



Subject-specific pedagogy: Development of biology teaching materials based on van hiele thinking theory



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ABSTRACT

The learning tools used by teachers at the junior high school level are inadequate. This research aims to develop teaching tools based on Van Hiele thinking theory. This research method was research and development. Data collection was carried out using expert design validation sheets covering material, media, language, student response questionnaires, and teacher assessment sheets. The research results indicate that the percentage of science teacher (biology) assessments on the product were 76.5% and with proper criteria, after revision, the results show a higher percentage was 83% with very feasible criteria. The preliminary results or limited field trials of students have a percentage was 83% with very feasible criteria. Meanwhile, large group product trials have a percentage was 84%. This shows that the results of large group trials are higher when compared to limited trials ($84\% > 83\%$). So, concluded of this research that the Subject Specific Pedagogy based on Van Hiele thinking theory is very feasible to use.

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INTRODUCTION

The student at school can be said to be not ready for learning. This is based on the provision of learning tools that are deemed insufficient to support a good learning process. Every learning requires a professional educator who has creative and innovative teaching abilities so that students are not bored and excited about following a lesson in class. Thus the learning objectives can be achieved, namely the development of students in gaining knowledge and understanding. The use of learning media is essential to increase the efficiency and effectiveness of learning. The media used in supporting learning must be varied and innovative and attract the attention of students. Because the media will fully awaken the brain's ability (Haka, Makrupah & Anggoro, 2020).

The development of students learn is not only determined by the school, its pattern, structure, and curriculum content but is largely determined by the competence of educators who



teach and guide students. Teachers must be able to create a learning environment that is effective, fun, and can be more competent in managing their class so that they can optimize the learning process of students. The teacher has a very important role in the implementation of the teaching and learning process in the classroom with students. Students will easily accept the material presented if a teacher makes teaching materials that are interesting, and easy to understand using innovative and varied learning methods (Hamalik, 2009).

Teaching materials are one of the means to facilitate the delivery of material from teachers to students. The teaching materials or supporting tools used can represent what educators are unable to say through certain words or sentences (Anggoro, Haka & Hawani, 2019). This is following the current curriculum of 2013. The curriculum of 2013 in Indonesia was prepared with the aim of producing more productive, innovative, creative, and effective human resources who can contribute to various aspects of social, national, and state life, to create a generation with life skills (Anugrah, Sofyan, Murwitaningsih & Susilo, 2020).

However, in reality, pre-observations at SMP Negeri 19 Bandar Lampung show that learning has not used a creative and innovative learning model. The curriculum used in SMP Negeri 19 Bandar Lampung is the curriculum of 2013, in which this curriculum emphasizes the aspect of understanding, while in learning students still show a lack of understanding with many students who ask each other questions when given the task of working on the questions. practice by the teacher. The quality of the learning process or student guidance and the implementation of additional tasks can be determined by mastering competence and applying knowledge, as well as teacher skills, especially for educators with additional tasks that support the progress of schools or Madrasah (Dermawati, 2013). Learning biology or science is a branch of science that studies living things and their constituent components (Guswita, Anggoro, Haka, & Handoko, 2018).

The effect of choosing strategies or models and learning media on various academic abilities has received less attention from teachers so that students' academic abilities do not increase even though innovative learning has been implemented (Darmawan & Nawawi, 2020). The strategy that must be chosen and prepared by a teacher in carrying out the learning process is to prepare interesting learning and can be followed by students with clear learning stages such as Van Hiele learning theory.

Van Hiele learning theory has the aim that students can understand the material presented by the teacher. Van Hiele learning theory has several phases that can be carried out in learning to realize learning goals. The first phase is the information phase. The information phase is the phase where the teacher provides knowledge about the material being explained, then the focused orientation phase, where students analyze the material from the teaching materials designed by the teacher. The third phase is a description, in which students are motivated to express their experiences about the material being studied in their language. The fourth phase is free orientation, in this learning phase, the goal is that students gain experience solving problems and using their strategies. The teacher's role is to choose appropriate material and problems to get learning that can increase the acquisition of various student information. The fifth phase is integration, where the teacher designs learning so that students can make a summary of the activities that have been learned. The purpose of learning in this phase is to interpret knowledge from what has been observed and discussed. (Musa, 2016). This study combines biology material based on Van Hiele thinking theory which is more widely used in learning geometry in mathematics.

RESEARCH METHODS

Research Design

The method used in this research was Research and Development (R&D) including Collecting, planning, developing preliminary product, preliminary field testing, main product



revision, main field test operational product revision, and operational field testing which was developed by Borg and Gall (Borg & Gall, 1983).

Population and Samples

The population in this research was science teachers and seventh-grade students, totaling 30 students used for wide-scale data and 12 students used for small-scale data. The research was conducted at SMP Negeri 19 Bandar Lampung through large-scale and limited-scale trials.

Instruments

The instrument used was the development of a Specific Subject Pedagogy (SSP), namely a closed questionnaire that had been validated by a team of experts, as well as student and teacher response questionnaires. The validation sheet instrument was filled in by 4 experts who assessed in terms of media, material, language, and learning tools. The questionnaire instrument was distributed to students, which contained a statement about the practicality of using LKPD in SSP, the ease of learning, and the clarity of the content displayed.

Procedures

The research stages include collecting, planning, developing the preliminary product, preliminary field testing, main product revision, main field test operational product revision, and operational field testing (Figure 1).

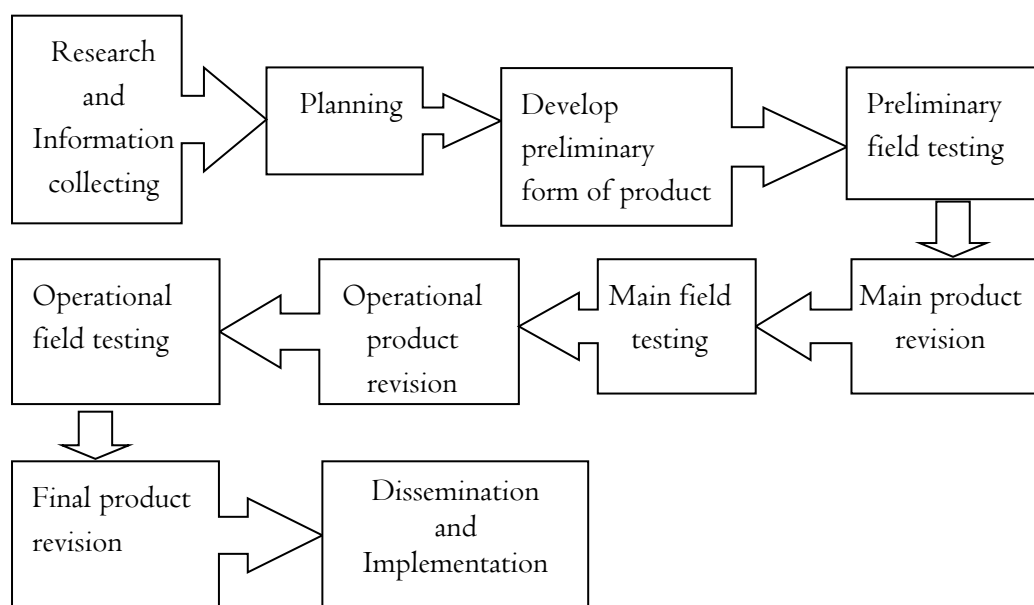


Figure 1. Steps for using the research and development (R&D) method

The researcher simplifies and limits it into seven stages. This research reaches the seventh stage of the ten stages in R & D research, namely arriving at the product revision stage after a limited trial is carried out, namely for students and teachers to see the response to the product being developed. This is in line with the opinion of Borg & Gall, which suggests that in research for the undergraduate level, research is limited to a small scale, that is until a product is produced after limited trials and includes the possibility to limit the research steps.

Data Analysis

Data analysis in this research was to used qualitative and quantitative data analysis techniques. Qualitative data in this research were obtained from the input of lecturers and teachers in the field of research at the validation stage, input from material experts, media experts, and linguists. Quantitative data is data that describes the results of product development in the form of Biological Subject Specific Pedagogy (SSP) based on Van Hiele thinking theory. The data obtained through the assessment instrument at the time of the trial were analyzed using statistics

The data analysis results were used as a basis for revising the product being developed. The response questionnaire was filled in by the teacher and students. The response questionnaire contains questions with semi-open answers. The writing order is the title, the statement from the researcher, the identity of the respondent, the instructions for filling in, and the question items. The quantitative response questionnaire data can be processed in a percentage presentation using a Likert scale as a measurement scale. This scale is structured in the form of a statement and is followed by four responses. A modified development research measurement scale from Riduwa (2018). The quantitative analysis score with the answer criteria can be seen in [Table 1](#).

Table 1. Assessment scores on the answer criteria

No	Quantitative analysis	Score
1	Strongly agree	4
2	Agree	3
3	Disagree	2
4	Strongly Disagree	1

The scores are one to four for strongly agree, agree, disagree, strongly disagree, representing a very negative to a very positive position. The level of scale measurement in this study uses intervals. The neutral response is intentionally omitted so that the respondent can show his attitude or opinion towards the statements submitted by the questionnaire. This is done to avoid errors in the Likert scale method, namely intermediate trend errors. The interval data can be analyzed by calculating the average answer based on the scoring of each answer from the respondent.

$$P = \frac{F}{N} \times 100\%$$

Note:

P : percentage eligibility

F : total score from data collection

N : total criteria score

The assessment score is then sought for the number average of trial sample subjects and converted the assessment statement to determine the quality and level of usefulness of the resulting product based on user opinions. The score conversion to the requirements for this assessment can be seen in [Table 2](#).

Based on the data in [Table 2](#), the development product will end when the assessment score of this learning media has met the eligibility requirements with the suitability level of the material, the feasibility of the media, and the technical quality of the learning materials using the Biology Subject Specific Pedagogy (SSP) Biology based on Van Hiele thinking theory on the material very interesting or interesting system of life organization.

Table 2. Eligibility criteria

Score Percentage (%)	Interpretation
$P > 80\%$	Very Decent
$61\% < P \leq 80\%$	Decent
$41\% < P \leq 60\%$	Decent enough
$20\% < P \leq 40\%$	Not Decent
$P \leq 20\%$	Very Inadequate

DISCUSSION

This research produced a product in the form of Biological Subject Specific Pedagogy (SSP) based on Van Hiele thinking theory for junior high school. This learning media was developed using research and development procedures (Borg and Gall). According to Borg and Gall, this development research can be simplified as needed. The results of preliminary research based on the results of an interview with one of the science (Biology) subject teachers at SMP Negeri 19 Bandar Lampung obtained information that the lesson plans made by the teacher had not developed varied learning models for students. Besides, new students use books as a learning resource in the classroom. This is following the relevant research submitted by Candra, Karyanto & Prayitno (2019) which states that the tools used by the teacher show that the devices are still general.

Syllabus analysis was not carried out because the curriculum of the 2013 syllabus was clear and had been used by all junior high schools. RPP analysis on teacher learning tools, several indicators do not contain specific material regarding life organization systems. The implementation of an effective, efficient and attractive learning process requires one important tool, namely a good learning implementation plan tool (Lubis, Djulia & Hasruddin, 2017). The syntax implementation in the lesson plans made by the teacher is also unclear the difference between teacher activities and student activities. The ability to think analytically should have begun to be developed by the teacher along with the implementation of the curriculum of 2013. Students who can think analytically will be able to understand difficult material and be able to solve every problem in the learning process in the classroom. Therefore, this analytical thinking ability is very important and should be developed by the teacher (Suryanda Azrai & Wari, 2016).

The results of interviews with the researcher to science or biology teachers at SMP Negeri 19 Bandar Lampung showed that students were less motivated to learn. The exercises are still very simple, namely working on the questions in the book. Based on the relevant research put forward by Ikawati & Suparman (2019) explains that SSP is the result of PCK (pedagogy content knowledge). PCK is pedagogical knowledge that is applied to teach specific content. The author chose to develop a Biology SSP based on Van Hiele thinking theory to overcome the problems described above. This is by relevant research from Nurhakim & Veriansyah (2019) which explains that teachers must be able to provide variations in the learning process by adjusting the learning model to the characteristics of the material and students as the audience. Through the use of instructional media, the planting of science concepts, principles, and laws will result in effective learning. (Widiatmoko & Pamelasari, 2012).

Many factors play a role in determining the success of student learning activities. These factors can come from within or from outside the students (Slamet, 2003). One of the dominant factors that determine the success of the learning process is to understand that each student is a unique individual and is different from one another. This difference can be seen from the learning style. If this uniqueness is respected, students will be able to develop themselves optimally according to their abilities (Azrai, Ernawati & Sulistianingrum, 2017). Motivation as one of the factors that support the achievement of learning objectives, it requires a concrete effort from the teacher to raise student motivation (Utariyanti, Wahyuni, & Zaenab, 2015). Selection and

determination of good teaching materials are fulfilling one of the criteria that teaching materials must be attractive, can help students to achieve competence (Departemen Pendidikan Nasional, 2007).

Teaching materials are a set of materials that have been systematically compiled and include all competencies that students need to master in learning activities (Kemdikbud, 2013). Teaching materials consist of knowledge (facts, concepts, principles, and procedures), skills, and attitudes. Teaching and learning activities will please students if the teacher can choose the right type of approach and learning model (Toy, Karwur, Costa, Langkun & Rondonuwu, 2018). Biology is included in science so that in understanding it, students not only learn about products, but also aspects of the process, attitudes, and technology. These three aspects in Biology learning can be obtained from experimental activities in the laboratory or also called practicum activities (Suryanda, Rusdi & Kusumawati, 2017). Learning tools developed are based on Van Hiele thinking theory wherein this learning theory is explained by Andriani, Jamiah & Bistari (2020) which explains that Van Hiele theory has three unique characteristics, namely elegance, comprehensiveness, and wide applicability, which means that the theory uses structure, simple statements that are described with concise statements with a big effect, including linking science with daily activities or practicum.

After the small group trial got an assessment with very decent results, then a field trial was conducted on 30 students of class VII D at SMP Negeri 19 Bandar Lampung. The percentage of large group trial results is 84% with a feasibility scale that is very feasible. Thus, it can be concluded that this large group trial experienced an increase of 1% over the small group trial. This means that the Biological SSP based on Van Hiele thinking theory developed by the researcher has very suitable criteria to be used as a tool in teaching and learning activities on cell material for grade VII SMP. According to Siregar, Siahaan & Hariyanti (2018) said that Van Hiele theory can build understanding hierarchically, each level has its own symbol and language, this theory provides a general descriptor at each level which is elaborated into more operational descriptions and this theory can describe the students thinking.

As stated by Kusumadewi, Yustiana & Nasihah, (2020) that the SSP contains the syllabus, lesson plans, and LKPD that teachers and students can use in a learning process that is based on the Van Hiele thinking theory with learning stages that emphasize the ability of children's skills. The SSP consists of several exercises ranging from cognitive to skills and is equipped with pictures that support the content of the material contained in the LKPD that is in the Science or Biology SSP. SSP is a form of learning tool that is more comprehensive, because "SSP is a form of heating learning materials into a comprehensive, educational and solid learning tool that includes competences, sub-competencies, materials, methods, strategies, media, and evaluation.

CONCLUSION

The development of subject-specific pedagogy (SSP) biology based on Van Hiele thinking theory received a response rating of 84% with very appropriate criteria by student responses and a very decent assessment was obtained based on the biology teacher's assessment with a percentage was 82%. The development of biological subject-specific pedagogy (SSP) based on Van Hiele thinking theory has the following characteristics: (1) the learning media is easy to use. (2) Learning media based on Van Hiele thinking theory helps understand the material (3) learning media can help students to learn actively and independently. (4) Subject-specific pedagogy (SSP) biology based on Van Hiele thinking theory can empower aspects of the skills of students.

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