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# Enhancing Vocational Students' Understanding of Energy Sector Developments through Industry-Based Training on Oil, Gas, and Geothermal

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***ABSTRACT***

*This study reports a community service activity aimed at enhancing vocational students' understanding of current developments in the energy sector, particularly in oil and gas, geothermal energy, and energy transition. The activity was conducted at SMK Migas Cibinong and involved 20 students from Grades 11 and 12 of the Oil and Gas Program. The training was implemented through an industry-based learning approach that combined material presentations, industrial case examples, contextual explanations, and interactive discussions. The training materials covered recent developments in the oil and gas industry, geothermal energy utilization, and the role of both sectors in supporting energy transition. Evaluation was conducted through participant observation and a post-training questionnaire assessing material relevance, perceived knowledge improvement, and training usefulness. The results showed positive participant responses, with mean scores of 4.8 for material relevance, 4.6 for perceived knowledge improvement, and 4.9 for training usefulness. Students also demonstrated active participation and increased interest in current energy-sector issues, particularly when industrial case examples were introduced. These findings indicate that industry-based learning activities have the potential to broaden students' perspectives, strengthen the connection between theoretical knowledge and industrial practice, and support vocational education in responding to evolving workforce demands.*

***Keywords : Industry-based learning; Energy transition; Geothermal energy; Oil and gas industry; Vocational education***



## INTRODUCTION

The energy sector, particularly oil, natural gas, and geothermal resources, plays a strategic role in supporting national development, industrial growth, and energy security in Indonesia [1]–[3]. In recent years, the sector has experienced significant changes driven by technological advancement, digital transformation, regulatory adjustments, and global commitments toward sustainable energy development. These changes have transformed the competencies required by the workforce, demanding not only strong technical skills but also a broader understanding of current industrial trends, energy transition policies, and emerging technologies.

Vocational high schools (Sekolah Menengah Kejuruan/SMK) are expected to prepare students with practical competencies that meet industry requirements. In energy-related vocational programs, students are trained to acquire technical knowledge and skills relevant to oil and gas operations and other industrial activities. However, several studies have reported that vocational education often faces challenges in aligning learning outcomes with rapidly changing industrial needs [4]–[6]. As a result, students may graduate with adequate fundamental competencies but limited exposure to contemporary developments occurring in the industry.

This challenge is particularly relevant in the energy sector. The oil and gas industry is currently facing issues such as declining production from mature fields, increasing implementation of digital technologies, and the need for operational efficiency. At the same time, geothermal energy has gained increasing attention as one of Indonesia's most promising renewable energy resources, supporting national efforts toward energy transition and sustainable development [7]. Consequently, future energy-

sector workers are expected to understand both conventional and renewable energy systems, as well as the broader direction of national energy policy and industrial transformation [8]–[10].

Based on preliminary discussions with teachers and students at SMK Migas Cibinong, it was identified that most classroom learning activities remain focused on fundamental technical competencies required by the curriculum. While these competencies are essential, students have limited opportunities to explore current issues such as energy transition, geothermal energy development, digitalization in oil and gas operations, and future career challenges in the energy sector. As a result, students may experience difficulties in relating theoretical knowledge acquired in the classroom to actual industrial practices and ongoing developments within the energy industry [11]–[14]. Several studies have suggested that industry-based learning and contextual educational activities can enhance students' understanding by connecting theoretical concepts with real-world applications. Exposure to industrial perspectives, technological developments, and practical case studies can help students develop broader insights and improve their readiness for future employment. Therefore, complementary learning activities are needed to enrich students' knowledge beyond formal classroom instruction and to strengthen the relevance of vocational education to current industry conditions.

In response to these needs, a community service program was conducted at SMK Migas Cibinong in the form of industry-based training focusing on developments in the oil and gas industry, geothermal energy, and energy transition. The training combined material presentations, contextual explanations, industrial case examples, and interactive discussions to facilitate active learning. Through this approach, students were expected to gain updated knowledge regarding current industrial developments and future opportunities in the energy sector [15], [16].

This activity aimed to enhance vocational students' understanding of recent developments in the energy sector, particularly in oil and gas, geothermal energy, and energy transition. In addition, the program sought to broaden students' industrial perspectives, improve their awareness of emerging industry trends, and support the alignment between vocational education and current workforce requirements. The activity also contributes to strengthening collaboration between higher education institutions and vocational schools in preparing future human resources for the evolving energy sector.

## METHOD

This community service activity was conducted at SMK Migas Cibinong, Bogor, Indonesia, to enhance vocational students' understanding of current developments in the energy sector, particularly in the oil and gas industry, geothermal energy, and energy transition. The activity involved 20 students from Grades 11 and 12 of the Oil and Gas Program and was facilitated by lecturers from the Petroleum Engineering and Industrial Engineering Departments of Universitas Bhayangkara Jakarta Raya. The activity was implemented through a structured industry-based training approach consisting of five main stages: (1) needs identification and data collection, (2) theme determination and material planning, (3) preparation of facilities and materials, (4) implementation of training, and (5) evaluation and feedback. The overall implementation procedure is presented in Figure 1.

The first stage involved needs identification and data collection through direct observation and informal discussions with teachers and students. This process aimed to identify students' existing knowledge, learning needs, and their level of exposure to current developments in the energy sector. In addition, relevant literature, industry reports, and regulatory documents related to oil and gas, geothermal energy, and energy transition were reviewed to ensure that the training materials reflected current industrial conditions. Based on the findings from the initial assessment, the second stage focused on determining the training theme and planning the learning materials. The selected topics included recent developments in the oil and gas industry, geothermal energy development in Indonesia, technological innovations, energy transition issues, and future workforce requirements in the energy sector. The materials were adjusted to the students' educational background to ensure accessibility and relevance.

The third stage involved the preparation of presentation materials, supporting learning modules, discussion questions, and training facilities. Classroom facilities and multimedia equipment, including projectors and audio systems, were prepared to support the learning process. The training materials were designed to combine theoretical explanations with practical industrial examples and contextual case discussions. The fourth stage consisted of the implementation of the training program through face-to-face learning sessions. The activity was delivered through presentations, contextual explanations,

industrial case examples, interactive discussions, and question-and-answer sessions. Students were encouraged to actively participate by sharing opinions, responding to questions, and discussing real-world challenges related to oil and gas operations, geothermal development, and energy transition. This approach was intended to help students connect classroom knowledge with actual industrial practices.

The final stage involved evaluation and feedback collection. The evaluation was conducted descriptively through direct observation during the training process and feedback obtained from participants through a post-training questionnaire at the end of the activity. The evaluation focused on student participation, responsiveness, engagement during discussions, and their ability to relate theoretical concepts to current industrial developments. The collected feedback was used to assess the relevance and usefulness of the training materials and to identify potential improvements for future community service activities.

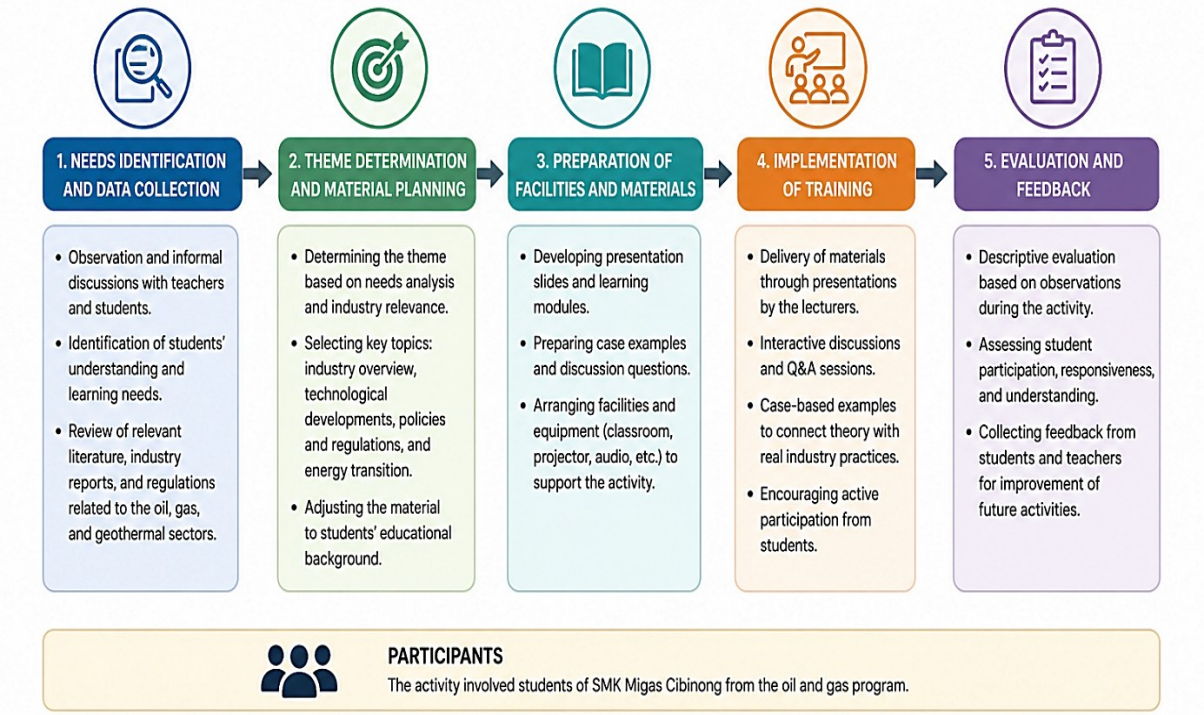


**Figure 1. Method of the community service activity**

## RESULTS AND DISCUSSION

The community service activity was successfully implemented at SMK Migas Cibinong and involved 20 students from Grades 11 and 12 of the Oil and Gas Program. The activity was conducted through a structured training session aimed at improving students' understanding of current developments in the energy sector, particularly in the oil and gas industry, geothermal energy, and energy transition. The implementation combined material delivery, contextual explanations, industrial case examples, and interactive discussions to create an engaging learning environment and facilitate knowledge transfer. The materials delivered during the activity were designed to provide students with a comprehensive understanding of both conventional and renewable energy sectors, as well as the broader context of energy transition in Indonesia. A summary of the main topics discussed during the training is presented in Table 1.

The delivery of the material was carried out interactively, allowing students to engage directly with the facilitators. During the sessions, students showed increasing interest, particularly when the discussion shifted from theoretical explanations to real-world industrial cases. This finding suggests that contextual learning approaches can help students better understand complex concepts related to the energy sector and improve their ability to connect classroom knowledge with industrial practices.

**Table 1. Main Training Materials on Energy Sector Development Delivered to Students**

| No. | Main Topic | Subtopics Covered | Key Discussion Points | Learning Focus | Relevance to Students |
|---|---|---|---|---|---|
| 1 | Development of Oil and Gas Industry in Indonesia[17], [18], [19] | Historical development; current production conditions; industry structure; regulation; technology | Declining production, mature fields, need for innovation, EOR, digital oil field | Understanding industry challenges and structure | Relates theory to real industrial conditions |
| 2 | Development of Geothermal Energy in Indonesia[6], [22], [20] | Potential resources; development history; technology; utilization; regulation | Renewable energy potential, development barriers, geothermal applications | Understanding sustainable energy systems | Expands knowledge beyond fossil energy |
| 3 | Oil and Gas vs Geothermal in Energy Transition[7], [23], [22] | Energy transition concept; comparison; national targets; future outlook | Role of gas as transition energy, geothermal as baseload, NZE target | Understanding future energy trends | Prepares students for future industry demands |

As shown in Figure 2, the learning atmosphere was interactive, with students actively listening, responding, and participating in discussions. The facilitators encouraged students to ask questions, share opinions, and relate the presented material to their prior knowledge and learning experiences. This interaction created a more dynamic learning environment compared to conventional one-way lectures. Students demonstrated positive responses throughout the activity and showed particular interest in topics related to energy transition, geothermal energy development, and future career opportunities in the energy sector. Their curiosity was reflected in the variety of questions raised, ranging from technical aspects of oil and gas operations to the role of renewable energy in supporting national energy security.

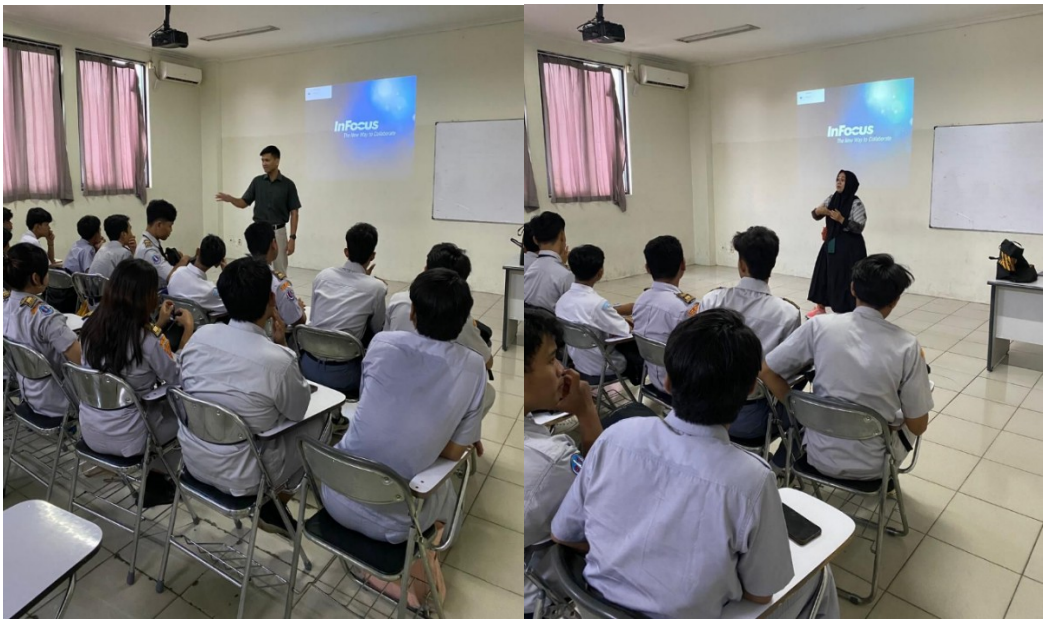


**Figure 2. Implementation of training session and interactive discussion with students**

In addition, the use of real industrial examples such as Enhanced Oil Recovery (EOR), digital oilfield applications, and geothermal power plant operations helped students connect theoretical knowledge with practical applications. This approach is consistent with the principles of vocational education, where learning is expected to be closely linked to real-world practices. The incorporation of industry-based examples enabled students to better understand how concepts learned in the classroom are applied in actual industrial settings.

To complement the observational findings, a post-training evaluation was conducted to assess participant perceptions regarding the training activity. The evaluation focused on three key aspects: material relevance, perceived knowledge improvement, and training usefulness. The results are presented in Table 2.

**Table 2. Participant Evaluation Results**

| Evaluation Aspect | Mean Score |
|---|---|
| Material Relevance | 4.8 |
| Knowledge Improvement | 4.6 |
| Training Usefulness | 4.9 |
| Overall Satisfaction | 4.8 |

The evaluation results indicate a highly positive response from the participants. Material relevance achieved a mean score of 4.8, suggesting that the topics delivered were closely aligned with students' educational needs and interests. The perceived improvement in knowledge obtained a mean score of 4.6, indicating that students considered the activity beneficial in enhancing their understanding of recent developments in the energy sector. The highest score was recorded for training usefulness, with a mean value of 4.9, reflecting students' perception that the activity provided valuable knowledge and insights beyond those typically obtained through regular classroom learning. These evaluation results support the observations made during the implementation of the activity. Students not only actively participated in discussions but also demonstrated a greater awareness of contemporary issues affecting the energy sector. The combination of contextual explanations, industrial case examples, and interactive discussions appears to have contributed positively to students' learning experiences and understanding of the topics presented.

Figure 3 shows the participants and facilitators after the completion of the activity. This documentation reflects the collaborative atmosphere established during the program and highlights the active involvement of students throughout the learning process. Such participation is important in vocational education because it helps strengthen students' confidence, motivation, and readiness to engage with future industrial challenges.

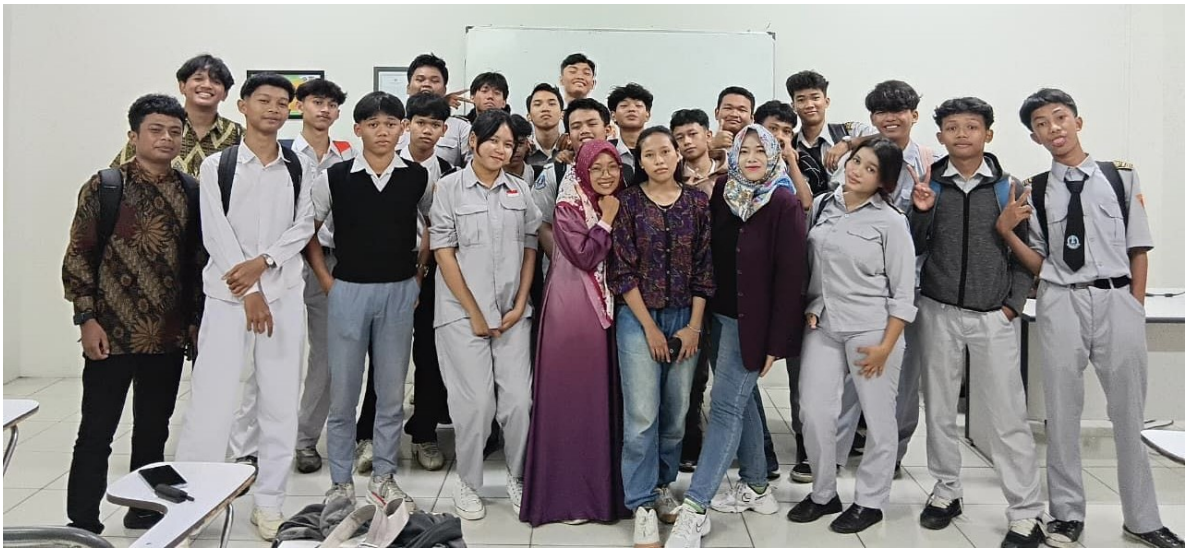

**Figure 3. Documentation of participants and facilitators after the activity**

From a broader educational perspective, the findings indicate that industry-based training activities can provide meaningful learning experiences for vocational students. The positive participant responses and high evaluation scores suggest that students value opportunities to learn about current industrial developments through direct interaction with practitioners and academics. These findings are consistent with previous studies on industry-based learning and experiential learning, which have reported that contextual learning environments can improve student engagement, motivation, and understanding by connecting theoretical concepts with practical applications.

Furthermore, exposure to emerging topics such as geothermal energy and energy transition introduced students to industrial developments that are not always discussed extensively in regular classroom instruction. This broader perspective is increasingly important because future energy-sector workers are expected to understand not only conventional energy systems but also renewable energy technologies and sustainability-related challenges. Through the integration of industrial examples and interactive learning approaches, students were able to gain a more comprehensive understanding of the evolving energy landscape in Indonesia. However, several limitations should be acknowledged. The evaluation relied primarily on participant perceptions and descriptive observations, without the use of objective pre-test and post-test measurements. In addition, the activity was conducted within a limited time frame, which restricted the depth of discussion for each topic. Despite these limitations, the findings indicate that the training activity provided a valuable learning experience and showed potential for improving students' awareness and understanding of current developments in the energy sector.

Overall, the results suggest that industry-based learning activities can serve as an effective complementary approach to vocational education by providing students with updated industrial knowledge, encouraging active participation, and helping bridge the gap between classroom learning and real-world industrial practices [24]–[26]. These outcomes support the importance of continued collaboration between higher education institutions and vocational schools in preparing future human resources for the rapidly evolving energy sector.

## CONCLUSION

The implementation of industry-based training at SMK Migas Cibinong provided vocational students with exposure to current developments in the oil and gas industry, geothermal energy, and energy transition. Through the integration of material presentations, industrial case examples, and interactive discussions, students demonstrated active participation and positive engagement throughout the activity. The participant evaluation results, which showed high scores for material relevance (4.8), perceived knowledge improvement (4.6), and training usefulness (4.9), indicate that the activity was well received and considered beneficial by the participants. These findings suggest that contextual and industry-oriented learning activities have the potential to broaden students' understanding of current industrial developments, strengthen the connection between theoretical knowledge and practical applications, and support vocational education in responding to evolving workforce demands. Although the evaluation was primarily based on participant perceptions and descriptive observations, the activity contributed positively to students' awareness of emerging trends and opportunities in the energy sector. Therefore, industry-based training can serve as a valuable complementary learning approach for vocational education, while future programs are encouraged to incorporate more comprehensive assessment methods to better measure learning outcomes.

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