Development of STEM Learning Based on Riverbanks Local Wisdom

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Abstract. Rivers are the heart of people's lives in various countries, including Indonesia. Various local wisdoms of riverbank communities are the cause of the formation of people's thinking patterns and attitudes in carrying out scientific, technological, mathematical, and engineering (STEM) innovations. However, riverbank local wisdom and STEM learning are often considered a challenge in itself, taught separately, and receive less attention from science teachers. The purpose of this paper is to develop STEM learning based on riverbank local wisdom as outlined in learning books. Therefore, this paper will report on the use of research and development designs to produce an appropriate STEM learning book based on riverbank local wisdom. The feasibility assessment involved five experts on local wisdom and STEM learning. Suggestions and inputs from experts are taken into consideration in the revision of this book. The results of the feasibility show that the developed book has met the aspects of design, format, material, language, and innovation. Thus, STEM learning books based on local riverside wisdom are feasible and can be continued in the implementation test in the classroom.

1 Introduction

Rivers are the heart of life for people in various countries. For example, the Nill (6,650 km) passes through Ethiopia, South Sudan, Sudan, Egypt, Congo, Kenya, Eritrea, Tanzania, Uganda, Burundi and Rwanda; the Amazon river (6,400 km) in the Americas; the Yangtze River (6300 km) in the Qingthai-Tibetan plateau; the Mississippi river (6,275 km) in North America; the Yenisei river (5,539 km) in Mongolia; the Yellow river (5,464 km) which flows through 9 provinces in China; the Mekong (4,350 km) through China, Laos, Cambodia and Thailand; and in Indonesia flow by major rivers such as the Kapuas river (1,143 km), the Mahakam river (920 km), the Barito river (900 km), and others. These rivers become transportation routes, trade, fisheries, agriculture, tourism, even some people use riverbanks as their residence [1]. Various activities of community life on this riverbank have directly or indirectly shaped the local wisdom of the riverbank community [2]. Local wisdom becomes a means of cultivating culture and defending oneself from negative foreign cultures.

Local wisdom becomes a way of life and knowledge, as well as various life strategies in the form of local community activities in solving problems in fulfilling their daily needs [3]. In South Kalimantan Indonesia; Local wisdom along the Barito river becomes their identity or personality that causes them to be able to maintain and use it for mutual welfare [4]. Local wisdom of the people along the Barito river can be in the form of regional culture, skills, entrepreneurship, arts, and crafts [5]. Local wisdom is taught from generation to generation, passed down from generation to generation. For example: making Jukung, Sasirangan cloth, Panting music, Pesam, river fishing, and others. These various local wisdoms are the cause of the formation of mindsets and attitudes of riverbank communities in innovating Science, Technology, Engineering, and Mathematics (STEM) to solve the problems of life on the riverbanks. Therefore; Learning local wisdom in schools alone is not enough to prepare students for success in life and careers. Therefore, the integration of local wisdom in STEM learning is believed to be able to build the concept of science and its application in solving riverbank problems [7].

In the Industry 4.0 era; STEM learning is believed to be the main driver for the country's economy and the glory of the nation [8]. Various STEM products have colored human life activities [9]. These products can be found in home appliances, schools, health, industry, entertainment venues, and others. Therefore, STEM learning has received major attention from various countries in the world [10]. STEM itself is interpreted as a learning approach that integrates the fields of science, technology, engineering, and mathematics in solving problems of everyday life [11]. Science involves

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mathematics as a data processing tool, while technology and engineering involve the application of science [12].

Science is compiled based on the results of observations/experiments and mathematical reasoning to explain natural phenomena. Science learning involves a scientific process to seek and discover the meaning of science, including through inquiry, discovery, and exploration [11] [13]. For example: a submarine is a form of applying hydrostatic pressure to a static fluid so that humans can dive into the depths of the ocean. Technology is human innovations to modify nature to meet the needs of life and its desires [14]. Technology is concerned with what can and should be (designed, made, and developed) from natural materials and natural materials, to meet human needs and desires. Several processes are used in technology that will be experienced by the submarine when it is in the water. Meanwhile, mathematics is concerned with patterns and relationships, or providing the right language for technology, science, or engineering. Today, technological innovation is increasing along with the development of mathematics [12]. For example: calculating the maximum depth for a submarine to dive in water.

The integration of STEM in science learning can increase students' interest in STEM and choose their future STEM career path [17][8][9]. In fact; most science teachers lack mastery of STEM content and pedagogy, negative beliefs about STEM, let alone teach it in class [18]. As a result; students are not interested in learning STEM during the educational stage, even from an early age [19]. Therefore, the current challenge in the world of education is how to apply STEM teaching and learning that is emerging today. In addition, science learning will be more meaningful if it not only integrates STEM, but also integrates local wisdom [7].Every human activity in the environment or local wisdom is inseparable from STEM literacy.

The development of STEM learning based on local wisdom is expected to facilitate the STEM thinking process in interpreting local wisdom, maintaining and improving the quality of local wisdom to support students' lives and careers in the future. In addition, students better understand cultural values, improve the STEM learning process, and develop their role in everyday life. The integration of local wisdom in STEM learning provides a comprehensive, meaningful, and unique experience [20]. This integration greatly facilitates the implementation of science learning based on characteristics from close to far, simple to complex, and from concrete to abstract. Therefore, the purpose of this paper is to develop STEM learning based on riverbank local wisdom as outlined in learning books.

2 Methodology

This research uses research design and 4D model development; but only limited to the design, define, and develop stages as presented in Figure 1.

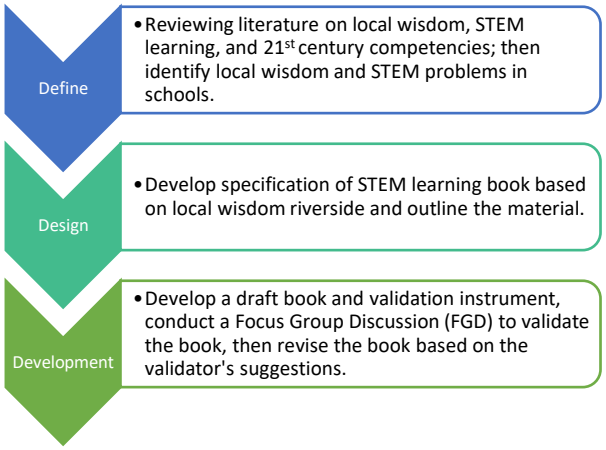

Fig. 1. Research design of STEM learning books based on local wisdom

The stages in the research and development of this book begin at the define stage. Researchers tried to study local wisdom on the riverbanks; local content curriculum, STEM learning, and 21st century competencies; followed by identification of local wisdom problems and STEM learning in schools. This identification is the first step in designing a book. In the Design phase, the researcher compiles the specifications of the book to be developed.

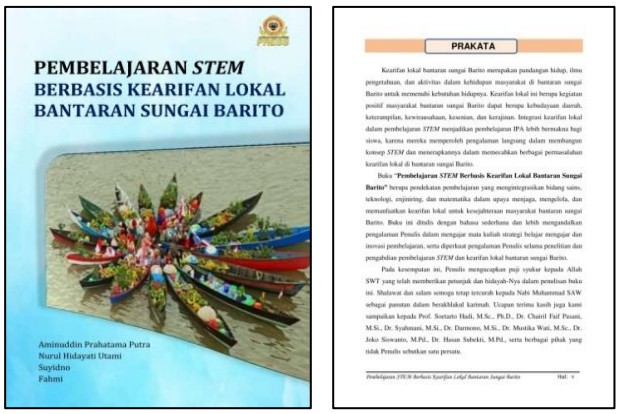

Fig. 2. Design of local wisdom-based STEM learning books

Next in the development stage, the researcher prepares an initial draft of the book referring to Table 1. The writing style uses simple and general language and relies more on the experience and insight of the researcher so that it is easy to learn and understand by the general public. In addition, a validation instrument for the book was developed. The book validation instrument has been declared valid and reliable. The cover and foreword of the developed book are presented in Figure 2.

Book validation through Focus Group Discussion on October 5, 2021 and attended by 2 experts on learning local wisdom along the Barito river and 3 experts on STEM Learning. Validation to measure aspects of material content, format, readability, and innovation. The data from the validation results were analyzed descriptively qualitatively, namely the average score (P) from the expert validation results adjusted to the assessment criteria very valid, valid, moderate, and

lacking; and also performed reliability analysis using Cronbach Alpha 0.77 and it is reliable. Based on expert advice and input; researchers make revisions so that a valid book is produced. The outline outlines the material as presented in Table 1.

Table 1. Design of local wisdom-based STEM learning books

Material Outline		Value-Criteria
The Beginning	Cover, foreword, preface, table of contents, table of tables, and list of figures.	3.85 (very valid)
Chapter 1 Introduction	Background, purpose and benefits of writing	3.80 (very valid)
Chapter 2 Riverbank Local Wisdom and STEM learning	Characteristics of riverbank local wisdom, STEM and STEM learning, and the relationship between local wisdom and STEM	3.80 (very valid)
Chapter 3 STEM Learnig Based on Local Wisdom	Definition, objectives, planning and implementation of learning (direct teaching, guided inquiry, guided discovery, project problem-based learning)	3.60 (very valid)
Chapter 4 Implementation of STEM Learning Based on Local Wisdom	Examples of implementation on materials for dyeing sasirangan fabrics, panting music, makasam, and mamanda	3.60 (very valid)
Chapter 5 Implication of STEM Learning Based on Local Wisdom	Implications for educators, students, teaching materials, and infrastructure	3.80 (very valid)

3 Results and Finding

3.1 Characteristics of STEM Learning Based on Local Wisdom

The surrounding environment is able to arouse students' interest and motivation in learning STEM [8] Utilization of the surrounding environment (local wisdom) as a learning resource makes learning more meaningful for students [21]. This is what underlies the importance of integrating local wisdom and STEM in science learning. For riverbank communities, local wisdom can be interpreted as a view of life, knowledge, and community life activities on riverbanks to meet their daily needs [3]. Meanwhile, STEM learning is a teaching and learning approach that integrates the fields of science, technology, engineering, and mathematics to solve life problems [17][8] Thus, STEM learning based on riverbank local wisdom can be interpreted as a learning approach that integrates STEM fields to solve riverbank local wisdom problems. The learning in question is not a learning model, but a STEM learning approach to solve the problem of local wisdom in riverbank communities. The learning objectives were adapted [21] and presented in Figure 3.

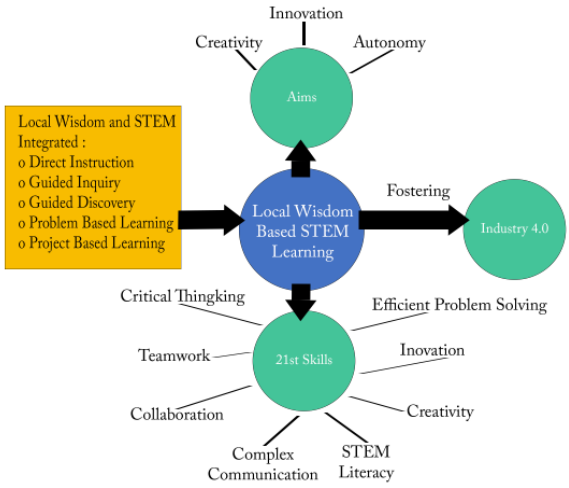

Fig. 3. The objectives of STEM learning based on local wisdom

Based on Figure 3; The purpose of STEM learning based on local riverside wisdom is to equip students with 21st century skills, namely critical thinking, team work, collaboration, complex communication, STEM literacy, creativity and innovation, and efficient problem solving. Students are equipped with 21st century competencies to become creative and innovative generations in life and careers in the industrial era 4.0 [21]. In this case, students are encouraged to recognize the problem of local wisdom along the river; then apply the STEM thinking process to build a concept or product engineering to overcome the problems it finds [16][18] Learning planning includes target setting, analysis of riverbank local wisdom and KI/KD science subjects, conducting crosscutting concepts (concepts that bridge boundaries in the STEM field and local wisdom issues), compiling learning indicators, compiling learning tasks along with the logistics. The implementation of learning can use the innovative models in Figure 4.

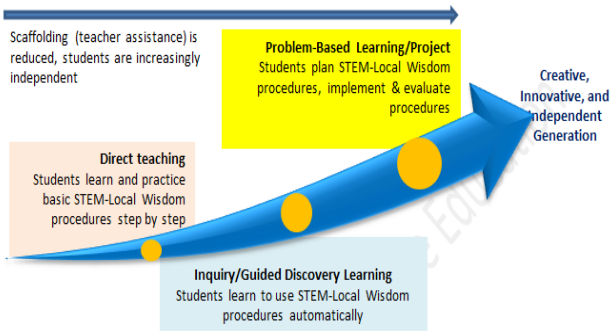

Fig. 4. Implementation of STEM learning based on local wisdom

Based on Figure 4, the best learning is learning that makes students feel happy and understand the material being taught [19]. Therefore, the implementation of STEM learning based on local wisdom is divided into three levels. This division is according to the level of autonomy (independence) of students in learning [22]. Level I, the lowest level, where students have not mastered the basic information and procedures of STEM based on local wisdom well. Educators can use direct teaching to teach these basic information and procedures step by step. Level II, when students mastered the basic information and procedures of STEM based on local wisdom well; educators begin to apply guided inquiry learning or guided discovery. Level III (the highest level) as the realization of the view of constructivism. Students are facilitated as creative, innovative, and autonomous learners in applying STEM thinking based on local wisdom in building concepts and product engineering to solve real-life problems [16].

3.2 Results of Validation of STEM Learning Books Based on Local Wisdom

Book validation to measure the quality of STEM learning books based on riverbank local wisdom in terms of material, format, readability, and innovation aspects. The results of the book validation are presented in Table 2.

Table 2. Design of local wisdom-based STEM learning books

Assessment Aspect	Validity		Reliability	
	Value	Criteria	α	Criteria
Material	3.61	Very valid	0.93	Very Reliabel
format	3.65	Very valid	0.85	Very Reliabel
Limitations	3.52	Very valid	0.88	Very Reliabel
Innovation	3.52	Very valid	0.75	Very Reliabel

Based on Table 2, all aspects of book validation have met the valid and reliable criteria. The validity of the material related to the coherence of the content and construct of the book material has met the valid criteria. The existence of coherence greatly facilitates the reader in understanding the flow of the material so that the achievement of learning objectives is maximized [22]. Book contains the main idea, supporting material, material examples, and conclusions [23]. The systematic arrangement of ideas is one of the determinants of the quality of writing [24]. Coherence is also found in the writing of this book format, which starts from the bottom line or main idea, followed by a more detailed supporting study. Aspects of the format of the book developed is categorized as very valid.

The format for writing a STEM learning book based on riverbanks local wisdom that is free according to the author's character and purpose is the main characteristic of this book. In order to attract people's reading interest, in general the books developed are written in detail but in a simple format. In this category, the developed book is categorized as very valid. This can be seen in the STEM learning book based on local wisdom along the river which is equipped with data and methods for its application in learning. The method is made simpler, combining scientific work with the local wisdom of the riverbank communities, so that the learning that is carried out feels direct benefits and real examples in their lives. Learning is more meaningful if students are actively involved in finding concepts from facts in the environment through direct observation and experimental methods [25]

The readability of the book has met the valid criteria. Means; This book is appropriate for the age or education level of the student. Readability of books affects the achievement of understanding the concept of reading results. This book is written in simple and easy-to-understand language so as to improve student learning outcomes. Language includes word choice, sentence structure, and paragraph structure. Visual includes typesetting or typography which includes letter size, line density, and writing width. The material described in good and clear sentences is expected to make it easier for students to decide a problem. A good book is written using an active and interesting sentence structure [26] state the need for clearer, firmer and convincing quotations in the development of written works [24]. it also explains that the use of active sentences is needed in book writing to provide a complete picture of what the reader wants. In this case, students can be motivated to learn STEM and choose a future STEM career path [8].

In addition to using active and interesting sentences, this book is also written in communicative sentences. In order to strengthen the firmness of the description, the book developed must minimize doubtful words or sentences. The use of straightforward and unambiguous words in the developed book obtained a very valid category. The descriptions in the book can be easily understood and do not confuse students. [27] explained that subject matter must tend to be easily understood by readers so that learning objectives are achieved. Communicative sentences are preferred by readers and increase the number of readers and readability of writing.

A good and systematic presentation of material in a STEM learning book based on riverbank local wisdom will certainly be able to provide a good understanding. In order to achieve this, it is necessary to have definitions and explanations of scientific concepts in the developed books. Aspects of definitions and explanations in this book are categorized as very valid so that in general the contents of the book will be easily understood by readers, making it easier for them to learn [29]. It definitions, explanations, examples, analogies, or metaphors are needed to facilitate the reader's understanding.

So that readers do not feel bored when learning and interacting with STEM learning books based on local riverside wisdom, innovations are made in the form of sentences or narratives that are entertaining or fun. In this aspect, the developed book obtained a very valid category. Narrative is needed to convey the content of the material and is one aspect of the feasibility of writing textbooks on science [27].

The five validators in addition to providing an assessment of the validity of the book, but also provide suggestions for improvement to improve the quality of the developed book. Suggestions for improvement given by the five validators are presented in Table 3.

Table 3. Summary of suggestions from the five validators in the Focus Group Discussion

Suggestions for Improvement from the Five Validators		Description
Book's contents	▪ The image of Silo, Webbed, and Integrated approaches in STEM should use creative and attractive images	Has been revised
	▪ Various local wisdoms along the Barito river should be given some examples of pictures	Has been revised
	▪ Examples of dominant learning in the field of physics, should also be given examples for the fields of chemistry, biology, and science.	Has been revised
	▪ Learning can develop life and career skills (religious, character); it's not clearly written in the book, it still needs to be emphasized.	Has been revised
	▪ Learning support KBM is colored by learning to know, learning to do, learning to be yourself, and learning to live together; it is not clearly written in the book, it still needs to be emphasized.	Has been revised
	▪ The depth of the material also needs to be considered again adjusted to the needs in learning.	Has been revised
	▪ It is necessary to add a local wisdom video link to enrich the reader's understanding	Has been revised
	▪ Each model should be equipped with lesson plans and worksheets so that readers not only understand the concept of the model.	Has been revised
Book's construction	▪ There are very long paragraphs, which should be simplified into 2 paragraphs.	Has been revised
	▪ Consistency in writing terms, correcting typos, spelling, and words.	Has been revised
	▪ Book layout and image visualization need to be improved	Has been revised
	▪ If possible, add an index.	Has been revised
	▪ Fix the STEM front cover, where the misaligned M position feels a bit annoying to the reader	Has been revised
	▪ The glossary should add terms or other words	Has been revised

After revisions were made according to the validator's suggestions, it can be said that the STEM learning book based on local wisdom along the riverbanks in criteria is very valid for use in science learning. All validity criteria have been met. This book was developed with the hope of attracting teachers' interest in reading to improve STEM content and pedagogy based on local wisdom. In addition, students are expected to be more interested in learning STEM based on local wisdom and choose a STEM career path in the future.

4 Conclusion

The STEM learning book based on riverbank local wisdom was developed to meet the demands of the world of education in the industrial 4.0 era. This book has met the criteria of validity in the aspects of material, format, readability, and innovation. The advantages of this book include the presentation of material using simple language, easy to understand, and related to the community environment along the river. Add to that the main implication of this research is that this book serves as empirical evidence for other countries who wish to research local wisdom in Indonesia. The weakness of the research is that it is still in the feasibility (validity) stage. Further research needs to be done at the implementation stage to obtain practicality and effectiveness data.

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