J-PEK (Jurnal Pembelajaran Kimia), p-ISSN: 2528-6536, e-ISSN: 2579-5945 *OJS*
Vol. 8, No. 1, June 2023, Page 43-50 *Universitas Negeri Malang*

Training of Development of Inquiry-Based and Project-Based Chemistry Learning Design for Chemistry & Science Teachers

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Abstract: Nowadays, the demands of curriculum are increasing in achieving better standards of learning process. The low ability of chemistry and science teachers in developing inquiry-based and project-based learning designs is a problem that must be solved. The ability of teachers in making learning designs is one of the pedagogic competencies and professional competencies that teachers must master in their professional development. So there is a need for community service or training to teachers to facilitate this. The method of implementing this community service activity includes the presentation of material on inquiry-based and project-based chemistry learning design, discussion and question and answer, and assistance to teachers in developing the learning design, until teachers are able to make inquiry-based and project-based chemistry learning tools (including lesson plans, teaching materials, and assessment instruments). The result of the training activities was an increase in the knowledge and skills of chemistry and science teachers regarding making inquiry-based and project-based learning designs. Enthusiasm and curiosity in developing knowledge about learning design make this training activity useful for participants.

Keywords: Learning Design; Chemistry; Inquiry; PjBL

INTRODUCTION

The inquiry-based learning process is one alternative in solving challenges in the 21st century. The ability of teachers in designing learning is one of the professional development of teachers, especially in pedagogic competence and professional competence (Patabang &; Murniarti, 2021). The learning system with conventional material delivery is often felt boring for students, so it is necessary to have activities in observing and practicing the material. However, the low ability of teachers to develop inquiry-based and project-based chemistry learning designs requires intensive attention at this time (Danumiharja, 2014). The results of the initial study show that knowledge and skills in designing and implementing inquiry-based and project-based chemistry learning for chemistry/science teachers, especially in Bojonegoro, are still lacking. Most teachers stated that there was a need for additional insight and training in the development of inquiry-based and project-based chemistry learning designs starting from making lesson plans, teaching materials, and assessments.

In the 21st century, it is necessary for teachers to strengthen the scientific approach and science literacy ability of students through inquiry-based learning and encourage the ability of students to produce contextual work, both individually and in groups by using a learning approach that produces problem-solving-based work, namely project-based learning (Erlina et al., 2022). The application of inquiry-based learning design and project-based learning is a demand of today's formal secondary school curriculum as outlined in the standard learning process (Ministry of Education and Culture, 2018). Referring to this, chemistry / science teachers need to have

knowledge and skills in designing and implementing inquiry-based and project-based chemistry learning.

Science learning should involve students in inquiry activities. Students associate their scientific knowledge with scientific knowledge from various sources that have been studied. Inquiry learning is important to apply so that students are free to elaborate on the concepts learned, not just the material recorded and memorized. Inquiry-based learning is learning that refers to 3 categories of activities, namely (a) what scientists do (investigating scientific phenomena using scientific methods to explain aspects of world events); (b) how students learn (through scientific questioning and engaging in scientific experiments as conducted by scientists); and (c) pedagogy or teaching strategies by designing and facilitating activities that lead students to observe, experiment, and experiment. Reviews known as obvious facts) (Septiani &; Susanti, 2021).

The advantage of inquiry-based learning is that students have responsibility for all tasks given, including experimental procedures, experiments, data analysis, and presentation of conclusions; have a spirit of learning to use their freedom in constructing knowledge; have the will to develop talents and rise from adversity; and be able to develop knowledge of science (Ancient et al., 2022). Inquiry-based learning has a significant influence on improving students' scientific argumentation skills (Sulistina et.al, 2020a), reminding environmental awareness (Sulistina et.al, 2020b), improving students' chemistry learning outcomes (Sulistina, et.al, 2012).

Project-based learning is a learning model that provides opportunities for students to learn by doing a project (Thomas, 2000), providing opportunities for teachers to manage classroom learning by involving project work (Rev., 2016). The advantages of project-based learning are (1) Increase learners' motivation to learn, encourage their ability to do important work, (2) Improve problem-solving skills, (3) Make students become more active and successful in solving complex problems, (4) Increase collaboration, and (5) Provide experience to learners learning and practice in organizing projects, and make allocations of time and other resources (Aditiyawarman, 2022). Project-based learning (PjBL) is designed to be used on complex problems that students need to invest. Through this PjBL, the inquiry process begins by raising guiding questions (A guiding question) and guide students in a collaborative project that integrates various materials in the lesson (Rahayu &; Fauzi, 2020).

The partners of the service activities in the form of inquiry-based learning design training and this project are chemistry teachers who are members of the Chemistry MGMP of Bojonegoro. Community service activities with the targeted teachers in this activity can take place smoothly with good coordination from the service team and MGMP teachers of Bojonegoro. This greatly supports the process of running the training so that it is expected to overcome the problem of the low ability of chemistry and science teachers in developing inquiry and project-based learning designs.

METHOD

The implementation method in the process of implementing community service activities is carried out in several stages, namely, (1) observation stages, (2) stages of implementing training activities which include; material presentation activities*, sharing sessions*, training and mentoring to teachers in developing learning designs, and (3) stages of activity evaluation. The details of the activities at each of these stages are as follows.

Observation Stages

Observation is an initial activity carried out by the community service team to find problems in the field, find solutions and take action to provide answers and overcome the problems found. The observation stage was carried out offline in Bojonegoro. The purpose of this observation is to analyze the problem of low teacher ability to develop inquiry and project-based learning designs,

and find solutions in the form of holding training that can facilitate teachers in developing the ability to make learning designs.

Implementation of Training Activities

The implementation of training activities is carried out by giving lectures in the form of material presentation on inquiry-based and project-based chemistry learning design. In addition, *a sharing session was also held* through discussion and question and answer activities between the service team and teachers. Training and mentoring to teachers in developing inquiry-based and project-based learning designs for chemistry/science materials are carried out until teachers are able to create learning tools (including lesson plans, teaching materials, and assessments) inquiry-based and project-based chemistry.

Evaluation Stages

The evaluation stage is carried out to find out whether the community service activities that have been carried out can make a beneficial contribution to the community, as well as find out how satisfied the trainees are with these activities. One of the functions of the evaluation implementation can illustrate the results of the implementation of training in terms of services provided during the training program which can be used as a step to improve service quality (Rifki et al., 2022). In addition, through this evaluation activity, the service team can correct if there are errors during the training implementation process.

RESULTS AND DISCUSSION

The results obtained from this training were found a number of active kumia/science teachers and there was an increase in ability in developing inquiry and project-based learning designs. The implementation of this community service has succeeded in training 35 training members from chemistry and science teachers on the process of making inquiry-based and project-based learning designs. This service program needs to be developed again and continuously to train teachers' abilities to be accustomed to making good learning designs. Through good learning design, the learning process will be better and more interactive so that it does not seem boring. The presentation of material on inquiry-based and project-based chemistry learning design was carried out by a service team from several lecturers of the Department of Chemistry, Faculty of Mathematics and Natural Sciences, State University of Malang.

Implementation of Activities

The training was conducted in Bojonegoro on August 13, 2022. The number of participants who attended the training was 35 people consisting of chemistry teachers and science teachers. The teachers who are the targets of service are teachers who have joined the MGMP of Bojonegoro. The team prepares an attendance list so that trainees can fill in the attendance list during the training. The initial event was the opening of the chief executive of community service activities and the chairman of the Chemical MGMP of Bojonegoro. Then continued with the delivery of material in the form of inquiry-based learning designs and projects by several lecturers from the community service team.

Figure 1. Opening and Delivery of Material by the Community Service Team

Initial material was given to 35 trainees and formed into 10 groups that will be guided on knowledge of inquiry and project-based learning design. The material was delivered by 5 material carriers who were community service teams. The subject matter presented was an introduction to learning design, steps in making inquiry-based and project-based learning designs, and things that must be done in the process of implementing learning design in teaching and learning activities and applied directly. Providing initial material conducted by Mr. Herunata regarding general problems in the chemistry / science learning process in schools and how to make inquiry-based learning designs and projects to solve problems in learning. The teachers who attended the training were very enthusiastic in listening to the material. After that, sharing sessions were also carried out through discussion and question and answer activities about the application, obstacles, and challenges of implementing learning experienced by teachers in the classroom using inquiry and project-based bassist learning.

Training and mentoring to teachers in developing the learning design, until teachers are able to make learning tools (including lesson plans, teaching materials, and assessments) inquiry-based and project-based chemistry. It is hoped that after attending this training, teachers will be able to take the knowledge that has been given both theory and practice so that they can open up making inquiry-based learning designs and projects well. After the training, teachers are also given tasks regarding the design of inquiry and project learning. From the overall group assignments collected, 3 learning designs were selected to be analyzed.

Results of Teacher Task Analysis

The training program carried out by the community service team is useful to strengthen the process of making inquiry-based learning designs and projects carried out by teachers to avoid things that are not in accordance with theory. Another purpose of this training is so that learning activities are not boring. Training is given at the beginning of the activity until the end of the training by looking at how the process of making learning designs and providing direction if the process experiences problems and correcting problems. Here are the results of an analysis of 3 inquiry learning design tasks that have been collected by teachers.

Table 1. Analysis of Teacher Assignments Regarding Inquiry Learning Design

Aspects	Group 1	Group 2	Group 3
Suitability of Learning Objectives	Learning objectives are in accordance with inquiry learning, because they conclude from experiments that have been done. "Through the inquiry learning process, students can think critically in identifying the characteristics of endothermic and exothermic reactions based on experimental data and infer endothermic and exothermic reactions, then skillfully carry out experiments to classify exothermic reactions and endothermic."	The learning objectives and activity descriptions are in accordance with the inquiry syntax. "Learners can design experiments on the physical properties (melting point, solubility, and electrical conductivity of solutions of ionic compounds and covalent compounds, and use knowledge of ionic bonding and covalent bonding."	Learning objectives are not compatible with inquiry learning, because there is no purpose that students infer from the experience/experiment that has been done. "Students can explain the tendency of an element to achieve its stability. Students can describe the arrangement of valence electrons of noble gas atoms (duplets and octets) and valence electrons of non-noble gases."
Learning Syntax Compatibility	The syntax or flow of learning objectives is in accordance with the steps that must be done in inquiry learning, namely observation to find problems, formulate problems, propose hypotheses, plan problem solving through experiments, carry out experiments, make observations and collect data, analyze data, and draw conclusions.	The syntax or flow of the learning objectives is in accordance with the steps that must be done in inquiry learning.	The syntax or flow of the learning objectives is not yet in accordance with the steps that must be done in inquiry learning. There is no step that shows that students make an experiment / observation to acquire their own knowledge. In addition, the syntax used is guided inquiry.
Suitability of Activity Description in Learning Syntax	Each description of the activities carried out is in accordance with the syntax of inquiry learning.	Each description of the activities carried out is still not entirely in accordance with the syntax of inquiry learning.	Each description of the activities carried out has not been in accordance with the syntax of inquiry learning.
Learning Device Compatibility	Learning tools in the form of worksheet are in accordance with inquiry learning.	Learning tools are quite complete because there is already worksheet, but it is not in accordance with the inquiry syntax.	There is no worksheet used for the learning process.

Table 2. Analysis of Teacher Assignments Regarding Project Learning Design (PjBL)

Aspects	Group 1	Group 2	Group 3
Suitability of Learning Objectives	The purpose of the experiment is in accordance with PjBL learning, because it designs a project in the form of voltaic cell experiments using surrounding materials and communicating through posters. "Through the PjBL learning process, students can analyze reaction spontaneity, voltaic cell charts, voltaic cell reactions, cell potential differences, voltaic series, and explain their usefulness by thinking critically, creatively, and skillfully designing voltaic cells using surrounding materials and being able to communicate them in the form of posters resulting from group collaboration."	There are only core competencies with no indicators or learning objectives.	The learning objective is appropriate, namely by designing experiments by raising problems that exist in real life and presenting them in the form of *prototypes*.
Learning Syntax Compatibility	The syntax or flow of learning objectives is not in accordance with the steps that must be done in PjBL learning, namely setting the project theme, setting the learning context, planning activities, processing activities, and implementing activities to complete the project. In the learning design, it is still not structured every step, but it includes learning on the PjBL model.	The learning syntax is less in line with the PjBL syntax.	The learning step is in accordance with the STEM-PjBL syntax based on Laboy-Rush theory.
Suitability of Activity Description in Learning Syntax	Each description of the activities carried out is quite in accordance with the PjBL learning syntax.	The description of activities is not appropriate, because some steps are not in accordance with the syntax of PjBL. among them, questions that are not included in the type of essential questions, there is no monitoring carried out by teachers on the student project process. In the learning tool, there is a lack of explanation that explains the activities of students or teachers in accordance with the PjBL syntax.	The description of activities is detailed and in accordance with the STEM-PjBL syntax based on Laboy-Rush theory because every activity carried out by teachers / students is described appropriately and also given a timeline related to student project assignments
Learning Device Compatibility	Learning tools in the form of question rubrics for assessment are in accordance with PjBL learning.	The learning tools used are not suitable because even though there is already worksheet, there is no assessment rubric for the resulting project.	Learning devices are not suitable, because there is no worksheet.

Evaluation

The obstacle faced in this training activity is that there are some teachers who from scratch do not know how to make the correct inquiry and project learning design. Must be more active in providing assistance and often repeat in practical activities to strengthen knowledge. The tasks given to the group are also still there that have not been collected due to less heterogeneous group

members. However, the team continues to monitor and remind teachers to submit assignments in order to get a certificate equivalent to 32 JP. The following are presented the results of evaluation documentation in the form of group photos and snippets of assignment results that have been collected by the teacher.

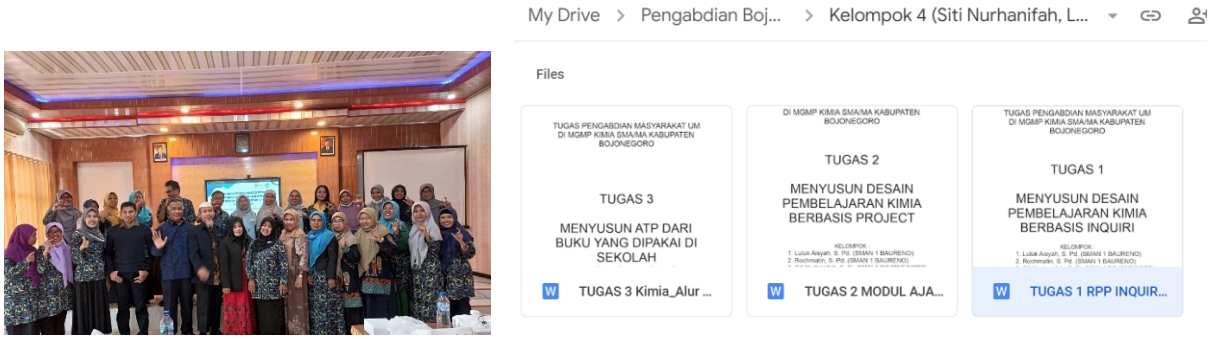

Figure 2. Task Evaluation and Collection Process

CONCLUSION

Training activities for the development of inquiry-based learning designs and projects in Bojonegoro that have been completed are applications of educational science in fostering enthusiasm in teaching and playing an active role in providing knowledge to students. With this training, it is expected to improve the ability of teachers to develop similar learning designs so that problems in learning can be resolved.

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