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Development of local wisdom-based Subject-Specific Pedagogy (SSP) to improve students' scientific literacy skills

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Abstract: Indonesia is a cultural nation with a richness of indigenous knowledge that must be conserved, one of which is science education in schools. This study intends to develop an integrated science Subject-Specific Pedagogy (SSP) based on the indigenous knowledge of producing Bobung wooden masks from Gunung Kidul, Yogyakarta, Indonesia and to improve students' scientific literacy. The study employed the ADDIE-based research methodology, which included needs analysis and preliminary research analysis. Planning and creating rough drafts of the product serve as the design phase, and expert validation and revision serve as the development phase. Implementation in a small number of classes, evaluation through SSP use, and dissemination for grade VIII students. The study's findings were used to create a SSP with components such as a syllabus, lesson plans, student teaching books and modules, student worksheets, and assessment sheets rated as very good based on experts' validation. The produced SSP can raise the scientific literacy of junior high school students in grade VIII with an N-gain of 0.69.

Keywords: Bobung wooden mask; integrated science; local wisdom; Subject-Specific Pedagogy.

Introduction

The industrial revolution that started in the 18th century impacted the progress of the Indonesian nation. The era of the industrial revolution is a time full of competition, so it is necessary to increase the competence of the younger generation in terms of science, technology, engineering, and mathematics (STEM) (Maryanti et al., 2020). Through the Ministry of Education, the government continues to prepare the younger generation to face the era of the industrial revolution 4.0, especially in improving human resources, innovation, and appropriate technology. Concerning subjects at school, integrated science teaches natural sciences related to technology (Ntemngwa & Oliver, 2018). The study of science includes a body of knowledge, a way of investigation, and a way of thinking associated with science as a product, process, attitude, and application. The science learning process consists of scientific process skills to develop scientific knowledge and technology, while scientific attitudes are related to the values of scientific character (Juhji & Nuangchalerm, 2020). Science applications that apply the concepts of physics, biology, and chemistry can produce products, where abstract concepts of science can be realized into something concrete and valuable (Pun et al., 2022). The direction of development and utilization of science concepts and technology should produce innovative products needed by the community (Van der Burg, 2019).

Science learning for students in the classroom should contribute to the formation of creative characters for reliable students in the future (Anisimova et al., 2020). The next generations of the nation are expected to be superior, innovative figures and reinforce the creative economy around them (de Figueiredo et al., 2019) without forgetting the values of local wisdom. Moreover, Indonesia is a cultured country, where local cultural values must be preserved. In this era of the industrial revolution 4.0, the role of scientific studies based on local wisdom (ethnoscience) is critical to be developed to maintain the existence of local knowledge

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so that the values of local wisdom persist along with the development of an increasingly modern era (Toharudin et al., 2021). Indonesia is a country with great potential to compete globally because of its solid cultural base (Quevedo et al., 2020). Indonesia is a country that has a variety of cultures and local wisdom values that spread from Sabang to Merauke.

Cultural diversity in Indonesia can be influenced by geographical factors (Parlindungan et al., 2018), where each region has diverse and unique local wisdom such as views on living life, knowledge and completing life strategies, traditional ceremonies, regional dances to traditional crafts. Every social group in an area already has basic knowledge related to concrete experience and is obtained through direct interaction with the natural surroundings, known as indigenous science (Thomas et al., 2019). However, local knowledge is often neglected in its development because scientific knowledge continues to grow. Whereas local knowledge usually plays a vital role in developing science and technology (Aldieri et al., 2020). Naturally, education practitioners and the community can collaborate in conducting ethnoscience assessment activities so that existing and developing knowledge in society (community science) can become scientific knowledge taught in school.

Ethnoscience research has begun to develop in various disciplines, including integrating culture into science learning (Dewi et al., 2021), physics (Rizaldi et al., 2021), biology (Rist & Dahdouh-Guebas, 2006), and chemistry (Zidny & Eilks, 2022). Those studies show that science learning content can integrate scientific knowledge with certain local cultures to be closer to students' lives, contextual, and meaningful. In the implementation of learning, students can reconstruct the knowledge they have previously with existing scientific knowledge (Lederman, 2019). Meaningful learning can be created by using the context of the local wisdom of the local community because it is directly related to real life (Jumriani et al., 2021), which can make students more motivated in learning (Ramdani et al., 2021). In addition, learning science based on local wisdom can also improve students' scientific literacy skills, which are very important to master in the era of globalization (Suprapto, 2016).

Scientific literacy skills refer to understanding natural science and its application to people's lives (Glaze, 2018). Scientific literacy is needed for the younger generation in developing their thinking to solve science-related problems (Ekantini & Wilujeng, 2018). However, several studies show that students' scientific literacy skills in Indonesia are still low (Winarni et al., 2020). PISA (Program for International Students' Assessment) also shows the same results that the scientific literacy skills of Indonesian students are ranked 70th out of a total of 78 countries. Furthermore, there is a need for a new strategy in science learning to improve students' scientific literacy. One of them is preparing science learning tools that link concepts, processes, and applications of local cultural values with scientific knowledge.

As one of the cultural cities in Indonesia, Yogyakarta has a wealth of local wisdom that develops in the community. One of them is the process of making the Bobung wooden mask which was developed by the people of the tourist village of Bobung, Gunung Kidul. When the harvest season arrives, local people use the Bobung wooden mask to play the banner dance (Subiyantoro, 2021). This dance was brought by Sunan Kalijaga as a medium of da'wah and is a form of community gratitude for the harvest they have got (Mulyono, 2020). Although the use of Bobung wooden masks is currently developing towards aesthetic art, these wooden masks are used as home decorations or souvenirs and have now reached the international market. The making of Bobung wooden masks has traditionally been carried out for generations and cannot be separated from the daily life of the Bobung people (Fajri, 2021). This shows that the local wisdom of the Bobung wooden mask has the principle of specific community knowledge in its manufacture, which is interesting to study and relates to scientific knowledge.

There is no justification for teachers instructing in class without a learning plan because a good teacher will always establish a plan for the learning process. Learning tools, which include a syllabus, lesson plans, teaching resources, learning media, and assessments, are one component of learning planning. The preparation is in accordance with each teacher's perceptions because there is no government uniformity regarding learning tools, according to the findings of the researcher's interview with the school principal. Teachers also have a lot of responsibilities outside of the classroom and at school, which leaves them with little time to create instructional materials, which hinders students' ability to learn to their full potential. In addition, teachers can create instructional materials depending on regional and local potential. It is hoped that students would be able to comprehend, apply, and utilize the knowledge they acquire in class to resolve issues they come across in daily life. SSP can be used by teachers and educational professionals to impart culturally specific knowledge, local wisdom, and community issues. Based on the description above, the authors developed learning tools in the form of Subject-Specific Pedagogy (SSP) based on local wisdom of making Bobung wooden masks and was expected to improve the scientific literacy of VIII grade students. The product specifications developed included

the syllabus, lesson plans, student textbooks, student worksheets, and assessment sheets.

Method

This study is a research and development (R&D) project based on the ADDIE model (Dick & Carey, 1996), consisting of analysis, design, development, implementation, and evaluation, as shown in Figure 1. The instruments in this study consisted of Subject-Specific Pedagogy (SSP) quality sheets for material experts, media experts, learning tools experts, education practitioners (science teachers), student response questionnaire sheets, pretest, and posttest question sheets, and student response sheets. Literature and documentation studies were conducted to collect the needs analysis of the developed SSP products. Validation sheets are used to obtain expert assessments of product quality. The data was obtained in comments and suggestions for improvement from the material expert, media expert, learning tools expert, and science teacher on the developed SSP. Questionnaires are used to collect product readability data based on student responses. The observation sheet is used as a guide in observing the implementation of the product in the learning implementation. The research instrument has been validated and declared feasible by the experts.

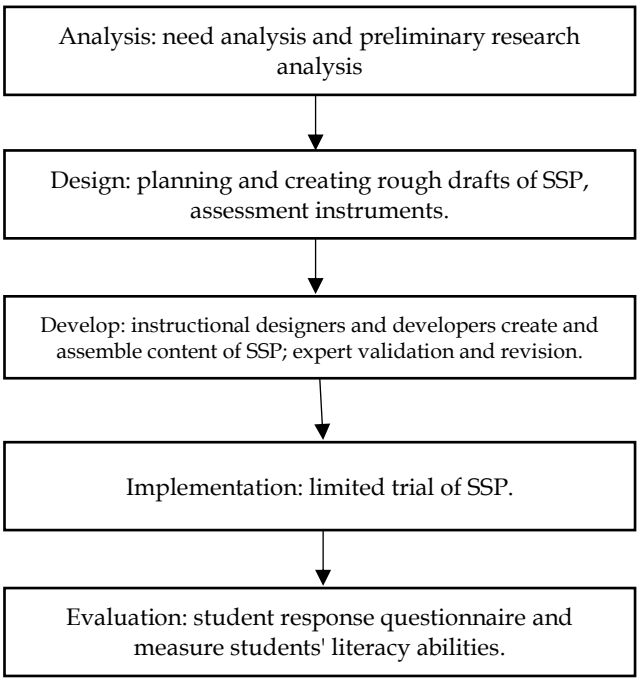

Figure 1. ADDIE model adapted from Dick and Carry (1996)

The assessments of SSP products were analyzed descriptively and quantitatively. Data obtained from product assessments conducted by experts, science teachers, and student responses were analyzed using Equation 1.

$$\bar{X} = \frac{\Sigma X}{(Nn)} \quad (1)$$

Where $\bar{X}$ is the average score of the assessment, ΣX is the number of assessment scores, N is the number of raters, and n is the number of questions. The average score obtained is then converted into qualitative form by finding the interval between the levels of very good (VG), good (G), less good (LG), and very poor (VP) using Equation 2.

$$interval = \frac{Max\ score - Min\ score}{number\ of\ interval} \quad (2)$$

The science literacy ability test measures students' scientific literacy skills. Equation 3 is used to calculate the scientific literacy test score.

$$score = \frac{total\ answer\ score}{\max score} \times 100\% \quad (3)$$

Furthermore, the increase in scientific literacy skills was analyzed using the N-gain equation from the results of the pretest and posttest as in equation 4.

$$N - gain\ (g) = \frac{posttest\ score - pretest\ score}{max\ score - pretest\ score} \quad (4)$$

The *N-gain* criteria used are $g \geq 0.7$ means the high category, $0.3 \geq g < 0.7$ is the moderate category, and $g <$ 0.3 is the low category.

The results of data analysis obtained from experts and practitioners are used to determine the validity of SSP products based on local wisdom. In addition, the results of field trials are used as the basis for assessing the effectiveness of the developed product by changing the quantitative scale to qualitative.

Result and Discussion

Subject-Specific Pedagogy (SSP) is a form of knowledge and part of a teacher's thought process structured systematically and thoroughly. The SSP in this study consisted of a syllabus, Lesson Plan, student textbook, Student Worksheets, and learning assessment sheets. With systematic learning tools, students are expected to master all learning competencies in a comprehensive and integrated manner. SSP learning tools can also be used as a guide for teachers in carrying out learning activities in the classroom to achieve competencies that must be mastered by students. The SSP, which is equipped with student textbooks and

students' worksheets, is expected to guide students in developing scientific literacy skills and solving problems they encounter. Furthermore, the learning assessment sheets are used as evaluation tools for learning achievement obtained by students.

The SSP in this study focused on integrated science subjects based on local wisdom of making Bobung wooden masks. The Bobung wooden mask is a fine art craft from the Bobung Tourism Village, Patuk, Gunung Kidul, Yogyakarta Special Region, Indonesia. Wooden batik craft in Bobung village started with the need for wooden masks for the art plays of the "Topeng Panji" dance as a medium for Islamic religious spread and ceremonies to express gratitude for the harvests obtained by the community (Nurjoyo et al., 2022). The Bobung wooden masks made by artisans have been developed as room decorations and souvenirs (creation masks) (Istiningsih et al., 2020). The production of wooden masks in Bobung village has existed since around 1960 and continues to grow until it has reached the international market (Widiyastuti et al., 2020).

The knowledge that develops in the community related to the principles and processes of making Bobung wooden masks can be analyzed scientifically according to the science learning materials for the Junior High School VIII grade of 2013 curriculum and developed in the local environment (Subiyantoro et al., 2021). The integration of cultural values in the science learning process in the classroom is expected to be able to increase the scientific literacy of students while at the same time being able to maintain the existence of local culture so that it can be recognized and preserved by the next generation. The right strategy for exploring community knowledge and integrating it with scientific knowledge is essential to develop (Parmin et al., 2019).

This study developed a learning tool in the form of Subject-Specific Pedagogy (SSP) of integrated science-based on local wisdom in making the Bobung wooden mask with the ADDIE model adapted from Dick and Carry (1996) as follows. Analysis, the analysis carried out is a needs analysis and preliminary study. Previously, a literature study related to the making of Bobung wooden masks was associated with the science concept of VIII grade according to the 2013 curriculum. The analysis results at this stage were known what learning tools would be developed and the instruments to be used. Furthermore, an analysis of learning resources as material for the preparation of the SSP is carried out, which includes availability, suitability, and ease of use. It is known that the learning tools that will be developed are in the form of Subject-Specific Pedagogy (SSP) which consists of the syllabus, lesson plans, student textbook, student worksheets, and assessment sheets.

Design and Development planning at this stage is carried out based on the results of the analysis stage. Analysis of the need for learning tools in the form of Subject-Specific Pedagogy (SSP) based on local wisdom. The making of Bobung wooden mask is then made as a draft of the syllabus, lesson plans, student's textbook, student worksheets, and assessment sheets based on the

Regulation of National MoE Republic of Indonesia No. 41 Year 2007. Furthermore, the SSP framework that has been designed at the Design stage is further developed and re-equipped. The production process for bobung masks as shown in figures 1 and 2, which is the foundation for SSP product development, is examined using the integrated science concepts. The SSP based on local wisdom for the making of Bobung wooden masks was developed by considering good quality requirements for further evaluation by experts and limited testing. Meanwhile, the SSP Based on local wisdom for the making of Bobung wooden masks that have been developed in this study can be shown as shown in Figure 3.

Figure 2. The process of making mask patterns contains scientific concepts.

Figure 3. Wood carving process using tools that utilize the concept of inclined plane

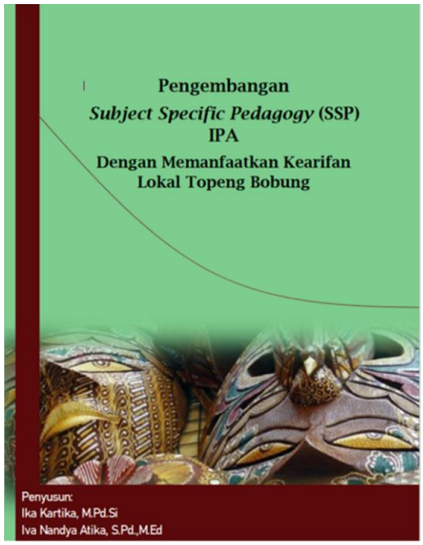

Figure 4. The SSP-based on Local Wisdom for the Making of Bobung Wooden Masks

Implementation and Evaluation, in this study, the good SSP product based on the assessment of experts was carried out in a limited trial on VIII grade students in Yogyakarta. The next stage evaluates the SSP product by processing the data resulting from the assessment of experts, education practitioners (science teachers), and student responses to improve the developed SSP product. The first component of the SSP is the syllabus, which is a plan for preparing and developing a framework for science learning activities based on the local wisdom of making Bobung wooden masks. The components of the syllabus include subject identity, school identity including the name of the education unit, class, semester, the theme of "local excellence", the field of study, core competencies, basic competencies, subject matter, learning activities, indicators, the assessment includes techniques, forms of instruments and example, time allocation, and learning resources.

The second component is the lesson plans which contain details of science learning materials based on local wisdom of making Bobung Mask which refers to the syllabus prepared. Lesson plans can be used to describe all learning activities that will and must be carried out by teachers and students. The components of the lesson plans include school identity, subjects, classes and semesters, subject matter, local excellence themes, time allocation, core competencies, basic competencies, competency achievement indicators, learning objectives, descriptions of learning materials, approaches, methods, and learning models, media, tools, materials, and learning resources, steps for learning activities, assessment, the identity of a lesson plan maker, worksheets, and assessment attachments. The third component of the SSP is the student's textbook and student worksheets, which contain science material based on local wisdom of making Bobung wooden masks and activities that students must complete. The components of the student's textbook and student worksheets developed are titles, learning instructions, basic competencies, or subject matter, supporting information, activities accompanied by work procedures, and the use of tools and materials, and assessments. Students' textbooks and student worksheets are developed based on indicators of scientific skills, such as simple experimental activities that support students to explain scientific phenomena with scientific inquiry and various problems that students must solve to develop problem-solving skills (Wahyudiati, 2020).

The fourth component is an assessment sheet or evaluation of student learning outcomes prepared with authentic assessment instruments. The authentic assessment instrument developed based on scientific literacy assessment is multiple-choice test questions. In addition, the compiled assessment instruments are equipped with grids, scoring rubrics, and assessment guidelines. The feasibility of natural sciences SSP based on local wisdom of making Bobung wooden masks is known from the results of the validator's assessment consisting of the material expert, media expert, learning tools expert, and science teacher. The material expert assesses the components in the student's textbook by filling out an assessment sheet of 20 statements that have been provided. As for the aspects evaluated, there are four aspects: material feasibility, presentation aspects, language aspects, and aspects of local wisdom. Media experts assessed the components in the student book, which consisted of visual aspects with 14 statements. Learning tools experts also evaluated the elements in the syllabus, lesson plans, and student worksheets with a total of 41 statements. Meanwhile, the science teacher assessed the components consisting of 5 aspects of material feasibility, presentation aspects, discussion aspects, local wisdom aspects, and visual aspects, with a total of 24 statements. Meanwhile, testing the effectiveness of SSP products in increasing scientific literacy skills is known through limited trials.

The validation results of the SSP component (syllabus, lesson plans, student's textbook, student worksheets, and assessment sheets) are used to assess the feasibility of the product. The assessment carried out by material experts got an overall average score of 3.75 in the Very Good category. Assessment according to media experts obtained an overall average score of 3.50 in the Very Good category. The evaluation from the learning tools expert received an overall score of 3.90 for the syllabus component, 3.98 for the lesson plan component, and 3.66 for the student worksheets component, where the three components of the learning

tools expert assessment were in the Very Good category. The assessment carried out by science teachers at schools obtained an overall average score of 3.6 in the Very Good category. The validation results mean that each component and the overall SSP developed is feasible to test according to the validators' assessment. In addition to assessing the SSP, the validator also provides suggestions for improving learning tools. All the constructive suggestions from the validators have been used to improve the SSP.

In addition to assessments by experts and teachers, the product of Subject-Specific Pedagogy (SSP) in science by utilizing local wisdom to improve scientific literacy skills is also used to obtain student responses. Students assess students' textbooks and student worksheets, and student responses are obtained with variations of negative and positive statements where participants can choose the answer to agree or disagree with the statements that have been provided. The results obtained where five students gave a positive response to the product with an overall average score of 0.65 in the Agree category. The student responses regarding the readability of student textbooks and student worksheets showed feasibility. Interestingly, they could be appropriately used, increasing knowledge of scientific literacy skills and knowledge of local wisdom, and easy to understand by VIII grade students.

A study conducted by Lai et al. (2019) found that students' scientific literacy skills could be improved by paying attention to the learning environment and the characteristics of learning materials. The results of the scientific literacy test show the extent to which students master science learning materials which consist of business and simple machines; plant structure and function; and additives and addictive substances and their impact on health. Furthermore, based on the pretest and post-test results on 20 students, showed an increase in the average post-test score with an N-gain of 0.69. The increased average posttest indicates that the SSP based on the local wisdom of Bobung wooden masks can improve students' scientific literacy skills at a moderate level.

Conclusion

This study has produced science learning tools in the form of Subject-Specific Pedagogy (SSP) based on local wisdom of Making Bobung wooden masks, which consists of the syllabus, lesson plans, student textbooks, student worksheets, and assessment sheets. with valid and reliable categories. The SSP was rated as being very good category by experts and teachers. Similarly, the outcomes of the students' responses fall into the very good category. As a result, it can be stated that Subject-Specific Pedagogy (SSP)-based on the local wisdom of making Bobung wooden masks, is appropriate for use in learning and can enhance students' scientific literacy that has been tested for validity and practicality.

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Author Contributions

Conceptualization; methodology; software; project administration; funding acquisition, I. K.; investigation; resources; data curation, I. N. A.; validation; formal analysis, H. P.; writing—original draft preparation; writing—review and editing; visualization; supervision, F. D. W and I. N. A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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