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Development of MOOC content with STEM approach and its influence on students' geographical literacy

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Abstract

This research aims to develop MOOC content with a STEM approach using the Schoology Learning Management System (LMS) and apply the developed product to assess its impact on students' geographical literacy abilities. The research falls under the category of Research and Development (R&D) with a mixed-method analysis. The development model used in this study is ASSURE. The research design implemented the one-group pretest-posttest design with the N-gain score test when a significant difference was found between the average pretest and posttest scores through the paired sample T-Test. The N-gain score was then used to determine the product's effectiveness based on Heke's category. Then, the trial subjects were selected by purposive sampling method based on the location and school criteria. The data collection instruments used were interviews and questionnaires. The study's findings show that the MOOC content developed using a STEM approach on the LMS Schoology is highly commendable, with a score of 98.8 percent. Furthermore, the analysis indicates a significant improvement in students' geographical literacy skills, as demonstrated by the N-gain test results, which show a high gain score of 0.7105. These outcomes confirm that using the STEM approach in MOOC content within the LMS Schoology is effective in enhancing students' geographical literacy.

Keywords: MOOC; STEM; LMS Schoology; geographic literacy

1. Introduction

The development of globalization requires the world of education to be able to adapt technological developments to improve the quality of education, especially in the implementation of learning activities. With the theme "Changing Our World: The 2030 Agenda for Sustainable Development", the SDGs, which contain 17 Goals and 169 Targets, are a global action plan for the next 15 years (effective from 2016 to 2030) to end poverty, reduce inequality, and protect the environment. The SDGs apply to all countries (universally), so all developed countries have a moral obligation to achieve the Goals and Targets of the SDGs (What SDGs are, etc.). In addition to various kinds of sustainable development, the SDGs also aim to solve education problems worldwide. Given that today's education has a crucial role in supporting the welfare of life, obtaining it is a fundamental right of every human being. Based on the annual UNESCO Education for All Global Monitoring Report 2012, Indonesia's education quality is ranked 64th out of 120 countries worldwide. Furthermore, in the latest 2015 UN development program report, Indonesia is in position 110 out of 187 countries in the Human Development Index (HDI) with a number of 0.684 (Pribadi, 2017). These conditions then become several considerations for the Indonesian government to encourage changes towards improving the quality of education for the community, which is considered to spur the achievement of other SDG goals and targets, especially in increasing Indonesia's HDI.

The many demands for life skills make countries in the world vying with each other to create an education system that is able to produce superior generations and is ready to compete in the life of the 21st century. In 1990, the United States government, through the National Science Foundation (NSF), introduced STEM (Science, Technology, Engineering, and Mathematics) as the theme of the education reform movement in the four disciplines (science, technology, engineering, and mathematics) as a career choice. A primary role for students, so that they can grow the workforce in STEM fields (Han, Capraro, & Capraro, 2015; Kapila & Iskander, 2014). According to Seedhouse (2016), the purpose of the STEM curriculum is to educate students using an interdisciplinary and applied approach by integrating several aspects or fields in science so that it can arouse enthusiasm and challenge students in learning. The importance of education with a STEM approach includes the increasing need for flexible human resources and the ability to apply knowledge in practical problem-solving.

STEM has been applied by some developed countries such as the United States, Japan, Finland, Australia, and Singapore (Permanasari, 2016). Like these countries, Indonesia has also adapted from the STEM approach as a response to the times and efforts to improve the quality of education. The STEM approach was adapted to strengthen the implementation of the National Curriculum (Curriculum 2013). This approach is believed to be in line with the essence of the 2013 Curriculum, which can be implemented through the use of project-based learning models or problem-based learning using scientific and engineering practices (Devi, Herliani, Setiawan, Yanuar, & Karyana, 2018). Human resources who are able to master STEM are projected to occupy better positions in various jobs, can answer the challenges of technological development, have scientific skills and understanding, and become the key to progress and innovation.

The effectiveness of STEM in learning has been proven by many previous studies, including showing the results that the application of STEM-based learning media consisting of carbon dioxide gas sensors and showing shows a significant difference relating STEM modules in the achievement of competencies (cognitive, affective, and psychomotor) between students who follow redox reaction learning with STEM learning and students who follow conventional methods of learning (Susanti, Hasanah, & Khirzin, 2018). Another study was conducted by Artobatama (2018), which shows that learning using an outbound-based STEM approach can be done to create a generation that understands the existence of technology and the creation of new technologies. This happens since, in STEM learning, students can produce work that increases enthusiasm for learning and competing. STEM also demands the independence of students through STEM-based worksheets so that students can carry out their own investigative activities to solve problems without being entirely taught by educators (Utami, Septiyanto, Wibowo, & Suryana, 2017). STEM learning contains methods that train how to think, behave, and problem-solving steps. This can make it easier for teachers to create learning concepts that can connect knowledge and skills so that students can easily understand them.

The 2013 curriculum also accommodates the learning framework "The Partnership for 21st Century Learning Skills" (Education Reimagined, 2019), which became the pioneer of the 4C (Critical Thinking, Communication, Collaboration, and Creativity) movement. Critical thinking skills (critical thinking skills) lead to students' ability to conduct analysis to solve a problem or make a decision. Creative thinking skills are the ability of students to create or develop new ideas. Communication skills are students' skills in listening, understanding, and conveying the results of thoughts, ideas, or other information through oral, written, or other symbols. Collaboration skills are skills to work together, synergize, and share roles and responsibilities.

The 4C competencies should empower students to attain higher-order thinking skills (HOTS) as part of their academic development. HOTS is a thinking process of students at a higher cognitive level developed from various cognitive concepts and methods and learning taxonomies such as problem-solving methods, bloom taxonomy, and learning, teaching, and assessment taxonomies (Saputra, 2016). Through HOTS, students can understand complex things, construct explanations, argue, and solve problems well. In a study conducted by Handayani and Priatmoko (2013), it was found that the application of HOTS-oriented problem-solving learning had a positive effect on chemistry learning outcomes, especially on the subject matter of electrolyte solutions and redox concepts. Not only students this curriculum also provides new directions for teachers to be able to master TPACK (Technological Pedagogical Content Knowledge) competencies. This competency integrates pedagogic, content, and technology elements in learning so that its development is needed to produce an effective, efficient, and more interesting learning process (Sintawati & Indriani, 2019). Teachers in Indonesia should master these competencies to realize the goals of national education and lead the Indonesian nation to compete in changes in the Industrial Revolution 4.0 era.

The use of technology in learning is absolutely necessary in order to adapt to the times. Ready or not, humans must be able to accommodate technology to achieve competence in learning. The existence of the COVID-19 pandemic, which forced the implementation of social/physical distancing policies, forced the realization of distance learning which cannot be separated from the use of technology and internet networks. It was confirmed by the Ministry of Education and Culture, Research and Technology through Circular Number 4 of 2020 which urges to postpone all school activities and switch to online learning or distance learning at home. Likewise, the Ministry of Religion oversees madrasas and followed the call by issuing Circular Letter Number B-686.1/DJ. I. I/PP.00/03/2020. In this case, the Ministry of Education and Culture provides freedom for each school to choose a distance learning platform according to their needs (The Ministry of Education, Culture, Research, 2020).

Educators and students must be able to adapt to IT without compromising the competencies that must be achieved in a learning activity. Mastery of technological literacy has an important role in the implementation of distance learning, including facilitating and increasing the effectiveness of the implementation of distance learning, facilitating information search and processing, facilitating communication and collaboration of teachers and learners, and directing users to uphold social ethics in using technology in distance learning (Latip, 2020). The study was further strengthened by Asmuni (2020), that the importance of increasing IT mastery competencies, including being able to overcome distance learning problems such as improving the quality and access to learning supervision.

The real form of technology used in education is reflected in the implementation of online learning (e-learning). The implementation of e-learning continues to grow along with the emergence of innovations in the fields of technology, information, and communication. One of the e-learning programs is LMS (Learning Management System). LMS is software that contains learning features that can make students and teachers enter an academic forum to conduct online teaching and learning activities anywhere and anytime as long as they are connected to the internet (Haniah, Asminiwaty, & Sihombing, 2019). Learning through LMS can assist teachers in packaging a lesson, which consists of delivering material, conducting discussions, evaluating student performance, and monitoring learning outcomes, which are then used as evaluation and improvement materials. At this time, LMS has been widely developed, one of which is Schoology. Haryanto (2018) wrote that some of the advantages of LMS Schoology are that it is easy to access, has many features, supports sending various types of files, supports the implementation of long-distance learning, and is effective and efficient.

The use of a well-conceived LMS can support the achievement of more optimal learning objectives. One of the optimization efforts is by integrating various learning tools tailored to the needs. For example, LMS Schoology can be integrated with learning methods such as MOOC (Massive Open Online Course). MOOC is an open-concept learning method, not only to provide more learning opportunities but also to improve the quality of the learning experience. Hardi, Gunawan, and Sumardi (2018) suggest many changes in students when MOOC learning is applied, especially in video content, where students can easily access, play, and record it. This method helps students to repeat the explanation given by the teacher according to their abilities.

Learning geography is presented to provide a learning experience that is oriented towards long-term decision-making abilities. The improvement in the quality of geography learning can be reflected in the level of mastery of geographic literacy. Geographic literacy is the ability to use geographic understanding and reasoning so that humans can live well and behave responsibly (Edelson, 2014). One of the reasons for the importance of increasing geographic literacy based on the research of Utami et al. (2017) is that, students with low geographic literacy skills will have difficulty using maps. It cannot be ignored, considering that maps are a characteristic and main tool in understanding geography material. Backler and Stoltman state that knowing location is the first step towards geographic literacy, and true literacy is the ability to use geographic knowledge and skills. Geographic literacy begins with map-reading skills, then location knowledge and skills to understand interactions between humans and the resulting culture.

Edelson states that geographic literacy consists of three main components: interaction, interconnection, and implication. Interaction is the ability to explore and understand natural and human systems in order to increase understanding of how the world works (Edelson, 2014). Furthermore, interconnection refers to increasing understanding of how the world is connected by teaching the interrelationships between various aspects that cause variations in conditions from one location to another. Variations in conditions between these regions are a result of historical, geographical, and social connections at local, regional, and global scales. The last component is the implication that leads to learning about the impact of interactions between systems. In the end, mastery of the implication component can be the basis of systematic ability for rational decision making. According to Edelson, the components of geographic literacy have been applied in research Sugiyono (2015) with the implementation result of the concept of "Geography as a Social Studies learning plan" to develop 21st century skills is feasible.

On the other hand, Kerski (2015) likens the civilizing of geographic literacy as a bench whose strength is supported by three legs, namely, core content, skills in using geographical tools, and geographic perspective. The core content is natural objects of physical geography and human geography in a large system. Then skills development, including the effective use of geographic tools. Many geographic tools and skills are focused on maps for spatial analysis. Geographic perspective, starting from spatial thinking to find answers about processes and phenomena that occur in a place. The geographic perspective also includes critical thinking that questions and investigates where data comes from, how to manage uncertainty, what problems are framed, and at what scale issues can be handled. The term increased "geographic literacy" in this study relates to Kerski's cultural literacy of geography, which is defined as the ability to comprehend geographic content, create and read information from maps, and analyze various phenomena using geographic viewpoints. The concept of geographic literacy is more complex than Edelson's concept of literacy. In the context of providing an understanding of a geographic framework that is easier for children to understand at a young age (elementary and middle school), it is sufficient if the imagination aspect or a geographic perspective is used to develop geographic literacy. Meanwhile, at the high school or college level, a more detailed concept of geographic literacy can be used, because they have received map material specifically (Sugiyanto, Maryani, & Ruhimat, 2017).

The education sector has responded to the development of technology, information, and communication in the form of e-learning, teleconference, blended learning, and other technology-based learning. But in reality, Indonesia is not yet fully ready to implement such a learning system. This is reinforced by the results of the needs analysis that researchers have carried out. The needs analysis that has been carried out in three schools with different criteria, namely SMAN 9 Malang, SMAN 1 Kabila, and MAN 1 Tulungagung. Based on the results of interviews and questionnaires given to several students and teachers, it can be seen that the learning carried out in schools has not maximized the development of technology. TPACK competence has not been fully applied in the development of learning models, so teaching and learning activities are still conventional. Limited abilities and difficult assumptions about TPACK competencies make teachers continue to carry out traditional learning.

This research aims to improve the quality of learning geography for basic knowledge of mapping. This is intended so that students have a strong understanding of the basics of mapping and the development of spatial intelligence as early as possible. Therefore, they can support successful learning in subsequent materials. In accordance with the details in the previous paragraph, this research with the pilot subject of high school students will develop sustainable geographic literacy skills based on the concept of civilizing geographic literacy, according to Kerski. The geographical literacy skills of students are honed through the presentation of various content and learning media. The learning approach used is STEM. The implementation of learning is adjusted to the current situation and conditions, where learning will be carried out online through one of the LMSs, namely LMS Schoology. Based on the explanation in the previous paragraphs, the objectives of this study can be formulated, namely, (1) Developing learning content with STEM to improve sustainable geographic literacy in students and (2) Testing the effectiveness of the developed product on increasing students' geographical literacy during the COVID-19 pandemic.

2. Method

This type of research is Research and Development (RnD) with mixed method analysis. The study utilizes the ASSURE development model, which involves analyzing learners, defining standards and objectives, selecting strategies, technology, media, and materials, integrating technology, media, and materials, encouraging learner participation, and evaluating (Sugiyono, 2015). This model was chosen because it is in accordance with the characteristics of the product to be produced, namely a technology, information, and communication-based learning platform. Several product development approaches were chosen to accommodate the various learning styles of students, including: (1) utilizing visual materials/objects, such as maps and pictures with various colors; (2) using digital media, such as video and webmap; (3) inviting students to express ideas through sketches/pictures; (4) always involving students in discussion activities; and (5) learning through simulation and practicum activities.

Geographic literacy in this study is oriented to Kerski's (2015) opinion, which refers to understanding geographic content, skills in creating and reading information from maps, and using geographic perspectives in interpreting various phenomena. Geographic literacy of students is built through the provision of materials and exercises to create and read information from maps. At the beginning and end of the learning activities, test questions (pretest and posttest) were given to measure the geographical literacy abilities of students before and after the implementation of learning using the developed product. This ability is measured based on the understanding and ability of students to interpret maps and apply them in various spatial-related contexts.

The product is developed based on the STEM approach. Through this approach, students do not just understand a material but also use their understanding in the form of analysis. The integration of each discipline of STEM approach in this study covers: (a) Science: presenting basic knowledge of mapping through modules equipped with explanatory videos and practicing questions. Through this, students are directed to be able to achieve learning objectives. (b) Technology: it is in the form of using ArcGIS Online for digital mapping and LMS Schoology as an online learning platform. (c) Engineering: it is in the form of making guidebooks and video tutorials on making maps as a guide for students to be able to make maps independently. (d) Mathematical: it is presented in the form of formula introduction and sample questions. As for the map module, remote sensing, and geographic information systems, there are sub-chapters for calculating map scale, aerial photography scale, and interval contours and slopes. A more detailed explanation of this research method is described as follow.

2.1. Research design

This research consists of two stages, namely, stage I is product development, which consists of potential and problem analysis, data collection, product design, product validation by experts, and revision. Phase II is a trial phase consisting of product testing, evaluation, and revision. The trial to determine the level of product effectiveness was carried out with a research design of one-group pretest and posttest design.

$$O_1 \; X \; O_2 \qquad (1)$$

Description:
O_1 : Pretest value before being given treatment

O_2 : Posttest scores after being given treatment
X : Treatment (use of MOOC content integrated with STEM in mapping basic knowledge materials)

The time for conducting product development trials is in the even semester of the 2020/2021 academic year. The product was tested on class XI IPS 1 MAN 1 Tulungagung students and X IPS 1 SMAN 9 Malang. The subjects were selected by purposive sampling based on location and school criteria. The flow chart of this research and development is presented in Figure 1.

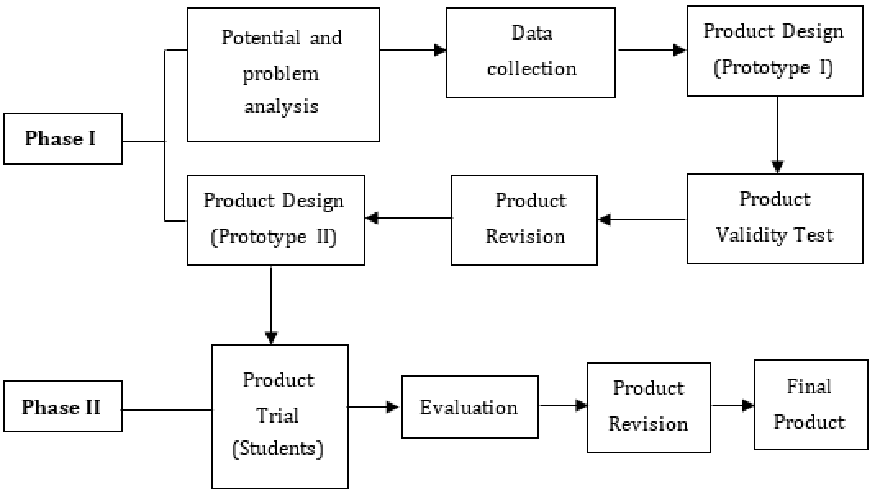

Figure 1. ASSURE Flowchart

2.2. Types and Instruments of Data Collection

The types of data collected in this research and development are quantitative and qualitative data. Qualitative data is written data obtained from comments and suggestions/input from material experts, media experts, and test subjects, which are then used as a basis for product improvement. Quantitative data is data in the form of numbers obtained from the results of product trials in the form of pretest and posttest values. In addition, quantitative data were also obtained from filling out questionnaires by material experts, media experts, and test subjects. The data that has been collected through several instruments is then analyzed to determine the feasibility and effectiveness of the product.

The data collection instruments used were interviews and questionnaires. The interview technique is used to find out specific and in-depth answers from respondents. Interviews were conducted with teachers of geography subjects at the high school/equivalent level to determine the use of TPACK criteria in developing learning models, learning obstacles, and students' general characteristics. The interview results are then used as one of the needs analyses and the basis for product development. The following instrument is a questionnaire given to the validator to assess the feasibility of the product and an evaluation and reflection questionnaire given to students to find out the strengths and weaknesses of the product.

2.3. Data Analysis Technique

The data collected through several instruments is then analyzed to determine the feasibility/validity and effectiveness of the MOOC-based LMS Schoology integrated with STEM on the basic knowledge of mapping to improve students' geographic literacy. The data analysis technique used by Sugiyono (2015) consisted of qualitative and quantitative analysis techniques. The results obtained then become the basis for improvement of product development.

2.4. Qualitative Data Analysis Techniques

Qualitative data in the form of pre-research interviews in Akbar (2016) are then used as a basis for needs analysis. In addition, qualitative data were also obtained from comments and input/suggestions from material experts, media experts, and test subjects. The data is then used as a basis for improvement to obtain a feasible, practical, and efficient product.

2.5. Quantitative Data Analysis Techniques

Quantitative data is data in the form of numbers obtained from the results of validation and test results. The percentage obtained from the material expert and media expert validation questionnaire was then calculated to determine the level of product validity. The formula used to calculate the percentage of data calculation is as follows. The formula for calculating the percentage of product validity data:

$$P = \frac{\sum X}{\sum Xi} X\ 100\% \qquad (2)$$

Description:
P = Percentage
∑X = Total score of respondents
∑Xi = Total score ideal
100% = Constant

After finding the average percentage of the results from the validation questionnaire of material experts and media experts, the meaning of these results is carried out. The meaning is carried out to determine the level of validity of the products developed that have been carried out. The validity criteria in Akbar (2016) are listed in Table 1.

Table 1. Product Validity Criteria

Percentage	Validity Level
85,01% - 100%	Very valid/can be used without revision
70,01% - 85%	Sufficiently valid/usable but needs minor revision
50,01% - 70%	Not enough valid/it is recommended not to use because it needs a major revision
01,00% - 50%	Invalid/can't be used

The next quantitative data is in the form of learning outcomes obtained after the implementation of product trials. The pretest and posttest data that have been tested for normality and show normal distribution results are then continued with the paired sample T-test to determine the significance of the differences. When a significant difference is found between the average pretest and posttest scores, it is continued with the N-gain test. The N-gain score is then used to determine the level of effectiveness of using the product based on the following categories (Table 2).

Table 2. Gain Score Sharing

N-Gain Score	Category
g ≥ 0,7	High
0,3 ≤ g < 0,7	Medium
g < 0,3	Low

Source: Heke (1999)

3. Results and Discussion

The research on developing this learning platform was carried out to achieve predetermined research objectives. One of these goals is to develop a MOOC-based LMS Schoology integrated with STEM on the basic knowledge of mapping to improve students' geographic literacy. The first stage in this development is to analyze the general characteristics of students and the learning situation presented by the teacher when teaching the basic knowledge of mapping. Based on the results of interviews and questionnaires given to several geography teachers, it can be seen that the students of class X specializing in social studies are generally creative, confident, and more active in socializing. As for the learning activities that teachers usually carry out in conveying basic knowledge of mapping, namely the lecture method and giving assignments in the form of drawing school plans and/or maps of Indonesia.

The second stage is reviewing Basic Competencies (BC) and formulating indicators and learning objectives that must be achieved after learning. BC that was implemented is BC 3.2 to understand the basics of mapping, remote sensing, and Geographic Information Systems (GIS) and BC 4.2 to make a thematic map of a province and/or one of the islands in Indonesia based on a map of the earth. The next stage is choosing strategies, technology, media, and teaching materials for learning. The strategy chosen is inquiry learning, a series of teaching and learning activities that prioritizes critical and analytical thinking processes. The technology used is ArcGIS Online, with the hope that students will be able to make maps independently according to predetermined procedures. In addition, technology is also applied as a learning platform, namely LMS Schoology. The media used include pictures and videos, as well as module teaching materials, making it easier for students to understand the material.

The fourth stage is the use or application of the selected technology, media, and teaching materials. At this stage, a development product called Prototype I was produced. The LMS Schoology systematics developed were presented sequentially, namely: (a) an introductory learning video containing an explanation of the design and learning steps that students must follow. (b) Teaching materials for basic knowledge of mapping are arranged in the form of modules consisting of a map module, a remote sensing module, and a geographic information system module. Each module is equipped with learning objectives, pictures and illustrations, explanatory video links and/or barcodes, and practice questions to hone students' skills. (c) A guidebook for making maps using ArcGIS Online, which is equipped with explanations and screenshots or screenshots for each step of map creation. (d) Video tutorial for making maps using ArcGIS Online. This video contains the same content as the manual, so students can choose which media suits their learning style. (e) Discussion forums in each learning activity to facilitate students who want to ask, answer, and express opinions. (f) Questions to measure the level of understanding of students before and after participating in learning. To ensure that the development product is suitable for use, Prototype I was then validated by two experts, material experts and media experts. Furthermore, product improvements were made based on the direction and input of the two experts and were called Prototype II.

The next stage is to realize the participation of students in learning to achieve the second research objective, which is to test the effectiveness and evaluate the product development results to increase students' geographical literacy. This stage begins with conducting a learning style survey followed by all students as test subjects. It aims to determine the suitability of students' learning styles with the product to be tested. The success of teachers in educating can be judged by their understanding of students' learning styles, and then applying learning patterns and methods that are in accordance with these learning styles (Marpaung, 2015). The survey results on the learning styles of the test subjects of this study are presented in Table 3.

Table 3. Learning Style Survey Results

Learning Style	Number of Students	Percentage
Visual	24	56%
Auditorial	2	5%
Kinesthetic	2	5%
Cannot be distinguished	15	35%

Based on these results, it can be seen that the product development approach chosen is in accordance with students' learning styles and is expected to improve their learning outcomes. This result has a relationship with the development model used ASSURE, which consists of analyze learner (potential and problem analysis), which can be seen in Figure 1. After participating in the survey, students participate in learning using development products (Prototype II). The increase in geographic literacy was measured based on the results of the pretest and posttest carried out before and after the implementation of learning. The last stage is evaluation and revision, which is the most important component in this research and development. At the end of the lesson, students are asked to fill out an evaluation and reflection questionnaire. In addition, evaluations were also obtained from comments, input/suggestions from material experts, and media experts. Through the evaluation results, it can be seen at the response and assessment of the products that have been developed. Weaknesses in a product component then become the basis for improvement or revision.

3.1. Improving Geographic Literacy with STEM

Wahyudi (2017) states that e-learning-based learning with Schoology as a supplement has been tested to be attractive, easy to use, useful, and effectively used for learning. This is in line with the research of Farizi, Umamah, and Surya (2021), which states that the learning environment with Schoology is proven effective in improving student learning outcomes. Based on the literature review and needs analysis that has been done, a MOOC-based LMS Schoology integrated with STEM was developed on the basic knowledge of mapping to improve students' geographic literacy. LMS Schoology is available on a website that focuses on collaboration to enable users to create, manage, interact, and share academic content. This is in line with the MOOC method, which is one form of innovation from distance education in the form of online learning on a large scale with unlimited participants and not tied to location. Therefore, the product development was tested on students from two different schools, namely SMAN 9 Malang and MAN 1 Tulungagung. In addition, the trial participants also consisted of two grade levels, namely class X (ten) and XI (eleven).

The learning approach chosen in the development of this product is STEM. This approach is quite flexible and can be packaged in various learning models (Permanasari, 2016). STEM learning requires students to be able to collaborate on generic competencies that include the domains of knowledge, attitudes, and skills. The skill area is closely related to KD 4.2, namely making a thematic map of a province and/or one of the islands in Indonesia based on a map of the earth. In this development product, there are guidebooks, video tutorials, and ArcGIS Online links to give students the opportunity to practice making maps in the form of webmaps. After participating in the exercise, students are directed to work on assignments in the Assignment section by making new maps independently per the provisions provided. The descriptive statistical results of assignment grades are presented in Table 4.

Table 4. Descriptive Statistical Results of Assignment Grades

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Task	43	80	100	97.21	6.296
Valid N (listwise)	43				

Table 4 shows that the task of making a new map obtained the lowest score of 80 and the highest score of 100. The average value of the task was 97.21, with a standard deviation of 6.296. The assessment is based on the students' skills in selecting and adding map layers, basemaps, and symbolization on the maps that have been created, as well as sharing webmaps links on the worksheets provided. A high average value indicates that there are almost no significant obstacles and difficulties. Guidebooks, video tutorials, exercises, and discussion forums assist students in carrying out these tasks.

The integration of LMS Schoology with the MOOC method and the STEM approach on the basic knowledge of mapping is aimed at improving students' geographic literacy. Geographic literacy refers to understanding geographic content, skills in creating and reading information from maps, and using a geographic perspective in interpreting various phenomena. This ability is ultimately intended so that students are able to solve various spatial problems with a sensitive attitude toward themselves and the environment so that the best decisions can be made. The increase in geographic literacy can be seen by comparing test results before and after the implementation of learning using various content presented in development products. The test is in the form of multiple-choice questions that have been validated by material experts with designs to measure mastery of concepts, reasoning, and skills based on learning objectives.

3.2. Geography Literacy Product Validation

This research produces a learning platform in the form of LMS Schoology with the MOOC principle so that anyone and anywhere can access it. The content developed is packaged as lightly as possible so that students easily understand it. The approach used to present the material in each content is the STEM approach. The product in the form of LMS Schoology contains 3 folders: Meeting 1, Meeting 2, and Meeting 3. In the Meeting 1 folder, there are teaching materials in the form of map material modules, remote sensing, and geographic information systems. Furthermore, in the meeting folder 2, there is video tutorial content and a guidebook for making maps using ArcGIS Online, as well as ArcGIS Online links to make it easier for students to practice making maps. The last folder of Meeting 3 contains the Assignment to make maps independently with the given conditions and ArcGIS Online links. At the beginning and end of the meeting, pretest and posttest questions are used to measure the increase in students' geographic literacy. The question refers to the concept of civilizing geographic literacy, according to Kerski.

The level of product feasibility was obtained from the assessment of 2 validators consisting of 1 media expert from an Education Technology lecturer and 1 material expert from a Geography Education lecturer. The results of product feasibility validation from the two experts can be seen in Table 5. Based on these results, it can be seen that the development product is included in very valid criteria with an average percentage of 98.8% in terms of assessing aspects of material/content feasibility, language feasibility, presentation and interactional feasibility, graphic feasibility, and linkages with approaches and methods used.

Table 5. Product D

No	Validation Subject	Validation Percentage Results	Maximum Percentage Gain
1	Material Expert	97,6%	100%
2	Media Expert	100%	100%
	Total	197,6%	200%
	Mean	98,8%	100%

Overall, it shows that the MOOC-based LMS Schoology platform integrated with STEM on mapping basic knowledge material is very feasible to use for learning. Even though it has been declared very feasible, suggestions and input are still received from both experts, so revisions and improvements are needed before the product is tested on students. The revised Prototype I was later called Prototype II.

3.3. Geography Literacy

Geographic literacy in this study is oriented to the opinion of Kerski. All geographic literacy skills were measured using a test consisting of 20 multiple-choice questions. The questions are arranged based on the geography subject matter of basic knowledge of mapping, which is designed to measure students' mastery of concepts, reasoning, and skills. Based on the results of the Kolmogorov-Smirnov and Shapiro-Wilk normality tests (Table 6), it was found that the pretest and posttest scores were normally distributed with a significance value of more than 0.05. First, the significance value Kolmogorov-Smirnov and Shapiro-Wilk normality tests of pretests 0.065 and 0.152 are more than 0.05 (constant). Two, the significance value Kolmogorov-Smirnov and Shapiro-Wilk normality tests of posttest 0.052 and 0.054 is more than 0.05 (constant).

Table 6. Normality Test Results Pretest and Posttest Values

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre_Test	.130	43	.065	.961	43	.152
Post_Test	.134	43	.052	.949	43	.054

3.3.1. Lilliefors Significance Correction

The results of the normality test showed that the data were normally distributed, there was the basis for choosing the next test, namely the paired sample T-Test, to determine the differences in the geographical literacy abilities of students. This test presents the results in Table 7 and Table 8.

Table 7. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post_Test	87.09	43	7.810	1.191
	Pre_Test	54.88	43	14.454	2.204

Table 8. Paired Samples Test

		Paired Differences			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	Post_Test - Pre_Test	32.209	12.692	1.935	16.642	42	.000

Table 7 presents data indicating that the mean pretest score was 54.88, with a standard deviation of 14.454, while the mean posttest score was 87.09, with a standard deviation of 7.810. This reveals that the posttest scores on average surpass the pretest scores. Additionally, Table 8 illustrates a disparity of 32.209 between the mean pretest and posttest values. The significance level (Sig. 2-tailed) of 0.000, being less than 0.05, suggests a noteworthy difference in students' geographic literacy skills before and after the treatment. Following a comparative analysis of pretest and posttest scores, the N-gain score test was conducted to assess the effectiveness of the developed product.

Table 9. N-Gain Score Test Calculation Results

					Statistic	Std. Error
N Gain Score	Mean				.7105	.02602
	Median				.7143	
	Std. Deviation				.17060	
	Minimum				.40	
	Maximum				1.00	
	Test of Normality	Kolmogorov-Smirnov	df	43	.101	
			Sig	.200		
		Shapiro-Wilk	df	43	.958	
			Sig.	.120		

Based on Table 9, it is known that the results of the normality test for a sample of 43 with a confidence level of 0.95 on the N-gain data of students showed a significance value of 0.200 on the Kolmogorof-Smirnov test and a value of 0.120 on the Shapiro-Wilk test. Each value is greater than 0.05 (sig. > 0.05), indicating that the N-gain data is normally distributed. Then, the average N-gain score to determine the product's effectiveness in increasing students' geographical literacy is 0.7105. Referring to the distribution of gain scores according to Heke (1999), the value of 0.7105 (g 0.7) is included in the high category.

Djamarah and Zain (2010) stated that every teaching and learning process always produces learning outcomes, so it can be said that learning outcomes are the end or peak of the learning process. The MOOC-based LMS Schoology product integrated with STEM on the basic mapping knowledge has been declared effective in improving students' geographical literacy. The percentage of students' success in answering posttest questions on each pillar of geographic literacy culture, according to Kerski (2015), is in Table 10.

Table 10. Percentage of Geography Literacy of Students

No	Category	Question Number	Success (%)
1	Geographic Core Content	1, 2, 4, 8, 9, 17	92%
2	Geographic Skills	3, 7, 11, 12, 15, 18, 19	84%
3	Geographic Perspective	5, 6, 10, 13, 14, 16, 20	86%
Average			87%

In the first category, namely understanding geographic core content, the questions consist of mapping, remote sensing, and geographic information systems concepts. Based on Table 10, it can be seen that the average success of students in working on the first category questions is 92%. This figure is the highest percentage of success among the other two categories. This can represent those students who already have a good understanding of the core geographic concepts. The second category is geographic skills, which consist of questions that lead to the process and use of maps, images, and aerial photographs. In this category, the percentage of success is 84%. This percentage is the lowest achievement when compared to other categories. Although students' geographical skills can be said to be good, they still need to be improved in the future. Furthermore, the third category, namely the geographical perspective, consists of questions of reasoning, scale calculations, and geographic decision-making. In this category, the percentage of students' success in working on the questions is 86%. This value indicates that the use of the geographical perspective of students is included in the good category and still needs improvement.

3.3.2. Evaluation of Research and Development Results

Based on a validation questionnaire by a material expert, it was found that the product development on Prototype I had obstacles, namely, the platform was less effective for schools in remote areas or difficult internet networks. In addition, material experts provide input or suggestions for testing on students carried out with flexible times so that students have no reason not to take the test due to network constraints. In this case, it is sought so that students have the opportunity to choose a time and place with a more optimal network. The next suggestion is to consider the selection of schools that are the subject of trials with different characteristics, such as location. Furthermore, in the media expert questionnaire, the results showed that in Prototype I, there were still shortcomings. It means that there was no identity of the maker or product compiler. So this will be a weakness in Prototype I because the assessor will easily manipulate it. Then, for the input column and media expert suggestions, in general, the products developed are good. In other words, it is worth implementing or continuing.

The Prototype I was then improved based on the results of validation by material experts and media experts. Improvements were made in the form of adding personal identities and photos of the compilers of the development products to be uploaded to LMS Schoology with the file name IDENTITY OF THE COMPOSITOR. Then, the product that has been perfected is called Prototype II. Furthermore, the product trial subjects were determined: students from two schools with different locations and characteristics (SMAN 9 Malang and MAN 1 Tulungaggung). In addition, product trials were also conducted at two different grade levels, namely class X (ten) and class XI (eleven). The timing of the trial starts with the pretest, presentation of the material at meeting 1, practice making maps at meeting 2, and making maps independently at meeting 3. In addition, the posttest implementation is also carried out with a flexible time and duration, from 16 to 20 June 2021. At this stage, it is known that the difference in the average results of the assignment and posttest scores is presented in Table 11.

Table 11. Differences in Average Grades for Assignment and Posttest

No	School Name	Class	Average Grades of Assignments	Average Posttest Score
1	SMAN 9 Malang	X IPS 1	98	87
2	MAN 1 Tulungagung	XI IPS 1	97	87

Based on Table 11, it can be seen that the average student assignment scores at MAN 1 Tulungagung and SMAN 9 Malang have differences. In terms of location, SMAN 9 Malang is in the city center, while MAN 1 Tulungagung is on the outskirts of the city. The existence of differences in the smoothness of internet access and completeness of facilities can be one of the triggering factors for differences in the value of students' assignments, which in carrying out these tasks are very dependent on the smoothness of the internet connection. Furthermore, the average posttest scores in both schools showed the same results. There was no difference in the results of measuring the geographical literacy ability of students from two different schools.

Furthermore, the evaluation is carried out by students after they have participated in learning using development products (Prototype II). Based on the results of the spread of evaluation and reflection, it is known that one of the biggest obstacles in the implementation of learning basic mapping knowledge using MOOC-based LMS Schoology integrated with STEM is the difficulty in understanding the material, especially in the sub-chapters calculating map scale, aerial photography scale, slope, and contour. So, this will be a weakness in the MOOC-based LMS Schoology in the geography literacy sub-chapters. As for the constraints on the network and learning devices, in this case, the laptop is not a significant problem because it only occurs in some students. Additionally, there are no significant obstacles to using LMS Schoology as a learning platform. It is in line with the ranking by Sudiana (2016), that LMS Schoology is at the second highest level after LMS Learnboost in terms of ease of use. Percentage of meaningful learning learned by students is presented in Figure 2.

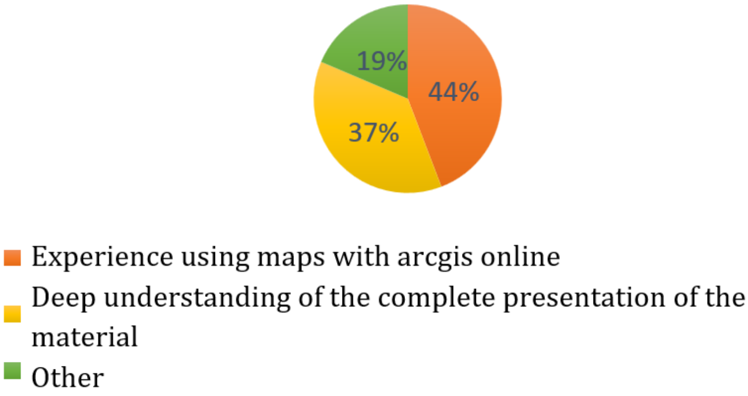

Figure 2. Meaningful Learning Learned by Students

The majority of students stated that they had a meaningful experience making maps using ArcGIS Online. It is in line with the needs analysis results that were carried out before the study; students from both SMA 9 Malang and MAN 1 Tulungagung had never used ArcGIS Online in previous learning. The experience of making maps using ArcGIS Online was presented at Meeting II-Practice Making Maps, which contains video tutorials and guidebooks to help students practice making maps using ArcGIS Online. Then, at Meeting III–Making Maps Independently, the instructions and conditions that students must follow in making maps using ArcGIS Online were presented independently. The use of ArcGIS Online as a form of GIS application in learning needs to be continuously developed. This has been proven to have a contribution to increasing student learning achievement (Arrasyid, Setiawan, & Sugandi, 2019). Furthermore, as many as 37% of the test subject students gained a deep understanding of the basic knowledge of mapping. This understanding was strengthened through the presentation of content at Meeting 1–Concept Strengthening. Learning content was presented at the meeting as module teaching materials equipped with practice questions and videos explaining the material. Presentation of material with various forms of media and flexible time can make it easier for students to understand a material based on their respective learning styles and speeds. Something that interests and is needed by children will certainly attract their attention; thus, they will be serious while learning.

Learning that is fully implemented with an online system (on a network), of course, cannot be separated from the problem of the availability of online learning tools and internet networks. Implementing flexible learning will provide opportunities for students to adjust the time and place of learning according to their individual readiness. This development product has provided meaningful learning for most students through experience making maps using ArcGIS Online.

Suggestions for students are that they can improve their independent study skills and be able to develop map-making skills using ArcGIS Online on other learning materials. In addition, teachers are expected to be able to use and develop e-learning platforms with various learning methods and/or approaches. Teachers must also be able to master geospatial technology and apply it in learning geography. For further researchers, it is recommended always to involve the use of geospatial technology in the implementation of research and development.

4. Conclusion

Based on the results and discussions that have been described previously, the following conclusions can be drawn: (1) Produced development products in the form of learning content with STEM on basic knowledge mapping materials that can improve students' sustainable geographic literacy. This development product has provided meaningful learning for most students in the form of experience making maps using ArcGIS Online. The product is included in the very valid category with a percentage of 98.8%. (2) The test of the effectiveness of using development products in learning shows an increase in gain of 0.7105, which is included in the high category. So, it can be stated that the development product has a high level of effectiveness in improving the geographical literacy of students. (3) Suggestions for students are that they can improve their independent study skills and be able to develop map-making skills using ArcGIS Online on other learning materials. Teachers must also be able to master geospatial technology and be able to apply it in learning geography. For further researchers, it is recommended always to involve the use of geospatial technology in the implementation of research and development.

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