REVIEW OF MULTIDISCIPLINARY EDUCATION, CULTURE AND PEDAGOGY
(ROMEO)
Volume 2 Issue 1 (2022)

DEVELOPMENT OF GUIDED INQUIRY MODEL OF SCIENCE (IPAS) LEARNING TOOLS TO TRAIN SCIENCE PROCESS SKILLS AND IMPROVE STUDENT LEARNING OUTCOMES

Naning Yuni Ardiyanti
Physics Teacher of SMK Negeri 1 Kalitengah Lamongan
E-mail: naningyuniardiyanti@gmail.com

Abstract
This research aimed to develop science learning materials (lesson plans, student worksheets, student book, and learning achievement test) based on the guided inquiry learning model using the 4D development model to facilitate students' science process skills and improve their learning achievement in environmental pollution. The learning materials were trialed on 35 junior high school students using a one-group pretest-posttest design, and the results were analyzed descriptively using quantitative-qualitative methods. The findings showed that: (1) the learning materials were valid (scored in the valid category of 3.00); (2) the materials were practical, with good implementation (scored in the good category of 3.8), readable worksheets and student books (students found the content and appearance interesting), and a very positive student response (85.6%); and (3) the learning materials were effective, with outstanding student activities in practicing science process skills (scored in the high category of 38.5%), very high student science process skills as shown by the achievement in the student worksheets (scored in the very high category of 3.46), and increased student learning achievement (N-Gain: 0.2-1.0). In conclusion, the science learning materials developed based on the guided inquiry learning model are eligible to facilitate students' science process skills and improve their learning achievement in junior high school.

Keywords: *Guided Inquiry Learning Model, Junior High School, Learning Achievement, Science Learning, Science Process Skills*

1. INTRODUCTION

Learning is an activity that is systematically carried out by teachers in instructional designs, which create an interactive process between students, teachers, and learning resources. According to Suprijono (2009), learning results in a permanent change in behavior due to experience. Behavioral changes resulting from learning involve changes in cognitive knowledge, psychomotor skills, values, and attitudes (affective).

As education progresses, the government continues to update the curriculum in Indonesia (Panjaitan et al., 2022). The current curriculum is the 2013 Curriculum, which mandates the use of the scientific approach in learning. According to Ministry of Education and Culture (Kemendikbud, 2013), the scientific approach is believed to develop students' attitudes, skills, and knowledge. The scientific approach encourages students to become more active in constructing their learning and skills, and to conduct investigations to find facts from phenomena. However, the application of the scientific approach in learning requires a change in the setting and form of learning, which is different from conventional learning. Therefore, it is necessary to use a learning model that is in accordance with the principles of the scientific approach, such as guided inquiry.

Guided inquiry is a model that focuses on the thinking process, building experience by actively involving students in learning (Kuhlthau & Todd, 2007). This model provides students with the opportunity to have a real and active learning experience, where they are trained to solve problems and make decisions. In this approach, the teacher acts as a facilitator by determining topics, questions, and supporting materials. Guided inquiry involves students in a scientific learning process like a scientist, where they solve problems by observing, collecting data carefully, and accurately (Olson & Loucks-Horsley, 2011).

Guided inquiry is suitable for teaching natural science subject matter (IPAS), such as environmental pollution material. In this subject, students can directly formulate problems, investigate widely, and build understanding, meaning, and new knowledge. Based on this new knowledge, students can learn to find solutions to overcome environmental pollution problems in groups.

Learning IPAS is not limited to discussing material in textbooks or informing students about knowledge. It emphasizes providing direct experiences to students to understand the biological symptoms that occur (Depdiknas, 2004). IPAS education is expected to be a vehicle for students to learn about themselves and the natural world. The learning process emphasizes providing direct experience to develop competencies to explore and understand the natural world scientifically. The critical factor in the learning process is to train process skills so that students can become more active in acquiring their own attitudes, skills, and knowledge.

Based on observations and interviews with one IPAS teacher and vocational students in Surabaya, it has been found that teachers often use cooperative learning models in their teaching. Although the guided inquiry learning model has been implemented, it has not been effective due to the lack of appropriate learning tools. Therefore, it is necessary to improve the learning tools for the guided inquiry model and Curriculum 2013.

It has also been observed that students are not proficient in conducting scientific investigations, as they are mostly fixated on what is delivered by the teacher. Only a few students are able to apply science process skills. The presentation of knowledge in science learning is often characterized by an overwhelming amount of facts and laws, and effective inquiry methods are not always applied to find concepts in the subject matter (Van Heuvelen, 2001). Students learn concepts through reading books or listening to teacher explanations, and as a result, their belief in science is formed through other people's notifications, not their own observations or modeling.

The 2013 curriculum emphasizes scientific activities such as observing, questioning, reasoning, associating, and communicating the results of learning. Therefore, it is essential to provide learning tools that can help students carry out these scientific activities, which are closely related to science process skills. IPAS learning is not only about mastering a collection of knowledge in the form of facts, concepts, or principles, but also a process of discovery.

Process skills need to be developed to enable individuals to learn independently, develop themselves, and learn throughout life (Muslimin Ibrahim et al., 2010). Science process skills are essential in conducting research and solving problems, which are necessary life skills for students. Therefore, it is crucial to develop an IPAS learning tool that uses the guided inquiry model to train Science Process Skills and Improve Learning

Outcomes of Vocational Students. As such, this research aimed to develop science learning materials (lesson plans, student worksheets, student book, and learning achievement test) based on the guided inquiry learning model using the 4D development model to facilitate students' science process skills and improve their learning achievement in environmental pollution.

2. RESEARCH METHODS

This study is a type of development research that aims to develop learning devices based on the modified 4D device development model. The 4D model is a systematic approach that includes four stages: Define, Design, Develop, and Disseminate. The learning device development plan in this study follows the flowchart of the device development stage as presented in Figure 1.

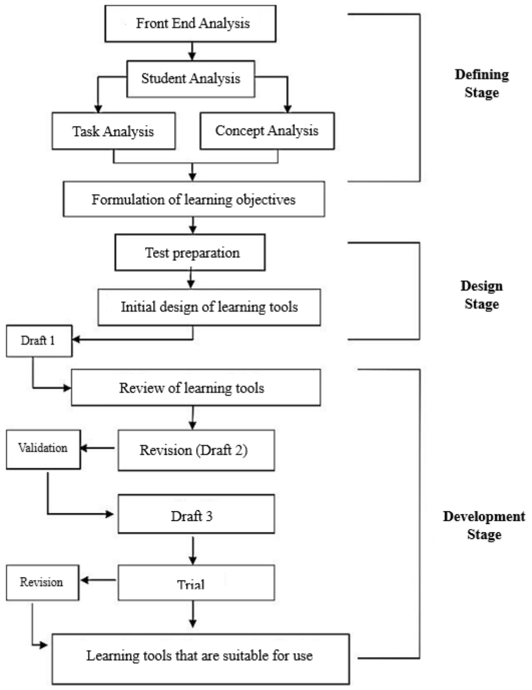

Figure 1. Flowchart of Device Development Stage
(Adapted from Mushmin Ibrahim (2002))

The research trial involved 35 students from class VII C of SMK Negeri 31 Surabaya during the 2014-2015 academic year. The study employed the One-Group Pretest-Posttest Design research design, which involves administering a pretest to the group before the intervention and a posttest after the intervention to measure any changes in learning outcomes. This design was chosen since the study only involved one group without a comparison group.

The research instrument used in this study was validated by three educational experts. The validation process involved reviewing the content, clarity, and relevance of the instrument to ensure that it accurately measured the intended constructs. The data collection techniques included observation, tests, and questionnaires. The material developed for this study was focused on environmental pollution material.

3. RESULTS AND DISCUSSION

3.1. Validity of the Learning Tool

The validation of the developed learning devices resulted in the following findings: The validity of the lesson plan was assessed on each aspect and was found to be in the "good" and "very good" categories. The teaching materials were found to be in the "valid" category. The LKS, which includes aspects such as instructions, content correctness, ability to process skills with guided inquiry models, procedures, and questions, were found to be in the "valid" category. The THB validity in terms of content validity, language, and question writing were found to be in the "valid" and "very valid" categories.

3.2. Practicality of Learning Devices

The practicality of the learning devices in this study was evaluated based on the implementation of learning, readability of teaching materials and LKS, and student responses.

1) Learning Practicability

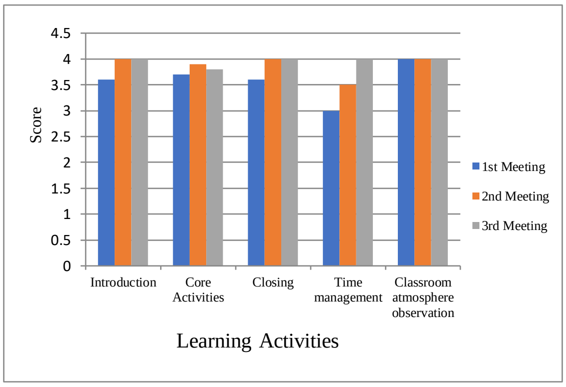

Figure 2. Diagram of Learning Implementation Observation Results

The success of the learning process is facilitated by guidelines that teachers use as references in managing learning activities. One of the learning tools developed by teachers is the RPP or lesson plans, which is a guide in the learning process as stated in PP No. 19/2005, concerning guidelines for developing learning tools for the 2013 curriculum. The lesson plan should at least contain learning objectives, learning materials, indicators, learning methods, learning resources, and assessment of learning outcomes (Kemendikbud, 2013).

The developed lesson plans consist of introduction, core, and closing activities, which include models, methods, and syntax or learning steps. The learning syntax/steps used to achieve the predetermined learning objectives or competencies refer to the guided inquiry model. The practicality of the learning device was evaluated based on the implementation of the lesson plan in the first, second, and third meetings, which were executed well.

2) Readability of Teaching Materials and LKS

According to Sugandi (in (Praptiwi & Handayani, 2012)), many components influence learning outcomes, including goals, materials, learning strategies, students and teachers as learning subjects, learning media, and the learning process. These components are interrelated, so the weakening of one component can impede the achievement of maximum learning objectives.

In line with the constructivist view of good learning, this study aims to facilitate active student participation and position the teacher as a facilitator (Westwood, 2008). To achieve this, LKS is provided as a guide for making measurements, observations, experiments, and conducting discussions. This allows students to interact with the material they learn and develop science process skills and inquiry to improve their understanding of the material or concepts.

The results of research on the readability of learning tools show that the material contained in the LKS is appropriate for the environmental context frequently encountered by students and aligns with the material in both the syllabus and lesson plans. This supports the achievement of basic competencies and trains students' science processes. According to Lee (2006), a contextual approach is essential in learning, as the presentation of contextual problems increases student learning motivation and provides a good understanding of the material being taught.

Regarding students' responses to the novelty of the material components and teaching materials, most students responded that the components are new, while some indicated that they were not new because they had previously encountered similar material in literacy activities. The readability of the developed teaching materials and worksheets suggests that they are practical for use in the learning process.

3) Student Response

Students' opinions on the learning tools and models provided show that they are interested in various components, including the lesson materials, LKS, teaching materials, teaching methods, and the stages carried out by teachers in the learning process. When asked about the novelty of the material or lesson content, most students responded positively, although some indicated that they had already encountered some of the material in pre-learning activities.

In particular, students responded positively to the components of science process skills, such as formulating problems, hypotheses, and conclusions, which they found to be new and valuable. This finding is consistent with the view that the ability to perform these skills is integral to learning scientific inquiry (Brum et al., 2020).

Overall, the analysis of student responses to the development of learning tools (including teaching materials and LKS) and the implementation of guided inquiry models indicates that students have responded positively to the learning process. Their responses meet the criteria of being "very good" (Riduwan, 2016).

3.3. Effectiveness of Learning Tools

The effectiveness of the developed learning tools can be evaluated based on student activities during the learning process, student science process skills test results, and student cognitive learning outcomes.

1) Student Activity

Positive student responses to the developed learning tools indicate that they are motivated to be more active in learning. Student activity is crucial in learning activities because it affects student learning outcomes. According to Piaget (as cited in (Slavin, 2008)), cognitive development largely depends on how actively children manipulate and interact with their environment. Therefore, by engaging students in learning using guided inquiry learning tools, students can be trained to be actively involved in learning, resulting in good learning outcomes in terms of concept understanding and science process skills. The diagram below illustrates the level of student activity during the learning process.

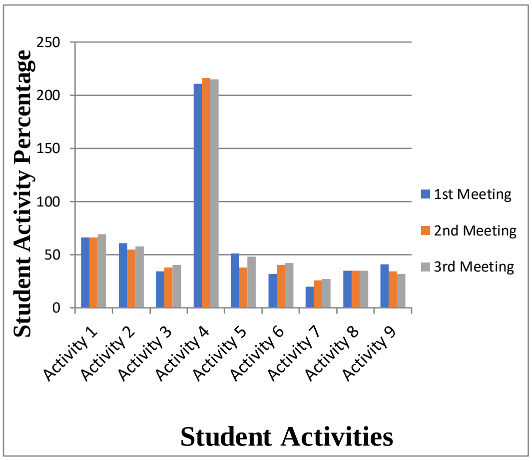

Figure 3. Diagram of Student Activity

Guided inquiry is well-suited to meet the demands of Curriculum 2013, which emphasizes the use of the scientific approach or science process skills (IPAS). The steps involved in guided inquiry learning enable students to learn actively. Students who use guided inquiry learning tools show high involvement in learning activities, particularly when practicing science process skills.

The highest level of student activity is observed in experimental activities that use student activity sheets (LKS) containing science process skills guided by the teacher, such as formulating problems, formulating hypotheses, observing, analyzing, and making conclusions. The results of the device trial are consistent with the findings of Devi et al. (2009), which suggest that the activities included in the LKS describe the actions or activities performed by students. These actions or activities serve as a means to enhance students' science process skills. This aligns with the statement of Astuti and Setiawan (2013), that the activities and questions presented in the LKS can aid students in developing their science process skills.

2) Student Science Process Skills Test Results

The developed learning tools focus on training students' science process skills such as formulating questions, hypotheses, observing, analyzing, and concluding. The results of the science process skills test indicate that students' skills in formulating questions and conducting experimental activities using the LKS have improved significantly. LKS I provides examples of how to formulate questions, hypothesize, observe, analyze, and conclude. In LKS II and LKS III, students conduct experiments independently under teacher guidance, which further enhances their skills. While students faced some obstacles in the concluding stage, the test results show that their skills in concluding have improved.

Overall, the results of the science process skills test demonstrate that the developed learning tools have been effective in training students' science process skills. The improvement in their skills is a positive outcome that will benefit students in their future studies and in their everyday lives.

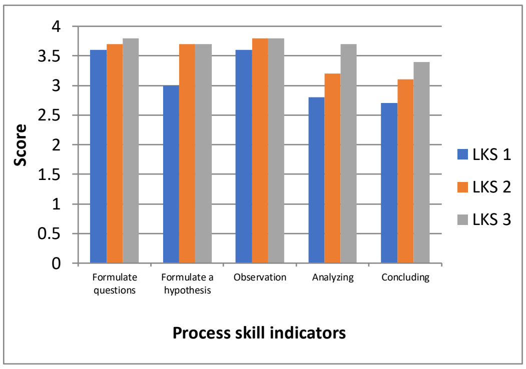

Figure 4. Diagram of Science Process Skills Ability in Working on the LKS

The LKS components that incorporate process skills are designed to enhance student engagement in the learning process. Through active participation in activities such as observation, discussion, and experimentation, students are given the opportunity to interact with the material and to develop their science process skills. To measure the effectiveness of the LKS in improving students' science process skills, student activities while working on the LKS are observed, and a cognitive test of process skills is administered to evaluate students' understanding of the process skills objectives. Science process skills encompass both cognitive and activity-based aspects. The cognitive test results of students' science process skills are presented below:

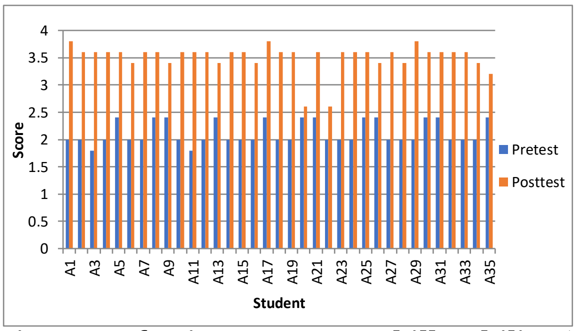

Figure 5. Diagram of Science Process Skills Ability (Cognitive)

Cognitive skills, which include intellectual skills and basic skills, form the foundation of science process skills, and are essential for students to master the concepts taught in science. The students' mastery of science process skills can be assessed through a process skills test, and in general, the results show that the students have acquired these skills effectively. This is indicative of the success of the teaching methods employed by the teachers, a viewpoint shared by Semiawan (1999), who emphasizes the importance of encouraging students to observe (count, measure, classify), look for space/time relationships, make hypotheses, plan research, control variables, interpret data, draw provisional conclusions, predict outcomes, apply knowledge, and communicate effectively.

Guided inquiry learning is a teaching approach that emphasizes student-teacher and student-student interactions, whereby students are encouraged to ask questions, form hypotheses, observe, analyze data, and communicate their findings. This approach has proven effective in training students' science process skills.

Observation worksheets have been used to evaluate student activity in science. In this study, the observed activities include formulating questions, hypotheses, observing objects, analyzing data, and drawing conclusions, which scored highly. Ebel & Frisbie (in (Subali, 2010)) also suggest that written tests are useful for assessing the knowledge base and performance, but cannot fully measure performance.

3) Cognitive Learning Outcomes

The activities that students engage in to practice science process skills have a significant impact on their cognitive learning outcomes. Through the use of guided inquiry learning tools, students' cognitive learning outcomes have improved significantly. The results indicate that the majority of students have achieved a high level of completeness in their cognitive learning outcomes, which is indicative of the effectiveness of the guided inquiry learning approach. The following diagram illustrates the students' cognitive learning outcomes test:

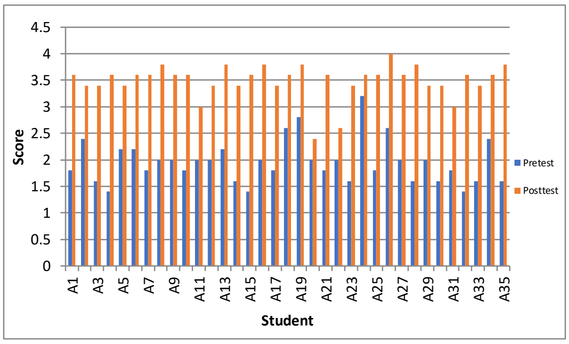

Figure 6. Diagram of Student Learning Outcomes Test

The effectiveness of guided inquiry learning is supported by the results of the question sensitivity analysis and N-Gain analysis. The question items are generally sensitive, and the learning outcomes of students, both individually and in a classical setting, are declared to be in the high category. The analysis showed significant differences between students' learning outcomes before and after learning, indicating the impact of guided inquiry learning.

Conducting pretest activities allows teachers to identify students' initial knowledge of the material, enabling them to provide appropriate treatment to improve students' understanding if there are indications of misconceptions. These results are supported by the validity and practicality of the learning tools used, such as lesson plans, worksheets, teaching materials, and cognitive learning outcome assessment instruments. The posttest results showed an average score in the complete category, demonstrating that IPAS learning using guided inquiry model tools has a positive effect on students' knowledge learning outcomes.

According to Piaget (in (Hughes & Hughes, 2012)), cognitive development largely depends on how actively children interact with their environment. Guided inquiry interactions in the classroom encourage students to find their own knowledge and promote science process skills development.

In summary, the research results indicate that the learning devices (lesson plans, LKS, teaching materials, and Learning Outcomes Tests) are suitable for use in the learning process, with good readability, implementation, and student responses in the good categories. Student science process skills in working on LKS are in the high category, which can be assessed through student activities, also in the good category. The most prominent activity is science process skills, and student learning outcomes have increased after the application of learning devices developed with the guided inquiry model.

4. CONCLUSION

The results of the research indicate that the IPAS learning tool guided inquiry model is effective in training science process skills and improving learning outcomes among vocational students.

To ensure proper implementation of guided inquiry model learning, it is recommended to pay attention to time management and preparation. This will enable the learning process to be carried out efficiently and effectively.

REFERENCES

Astuti, Y., & Setiawan, B. (2013). Pengembangan lembar kerja siswa (LKS) berbasis pendekatan inkuiri terbimbing dalam pembelajaran kooperatif pada materi kalor. *Jurnal Pendidikan Ipa Indonesia*, *2*(1).

Brum, G., McKane, L., & Karp, G. (2020). *Biology: exploring life*. John Willey and Son, INC.

Depdiknas. (2004). *Penyusunan Perangkat Pembelajaran*. Depdiknas.

Devi, P. K., & Renny Sofiraeni, K. (2009). *Pengembangan Perangkat Pembelajaran*. P4TK IPA.

Hughes, A. G., & Hughes, E. H. (2012). *Learning & teaching pengantar psikologi pembelajaran modern. Penerjemah SPA teamwork*. Yogyakarta. Bandung: NUANSA.

Ibrahim, Mushmin. (2002). Pengembangan Perangkat Pembelajaran. Modul Disajikan pada Pelatihan Terintegrasi Berbasis Kompetensi Guru mata Pelajaran Biologi SLTP. *Jakarta: Dirjen Dikdasmen Depdiknas*.

Ibrahim, Muslimin, Nur, M., & Kasdi, A. (2010). *Dasar-dasar proses belajar mengajar*. Surabaya: Unesa University Press.

Kemendikbud. (2013). *Kurikulum 2013*. Badan Penelitian dan Pengembangan Kementerian Pendidikan dan Kebudayaan.

Kuhlthau, C., & Todd, R. (2007). *Guided Inquiry: A Framework for Learning Through School Librariesin 21st Century Schools. CISSL. New Jersey*.

Lee, M. (2006). What does constructivism suggest for science education. *California State University, Northridge*.

Olson, S., & Loucks-Horsley, S. (2011). Inkuiri dan Standar-Standar Pendidikan Sains Nasional. *Translated by Ismunandar, Agustiani ED, Astuti DRF (Bandung: Qitep in Science SEAMEO)*.

Panjaitan, K., Sihombing, E., Pasaribu, C. C., & Siregar, C. A. E. (2022). Students'difficulties In Speaking Comprehension of Vocational High School Students. *ROMEO : Review of Multidisciplinary Education, Culture and Pedagogy*, *1*(2), 69–74. https://doi.org/https://doi.org/10.55047/romeo.v1i2.94

Praptiwi, L., & Handayani, L. (2012). Efektivitas model pembelajaran eksperimen inkuiri terbimbing berbantuan my own dictionary untuk meningkatkan penguasaan konsep dan unjuk kerja siswa SMP RSBI. *UNNES Science Education Journal*, *1*(2).

Riduwan. (2016). *Skala Pengukuran Variabel-Variabel Penelitian*. Alfa.

Semiawan, C. (1999). *Pendidikan tinggi: peningkatan kemampuan manusia sepanjang hayat seoptimal mungkin*. Direktorat Jenderal Pendidikan Tinggi, Departemen Pendidikan dan Kebudayaan.

Slavin, R. E. (2008). *Cooperative Learning: Teori, Riset dan Praktik, Terj. Nurulita*. Nusa Media.

Subali, B. (2010). Pengukuran Keterampilan Proses Sains Pola Divergen Mata Pelajaran Biologi SMA di Provinsi DIY dan Jawa Tengah. *Proceeding Seminar Nasional Biologi "Biologi Dan Pengembangan Profesi Pendidik Biologi*, 82–98.

Suprijono, A. (2009). *Cooperative learning: teori & aplikasi PAIKEM*. Pustaka Pelajar.

Van Heuvelen, A. (2001). Millikan lecture 1999: The workplace, student minds, and physics learning systems. *American Journal of Physics*, *69*(11), 1139–1146.