# Workshop on Enhancing Chemistry Teachers' Practical Skills Using Laboratory Instruments

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***Abstrack***

*Educational transformation in the era of the 4.0 industrial revolution requires teachers, especially chemistry teachers, to have laboratory skills relevant to the development of modern instrument. However, observation of MGMP Chemistry teachers in Sidoarjo Regency show that their practical skills are still limited, especially in the use of modern analytical instruments, due to a lack of facilities, a lack of hands on training, and the dominance of online training in the use of spectrophotometer and calorimeters. The implementation method included the stages of needs analysis, module and demonstration video design, product development through expert validation, workshop implementation at the Central Laboratory and Chemistry Laboratory of the faculty of Mathematics and Natural Sciences, State University of Malang and feedback based evaluation of participants. The training results showed that more than 70% of participants experienced a significant increase in their instrument usage skills, while the other 30% reported a fairly good improvement. The participants response was very positive, with appreciation for the hands-on experience, introduction to modern instruments, and motivation to integrate practical work into chemistry learning in schools. This activity proved to be effective in strengthening the professional competence of chemistry teachers acquired technical skills in operating instrument, colleting data, and analyzing experimental results, as well as methodological understanding in integrating modern practicums into chemistry learning in schools. Thus, this program contributed significantly to improving the quality of contextual, interactive, and practice-based chemistry learning in line with the demands of the digital era.*

***Keywords:*** *Workshop, chemistry teachers, practical skills, spectrophotometer, bomb calorimeter.*

## 1. INTRODUCTION

The digital transformation of education systems around the world currently provides opportunities for innovative approaches, particularly in overcoming complex conceptual learning challenges that are difficult to addres using traditional methods. The era of the 4.0 industrial revolution is driving change and improvement in all fields (Putri, D. P., et al., 2025). Globalization, digital discruption, rapid technological advances, and the need for sustainable development have changed not only what students need to learn, but also how educators must be prepared to teach (Jahan. M and Nava J., 2024). Human resource Development (HRD) has become a crucial factor in facing the 4.0 industrial revolution. In addition, in 21st century teaching, education has become increasingly important to ensure that student have learning and innovation skills, skill in using technology and information media, and are able to work and survive using life skills (Sulistyorini, S. et al., 2019).

The 21st century is known to everyone as the century of knowledge, which is the main foundation of all aspects of life. One of the fields of education that is required to keep up with the development in digital transformation is natural sciences related to practical skills or practical work, such as chemistry. Currently, the development of practical instruments in chemistry learning has experienced rapid progress. Many sophisticated instruments have been developed to support the practicum process, which is expected to increase the effectiveness of learning and make it easier for teachers and students to conduct experiments (Pakaja, J. A., et al., 2023). Educators are the most dominant factor in driving independent

learning, namely by creating effective learning and having proficient learning skills (Widarti, H. R. et al., 2023). However, the reality in the field shows that technological developments have not been accompanied by an increase in teachers skills in utilizing them. A more specific problem aries in the context of chemistry teachers, where most teachers still experience difficulties in using modern practical instruments. A study by Novita (2020) reports that many teachers consider conducting practical work to be burdensome due to limitations in time, tools, materials, and the necessary instructions. As a result, chemistry practical work, which should be the main means of developing scientific procces skills, is rarely carried out optimally. This confirms that teachers competence in operating practical instruments is still an issue that needs to be addressed.

Previous studies have shown that various training programs for teacher tend to be conducted online or in a hybrid format. For example, training on e-exam questions development and instructional video development during the pandemic emphasized the use of ICT-based technology (Kurniawan et al., 2021). Then there was training conducted by HR. Widarti (2023) on the development of constructivist-based learning modules for education practitioners at SMAN 3 Sidoarjo. However, training such as this often does not provide hands-on experience for teachers in operating real world instrumements, so their practical skills have not developed optimally. Based on initial observations of teachers who are members of the chemistry MGMP at Sidoarjo Regency High School, it was found that although most teachers have good basic laboratory skills, they face obstacles in optimizing these competencies. The gap between online training that does not provide direct practical experience and the result of observations of teachers from the Sidoarjo Regency High School Chemistry MGMP became the main focus of this community service activity.

Education is considered to be of high quality if learning is conducted in an interactive, engaging, onjoyable, challenging manner that encourages students to actively participate in achieving their goals (Kwame Abroampa, W. et al., 2025). While previous studies have focused more on online aspects and digital content development, this community service program present a different approach with face-to-face training (offline) packaged in a workshop on practical skills using real instrument, supported by and introduction to modern laboratory instruments. Spectrophotometry and calorimeter instruments were chosen because they are instruments that can be used in high school chemistry practicums. This approah not only trains teachers to understand technology, but also ensures they have practical skills. Thus, this activity is expected to addres the real needs of chemistry teacher in improving their practical skills while strengthening the quality of chemistry learning in schools.

## 2. METHODE

The steps for implementing the community service activity “Workshop on Improving the Pratical Skills of Chemistry Teachers in the Sidoarjo District MGMP through Spectrophotometry and Calorimeter Instrument Practicum at the Malang State University Laboratory” are as follows:

**a. Analysis stage**

An analysis of the partners was conducted through surveys and observations. The results showed that the practical laboratory skills of high school chemistry teachers in Sidoarjo Regency were low, mainly due to limited facilities. Therefore, the partners needed training to improve their practical skills, an introduction to medern laboratory equipment, and support for practical workshop that could be used in school with limited facilities.

**b. Design stage**

The training products were designed in the form of practicum modules and demonstration videos, with the selection of appropriate media based on the result of the analysis of the concept and characteristics of the educators (Rokhim. D and Widarti. H, 2020). The modules contained guidelines on the use of laboratory equipment, simple practicum prosedure, and occupational safety aspects. The videos were created as visualizations of the practices to support the teachear’s understanding.

**c. Development stage**

This stage involves the preparation of modules and videos, validation by laboratory and education expert, and revisions based on feedback to make the products more effective and practical to use.

**d. Implementation stage**

A training workshop for MGMP Chemistry teachers in Sidoarjo was held at the UM Chemistry Laboratory. The training fovused on skills in using laboratory equipment, both traditional and modern.

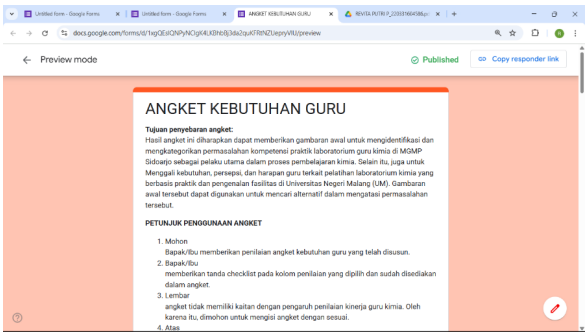
**e. Evaluation stage**

The effectiveness of the training and the suitability of the workshop were assessed through

participant feedback. The evaluation result were used to refine the product to better suit the needs of chemisty learning in schools.

## 3. RESULT AND DISCUSSION

The result of this community service program is the implementation of a training workshop for chemistry teachers in the Sidoarjo MGMP. The community service program began with the distribution of a questionnaire on teacher's needs as an initial overview to identify and categorize issues related to the laboratory skills of chemistry teachers in MGMP Sidoarjo as the main actors in the chemistry learning process. In addition, it also aimed to explore teacher's needs, perceptions, and expectations regarding practice-based vhemistry laboratory training and introduction to facilities at Malang State University (UM).




**Picture 1** .Teacher needs questionnaire

The questionnaire respondent in figure 1 were chemistry teachers in the Sidoarjo MGMP who taught at several schools, such as SMAN 1 Gedangan, SMAN 2 Sidoarjo, SMAN 1 Tarik, MA Terpadu Islam Darul Fikri, and so on. The result of the questionnaire figure 3 show that more than 50% of respondents routinely conduct chemistry practicums for each subject that can be taught with procedural knowledge. However, respondents face many obstacles in conducting practical activities, including schools that do not have laboratories, inadequate practical materials, and the absence of laboratory assistants, which reduces the amount of time available because they have to prepare the necessary tools and materials themselve. Im addition, some toold do not function properly, there are obstacle in teaching students how to use the tools, some chemical can no longer be used, and students lach the literacy to understand the instructions before the practical activity begins. Almost all chemistry teachers in the Sidoarjo MGMP have never participated in laboratory practice training activities, even though laboratory practical skills are very important for chemistru teachers. From the various training activities offered in the questionnair, almost all respondents were interested in training in the form of direct practice workshops in chemistry laboratories.

Hands-on workshops in chemistry laboratories were chosen because almost all respondents agreed that such training was effective in helping to improve teacher's professional competence. Respondents gave varied responses regarding the training they wanted to learn more about more about, including meaningful experiments for student, skill in using laboratory equipment, handling hazardous materials, experimental techniques, data analysis techniques, skills in using instrument such as calorimeters, voltmeter, ammeter, redox practicum, practicum skills related to daily life, skills in using modern instruments, and good laboratory management skills. The next stage is the development of a community service design by identifying all the necessary requirements and practical skills. Therefore, it was decided that the community service activity would include training in the use of spectrophotometers to measure samples and the use of calorimeters to measure the heat of combustion of coal samples.

Based on the mapping of these needs, the next step is to formulate the design of community service activities by designing all the necessary tools and facilities. The results of the analysis show that significant improvements in teacher competence can be focused on mastering modern analytical instruments that are directly related to chemistry learning at the secondary school level. Therefore, it was decided that this community service activity would focus on training in the use of spectrophotometers for quantitative analysis of samples, as well as bomb calorimeters for determining the combustion heat of solid fuels such as coal The selection of these two instruments was

based on their urgency in strengthening teachers' experimental skills, as well as their relevance to the topics of energy chemistry and quantitative analysis, which are often challenging in learning.

The workshop was designed as an intensive practical session held at the Central Laboratory of the Faculty of Mathematics and Natural Sciences (FMIPA) UM and the Chemistry Laboratory of FMIPA UM. The series of activities began with an opening ceremony in the FMIPA UM hall, followed by a presentation on modern practical instruments by Mrs. Surjani, head of the Central Laboratory of FMIPA UM.


**Picture 2**. Opening ceremony

Subsequent activities include a visit and orientation to modern laboratory instruments, guidance on the use of spectrophotometers and calorimeters, and hands-on training covering sample preparation, instrument operation, data collection, and analysis and interpretation of experimental results. Participants first visit the laboratory to see and learn about the functions of each modern practical instrument. Participants then carried out hands-on training activities covering sample. preparation, instrument operation, data collection, and analysis and interpretation of experimental results from UV Vis spectrophotometers and calorimeters. Thus, this activity not only provides technical skills in operating instruments, but also trains teachers in analytical and methodological aspects that are essential for developing practical skills in schools. It is hoped that through this practice-based training model,-teachers will be able to improve their proficiency in using laboratory instruments while integrating this experience into more applicable and contextual chemistry learning strategies.



**Picture 4.** Instrument practicum

The workshop participants completed a questionnaire on achievement after the activity ended. The results showed that 70% of the participants responded that the workshop had a very positive impact on improving their proficiency in using laboratory instruments, while 30% of the participants stated that it fairly improved their skills in using practical instruments. The training participants expressed very positive impressions of the workshop, emphasizing that it was memorable, enjoyable, inspiring, and provided real benefits for improving the professional competence of chemistry teachers. They felt that they had gained new insights, especially regarding the use of modern laboratory instruments such as UV-Vis spectrophotometers, calorimeters, XRD, and SEM, which they had never encountered before.

In addition, participants also appreciated the opportulary to visit the Central Laboratory of the Faculty of Mathematics and Natural Sciences, University of Malang, and to participate in simple, practical learning activities. This training was considered capable of rekindling the spirit of learning, providing motivation to integrate chemistry practicums into meaningful leaming, and adding skills in laboratory management and handling hazardous materials. However, some participants hoped that similar activities could be carried out more regularly with a longer duration, accompanied by the development of simple practicum materials that could be adapted to laboratory facilities in schools. Overall, this activity was considered highly beneficial, enriching experiences, strengthening collaboration between UM and the Chemistry MGMP of Sidoarjo Regency, and providing inspiration to continue innovating in chemistry learning at schools.

## 4. CONCLUSION

Digital transformation in the era of industry 4.0 requires chemistry teachers to master modern laboratory instruments. However, limited facilities, time, and lack of training mean that teachers' practical skills remain low. Observations by the Sidoarjo Chemistry Teacher Working Group show that practical work is rarely optimal due to constraints in facilities, materials, and lack of direct experience. This community service activity offers a solution through face-to-face workshops focusing on the use of spectrophotometers and calorimeters. The workshop includes needs analysis, module and video development, validation, thining at the UM laboratory, and evaluation. As a result, the majority of participants stated that their practical skills had improved significantly, they had gained new insights, and they were motivated to integrate practical work into chemistry learning. Teachers also hoped that similar activities could be carried out more regularly with a longer duration.

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