

Research article

Developing Teaching Materials Using STEM on Population, Human Development Index, and Demographics

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Abstract.

It is important in 21st-century learning to develop learning materials in digital form and teaching activities that require students to develop critical thinking, communication, creativity, and collaboration skills. 21st-century learning involves student-centered learning, where students are required to be more independent. Analysis of the needs of grade XII IPS 2 students at SMAN 2 BATU showed that the students needed interactive digital-based learning materials to support them, especially materials on the population, human development index (HDI), and demographics. This research therefore aimed to produce these digital learning materials using STEM (science, technology, engineering, mathematics) approaches. The ADDIE model was used, and qualitative and quantitative data were collected. Data were analyzed using percentage analysis techniques. The digital learning material products prepared were tested on 20 students of grade XII IPS 2 at SMA Negeri 2 Batu. Their validation was tested by material experts and media experts, obtaining validity values of 96% and 98%, respectively, which could both be classified as 'very valid'. Furthermore, an eligibility test was carried out with geography teachers and students, and a result of 91% was obtained, which could be classified as 'very feasible/very interesting'. Based on the results, it is feasible to use the STEM-based digital learning materials of population, HDI, and demographics effectively in geography learning.

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1. Introduction

21st-century learning requires students to have critical thinking, communication, creativity, and collaboration. In addition, 21st-century learning refers to student-centred learning (SCL), where students must be more independent. Therefore, to make it happen, a learning device is needed, one of which is learning materials that can direct students in their learning activities. Learning materials to be used in learning and teaching activities must be tailored to the characteristics of the students. Students in today's era belong to generation Z or i-Generation that relies on technology, gadgets, and social media activities. This situation, of course, affects the character of students' learning, which tends to use digital technology that is more practical. Analysis of the needs of grade

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XII IPS 2 students at SMAN 2 BATU shows that students need interactive digital-based learning materials to support learning, especially population quality sub materials, HDI, and demographic dividend. At least the utilization of digital learning materials and teachers' mastery towards the development of digital teaching, the product of digital learning materials, becomes very important for now.

Digital learning materials were learning materials arranged systematically and poured in digital form to facilitate students and teachers' learning processes. The purpose of the development of learning materials is to promote the efficiency of education by improving the quality of learning and teaching [1]. The objectives of learning materials, according to [2], include: 1) helping students to learn something, 2) providing a variety of choices of learning types that suit their wants and needs, 3) making it easier for teachers to carry out learning, and 4) making learning activities more enjoyable. Based on the description, one conclusion can be drawn that the development of digital learning materials aims to help students in the learning process and facilitate teachers in the implementation of learning. The ultimate goal of developing digital learning materials is to improve the quality of teaching and learning.

The creation of 3D Flipbook becomes a digital teaching material with a flip builder application. [3, 4] state that flip builder is software used to create flipbooks. The guidelines will become more varied and attractive to students with flip books so that students will be more diverse in grades and students' cooking outcomes will be more beautiful. Similarly,[5] results can be students of the wrong level of misunderstanding the concept of geography into digital teaching materials in the form of flipbooks. In addition, the back leaves with the help of flip builder science process skills in students [6, 7]. At that time, the back, in a way, became a perfect location for both teachers and students and the opportunity to be crafted into a good teaching material [8].

One approach that can be used in the development of teaching materials is the STEM approach. STEM is an acronym for science, technologie, ingénierie, mathématiques and [9, 10] argues that STEM is a meta-discipline at the school level involving science, technology, engineering, and math teaching in an integrated approach. Each discipline is not shared but treated as a dynamic unity. The STEM approach aims to address real-world situations through a problem-solving process used by engineers and scientists [11]. The purpose of the STEM approach in line with the demands of 21st-century education is to establish students who have science and technology literacy seen from reading, writing, observing, and doing science and can develop their competencies to be applied in dealing with problems in their daily lives related to STEM disciplines [12, 13]. The application of STEM approaches to learning activities that use learning materials and

modules can positively impact [14]. The significant effects include increasing students' reasoning skills [15, 16], increasing students' creative thinking ability [17], and improving understanding of students' concepts and critical thinking abilities [18]. In addition, based on [19], stem use in geography learning materials can improve student learning outcomes.

The development research will be conducted by researchers in the form of the development of STEM-based digital learning materials on population quality sub-materials, HDI (Human Development Index), and demographic dividend based on the analysis results. The sub-material is included in KD 3.5, analyzing population dynamics in Indonesia for the development planning of grade XI high school Geography subjects. Digital learning materials contain subject matter, infographics, images, videos, and links that support sub-materials. Digital learning materials are made in the form of flip books using a STEM approach.

2. Method

Development research was conducted by researchers using the ADDIE development model (Analysis-Design-Development-Implementation-Evaluation). Researchers use the ADDIE model because it is composed of five simple steps that are easy to understand and apply so that it is suitable for the development of researchers' learning materials. The five stages include analysis, design, development, implementation, and evaluation [20, 21]. In this research and development, researchers only reached the implementation stage because it is by the objectives of research and development of researchers, namely producing digital learning materials in sub material Population Quality, HDI, and Demographic Bonus by using STEM approach. Here are the stages of the ADDIE development model that researchers will do:

Figure ??. ADDIE Model Research and Development Procedure

This type of data in research and development is qualitative and quantitative data. Qualitative data is obtained from product development questionnaires in the form of assessments, criticisms, and product suggestions by validators, teachers, and students, and quantitative data received is the result of the percentage of polling. The test subjects in this study were students of SMAN 2 BATU class XII IPS. The selection of the issue is because the students of grade XII IPS have studied Geography KD 3.5, which analyses the dynamics of population in Indonesia for development planning. Instruments in this research and development use questionnaires in the form of questionnaires of students

and teacher’s needs, validation questionnaires by material and media experts, and questionnaires of teacher and student responses to digital learning materials.

Furthermore, the trial phase is carried out after the digital teaching material product is declared valid by the validator of the material and learning materials. The trial aims to determine the feasibility of digital learning materials that have been developed— data analysis techniques in this research and development use percentage analysis techniques. Data analysis techniques in the questionnaire aim to find out the feasibility level of digital learning materials that have been developed on a multilevel scale using percentage techniques. The formula used to determine the feasibility of digital learning materials from validators is as follows:

$$P = \frac{x}{xi} \times 100\%$$

Description:

P = Percentage

x = Gain Score

xi = Maximum score

Percentage results of the data obtained are converted into quality statements by looking at the eligibility criteria in Table 1.

TABLE 1: Eligibility Criteria.

No	Validity Criteria	Qualifications	Equivalent
1	01,00% - 50,00%	Invalid	Not Worth It
2	50,01% - 70,00%	Less Valid	Less Worthy
3	70,01% - 85,00%	Valid Enough	Pretty Decent
4	85,01% - 100,00%	Very Valid	Very Feasible

Source : Instrumen Perangkat Pembelajaran (2013)

3. Result and Discussion

This research and development of digital learning materials refer to the ADDIE development model. However, researchers only reached the implementation stage in this research and development because the objectives of this research and development are to produce digital learning materials, sub material population quality, HDI, and demographic dividend. The description of the stages of development of digital learning materials carried out by researchers is as follows.

3.1. Analysis

Researchers conduct problem analysis and development research objectives at the analysis stage through student needs analysis, teacher needs analysis and curriculum analysis. The main problem used for this development research is based on the results of a study of the needs of teachers and students. The utilization of digital learning materials on population quality materials, HDI, and demographic dividend by geography teachers and students of grade XII IPS 2 from SMAN 2 Batu is relatively few. In addition, students need digital learning materials that integrate images, videos, infographics, and links from the internet for their learning process because they rarely use learning materials other than textbooks from school. The selection of digital learning materials development is also based on the development of technology and information that affects the characteristics of students, namely preferring digital learning materials that can be accessed anytime and anywhere.

STEM approach selection in learning materials is based on 21st-century proficiency competencies where students must have critical thinking and problem-solving skills, communication skills, creativity and innovation, and collaboration. In addition, based on information from geography teachers at SMAN 2 Batu, Mr Ali Ridho, S.Pd, M.M, SMAN 2 Batu has collaborated with outside parties to implement STEM approaches in learning activities. Thus, stem-based learning materials are needed to support learning activities at SMAN 2 Batu. The material in the digital teaching material, namely population dynamics, follows the Basic Competencies in the Curriculum 2013 SMA / MAS revision 2017. The selection of population quality sub-materials, HDI, and the demographic dividend in digital learning materials is due to the analysis of students' needs stating that they have difficulty learning the sub material.

3.2. Design

At the design stage, researchers designed the development of the product according to the results of the needs analysis. The procedure of planning or designing digital learning materials carried out by researchers in the preparation of the concept of digital learning materials to be developed, the collection of a list of components of learning materials such as materials, articles, images, videos, infographics, link links that will be incorporated into digital learning materials, student exercises and activities following the STEM approach, the design of digital learning materials, and the preparation of evaluation tools. The source used for the material results from collecting literature data

from various sources that can be accounted for. The concept of media will be developed in the form of digital books with .exe and HTML formats to be applied by students through PCs and smartphones. The design made at this stage is in display designs and components in digital learning materials.

Furthermore, researchers conducted an evaluation tool in validation sheets, teacher response questionnaires, and students. The structured validation sheet is intended for expert validators of materials and media design to determine the validity and feasibility of digital learning materials developed. In addition to the validation sheet, researchers also compiled questionnaires aimed at teachers and students in response to the learning materials that have been created.

3.3. Development

At the development stage, researchers will produce a prototype based on media design prepared in the previous stage, namely the analysis and design stage. In the development process, researchers conduct a selection of components collected at the design stage to obtain appropriate parts and support the content of digital learning materials products. Digital learning materials are compiled by researchers with the help of Microsoft publisher software, Microsoft Word, and flip builder. The selection of this three software is due to its easy application to accelerate the development of digital learning materials.

The design of digital learning materials developed will go through an internal test process by a material expert validator and teaching material design. Suggestions and recommendations from each validator will serve as the basis for the revision of digital learning materials. Digital learning materials products that have been validated will then be tested in schools to find out the response of teachers and students to digital learning materials developed. The results of validation by experts in materials and design of learning materials are as follows.

TABLE 2: Recapitulation of Expert Validation Test Results of Materials and Learning materials Design.

Validation	Score	Percentage (%)	Qualifications
Material Expert	65	96%	Very Valid
Learning materials Design Expert	86	98%	Very Valid

Source: Researcher (2020)

The validation process by the material expert on aspects of STEM assessment, content feasibility, and presentation of learning materials obtained the result that the

total assessment score of the overall part is 65 then, the percentage of validation by the material expert from the general aspect of the assessment is 96% with a "very valid" qualification. In addition to providing a score, the material expert validator also offers suggestions and recommendations to improve the concept map section by writing the population quality factor and the dimensions of the Human Development Index into the concept map flow. The validator also provides input related to writing errors as well as punctuation in digital learning materials. Therefore, researchers made improvements to the writing of image and video sources, added flows to the concept map, and corrected writing errors and punctuation marks.

The validation process by the teaching material design expert on aspects of the presentation order, cover design, digital teaching material content design, writing feasibility, font usage, layout, illustration, and appearance design obtained the result that the total assessment score of the overall aspect is 86 then, the percentage validation result by the design expert from the general part of the assessment is 98% with a "very valid" qualification. In addition to scoring every aspect of the evaluation, the design expert validator also provides suggestions and recommendations to improve the back cover page by adding a synopsis of digital learning materials, adding developer profiles to digital learning materials, revising fonts on any of the pages on digital learning materials (student activities on population ageing topics and demographic dividend), and improving the distance between images and text in the apperception section of population ageing topics and demographic dividend. In response, the researchers made improvements to the backcover page section, adding developer profiles, improving the use of font types and drawing distances with text on pages directed by design validators.

3.4. Implementation

The trial phase was conducted on 20 students of grade XII IPS 2 and teachers of geography subjects at SMAN 2 Batu. The trial took place on November 25, 2020, online due to the Covid-19 pandemic. Data were obtained in the form of quantitative data from the percentage of teacher and student response questionnaires and qualitative data obtained from suggestions, comments, and criticisms from both students and teachers. The score obtained will then be 100 percent and described in the form of a sentence. Analysis of teacher and student response data aims to find out the ability and feasibility of digital learning materials based on the opinions of teachers and students. Here's a description of the analysis of teacher and student response data.

TABLE 3: Recapitulation of Teacher and Student Response Results.

Validation	Score	Percentage (%)	Qualifications
Teacher	98	91%	Very Feasible
Students	92	91%	Very Feasible

Source: Researcher (2020)

The response of geography teachers at SMAN 2 Batu, Mr Ali Ridho, S.Pd, M.M to the aspects of usefulness, clarity of information, use of STEM elements, language use, clarity of instructions, font usage, display design, and practice of the question obtained the results that the total assessment score of the overall aspects and indicators is 98 then, the percentage of teacher response questionnaires as a whole is 91% with "very feasible" qualifications. In addition to providing scores, teachers also provide suggestions and recommendations that learning materials are suitable and can be developed. In addition to obtaining data from teacher response questionnaires, researchers also received data from student response results.

The response of grade XII students of SMA Negeri 2 Batu showed that the average score was 84. The total average score that can be obtained is 92. Judging from the total average score obtained with the maximum total score obtained, the percentage of student response results as a whole is 91%, with a "very decent" qualification. Based on the calculation of teacher and student response data, overall digital learning materials of population quality sub-material, HDI, and demographic dividend using STEM approaches obtained an average percentage of 91% with "highly feasible" qualifications. Students are interested in digital learning materials because they are attractive, can be directly connected to links that support the material, and the approach used also attracts students. The advice from students is for learning materials to be used offline.

4. Conclusion

Research and development that has been implemented produces digital learning materials, sub material population quality, HDI, and demographic dividend based on STEM. The final product of digital learning materials sub material population quality, HDI, and STEM-based demographic dividend is filed with .html format to be used online through digital screens such as smartphones and PCs. The development of interactive and accessible digital learning materials for students online and readable on smartphones, laptops, and PC is appropriate and can increase learning motivation and interest in reading students [22, 23, 24]. Following the results of research conducted by [25, 26], digital learning materials can increase students' motivation and interest in reading.

Digital learning materials that researchers have developed have gone through the validation stage by material experts and teaching material design. Based on the results of validation data analysis by material experts and learning materials design obtained an overall percentage of 96% and 98% with "very valid" qualifications. So it can be concluded that digital learning materials are included in the capability "very valid" to be applied. The results of the analysis of teacher and student response data obtained an average percentage of 91%, so those included in the qualification are "very feasible / very interesting".

The advantages of digital learning materials that researchers have made include 1) being easy to carry and can be accessed anytime and anywhere because it is a file that can be stored in a smartphone or PC, 2) being environmentally friendly or paperless because it can be accessed without having to be printed on paper such as textbooks, 3) is equipped with search or search features, so that students can easily find the words they want to find in digital learning materials quickly and precisely, and 4) is interactive because it already contains various images, videos, hyperlinks (links), and online quizzes that support the discussion material in it.

The shortcomings of digital learning materials compiled by researchers include 1) the deepening and limited breadth of materials, because learning materials only examine sub-material of population quality, HDI, and demographic dividend, 2) in their use required electronic devices such as computers, smartphones, notebooks, and laptops, and 3) less effective when used jointly by students, for example in one digital screen digital learning materials by more than four students.

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