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STEM Based B-Netra as a Media to Foster Scientific Literacy of Students with Visual Impairment

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Abstract. The purpose of this study is to develop the STEM-based B-Netra as a learning media to promote the scientific literacy of visual impairment's student. This study employed an R&D approach with the 4D procedure. It consisted of define, design, develop, and disseminate stages. The Design stage involved the media. The Develop stage involved validating the media content validity. The content validity was conducted using the Delphi technique with three experts (learning technology expert, science education expert, and linguist). The data collecting by questionnaire using Likert scale. Data were analyzed by descriptive statistics to determine the quality of the media. This study succeeded in developing a media called B-Netra, a STEM-based media that can be used to train elementary school students' scientific literacy. The quality of the media is in the very good category based on the assessment of learning technology experts, while science education experts and linguists said the quality is good. Overall, B-Netra was evaluated as a good media to foster scientific literacy of Visual impairment students. It is hoped that B-Netra can facilitate the delivery of science materials to students with visual impairment so that they can gain various experiences with science in a fun way.

INTRODUCTION

Literacy is one of the most crucial skills for dealing with the difficulties of the twenty-first century. Similarly, in 2015, the World Economic Forum claimed that foundational literacies, problem-solving capabilities, and character qualities are the most important components of 21st-century existence [1]. Scientific literacy is a type of literacy that requires improvement in relation to foundational literacies and problem-solving.

Until date, it has been assumed that scientific literacy can increase students' potential and competitiveness. According to the National Science Education Standards, scientific literacy skills put a strong emphasis on the application of concepts and science in solving a problem [2]. In response to this demand, effective pedagogical patterns must be designed so that students can collaborate, think critically and creatively, and be scientific and technology literate [3]. In fact, however, scientific literacy in Indonesia remains poor. In 2012, UNESCO discovered that Indonesia's reading index was 0.001. Based on this finding, it was able to deduce that just one out of every thousand people in Indonesia had developed a reading habit [4]. A recent survey conducted by PISA (Program for International Student Assessment) in 2018 showed that Indonesia's scientific literacy ranked in the bottom sixth with an average score of 396, compared to most other OECD countries with an average score of 489 [5]. According to the result of the study, Indonesian students' scientific literacy is still far behind that of other nations. The small quantity of science learning resources in Indonesia, which largely comprise instructional materials, may contribute to the country's low literacy rate [6]. Research from [7] shows that most of the scientific literacy (67%) of Indonesian students are at the nominal level and the students are at the functional level. 67% of these students already have concepts to connect science with other disciplines, can write scientific terms, but they still have misunderstandings. Meanwhile, students who understand the theory and explain the concept correctly, but they have limited understanding and find it difficult to explain the concept with their own opinion.

Visual impairment ness is a condition in which a person's sense of sight is warped, resulting in vision limits [8]. Despite their limitations, persons with visual impairment can nevertheless harness the potential of the other five

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senses, such as hearing (audio) and touch (kinesthetic and tactile), for the purpose of learning. Various tools have been developed to assist Visual impairment people, however not all of the tools produced can be accessed and utilized by all Visual impairment people because practically all existing tools, particularly technology-based ones, are rather expensive. Furthermore, the instruments utilized are rigid and difficult to utilize in some situations.

Students with visual impairment have special needs in the form of Braille to support their reading and writing skills. If the basic skill of reading and writing has been mastered well, it will be easy for students to learn knowledge and information in a more complex learning process [9][10] stated that students with virtual impairment can be helped by learning media assisted by assistive technology. Students with visual impairment s are similarly affected by the scarcity of scientific learning tools [9].

This is what causes students with virtual impairment to have limited reading and writing abilities. The implication is that other complex abilities such as scientific literacy are also low. Scientific literacy is an important ability that students must have to be able to solve real-world problems [11][12]. As a result, a breakthrough that makes it simpler for Visual impairment students to increase their scientific literacy is required. STEM as a connected and relevant approach for students. STEM directs students to be better at solving problems, being innovative, thinking logically, and being technologically literate [13][4].

STEM has the potential to improve Visual impairment pupils' scientific literacy since it focuses not only on the knowledge component but also on the skills. The skill component is regarded as critical since students will learn more successfully if they can maximize the potential of all five of their senses [15]. Even if they have poor eyesight, Visual impairment persons may participate in reading activities since the STEM method allows them to take advantage of other senses. As a result of STEM-integrated learning, students should be able to: 1) evaluate and solve issues; 2) be creative; 3) reason logically; and 4) be fluent in technology literacy [16].

The following are some of the benefits of adopting the STEM approach to instructional media: 1) Visual impairment people can understand science concepts easily because these concepts are presented in the form of fictional stories; 2) Visual impairment people can concretize an object from the material discussed through an embossed image through kinesthetic and tactile activities; 3) B-Netra can familiarize students with using information technology such as smartphones as a learning resource because B-Netra is equipped with a scanable QR code that is connected directly to social media; 4) B-Netra also has an audio impression that can strengthen the understanding of Visual impairment learners. B-Netra is essentially an evolution of numerous learning media that have been utilized by Visual impairment students, but these media still have limitations in assisting Visual impairment students in learning. Braille books are examples of learning material produced by specialists for students with vision impairments. Braille books greatly assist students in their reading and writing activities; yet, due to the expensive cost of the books, the creation of media based on braille books is quite limited. There are also miniature objects that make it easier for children to recognize an object in a small version. Miniature items are not flexible. In addition, the characteristics of miniature items differ from those of the real objects. Another type of learning media is a tape or recording device, which cannot be utilized under specific circumstances. B-Netra is a solution that can be offered by researchers because basically this instructional media combines kinesthetic, tactile, and audio learning activities. B-Netra is adaptable and simple to use anywhere and at any time. Furthermore, in addition to providing material, B-Netra educates students to be able to use information technology to gain knowledge.

Research Questions:

1. What is the structure of B-Netra as a STEM-based media for elementary school students with visual impairment?
2. How is the quality of B-netra based on expert assessments?

METHOD

This study employed an R&D approach with the 4D procedure. It consisted of define, design, develop, and disseminate stages.

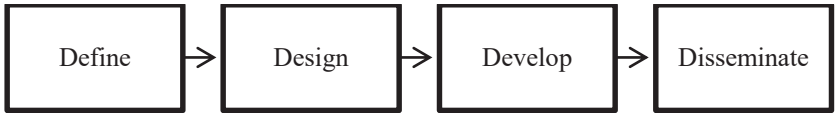

FIGURE 1. 4D procedure

Define is the stage where Visual impairment students' needs analysis was conducted through a literature review. Design involves activities to design B-Netra based on the results of the needs analysis. Develop refers to the stage where validity tests were performed by experts. Develop is a complex stage where B-netra that has been designed is then given advice and assessment by experts to determine the validity of the content. Furthermore, a limited trial with a small number of students was conducted to determine the response to the ease of use of B-Netra and the convenience of its use. The next stage of development stage is a trial on students to determine its effectiveness in increasing scientific literacy. However, this study was not carried out and the researcher recommends further research by other researchers. The final stage is dissemination, namely the dissemination of B-Netra to the public via youtube to collect feedback from user/ viewer.

The research data included both qualitative and quantitative data. The experts' feedback provided qualitative data, while the validation findings stated on the instrument expert's evaluation sheet provided quantitative data. Before going through the validation process, B-Netra underwent the instrument test stage. This was done so that each assessment item could reflect the quality of a good instructional media for Visual impairment students. The expert validation test was carried out after the three assessment instruments were validated by the instrument expert. The expert validation criteria include:

TABLE 1. Expert Validation Criteria

Expert	Evaluated Aspects
Media expert	Purpose, function, quality, practicality, use, and presentation of the information
Material expert	Material components, STEM aspects, scientific literacy aspects, reading content, and usage
Linguist	The level of student understanding, quality of content, instructions, presentation, and content

At the validation stage, the experts would evaluate B-Netra using 1-5 Likert scale with the following criteria:

TABLE 2. Scoring Criteria

Score	Category
5	Very Good
4	Good
3	Fair
2	Poor
1	Very Poor

The score obtained from each expert was analyzed using the following equation:

$$\text{Score} = \frac{Score\ given\ by\ the\ expert}{Maximum\ score} \text{ x } 100 \quad (1)$$

The expert validation score was categorized according to the following criteria:

TABLE 3. The Criteria of Media Quality

Scoring Scale	Category
81 – 100 %	Very Good
61 – 80 %	Good
41 – 60 %	Fair
21 – 40 %	Poor
< 21%	Very Poor

B-Netra would get positive responses if the total percentage of expert validation score > 61.

RESULTS AND DISCUSSION

The development of the product began with the analysis of visual impairment students' needs. The data revealed that there has been relatively little progress in the production of learning media, particularly in scientific literacy content, up to this point. Furthermore, an analysis of visual impairment students' learning styles showed that the majority of the pupils emphasized the use of touch (kinesthetic & tactile) and hearing (audio) due to the instructional media's flexibility, safety, and durability. After identifying problems, the learning media was designed according to the needs of students with visual impairment. The B-Netra instructional media was designed according to the standards commonly used by braille books [17,18], such as the placement of the book's identity, the placement of the user manual (B-Netra), the placement of the original object, the placement of the QR code, and audio clarity. The book's identities such as the title and author's name can be found on the cover page as in Fig. 2.

FIGURE 2. B-Netra Cover

There are three main components found inside the book; they consist of braille writing, original objects, and QR codes that can connect users to audio on YouTube.

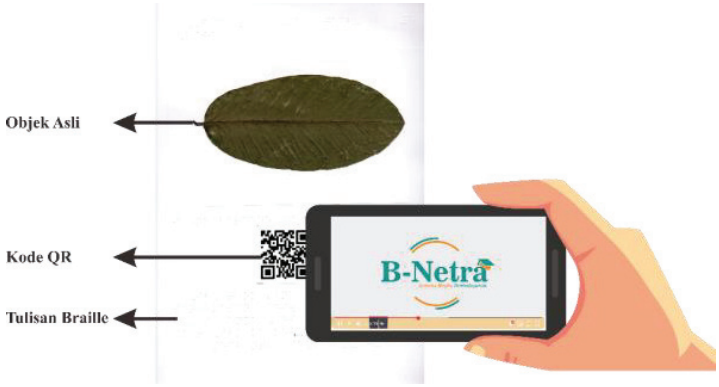

FIGURE 3. B-Netra content

The materials discussed in B-Netra cover four types of leaves that can be found around Visual impairment students such as guava leaves, betel leaves, bay leaf, and soursop leaves. The coverage of STEM in B-Netra includes: (1) Science, where B-Netra presents material in the form of natural science; (2) Technology, which is manifested in the form of a QR code feature that can be scanned using a smartphone; (3) Engineering, B-Netra emphasizes the use of information technology in obtaining knowledge; (4) Mathematics, B-Netra contains logical and systematic explanations of natural science concepts.

At the development stage, the content validation was carried out by a learning technology expert, a science education expert, and a linguist to determine the quality of the B-Netra instructional media. The media was tested on grade 6 of elementary students to find out the user's response to the media, especially from the aspect of readability and ease of use. The dissemination process was conducted to collect feedback from the users. Dissemination was done via YouTube.

TABLE 4. Expert validation result

No	Group of expert	Score	Category
1	Learning technology Expert	91.66	Very Good
2	Science education Expert	80	Good
3	Linguist	72	Good
	Total Score	243.66	-
	Average Score	81.22	Good

B-Netra received an average score of 81.22 based on expert evaluation, placing it in the "Good" category. This demonstrates that the instructional media received a favourable reaction from the validators so that it can be utilized to foster scientific literacy of students with visual impairment. Is it also qualitative data According to the instructional media specialist, B-Netra is of very high quality for usage by Visual impairments' students. The media expert provided the following feedback: 1) Regarding the function and goal of learning, the expert believed that the presentation of information through B-Netra and the application of STEM in the media was still inadequate. Despite the fact that this component did not receive a good grade, the validator determined that the product generated was "adequate" for meeting the Visual impairment pupils' needs. It would suffice if it were merely developed to that degree; 2) the validator assumed that the objects contained in B-Netra were not entirely long-term durable.

Furthermore, the science education expert determined that the content development of the B-Netra media was not totally optimal, but it could be classified as "Good" for Visual impairment pupils. This validation stage was performed only once. The materials provided in B-Netra were regarded "Good" and thus, a review step was skipped. As a result, B-Netra could be utilized directly in the following level. According to the linguist, the usage of language in B-Netra should be enhanced by including extensive and more understandable explanations for Visual impairment students. Furthermore, it would be preferable if the media could provide instructional language, such as introductions and learning objective statements, before moving on to the core material. The linguist believed that the language used in B-Netra was adequate, and that the media could be utilized in the next stage.

The development of the STEM-based B-Netra which was intended to improve the scientific literacy of Visual impairment students has gone through various stages mentioned in the 4D (four-D) model. To establish the quality of the instructional media (B-Netra), development was carried out in phases. Experts have classified B-Netra as a good reading option for Visual impairment students. According to the experts, B-Netra can also be used to teach science to students with visual impairment. The materials contained in B-Netra are easy to understand because they are conveyed through short stories. B-Netra allows Visual impairment students to learn about science, think logically and learn to use technology to obtain information.

During the define through to the development stages, B-Netra demonstrated the alignment between the learning requirements with the desired outcomes. STEM-based materials found in B-Netra have the potential to create relevant learning experiences for students who are visual impairment [19][20]. The use of short tales in presenting knowledge makes it simpler for the adolescents to grasp and enjoy science. Furthermore, the real objects found in B-Netra correspond to the students' thinking processes, which range from abstract to concrete. The "QR code" feature introduces pupils to a unique experience in which they may acquire information using their cellphones. Overall, B-Netra has a distinct appeal for pupils since they may study a variety of topics about science and technology by using it. The increased student enthusiasm, which is supported by professional opinions, demonstrates that the aims of scientific literacy may be met with the adoption of B-Netra for Visual impairment students' learning.

The B-Netra instructional media has the potential to foster scientific literacy of Visual impairment learners because: 1) Science materials are given in the form of short stories written in braille, so they are quite simple to grasp. Short tales offer the benefit of stimulating students' imaginations and drawing their attention to learning. Students gradually learn to like science-related topics since they are presented in an entertaining manner [21][22]; 2) B-Netra is an instructional media that helps students go from abstract to concrete thinking. It displays the original objects mentioned in the tale [23]. B-Netra presents content not only in the form of description, but also in the form of reality; 3) B-Netra was developed by adopting a STEM (Science, Technology, Engineering, and Mathematics) approach so that students with visual impairment can learn more than one scientific discipline; and 4) B-Netra is able to excite 3

(three) of the five senses of Visual impairment pupils at the same time: auditory, kinesthetic, and tactile. Students with visual impairment s are thought to learn effectively if they use more than one of their five senses. As a result, B-Netra offers 3 (three) key characteristics that can help students realize the potential of their five senses, such as braille features and unique items for the sense of touch (kinesthetic and tactile), as well as audio included in a QR code to stimulate the sense of hearing.

The product developed in this study has gone through the stages of quality testing by an instructional media expert, a material expert, and a linguist. The results of the expert validation indicated that B-Netra had a "good" quality to foster scientific literacy of students with visual impairment . This is inseparable from the characteristics of B-Netra that can fulfill; 1) the learning style of Visual impairment students; 2) the need for flexible learning support; and 3) the need for student scientific literacy development.

CONCLUSION

B-Netra has been successfully developed, a STEM-based media that is possible to promote the scientific literacy of blind elementary school students. Based on the results of expert assessments, B-netra has good quality. As a result, B-Netra offers 3 (three) key characteristics that can help students realize the potential of their five senses, such as braille features and unique items for the sense of touch (kinesthetic and tactile), as well as audio included in a QR code to stimulate the sense of hearing.

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