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Innovation in chemistry learning: enhancing learning quality through training on the implementation of project- and game-based learning for the chemistry MGMP in Sidoarjo

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ABSTRACT

Students often consider chemistry as a difficult subject to understand because that most teachers still use conventional teaching methods and lack of application of innovative learning media. Along with the times, a student-centered learning approach is one of the potential innovations that can be applied in learning chemistry, such as project- and game-based learning. This community service aims to enhance teachers' understanding and skills in implementing project-based learning and games in chemistry learning. The methods of this service are lectures and training. The subjects were 89 chemistry teachers from 40 high schools who are members of the Chemistry MGMP in Sidoarjo. The activities were carried out in the form of: (1) Socialization and sharing sessions on PjBL; (2) Socialization and sharing sessions on GBL; (3) Integration of project- and game-based learning in chemistry learning; (4) Demonstration of project- and game-based learning in chemistry learning; and (5) Sharing session on project-based teaching modules and games in chemistry learning. After participating in the activity, teachers' understanding increased by 35.37%. This activity produces outputs in the form of best practices and teaching modules.
Keyword: Chemistry Learning, Community Services, GBL, PjBL

ABSTRAK

Siswa seringkali menganggap kimia sebagai mata pelajaran yang sulit dipahami karena sebagian besar guru masih menggunakan metode pengajaran konvensional dan kurangnya penerapan media pembelajaran yang inovatif. Seiring perkembangan zaman, pendekatan pembelajaran yang berpusat pada siswa menjadi salah satu inovasi potensial yang dapat diterapkan dalam pembelajaran kimia, seperti pembelajaran berbasis proyek dan game. Pengabdian kepada masyarakat ini bertujuan meningkatkan pemahaman dan keterampilan guru dalam mengimplementasikan pembelajaran berbasis proyek dan game dalam pembelajaran kimia. Metode pengabdian ini adalah ceramah dan pelatihan. Subjek pengabdian adalah 89 guru kimia dari 40 SMA yang tergabung dalam MGMP Kimia Kabupaten Sidoarjo. Kegiatan yang dilakukan berupa: (1) Sosialisasi dan sharing session terkait pembelajaran berbasis proyek; (2) Sosialisasi dan sharing session terkait pembelajaran berbasis game; (3) Integrasi pembelajaran berbasis proyek dan game pada pembelajaran kimia; (4) Demonstrasi pembelajaran berbasis proyek dan game pada pembelajaran kimia; dan (5) Sharing session terkait modul ajar berbasis proyek dan game pada pembelajaran kimia. Setelah mengikuti kegiatan, pemahaman guru meningkat sebesar 35,37%. Kegiatan ini menghasilkan luaran berupa best-practice dan modul ajar.
Keyword GBL, Pembelajaran Kimia, Pengabdian kepada Masyarakat, PjBL

1. Introduction

Chemistry learning is often a challenge for most students and is considered a difficult subject to understand [1], [2], [3]. This is due to the abstract and complex of chemistry concept [4]. In addition, students' learning difficulties are often caused by a lack of interest in participating in the learning process. This may be influenced by teaching methods, as many teachers still use the lecture method which makes learning monotonous and boring, and teachers have not used interesting media in learning [3], [5]. Therefore, innovation in learning is very important, especially those that are relevant to technological developments and adjust to students' learning needs.

Along with the times, a student-centered learning approach is one of the potential innovations to be applied in chemistry learning [6], [7]. Examples of student-centered learning are project- and game-based learning. Project-based Learning (PjBL) involves students in the exploration and application of knowledge through projects or tasks that focus on solving problems or achieving specific goals [7]. This approach allows students to gain hands-on experience in applying their knowledge and to develop essential skills such as problem-solving, communication, and teamwork. Meanwhile, Game-based Learning (GBL) is an innovative learning model that uses game elements to create an interactive and engaging learning experience [8]. Game aspects such as scores, levels and prizes can increase student engagement. However, in practice, teachers who are facilitators still often find difficulties in implementing project- and game-based learning processes. Based on the results of a preliminary study conducted on chemistry teachers who are members of the Chemistry MGMP in Sidoarjo, it was found that teachers' skills in designing project- and game-based learning methods and media were still limited. Therefore, the community service team proposes a program entitled "Innovation in Chemistry Learning: Enhancing Learning Quality through Training on the Implementation of Project- and Game-Based Learning for the Chemistry MGMP in Sidoarjo."

The Sidoarjo Regency High School Chemistry Working Group or Musyawarah Guru Mata Pelajaran (MGMP) Kimia Kabupaten Sidoarjo is an organization formed as a platform for Chemistry teachers in Sidoarjo Regency to continually develop their professionalism [9], [10]. This forum plays a role in improving teacher competence through various activities, such as training sessions, workshops, seminars, and discussions on the latest issues in learning and pedagogy. By equipping chemistry teachers with the ability to implement project- and game-based learning, it is expected to improve the quality of chemistry teaching in secondary schools in Sidoarjo. This community service aims to enhance teachers' understanding and skills in implementing project-based learning and games in chemistry learning.

2. Methods

The methods used in this research are lecture and training [9]. The lecture method was employed to convey basic concepts, theories, and information related to project- and game-based learning. Through this method, participants gain an initial understanding of the importance of innovation in chemistry learning as well as the basic principles underlying these two approaches. Meanwhile, the training method is applied to provide participants with hands-on experience in designing and implementing project- and game-based learning.

The target participants of the community service activities are 89 chemistry teachers from various high schools who are members of the Chemistry MGMP in Sidoarjo. The activities were conducted offline over two meetings. The first meeting was held at SMA Negeri 1 Taman with 3 agenda items, including: (1) Socialization and sharing sessions on project-based learning; (2) Socialization and sharing sessions on game-based learning; and (3) Integration of project- and game-based learning in chemistry learning. The second meeting was held at SMA Negeri 3 Sidoarjo with 2 agenda items, including: (1) Demonstration of project- and game-based learning in chemistry learning and (2) Sharing session on project-based teaching modules and games in chemistry learning.

The success of this community service activities can be assessed from the following indicators, including: (1) The outcomes of this community service activity include best practice on project and game-based learning experiences that can be a reference for teachers in the learning process, as well as project- and game-based teaching modules in chemistry learning, and (2) The achievement of activity outcomes and the competency improvement of participants as measured by the comparison of pre-test and post-test results.

3. Results and Discussion

3.1. Overview of the activity implementation

The first community service meeting was held at SMA Negeri 1 Taman. This activity was attended by dozens of chemistry teachers from various high schools who are members of the Chemistry MGMP in Sidoarjo. During the first meeting, there were 3 topic presentation sessions. The first sessions related to the project-based learning (PjBL), and then was followed by a session on game-based learning. The third session focused on integrating project- and game-based chemistry learning. During each session, participants were given assignments best-practice on project- and game-based learning experiences in chemistry learning. The first community service meeting can be seen in Figure 1.

Figure 1. The first community service meeting.

The second community service meeting was held at SMA Negeri 3 Sidoarjo. This activity was also attended by dozens of chemistry teachers from various high schools who are members of the Chemistry MGMP in Sidoarjo. During the second meeting, there were 2 topic presentation sessions. The first session was a demonstration of project- and game-based learning in chemistry learning. The second session was a sharing session, where participants discussed about project- and game-based teaching modules they had developed during the activities. The second community service meeting can be seen in Figure 2.

Figure 2. The second community service meeting.

3.2. Socialization and sharing sessions on project-based learning

In the first session of the first meeting, a speaker delivered a presentation on Project-Based Learning (PjBL). Project-based learning (PjBL) is a learning model that allows teachers to manage classroom learning by involving students in project work [7]. In this model, students explore, evaluate, interpret, synthesize, and process information to produce various learning outcomes. PjBL provides opportunities to expand knowledge and develop skills through investigation-based problem solving. In addition, this model has significant instructional impacts, such as enhancing students' ability to master topic creatively and innovatively, as well

as fostering student's creativity and productivity. PjBL is a student-centered approach, where the teacher acts as a facilitator.

In practice, the project-based learning model consists of six stages, including (1) Learning begins with essential questions; (2) Planning is conducted collaboratively between teachers and students; (3) Teachers and students jointly plan activities to complete the project; (4) Teachers are responsible for assist the project process undertaken by students; (5) Assessment is carried out by teachers to measure students' achievement of competency standards; (6) At the end of the lesson, teachers and students reflect on the activities and results of the project. The advantages of project-based learning include improved problem-solving skills, increased learning motivation, collaboration, research skills, and resource management. However, the challenges include the need for more time and cost, adequate facilities, and sometimes limitations in mastering the topic thoroughly.

3.3. Socialization and sharing sessions on game-based learning

In the second session of the first meeting, a speaker delivered a presentation on Game-Based Learning. Game-based learning (GBL) is a learning method that uses games as a tool to deliver instructional topic [11]. Currently, there are various types of GBL commonly used in education, ranging from conventional methods (without using electronic devices) to video game-based approaches, utilizing both desktop and mobile platforms. An example of conventional GBL is Team Games Tournament (TGT), while video game-based GBL examples (via websites and mobile applications) include Educandy, Wordwall, Baamboozle, and Mentimeter.

Game-based learning is a student-centered approach. However, it is important to note that GBL is not a replacement for traditional teaching methods, but rather a supplementary tool aimed at enhancing students' motivation and learning outcomes. Therefore, teachers should select games that are appropriate for the material being taught and adjust the game's difficulty to match the complexity of the content.

3.4. Integration of project- and game-based learning in chemistry learning

This session discussed how to integrate project- and game-based learning into a cohesive chemistry learning flow. This approach combines the advantages of PjBL, which allows students to learn through exploration and the completion of real projects, with game elements that foster an interactive and enjoyable learning environment. For example, Quizizz can be used as a learning media within the project-based learning model (PjBL) in chemistry learning. Quizizz can be used as a learning media that supports project-based learning syntax or as a formative assessment tool. This is line with research by Purba et al. [11] which found that the PjBL model using Quizizz can improve student learning outcomes with moderate categories. In addition, Quizizz can assist in evaluating learning effectively.

3.5. Demonstration of project- and game-based learning in chemistry learning

In this session, the process of making fermented sticky rice (tape ketan) was presented as an example of applying project-based learning to the sub-topic of Factors Affecting the Rate of Reaction. Through this project, students not only learn about the theory of chemical reactions, but also find out how temperature, concentration, surface area of the touch area, and the presence of a catalyst affect the fermentation rate in the process of making sticky rice tape. The integration of project-based learning with daily life aims to make learning more meaningful and relevant to students. By linking material concepts to real contexts, students can see how the knowledge learned plays a role in everyday life, thus increasing student motivation and understanding.

In addition, there is also a demonstration of the application of learning using the Teams Games Tournament (TGT) or Game-Based Learning (GBL) method, both online and offline. Game-based learning media can be divided into 2 types, including: physical game learning media (example: Chempoly, Chemical Ladder Snakes, Chemical Cards) and non-physical game learning media using platforms/applications such as Quizizz, Kahoot!, Baamboozle, Wordwall. This method is considered effective to increase student engagement, motivate students in learning, and strengthen concept understanding through fun learning activities. Demonstration of project- and game-based learning in chemistry learning can be seen in Figure 3.

Figure 3. Demonstration of project- and game-based learning in chemistry learning.

3.6. Socialization and sharing sessions on game-based learning

In this session, the facilitator provided an opportunity for participants to share their experiences and challenges in developing and implementing the teaching module. The participants discussed the implementation of project- and game-based learning methods in the classroom, with the aim of increasing student involvement, deepening understanding of the topic, and creating a more interactive and interesting learning atmosphere. This session also served as a platform for exchanging ideas and strategies, as well as receiving feedback from both the facilitator and peers, with the aim of helping participants improve their existing modules. Sharing session on project-based teaching modules and games in chemistry learning can be seen in Figure 4.

Figure 4. Sharing session on project-based teaching modules and games in chemistry learning.

3.7. The success of community service activities

The success of this community service activities can be assessed from the following indicators:

3.7.1 Achievement of Activity Outcomes

The outcomes of this community service activity include best practice on project and game-based learning experiences that can be a reference for teachers in the learning process, as well as project- and game-based teaching modules in chemistry learning that can be assists in planning and implementing more structured learning. The best practice on project- and game-based learning experiences in chemistry learning as the outcomes of this community service activity can be seen in Figure 5. Meanwhile, the project and game-based teaching modules in chemistry learning as the outcomes of this community service activity can be seen in Figure 6.

Figure 5. Best practice on project- and game-based learning experiences in chemistry learning.

Figure 6. Project and game-based teaching modules in chemistry learning.

3.7.2 Competency Improvement of Participants

There was an increase in participants' understanding of the concept and implementation of Project- and Game-Based Learning (GBL), as measured by the comparison of pre-test and post-test results. The pre-test aims to identify the participants' initial level of understanding, while the post-test aims to measure the participants' increased understanding after attending the training [9]. The results of the pre-test and post-test recapitulation are presented in Table 1.

Table 1. The results of the pre-test and post-test recapitulation.

No.	Question Indicators	Percentage	
		Pre-Test	Post-Test
1.	Basic concept of Project-Based Learning (PjBL)	55	95
2.	Planning for PjBL	45	90
3.	Implementation and evaluation for PjBL	50	85
4.	Basic concept of Game-Based Learning (GBL)	60	90
5.	Planning for GBL	70	92
6.	Implementation and evaluation for GBL	50	88
7.	How to integrate PjBL and GBL elements in learning	45	85
8.	How to assess student learning outcomes from the combination of PjBL and GBL	55	88
Average Percentage		53.75	89.12

Based on the analysis between the pre-test and post-test results, it is stated that the participants' competence in understanding the concepts and implementation of Project- and Game-Based Learning has increased by 35.37%. This indicates that the implemented program has been successful. The success of a program can be

measured by its execution process and outcomes [12]. From a process perspective, the community service activities were conducted as planned and achieved the intended objectives. Meanwhile, from an outcome perspective, the activities also had a positive impact on enhancing participants' competencies.

4. Conclusions

The community service program that has been implemented supports the continuous professional development of teachers who are members of the Chemistry MGMP in Sidoarjo. Through this training, chemistry teachers gain a deeper understanding of project- and game-based learning concepts, as well as the ability to integrate both approaches into chemistry lessons. After participating in the activity, teachers' understanding increased by 35.37%. The training also produced best-practice on project- and game-based learning experiences in chemistry learning, along with teaching modules that can be used as references to support teachers in implementing these innovative methods in classrooms. The follow-up plan of this community service activity is to measure the long-term impact of the application of Project- and Game-based Learning on the quality of chemistry learning

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