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Empowering Future Pharmacists in Chemistry Analysis of Nutraceuticals

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Abstract

Gen Z remains active across social media platforms and is strongly interested in digital and social impact. This community service aims to empower future pharmacists in East Java, Indonesia, by increasing their understanding of nutraceuticals through chemical analysis. Students acquire essential skills for their academic activities through practical training in chromatographic analysis and antioxidant activity measurements. This service equips students with practical skills in analyzing nutraceuticals, preparing them for further pharmaceutical studies. The training program was carried out for 88 high school and vocational school pharmacist students using Participatory Action Research (PAR). The main topics discussed are analysis using thin-layer chromatography, evaluation of functional groups in polyphenols, and assessment of antioxidant effectiveness. Pharmacy lecturers facilitate the program by guiding participants in practical competencies. This service results in success, with a better understanding of nutraceuticals and analytical skills gained. This service emphasizes the importance of practical training and educational interventions in preparing students for advanced pharmacy studies.

Keywords Chemistry Training; Nutraceutical Analysis; Pharmacy Education; Practical Skills Development

1. INTRODUCTION

By introducing the term Generation Z (Gen Z), Pew Research paved the way for further research and understanding (Petrelli et al., 2023). As Gen Z grew up between 1995 and 2010, they were exposed to raging digital technology, resulting in unique perspectives and experiences in learning to communicate and interact with people. They are Internet-savvy, so they are dubbed the Net Generation or Generation (Eberhardt, 2017). The world, which was molded by the Internet, shaped their personalities. These distinct features separate them from the Millennials and preceding generations based on their values, behavior, and expectations. It is effortless for Gen Z to view information, stream videos, or examine images and experiences that are distant become nearby (Smith & Cawthon, 2017). By having unlimited access to information, they can connect with different perspectives, values, and life experiences. With unlimited access to information, they can learn various topics and current issues that are significant when they enter higher education as college students.

Therefore, Gen Z remains active across social media platforms and is strongly interested in digital and social impact. They can keep up well with changes in health needs and have much enthusiasm and strong will. To effectively learn, it is necessary to understand the characteristics, needs, and prospects of Gen Z. The uniqueness of Gen Z is reflected in the way they decide; they appreciate more visual stimuli, such as pictures and videos, and seek a real and deeper experience rather than just words (Petrelli et al., 2023). Understanding Gen Z's uniqueness is crucial in appreciating their perspective on education. The situation is even more relevant as pharmacy education moves into the new normal and transition phase post-COVID-19. It marks an important moment to fast-track the development of professional pharmacy education (Rhoney et al., 2021). As an initial step, the Faculty of Pharmacy of Universitas Surabaya, Indonesia, has conducted training for Senior High School (SMA) and Pharmacy Vocational High School (SMK Pharmacist) students in East Java, Indonesia. It included chemical analysis, Curcuma species, and herbal drink (nutraceutical analysis).

Nutraceutical is a term that combines the words 'nutritional' and 'pharmaceutical' (Parasuram Rajam et al., 2019). Nutraceuticals serve as more than just nutrients; they can also function as medicine, providing physiological benefits and potential protection against chronic diseases. Nutraceuticals' potential includes improving health quality, delaying aging, preventing chronic diseases, and supporting whole-body function (Nasri et al., 2014). Three concerns in nutraceutical products are safety, efficacy, and quality (Komala et al., 2023). The two species that will undergo

analysis through chemical methods in this training are Curcuma xanthorriza and Curcuma domestica, both varieties of which have been processed into instant powder drinks. We will do three chemical analyses in vitro: a qualitative assessment of their chemical composition through thin-layer chromatography, polyphenol functional groups, and antioxidant activity analysis through redox reactions.

Both SMA and SMK pharmacists are at secondary education levels. Graduates from SMA and SMK pharmacists can choose to advance their education at the university level. However, the approaches used to prepare students for their goals differ. SMA offers a broad range of knowledge and emphasizes a conceptual curriculum to prepare students for higher education. On the other hand, SMK pharmacists prioritize skill development for students' seamless integration into the workforce (Aziz & Indrawati, 2017). Pharmacy is a multidisciplinary field that demands scientific knowledge, strong skills, and professionalism (Gultom, 2021). The differences in SMA and SMK pharmacist curricula will require unique adaptations when transitioning to university. This Community Service initiative can offer students insights into the environment and systems at the university level.

This community service aims to give SMA and SMK pharmacist students in East Java, Indonesia, initial bachelor's degree education, specifically in pharmacy. In addition, this community service aims to improve the students' understanding of nutraceuticals from a chemical point of view and their experiences in chromatography analysis, polyphenolic functional group analysis, and anti-oxidant activity measurements. Through this service, students are expected to gain significant benefits in preparing for the next level of education at a bachelor's degree in pharmacy. This will be achieved by providing practical competencies required in chemical analysis, which will enhance their understanding of nutraceuticals from a chemical point of view and their experiences in chromatography analysis, polyphenolic functional group analysis, and antioxidant activity measurements.

2. METHODS

This community service was conducted through a training program utilizing the Participatory Action Research (PAR) method. PAR protocol stipulates the necessity for a collaborative approach and participation of participants throughout the preliminary to final stages. This means that the research participant is not an object but someone who participates in discussions, dialogues, and decisions about how a study will be developed and what actions will follow (Rusli et al., 2024). Eighty-eight individuals from 15 SMA and 8 SMK pharmacists in East Java, Indonesia, were divided into 18

groups for the event. At the Qualitative Chemistry Analysis Laboratory, Faculty of Pharmacy, Universitas Surabaya, the training was conducted in 4 batches. Key topics were covered: evaluation of chemical markers' quality involved the analysis using the thin-layer chromatography method (Departemen Kesehatan Republik Indonesia, 2008); the evaluation of polyphenol functional groups was conducted using the $FeCl_3$ reagent (Klangmanee & Athipornchai, 2019); The effectiveness of antioxidants was evaluated through qualitative redox analysis using the $KMnO_4$ reagent (Orman et al., 2016; Zhou et al., 2015).

Pharmacy lecturers from the pharmacy chemistry laboratory at the Faculty of Pharmacy, Universitas Surabaya, facilitated this training. The service team comprised laboratory education staff and pharmacy students, all contributing to the successful execution of the program. Some of the coaching methods applied during the service were:

- The training module served as a comprehensive guide for trainees and facilitators. It outlined various activities to ensure consistency in material delivery.
- Material exposure for conceptual understanding: material exposure involved conveying foundational information to participants, covering concepts, principles, and practical knowledge before practical application began.
- Video tutorials were used to visually show practical applications, helping trainees understand how to use tools and instruments.
- Interactive discussions have fostered an exchange of information and knowledge among participants and facilitators. These discussions deeply delved into concepts, encouraging exploration of various perspectives and promoting collaborative learning.
- Evaluation for enhanced understanding: evaluation processes, including pre-tests and post-tests, were used to gauge participants' understanding and track their progress.

3. FINDINGS AND DISCUSSION

The community service starts by distributing training modules as digital files a week before training. Providing this module is easy for Gen Z, as they spend most of their time with their electronic devices. Törőcsik (2014) conducted a study that revealed similar findings. The study showed that Gen Z is a tech-savvy and globally connected generation, effortlessly navigating the digital realm and influencing their preferences, behavior, and communication patterns (Törőcsik et al., 2014). The design

of this training module was based on a continuous and iterative systematic design cycle for instruction(Akker et al., 2013; Sarwar et al., 2017). It starts with assessing educational gaps in SMA and SMK pharmacists and then devising a potential intervention using nutraceutical analysis training(Akker et al., 2013). This module is designed to help Gen Z develop literacy skills in understanding written information using illustrated work procedures and visual result representations (figure 1). This information will enable participants to finish a nutraceutical analysis project successfully. As a result, this training enables participants to think critically and complete the analysis project (Angkowati & Zaini, 2018).

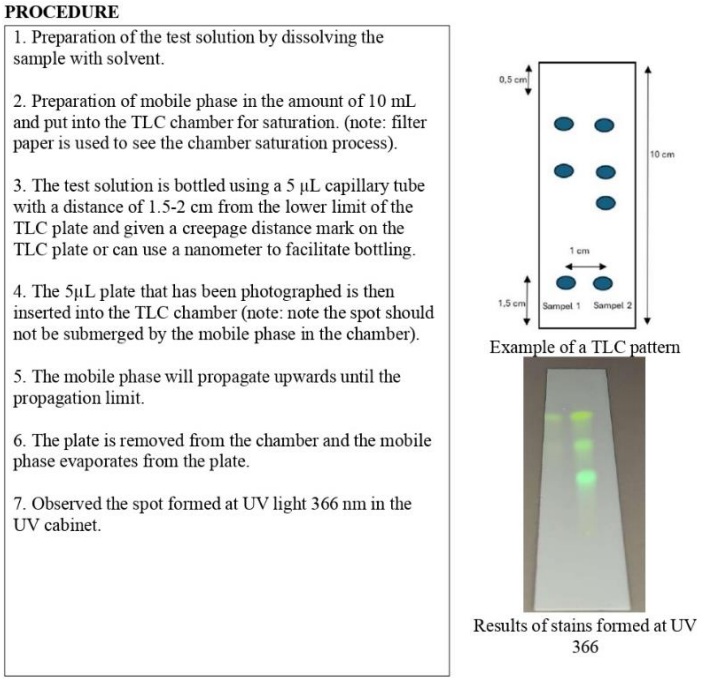

Figure 1. Pages in the training module contain illustrated pattern work procedures and visual result representations (originally written in Indonesia).

Three nutraceutical analysis topics taught are under the Curriculum Framework for Pharmacy Programmes in Indonesia (Cokro et al., 2021). At the start of the training, participants will be given explanations covering nutraceutical analysis, lab procedures, and safety measures. Following that, the lecturer as facilitator will guide participants to use the training module for nutraceutical analysis (figure 2).

(a) (b)

Figure 2. (**a**) Participants are encouraged to listen closely to the facilitator's explanation panel; (**b**) Facilitators conduct the mentoring process for nutraceutical analysis.

Learning videos have been implemented to improve the effectiveness of the training analysis process. An example shown during the training session was a thin-layer chromatography plate blotting video tutorial. These videos can also be accessed online at https://youtu.be/05HmskioYIo. With online access to learning videos, participants have greater control over their learning process. Moreover, participants can rewatch the video tutorials if necessary, boosting their understanding. Learning videos not only make analysis more interesting but also enhance safety by increasing vigilance(Talib et al., 2017). His research in 2012 demonstrated the value, flexibility, and cost-effectiveness of learning videos or tutorials in enhancing students' chemical problem-solving skills (He et al., 2012). The nutraceutical analysis training was met with enthusiasm from all participants during the training and discussions. Figure 3 displays the documentation of participants' activities during the training.

(a) (b)

Figure 3. (**a**) The participants' enthusiasm during the discussion process.; (**b**) Snapshot of participants in one of the batches.

Pre-test and post-test methods can be employed to evaluate participants' knowledge and understanding of the provided material (Setiawan et al., 2023; Shivaraju et al., 2017). To accommodate the digital literacy of Gen Z, who are well-

versed in the digital world, we conducted the pre-test online through the 'Google Forms platform. The platform was selected for its user-friendly interface, easy accessibility, and intuitive layout. At the end of the session, a post-test was conducted using the platform 'Quizizz.' Quizizz offered gamification features such as leaderboards, timers, and power-ups, which made the post-test more engaging for Generation Z. In addition, Quizizz encourages interactivity and increases competition between participants, making the evaluation process more fun and dynamic.

There are four parts in which the pre-test and post-test questions are divided. Questions 1 and 2 gauge the general understanding of concepts related to chemical analysis. Questions 3 to 6 focus on assessing the effectiveness of chemical markers through thin-layer chromatography. The evaluation of polyphenol functional groups using the FeCl3 reagent is the focus of questions 7 to 8 in the third part. Qualitative redox analysis with KMnO4 reagent assesses antioxidant effectiveness in questions 9 to 10. Out of 88 participants, the pre-test average score was 44.18, and the post-test average was 74.20. The enhancement in comprehension of the components is visualized in figure 4. The data analysis indicated a substantial increase in participants' comprehension, with an average rise of 30.54. The training was highly effective, with participants demonstrating a 69.13% average improvement in understanding chemical analysis concepts.

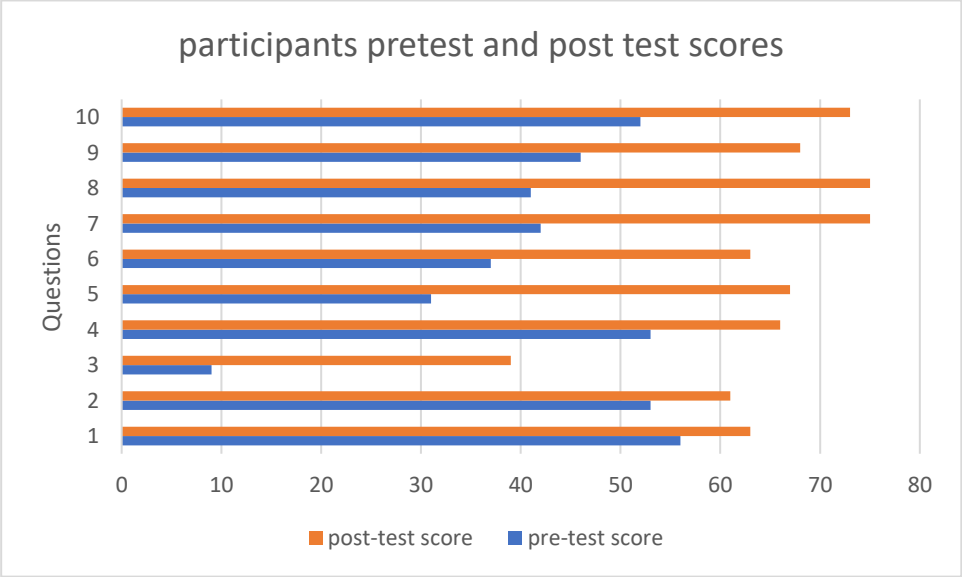

Figure 4. Chart for assessing comprehension of the material component.

This empowerment significantly impacts multiple segments. To begin with, it assists students in determining their interests in the pharmacy field. Students' interest in particular areas, such as chemical analysis, can fuel their motivation to excel academically (Kwiek et al., 2007). High schools are also affected, as training topics can be merged with practicum activities as learning topics. Additionally, students are

impacted by this empowerment when collaborating in teams. They can recognize their strengths and understand how they can contribute to the team. In a professional setting, it is vital to empower individuals with a growth mindset and effective team communication skills for early-stage problem-solving (Bradley et al., 2021).

4. CONCLUSION

The effectiveness of the nutraceutical analysis training program significantly improved by using digital training modules, interactive learning tools, and data-driven assessments. The methods were designed to meet the tech-savvy needs of Gen Z participants, promoting accessibility, engagement, and understanding. Integrating digital platforms like Google Forms, Quizizz, and instructional videos facilitated active participation and knowledge retention. Analysis of pre-test and post-test results demonstrated a substantial improvement in participants' understanding of chemical analysis concepts, affirming the success of tailored instructional strategies. These findings highlight the importance of leveraging technology and interactive methods to optimize learning outcomes in training programs. Students must discover and cultivate their interests, particularly in pharmacy, early. Strengthening motivation leads to improved academic achievements and career advancement. Government support is expected to facilitate digital and face-to-face training integration, preparing the next generation for higher education and workforce challenges.

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