,86	High
$0,3 < g \leq 0,7$	11	18,97	Medium
$g \leq 0,3$	3	5,17	Low

N-Gain Test Results for Every Aspect of Scientific Literacy		
Aspects	N-Gain Score	Category
Science Content	0,72	High
Science Competency	0,72	High
Science Context	0,71	High
Average N-Gain Score	0,72	High

Based on Table 5, it can be seen that the 58 samples of students in Classes XI MIPA 1 and XI MIPA 2 SMA Teuku Umar Semarang experienced an increase in their scientific literacy skills. Based on the N-Gain score obtained, there were 55 students in the medium-high category with a percentage of 94.83%, while 3 other students did not experience an increase in their scientific literacy skills and were even declared incomplete. The increase in scientific literacy skills was also strengthened by the acquisition of N-Gain scores in each aspect of scientific literacy which showed high category results in all aspects of scientific literacy. Apart from that, the overall average N-Gain score obtained also shows an increase in students' scientific literacy skills, namely 0.72 in the high category.

Aspects of scientific knowledge are trained in constructivist learning activities, where in this approach students are directed to build their own knowledge of phenomena and problems that are integrated with the scientific context. This learning component is supported by the presentation of material integrated with learning multimedia such as images, videos and virtual simulations with the aim of facilitating information material for students in formulating a phenomenon or problem being presented.

The science competency aspect consists of students' competence in explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically (OECD, 2019). The competency to explain phenomena scientifically in its implementation is trained through inquiry, learning community and questioning activities. In inquiry activities, students are guided to formulate problems and analyze in depth the discovery of problem solving or scientific phenomena that have been presented based on the results of the knowledge they have built at the constructivism stage. Students are then directed and facilitated to optimize their understanding by presenting questions (questioning) in the e-module as material to encourage students' critical thinking in developing problem-solving hypotheses based on evidence and theories that have been studied in previous activities. The questioning learning stage also seeks freedom for students to ask each other questions, both among their friends and the teacher as facilitator. Carrying out a more in-depth study of the problem or phenomenon is carried out in groups by students exchanging ideas and being open through discussion activities (learning community) with the aim of expanding students' information and understanding in explaining phenomena scientifically.

The competency to evaluate and design scientific investigations is realized through modeling activities which is an advanced stage after students carry out in-depth studies and develop hypotheses for solving a problem. The modeling learning approach stage aims to improve students' science process skills through activities such as practicums, virtual experimental simulations, and body movement simulations related to joints, the nature of muscle work, and so on. Practical activities carried out by students in order to obtain data and scientific evidence as material for evaluation and investigation of the hypotheses they have designed in the previous stage.

The competency to interpret data and evidence scientifically is realized through reflection activities which aim to evaluate and conclude the results of solving a problem or scientific phenomenon based on the data and evidence they have obtained in the previous stage. In this learning approach, students can communicate and conclude the results of their scientific thinking with group friends in front of the class to be reviewed together at the end of the learning process.

Aspects of the scientific context are trained in the entire series of learning activities in the human mobility material e-module. This is because the PISA scientific literacy assessment at the cognitive level does not only assess context, but assesses knowledge and competencies related to context (OECD, 2023). Therefore, the context aspect is an aspect that is integrated with the knowledge aspect and competency aspect. The human mobility material in this research is contextualized through material elements that are associated with

problems in the nervous system and human movement system, such as knowledge and bioprocesses about a disorder/disease, efforts to maintain health to avoid a disorder/disease, and phenomena related to everyday life. student day.

Dissemination Stage

The product distribution stage is the stage carried out by researchers to share the results of e-module development after going through feasibility, practicality and effectiveness tests. The CTL-based e-module on human mobility material which has been declared feasible and practical to be applied in learning and effective in improving students' scientific literacy skills, the e-module product is disseminated by researchers to Biology subject teachers at Teuku Umar High School Semarang to serve as reference material teach human mobility material.

CONCLUSION

Based on the research objectives, it can be concluded that electronic modules based on Contextual Teaching and Learning (CTL) on human mobility material are declared very feasible by material experts and media experts, declared very practical by teachers and students to be applied in learning, and declared effective for improving abilities students' scientific literacy.

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