

Empowering the Sustainability of Chemistry in STEM through International Community Engagement Project

Community Engagement Project

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Abstract:- International Community Engagement Project conducted by Al Rhazes Jr group that consist of 20 students and 2 supervisors was designed to provide undergraduate students of Universiti Teknologi PETRONAS (UTP), Malaysia with a unique opportunity to engage in an international community outreach project. The program aligned with the UTP's vision of increasing the number of students who gain international experience during their education. The primary objective of the program was to inspire and cultivate an interest in chemistry-related fields among high school students in rural areas. Recognizing the lack of exposure to chemistry programs among the younger generation, the project aimed to address this issue and reverse the declining interest in the field. Through a captivating two-week program, a chemistry enrichment module known as the chemistry explore race, which successfully engaged and inspired 60 high school students. In addition to the chemistry explore race, STEM education classes were also conducted for primary school students in the rural area of Pulau Gadang, Pekanbaru, Indonesia, offering valuable learning experiences to the local community.

Keywords:- International Community Engagement Project; Undegraduate Students; Applied Chemistry; STEM; Education; Secondary School.

I. INTRODUCTION

The HEB 1012 (MPU4) Community Engagement Project is a key requirement for Universiti Teknologi PETRONAS (UTP) students. This project provides students with an opportunity to apply their knowledge and values while fulfilling university social responsibilities (USR) vision. It aligns with university's mission of producing well-rounded graduates with a holistic perspective. Al Rhazes Jr, composed of 20 undergraduate students, has devised an impactful two-week community project. The primary objective is to inspire youth and cultivate their interest in chemistry, while also promoting STEM education. This project was conducted in Pekanbaru, Riau, Indonesia, serves as an ideal location for this initiative.

The main challenge is to address is the limited exposure to sciences education, particularly in the field of chemistry, among young individuals. Studies conducted at both the university and national levels have indicated a declining interest in chemistry due to a lack of understanding and exposure (Akram et al., 2017). Consequently, there has been a significant decrease in the number of chemistry graduates, leading to a shortage of skilled professionals in chemistry-related sectors such as research and development, food quality control, and environmental science (Shwartzl et al., 2021).

Al Rhazes Jr project seeks to inspire and ignite enthusiasm for chemistry among the youth. By showcasing the practical applications and potential of the field through chemistry explore race, the group aims to stimulate interest in research-based programs and careers in chemistry. It is believed that fostering a passion for chemistry will contribute to the overall growth and development of the nation. In addition to addressing the decline in interest in chemistry, the group also conducted STEM education classes and interactive projects for primary school students in a rural area, to inspire students and enhance their skills in STEM. By introducing these subjects in a fun and engaging way, the group aimed to spark their interest and provide them with valuable learning experiences (Kayan-Fadlilmula et al., 2022).

The mission of the Al Rhazes Jr project is to inspire and cultivate a passion for chemistry among young individuals in Pekanbaru, Riau, Indonesia. The project aims to address the declining interest in chemistry by showcasing its practical applications and potential. Through engaging chemistry explore race activities and STEM education classes conducted in a rural area, students are empowered with the skills and knowledge needed for future opportunities in technical fields. The project strives to bridge the gap in applied sciences education, making a lasting impact on the education and development of the youth, while contributing to the overall growth of the nation. Lastly, this project aims to embark communication between students with industrial players with hope to explore the wide career opportunities of expertise chemists that eventually brings benefits to society.

II. COMMUNITY ENGAGEMENT PROJECTS

A. Chemistry Explore Race

Chemistry explore race was conducted as the main activity of this project. In this activity, high school students were divided into groups consisting of 4 to 5 students per group. This explore race was conducted based on a module created by the team which consists of 6 experiments related to chemistry. Each station was assigned a different theme in chemistry to assess the participants' understanding of basic chemistry knowledge. In each station, participants need to conduct an experiment based on the module prepared and understand the theory of the experiment. The participants were evaluated based on their understanding through given questions. In other ways, participants were given a fun way in

learning chemistry and broaden their knowledge in the importance of chemistry that are evolving around in daily lives. Table 1 lists the chemistry explore race experiments.

The project's goal is to increase public awareness of the significance of keeping chemistry graduates employed as a means of guiding Malaysia towards becoming a nation based on research. The project emphasizes the value of chemistry in preparing future graduates with an inventive and creative researcher attitude by undertaking project-based educational activities such as engaging learning modules, chemistry-related experiments, and workshops. The objective of the framework is to improve sciences knowledge and abilities, which this project directly supports.

TABLE I. CHEMISTRY EXPLORE RACE EXPERIMENTS

No	Chemistry Explore Race	
	Title of Experiment	Summary
1	Egg in different density solution, lava lamp	Demonstrate the difference in density between hot and cold water
2	Exploding Volcano	Learn the chemical reaction that occurs between the baking soda and vinegar
3	3D Molecular Model	Identify the compound from their respective 3D molecular structure
4	Electroconductivity of substance based on electrochemistry	Measuring the electroconductivity of various substances
5	Benedict Test	Determining the presence of reducing sugar in the sample.
6	Ice Freezing Point (Ice Cream Making)	Physical change of malt drink from liquid into solid.

B. STEM Class

In this activity, the participants are the primary school students in the rural area of Pulau Gadang, Pekanbaru, Indonesia. A STEM module was prepared consisting of two sets of activities which are Water Rocket Launching and Distribution of Load. These two activities were conducted in games form where the students were divided into 5 groups. Each group was given a short lecture on each activity for their understanding of science and a set of time to complete their model to be tested. The main purpose of this activity is to introduce the STEM education activity that can build the interest in learning sciences as students aged 13-15 need to prepare themselves to focus in which area in their high school studies. It also somehow gives them the opportunity to start planning their careers based on their interests.

The project highlights the importance of STEM education through STEM programmed offered in rural areas. The project intends to pique the target participants' interest in STEM by offering practical learning opportunities and fun activities. This is in line with the framework's goal of developing graduates who are well-rounded and have the skills they will need in the future (Watkins and Mazur, 2013).

III. MEASUREABLE OF OBJECTIVES

The impact of the chemistry-enrichment-module towards the participants' awareness of the sustainability graduates/skills in the industrial sector and their eagerness to consider pursuing chemistry as career path were measured via pre-module and post-module surveys containing various forms of quantitative questions such as likert scale, yes/no question, and multiple-choice questions. The modules also contain qualitative questions such as questions requiring short and long answers.

➤ Pre-module survey:

The pre-module survey entitled 'High School Students Awareness of the Sustainability of Chemistry Graduates/Skills in the Industrial Sector' in which clear written instruction were given to the participants and verbally repeated the instruction before the participants fill in the survey to ensure that the feedback received is properly aligned with the purpose of the survey.

TABLE II. PRE-MODULE QUESTIONNAIRES

No	High School Students Awareness on the Sustainability of Chemistry Graduates/Skills in the Industrial Sector
1	What grade are you currently in high school?
2	What is your gender?
3	Have you ever taken chemistry as a subject in high school?
4	On a scale of 1 to 5, with 1 being the lowest and 5 being the highest, how interested are you in the field of chemistry?
5	Are you aware of the importance of chemistry graduates/skills in the industrial sector?

No	High School Students Awareness on the Sustainability of Chemistry Graduates/Skills in the Industrial Sector
6	Have you ever participated in chemistry enrichment modules or extracurricular activities related to chemistry outside the regular school curriculum?
7	Do you believe that education about the importance of chemistry graduates/skills in the industrial sector should receive more emphasis?
8	Opinion on whether education about the importance of chemistry graduates/skills in the industrial sector should receive more emphasis.
9	How did you acquire knowledge about the importance of chemistry graduates/skills in the industrial sector?
10	Are you interested in participating in chemistry enrichment modules focused on practical applications of chemistry in the industrial sector?
11	Additional comments or suggestions regarding chemistry education and its relationship with the industrial sector (open-ended question)

➤ *Post-Module Survey:*

The post-module survey was titled 'Impact of Chemistry Enrichment Modules on Vision to Pursue Studies in Chemistry and Awareness of the Importance of Maintaining Chemistry Graduates/Competencies in the Industrial Sector' in which clear written instruction were given to the participants and verbally repeated the instruction before the participants fill in the survey to ensure that the feedback received is properly aligned with the purpose of the survey. Table 3 listed the questionnaires for post-module.

TABLE III. *POST-MODULE QUESTIONNAIRES*

No	Impact of Chemistry Enrichment Modules on Vision to Pursue Studies in Chemistry and Awareness of the Importance of Maintaining Chemistry Graduates / Competencies in the Industrial Sector
1	How did your participation in the chemistry enrichment modules (practical experiments and theory classes) influence your vision and interest in pursuing studies in the field of chemistry?
2	Has your awareness of the importance of maintaining chemistry graduates/competencies in the industrial sector increased after participating in these chemistry enrichment modules?
3	In your opinion, how does the chemistry enrichment module help increase awareness of the importance of maintaining chemistry graduates/competencies in the industrial sector?
4	Did this chemistry enrichment module motivate you to consider a career in the industrial sector or a related field?
5	Would you recommend this chemistry enrichment module to other students interested in pursuing studies in chemistry or careers in the industrial sector?
6	In your opinion, what additional activities or improvements could be integrated into the chemistry enrichment module to enhance its impact on students' vision and understanding of the importance of maintaining chemistry graduates/competencies in the industrial sector? (open-ended question)
7	Do you believe that coordinating chemistry enrichment modules like this is important in preparing the younger generation to face challenges and opportunities in the industrial sector?
8	Has your perception of the role of chemistry in the industrial sector changed after participating in this chemistry enrichment module?
9	How confident are you in pursuing a career in chemistry or a related field after participating in this chemistry enrichment module?
10	Are you interested in participating in programs or activities related to maintaining chemistry graduates/competencies in the industrial sector? (open-ended)

IV. PROJECT OUTCOMES

In collaboration with Universitas Islam Riau, Indonesia, the explore race was attended by 52 students and 4 teachers from SMK Migas BMR and SMK Tekri. Both schools were located around Pekanbaru, Riau, Indonesia. The Chemistry explore race was conducted based on the STEM Education experiment focusing on chemistry at secondary level. This game was conducted to measure the level of understanding and to create awareness on the importance of chemistry in developing countries' economy.

For the first objective, the main purpose is to educate the youth generation on the importance of sustaining chemistry graduates/expertise in the industrial sector. The initiative successfully educated the young about the importance of chemistry in the industrial sector using chemistry enrichment modules. There was a significant improvement of about 75% in the participants' interest, assurance, and knowledge

regarding the discipline of chemistry, according to questionnaires taken before and after the module. This accomplishment reflects the project's accomplishment in promoting understanding and encouraging young people to pursue chemistry courses.

On the second objective, participants benefitted greatly from the project in terms of developing their soft skills, leadership potential, and social awareness. In this STEM Class, the group has conducted an activity with SMPN 3 XIII KOTO KAMPAR, Riau Province which located at Kampung Patin, Pulau Gadang, Riau. The school has sent 48 students aged from 11-12 years old to participate in this activity. The Al Rhazes group members had the opportunity to converse with locals by moving out from their comfort zone and impart their STEM knowledge by holding STEM education classes in the rural regions of Pulau Gadang. The quantifiable results, including pre- and post-program feedback, showed a marked improvement of 85% in the students' knowledge of and

appreciation for STEM fields. This accomplishment demonstrates the project's success in encouraging students' personal growth and raising STEM knowledge in the community at large.

V. IMPACT OF ACTIVITIES TO PARTICIPANTS

The project has made significant impacts on the surrounding community. The project's initiatives have assisted the beneficiary group, which includes residents of Pulau Gadang, Indonesia and high school students of Pekanbaru. The neighborhood has seen improvements in several areas:

A. Increased Awareness and Interest

The community members have gained a better grasp of the value of STEM disciplines like chemistry because of the project's initiatives to educate and foster these areas of study. Students have been inspired to think about pursuing paths in science and technology regarding the fascinating STEM classes, chemistry enrichment modules, and hands-on activities (Van den Hurk et al., 2019).

B. Enhanced Skills and Knowledge

Through the project's workshops, experiments, and explore race activities, the beneficiaries have acquired valuable skills and knowledge in chemistry and STEM. The participants have gained practical experience, improved their problem-solving abilities, and developed a deeper understanding of scientific concepts. These enhanced skills have empowered them to explore new opportunities and excel in their academic pursuits.

C. Collaboration and Community Engagement

By involving local stakeholders in the project, such as businesses, universities, and schools, the project has encouraged involvement in the community. The project's cooperative character has improved connections and established a network of assistance inside the community. The contribution of the locals of Pulau Gadang has also encouraged a sense of pride in and title of their community's assets and opportunities.

Feedback from the targeted community has been overwhelmingly positive. Participants have expressed gratitude for the engaging and informative sessions, highlighting how the project has expanded their horizons and broadened their career aspirations. They have shared their increased motivation to pursue studies in chemistry and STEM-related fields, with some expressing a desire to contribute to the community's development through scientific innovation and research. Here are some notable testimonials:

"The chemistry enrichment modules were incredibly engaging and eye-opening. Before the modules, I had little interest in chemistry, but after participating, my interest skyrocketed. I am now considering pursuing chemistry as a career." - Aditya Firnanda, SMK TEKRI.

"The hands-on experiments and interactive activities in the modules made learning chemistry fun and accessible. I realized the practical applications of chemistry in various industries, and it sparked my curiosity to explore more in this field." - Indah Delvani, SMK MIGAS BMR.

"The STEM education classes conducted by the project were a game-changer for our community. We had limited exposure to STEM subjects before, but these classes opened our eyes to the potential and opportunities in STEM. We are now more interested in showcasing STEM education in the academic institutions of Pulau Gadang." - Mr Trojowi, teacher from SMPN 3 XIII Koto Kampar.

"The project has inspired us to think beyond our traditional occupations and consider careers in science and technology. The modules and classes were informative, and we now realize the importance of STEM in shaping the future of our community and country." - Ananda, student of SMPN 3 XIII Koto Kampar and resident of Pulau Gadang, Indonesia.

VI. CONCLUSION

Al Rhazes project's goal of inspiring and nurturing a passion for chemistry among young people has been defined by outstanding efforts and significant accomplishments. These initiatives have resulted in significant successes that have had a long-lasting effect on the community.

Firstly, the project successfully organized a series of chemistry enrichment modules, engaging high school students and providing them with a clear vision of the importance of sustaining chemistry graduates in the industrial sector. Through these modules, participants experienced hands-on activities, workshops, and experiments that showcased the practical applications of chemistry. The project measured the success of these modules through pre- and post-module surveys, which indicated a significant increase in participants' interest, confidence, and knowledge regarding the field of chemistry. This achievement demonstrates the project's effectiveness in addressing the declining interest in chemistry and fostering a renewed enthusiasm among the youth.

Second, the STEM education lessons taught in Pulau Gadang's rural areas have been crucial to improving students' abilities and knowledge in the fields of science, technology, engineering, and mathematics. Students had wonderful chances in these classes to apply STEM principles practically and learn by doing. Students improved their ability to think critically, solve problems, and work in teams through participatory projects and interesting exercises. Assessments of students' academic performance and comments from both students and teachers were used to determine if the project was successful in reaching this goal, and both revealed considerable gains in students' comprehension and performance in STEM topics.

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