TEXTBOOK DEVELOPMENT ON ADDITIVE AND ADDICTIVE MATERIALS USING INQUIRY BASED LEARNING STEM APPROACH IN INCREASING STUDENT SCIENCE LITERACY

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Abstract. *The purpose of this study was to create a textbook that would serve as instructional resources for additive and addictive materials using inquiry based learning model and STEM approach in increasing students' scientific literacy. The method of this research was development research with ADDIE model. The qualitative data came from suggestions, while the quantitave data came from likert and guttman questionnaire and also the result of SPSS data processing. The result of this research, inquiry based learning with STEM approach made students should be able to recognize scientific problems, describe scientific phenomena, and use scientific data in daily situations. From validation result showed a very valid category, and pretest-posttest result showed an n-gain percentage of 80.17% (very effective). It can be conclude that students' scientific literacy was successfully raised through the use of textbooks that combined the STEM approach and inquiry-based learning paradigm.*

Keywords: *textbook, inquiry based learning model, STEM approach, scientific literacy.*

INTRODUCTION

Enhancing the caliber of human resources required in the twenty-first century, often known as the globalization century, is largely dependent on education. Students study a variety of sciences, including the natural sciences (IPA), in the field of education in order to enhance the caliber of human resources. The purpose of science education is to provide students the scientific literacy abilities they need to think scientifically, comprehend the environment, and solve social problems [1]. However, teacher-centered models and approaches have not been fully implemented in Indonesian science literacy education, nor has the scientific literacy learning process been given full priority. Students become inert in class as a result, and if this keeps up, they will lack scientific literacy and find it challenging to compete in the twenty-first century [2].

A key component of learning science is developing scientific literacy. The capacity to use scientific knowledge in personal, social, and global contexts is known as scientific literacy [3]. Scientific literacy is divided into four levels, namely nominal, functional, conceptual/procedural, and multidimensional literacy. In nominal literacy, students know the name of the concept but do not describe further about the concept. On the other hand, in functional literacy, students already know the information contained in the concept but cannot verify the truth of the concept itself. In conceptual literacy, students can analyze concept relationships, and in multidimensional literacy students can apply concept relationships in everyday life [4]. Scientific literacy is demonstrated by the ability to recognize scientific problems, provide a scientific explanation for events, and apply scientific evidence in daily life [5].

In order to equip pupils with the scientific literacy skills required in the twenty-first century, scientific literacy education is crucial. But according to the PISA evaluation, Indonesia came in at number 74 out of 79 nations [3]. With a percentage of 22.80%, the study found that junior high school pupils'

scientific literacy was extremely low, particularly in Malang. Furthermore, pre-research observations showed that students' scientific literacy skills fell into the low group at a rate of 42.70%. Actually, junior high school, which spans from 13 to 15 years old, is the ideal age to comprehend the nature of science that would be applied in daily life [6]. Factors like repetitive learning environments and a lack of student focus contribute to the low degree of scientific literacy among pupils [7].

Enhancing learning through the use of appropriate and adequate learning models is one strategy to raise students' scientific literacy. The learning model is an *inquiry based learning model* [8]. This learning combines theories previously obtained by students with new evidence collected from the process of finding out phenomena. That way, students will respect the opinions of others, have high curiosity, think critically, logically, and creatively. *Inquiry Based Learning* is a process of acquiring knowledge by conducting experiments to solve problems by asking or finding out. The combination of *inquiry based learning* with the STEM approach also provides very potential results. Scientific literacy research backs this up, demonstrating that inquiry-based learning with a STEM focus may be the best strategy to help children develop the scientific literacy abilities they'll need in the twenty-first century [9]. *Inquiry Based Learning* itself has the syntax of *Orientation, Conceptualization, Investigation, Conclusion, and Discussion activities.* This syntax leads to higher cognitive intelligence and the focus changes from teacher to student [10]. One of the many learning areas that can benefit from the use of the Inquiry Based Learning learning model in conjunction with the STEM approach is science education at the SMP/MTs level, which is best equipped with scientific literacy skills at the 13–15 age range [11]. Science learning with *Inquiry Based Learning* (IBL) STEM approach can be developed on science material that is closely related to everyday life , namely additive and addictive substance material

Materials for additive and addictive substances taught in schools include the meaning, types, effects, and efforts to prevent the dangers of their abuse. However, not all students can understand this material well because the subject matter is too much memorized [12]. This is known from the learning outcomes of additive and addictive substances of students who are in the low category. The findings of field observations and interviews revealed that the information about additive and addictive chemicals is rote and abstract, making it challenging to absorb. Another reason is that the teacher uses the lecture method so that students feel bored. At this time, the teaching materials used are also still monotonous and unable to arouse students' scientific literacy processes.

In studying additive and addictive substance materials, appropriate teaching materials are needed in order to be able to make it easier for teachers to carry out learning that awakens students' scientific literacy. The availability of instructional resources can boost students' enthusiasm to learn, keep them from getting bored, and improve their comprehension of the material [13]. One of the teaching materials is textbook. Textbook is a teaching material made by teachers to prepare for systematic and practical learning. With the existence of textbook, in addition to making it simpler for teachers to provide or clarify content, students should be able to practice on their own, have the courage to voice their thoughts, and enhance their logical thinking skills. The textbook is structured in such a way as to emphasize to students that students must optimally master the lessons presented. The Textbook is equipped with various kinds of media such as animation, video, images, audio, and is equipped with evaluation activities to determine the level of student mastery [14]. The textbook consists of several elements, namely learning objectives, basic instructions, activity sheets, exercises, and evaluations that allow immediate feedback [15]. Based on the explanation above, it is possible to *Develop a Textbook on Additive and Addictive Materials Using Inquiry Based Learning Model STEM Approach In Increasing Students' Scientific Literacy* to support the needs of abilities in the 21st century. The use of textbooks as teaching materials is expected to be a useful learning resource for students [13].

METHOD

This research uses *Research and Development (R&D)* , namely developing and

validating educational products to be applied in learning [16]. The research design was *a pre-experimental one group pretest-posttest design* conducting a test at the beginning before treatment, giving treatment, and conducting tests at the end of treatment. This research design can make comparisons of variables from the same experimental group [17]. The final output is a textbook that addresses additives and addictive drugs using a STEM approach and an inquiry-based learning style. The development model is the ADDIE model, one of the systematic learning design models and has been applied in many media design and development methodologies [16]. Analysis, design, development, implementation, and evaluation are the five phases that make up the ADDIE model.

Figure 1. Development Model [18]

The research subjects were 28 students of class VIIIC junior high school, while the object of research was teaching materials for additive and addictive substances with an *inquiry-based learning model based* STEM approach. The data obtained from this study are qualitative and quantitative. Qualitative data comes from suggestion and responses from supervising lecturers, validators, teachers, and students. The quantitative data comes from needs analysis assessments, material validation questionnaire, media validation questionnaire, correctness of concepts validation questionnaire, teacher practicality test, student readability test, and student effectiveness test. Data collection instruments were interview and observation sheets for teachers and students, needs analysis questionnaires, validation of material, media, and correctness of concepts, as well as tests of practicality, readability, and student effectiveness.

Analysis is the initial step. The analysis activity's goal is to examine the necessity of creating instructional materials using a specific model or methodology in order to raise students' scientific literacy. The analysis was carried out by studying literature, interviewing science teachers, and observing the state of learning at school, as well as distributing questionnaires to analyze students' initial abilities regarding scientific literacy. After the analysis, proceed with the design stage. Planning for the creation of instructional materials is done during the design stage by looking at the curriculum, KI, KD, IPKD, and the necessary learning objectives. Additionally, creating textbook-style teaching materials and learning scenarios based on the findings of the earlier analysis [16].

Development or development is the third step. During the development phase, the design of instructional materials is implemented. In carrying out this stage, there is an important goal, namely to realize teaching materials for teaching and learning to achieve learning objectives. Products that have been developed must go through the test and revision stages so as to produce the final product to be implemented in learning activities. Product testing includes media validation tests, materials, and the correctness of the concept. After being validated, it is then tested for practicality and readability. An experienced validator conducted the validation test to determine the validity of the previously created media. However, the purpose of the instructor practicality and student readability tests is to ascertain whether the instructional materials being created are feasible [16].

Media validation test, material validation, practicality test, and readability test using a *Likert scale* 1 - 4. The assessment criteria are shown in table 1.

Table 1. *Likert Scale Criteria*

Scale	Criteria
1	Strongly disagree
2	Don't agree
3	Agree
4	Strongly agree

The formula is used to calculate the Likert scale

$$N = \sum T \; x \; Pn$$

N = total value
T = total respondents
Pn = selected Likert scale

Then look for the Y value, which is the highest Likert scale multiplied by the number of respondents. Percentage can be calculated by equation 1.

$$Percentage\ \% = \frac{N}{Y} x\ 100 \quad \ldots(1)$$

in order for the data to be shown using the standards shown in Table 2.

Table 2. Percentage of Likert Scale Criteria

Percentage (%)	Criteria
0 – 25	Totally invalid
26 – 50	Invalid
51–75	Valid
76 – 100	Very Valid

The use of a scale of 1-4 so that respondents choose one side, namely the positive or negative side [19]. In the meanwhile, the Guttman scale, which has a scale value of 0–1, is used in the validation test to see whether the concept is correct.

Table 3. *Guttman* Scale Criteria

Scale	Criteria
0	It is not in accordance with
1	In accordance

Guttman scale analysis using equation 2.

$$Percentage\ (\%) = \frac{\sum xi}{\sum x}\ x\ 100 \quad \ldots(2)$$

P = Percentage of results (%)
xi = Value obtained
x = Maximum value
After being analyzed, the percentage of criteria can be interpreted as table 4.

Table 4. *Guttman* Scale Criteria

Percentage (%)	Criteria
0 - 50	Invalid
51 - 100	Valid

Guttman scale aims to display answers that are firm/definitely appropriate or inappropriate [20].

Applying the previously created instructional materials to the real-world circumstances and settings in the classroom is the goal of the following stage, known as implementation. The implementation phase's primary goal is to guide students toward achieving learning objectives, facilitate students to solve problems, and know that students' abilities have increased at the end of learning. In the implementation stage, a pre-arranged scenario is needed to create the desired learning process [16].

An evaluation was conducted in this study in order to improve the research. Both formative and summative assessments were included in the evaluation. In order to make improvements as quickly as possible, formative assessment is done during the stages of analysis, design, development, and implementation. Formative evaluation consists of reviews by supervisors, validator lecturers, teachers, and students. While summative evaluation is carried out to ensure the achievement of the overall research objectives. At the evaluation stage, data were collected on effectiveness to improve the teaching materials that had been developed [16]. Pretest efficacy information The t-test and n-gain test were used to examine the posttest. To find a significant difference between the pretest and posttest data, use SPSS software to perform a T-test. The following is the hypothesis.

1. H_0, which states that the pretest and posttest results do not differ significantly
2. H_1, which states that the pretest and posttest results differ significantly.

When the significance is > 0.05, H0 $_{is}$ accepted and H1 $_{is}$ rejected, and when the significance value is <0.05, H1 $_{is}$ accepted and H0 $_{is}$ rejected [21]. Once the significance is known, the n-gain test is carried out in order to see the effectiveness of using textbook. *N-Gain* test analysis with equation 3.

$$g(\%) = \frac{nilai\ postest - nilai\ pretest}{nilai\ maksimum - nilai\ pretest} x\ 100 \quad \ldots(3)$$

g (%) = percentage test *N-Gain*
After getting the percentage value, the data can be interpreted as table 5 [22].

Table 5. Percentage of *N-Gain Criteria*

Percentage (%)	Criteria
0 – 25	Very ineffective
26 – 50	Ineffective
51–75	Effective
76 - 100	Very effective

RESULT AND DISCUSSION

In order to improve students' scientific literacy, this study used the inquiry-based learning model STEM approach to create learning materials in the form of textbooks on additive and addictive drugs. The ADDIE paradigm, which comprises the phases of analysis, design, development, implementation, and evaluation, was used in the creation of this instructional resource. Data on the need for instructional materials on additive and addictive chemicals with suitable models and ways to improve students' scientific literacy was gathered throughout the analysis stage. According to the findings of the analysis of students' scientific literacy skills, 42.70% of them have low scientific literacy skills, indicating the need for a rise in scientific literacy.

Design is the second step. Planning for the creation of instructional materials is done during the design phase by going over the curriculum, KI, KD, IPKD, and necessary learning objectives. Furthermore, using the findings of the prior needs analysis to build learning situations in the form of lesson plans and teaching materials in the form of textbooks. The selected content is addicting and cumulative, and it has a direct connection to the issues junior high school pupils face. Additionally, this content is teacher-centered and rote, therefore an inquiry-based learning model and a suitable STEM approach are required to help students develop their scientific literacy abilities by enabling them to recognize scientific problems, explain phenomena, and apply scientific evidence.

Table 6. Design Models, Approaches, and Indicators in The Textbooks

Model	Approach	Indicator
Orientation	*Science, technology*	Identify scientific issues
Conceptualization	*Science, technology, engineering*	Explain scientific phenomena
Investigation	*Science, technology, engineering, mathematics*	Determine scientific problems and provide explanations for scientific phenomena
Conclusion	*Science*	Explain scientific phenomena
Discussion	*Science, technology*	Using scientific evidence

The third stage is the development stage, during which the design of instructional materials is realized.

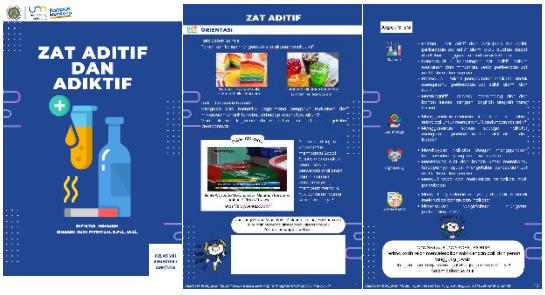

Figure 2. Design of Textbook Teaching Materials

Using the STEM methodology and the inquiry-based learning syntax, the textbook teaching materials are organized methodically and practically. Students begin learning from the orientation, conceptualization, investigation, conclusion, and discussion stages in this textbook. Students can recognize scientific problems, describe phenomena, and use scientific evidence at every level. This learning textbook is equipped with various features that can be utilized by students such as an information corner, a *games corner*, a scientific quiz, a facts corner, and a character corner. Technology-based features are presented such as the use of *QR codes*, *live worksheets*, links, learning videos, and so on. The textbook concludes with assessment questions pertaining to students' scientific literacy skills. It is anticipated that textbook teaching materials that are methodically created using suitable models and methodologies will be able to improve students' comprehension of the subject matter and scientific literacy.

After going through the development stage, the teaching materials are then tested for validity. The validity test includes media validation tests, materials, and the truth of the concept. Table 7 displays the validation test results.

Table 7. Validation Results

No	Validation	Mark	Criteria
1	Media	93.75%	Very valid
2	Material	84.25%	Very valid
3	Concept Truth	100%	Very valid

These statistics demonstrate that the media's legitimacy is based on very reliable standards for appearance, navigation, features, illustrations, language, and other areas. The validity of the material is also in the very valid criteria of grammatical feasibility, suitability of content, suitability of models and approaches, and suitability of evaluation questions with scientific literacy. The validity of the correctness of the concept is in the very valid criteria, which means that the conceptional concepts compiled in the textbookes are suitable for implementation in learning.

After conducting the validation test, it is continued with practicality and readability tests. The results of the test are presented in table 8.

Table 8. Practicality and Readability Test Results

No	Test	Mark	Criteria
1	Practicality	96.60%	Very valid
2	Legibility	92.04%	Very valid

Based on these data, it is known that the textbook teaching materials developed are in very valid criteria from the practicality test by the teacher and the readability test by students. So that this textbooke can be applied to learning in the classroom.

After the product developed is declared very valid, it is followed by implementation in the classroom with pre-designed scenarios and teaching materials. Students are asked to work on *pretest* questions to find out students' initial scientific literacy at the beginning of the meeting. Then, conducting trials of giving treatment in class, and at the end of the meeting, students do *a posttest* related to the implementation of learning using the developed teaching materials. The *pretest* and *posttest* questions totaling 15 questions are arranged based on the level of scientific literacy and indicators of scientific literacy.

Table 9. *Pretest-posttest* Evaluation

Levels	Indicator	Question number
Nominal	Identify scientific issues	1, 6, 7, 11
functional	Explain phenomena	2, 3, 5, 8, 12
Procedural/ Conceptual	Using scientific evidence	4, 9, 10, 13, 14, 15

In this study, the evaluation consisted of formative evaluation and summative evaluation. Formative evaluation is carried out at the analysis, design, *develop*, and implementation stages with the aim of making improvements as soon as possible. Formative evaluation consists of reviews by supervisors, validator lecturers, teachers, and students. While summative evaluation is carried out to ensure the achievement of the overall research objectives. The evaluation stage is to collect effectiveness data from the results of *the pretest* and *posttest* to evaluate the teaching materials being developed to make them more effective.

To ascertain the importance of the independent variables to the dependent variable, a t-test was used in this assessment analysis. Table 10 displays the T test results using the SPSS program.

Table 10. T-test Results

	std. Deviation	t	Sig.(2-tailed)
Pair 1 *Pretest-Posttest*	7,398	-23,885	.000

H1 is accepted and H_0 is denied since the significance level is less than 0.05, indicating that the pretest-posttest findings differ significantly. After that, *the n-gain was analyzed* with SPSS which is shown in table 11.

Table 11. *The n-gain test results*

Pretest	*Posttest*	Difference	*N-Gain*	Percentage and criteria
58.30	91.69	41.69	0.8	80.17% (Very effective)

One of the extremely successful criteria is the N-Gain value, which measures how well

textbooks on additive and addictive substance topics work with the STEM approach inquiry-based learning paradigm. This is consistent with research by Abdurrahman (2019) and a number of other studies that show that the STEM approach combined with an inquiry-based learning model can be the best way to help students develop the scientific literacy abilities they will need in the twenty-first century.

CONCLUSION AND SUGGESTION

In order to improve students' scientific literacy, this study created a textbook on additive and addictive content utilizing the STEM inquiry-based learning model. As a result of this study, students were able to recognize scientific problems, describe scientific occurrences, and use scientific evidence in their daily lives through inquiry-based learning using a STEM approach. From this research, media validation data was obtained at a percentage of 93.75% (very valid); material validation 84.25% (very valid); concept correctness 100% (very valid); teacher practicality test 96.60% (very valid); student readability test 92.04% (very valid); the percentage of N-Gain was 80.17% (extremely effective), and the effectiveness test of the pretest and posttest findings revealed a significant difference between the two using the t-test. According to the statistics, using a textbook in conjunction with the STEM inquiry-based learning methodology is a highly legitimate and successful way to help students develop their scientific literacy. Suggestions for further research, inquiry based learning model and STEM approach can be applied to many other science materials to increase students' scientific literacy.

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