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Digital Ethnobotany Education for Preserving Plant-Based Health Knowledge: A Mixed-Methods Study

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ABSTRACT: Ethnobotanical knowledge connects plant resources with food, traditional medicine, health-related practices, and cultural heritage, yet younger generations may have limited awareness of these relationships. This exploratory mixed-methods study examined students' perceived learning and experiences of a digital design-based learning (DBL) activity in a Malaysian university ethnobotany course. Ninety-seven students from interdisciplinary programmes participated in a synchronous online course in which groups developed digital posters on flowering plants. The posters covered botanical identity, geographical and cultural contexts, reported medicinal, health-related, beauty, and culinary uses, as well as the conservation of plant resources and associated ethnobotanical knowledge. The course generated 51 posters covering 17 flowering plant profiles. Eighty-five students submitted reflections (87.6% of the cohort). In retrospective self-assessments collected at course end, mean current ratings exceeded recalled pre-course ratings across three domains: ethnobotany definitions (mean 2.02 to 3.81), cultural heritage (2.68 to 3.89), and sustainability (2.33 to 3.80), on a four-point scale. For the DBL activity, 67 respondents (78.8%) rated it highly effective and 18 (21.2%) rated it effective. Reflections described students' appreciation of plants in health practices, everyday life, and cultural knowledge, alongside interest in preserving ethnobotanical heritage. The findings indicate positive student perceptions and higher reported self-ratings, but do not demonstrate objective knowledge acquisition, long-term retention, or effects on public understanding or health. Future research should verify poster content, assess objective learning, and evaluate audience understanding of plant-use evidence.

1. INTRODUCTION

1.1 Ethnobotany, Plant Resources, and Human Well-Being

Plants are valuable natural resources that support human well-being through their contributions to food, traditional medicine, personal care, and cultural practices. Ethnobotany provides an important interdisciplinary perspective for understanding the relationships between people and plants within their ecological and cultural contexts, including how plant knowledge is developed, shared across generations, applied in everyday life, and preserved for the future (Mendoza et al., 2023; Silveira & Boylan, 2023). By connecting traditional knowledge with contemporary scientific research, ethnobotany offers opportunities to inform pharmacognosy, advance medicinal plant research, and deepen understanding of the potential contributions of plant resources to human health. Recognising traditional plant knowledge while complementing it with rigorous botanical

identification, scientific investigation, and appropriate safety and efficacy assessments can further strengthen its contribution to responsible research, cultural preservation, and the sustainable use of natural resources.

Beyond their direct uses, plants support ecosystem functioning and contribute to environmental quality, climate resilience, and human health. Hunter et al. (2023) highlighted the potential of urban green and blue spaces to promote public health and well-being, address health inequities, and generate environmental and social co-benefits. Similarly, Jia and Turcu (2025), in a systematic review of 178 primary studies, examined the health-related benefits of urban green infrastructure, including urban vegetation, parks, trees, green roofs, and community gardens. Their findings reinforce the importance of recognising vegetation as an essential component of healthy and sustainable environments.

Understanding the value of plant resources also requires awareness of the ecological challenges affecting biodiversity. Bang et al. (2022) documented substantial economic costs associated with biological invasions in India, alongside considerable gaps in the available evidence. More recently, Omer et al. (2026) examined how future climate and land-use changes may influence global plant invasion risks. These studies illustrate the importance of improving knowledge about plant diversity, ecological relationships, and environmental change. Although they do not directly evaluate educational interventions, they provide a broader rationale for developing botanical literacy that enables individuals to recognise plants as valuable natural resources and understand their roles in environmental sustainability.

1.2 Botanical Awareness, Ethnobotanical Knowledge, and Environmental Literacy

The continuity of ethnobotanical knowledge depends partly on whether younger generations recognise plants as more than background features of their surroundings. Limited attention to plants, commonly discussed through the concept of plant awareness disparity or plant blindness, can restrict people's appreciation of plant diversity and their understanding of the ecological and societal roles of plants. Stroud et al. (2022) highlighted the importance of addressing plant awareness disparity, while Brownlee et al. (2021) demonstrated how plant representation in introductory biology textbooks can reflect this disparity. More recent research has emphasised the importance of assessing plant awareness and developing educational approaches that strengthen students' engagement with botanical knowledge (Pany et al., 2024).

Botanical literacy provides a complementary framework for understanding the knowledge and competencies needed to recognise plants, interpret their characteristics, and appreciate their significance. Arif et al. (2025), in a systematic literature review, examined the concepts and domains associated with botanical literacy, highlighting the need for a clearer understanding of how botanical knowledge is conceptualised and developed through education. Related work on environmental and sustainability literacy has emphasised the interconnectedness of knowledge, skills, attitudes, and the capacity to make informed decisions about environmental challenges (Sanchez et al., 2025). Together, these perspectives suggest that botanical education can contribute to broader environmental literacy by helping learners understand the relationships between plant resources, ecological processes, cultural practices, and sustainable living.

Ethnobotany provides a valuable context for developing this understanding because it connects botanical knowledge with the lived experiences and cultural practices of different communities. Research on ethnobotany education has explored how local plant knowledge can enrich science learning and strengthen connections between biological concepts and everyday life (Flores-Silva et al., 2024; Rinto et al., 2023). Marsandi et al. (2025) further examined the integration of ethnobotany and Indigenous knowledge into higher education curricula, highlighting the relevance of incorporating these knowledge systems into formal learning. This integration can encourage students to appreciate plants not only as biological organisms but also as resources associated with traditional medicine, food practices, cultural identity, and environmental stewardship.

Developing botanical awareness across academic disciplines is particularly relevant because environmental sustainability requires contributions from individuals with diverse professional backgrounds. In this case, Husamah et al. (2025), highlighted the interdisciplinary nature of botanical literacy and identified inquiry-based learning and connections with everyday life as relevant educational strategies. By connecting botanical knowledge with wider environmental and societal concerns, ethnobotany education offers opportunities to engage learners who may have limited prior exposure to plant sciences.

1.3 Digital Communication, Botanical Literacy, and Sustainability Education

Digital learning technologies offer promising opportunities to organise, interpret, and communicate complex botanical information in accessible and engaging formats. Through digital platforms, learners can combine text, images, diagrams, and

other visual elements to present plant identity, geographical distribution, cultural significance, reported applications, and conservation information in a coherent format. Recent studies have demonstrated the potential of digital plant identification tools to support plant-related learning and biodiversity awareness (Coşkunserçe, 2024; Wong & Ng, 2026). In addition, Schunko et al. (2025) highlighted opportunities to strengthen plant awareness by connecting botany education with ethnobotanical knowledge and culturally situated learning.

Digital communication may also support wider sustainability education by making scientific information more accessible and facilitating the communication of complex environmental concepts. Aung et al. (2026), in a scoping review of digital science communication, identified immersive technologies, game-based learning, and online platforms as approaches that can support sustainability literacy through interactive engagement, contextualised learning, and flexible access to educational content. However, the review also highlighted the need for better pedagogical integration, accessible technologies, appropriately tailored content, and stronger evidence of long-term behavioural outcomes.

Digital literacy is another important consideration in this process. Xu et al. (2026), in a systematic literature review focusing on agricultural technology, examined the role of digital literacy in technology adoption and efficiency. Although their research concerns agricultural rather than botanical education, it reinforces the relevance of digital competencies in enabling individuals to engage with technology-supported knowledge and practices. When applied to ethnobotany education, digital tools can provide a practical means of synthesising information from different sources and presenting plant-related knowledge to diverse audiences.

The value of these approaches extends beyond the communication of scientific information to the development of environmental awareness and responsible decision-making. Ampofo et al. (2026) examined relationships between community-based environmental education, green literacy, and pro-environmental behaviour in urban and rural China. Their findings suggest that different dimensions of green literacy are associated with environmental behaviour, while also highlighting the importance of local social contexts. Similarly, Cosquer et al. (2026), in a scoping review of biodiversity education, identified the importance of evaluating educational initiatives beyond immediate individual-level outcomes and considering wider ecological and collective impacts. These findings support the need for educational interventions that connect knowledge acquisition with opportunities for reflection, communication, and environmental engagement.

In this context, digital poster development offers a practical learning activity through which students can synthesise botanical and ethnobotanical information into visual educational resources. Rather than focusing exclusively on plant identification, students can explore how plants relate to cultural heritage, reported medicinal and culinary uses, and conservation. The collaborative process also provides opportunities to practise information retrieval, critical interpretation, teamwork, and scientific communication. Nevertheless, the educational value of such materials depends on the accuracy of the information presented, the credibility of the sources consulted, and the distinction between traditional-use reports and scientifically established evidence.

1.4 Design-Based Learning for Interdisciplinary Ethnobotany Education

Design-Based Learning (DBL) offers a student-centred approach that combines knowledge acquisition with the creation of tangible outputs. By engaging learners in the design of an artefact to communicate or address a particular challenge, DBL can provide opportunities to apply theoretical concepts, organise information, and communicate ideas through purposeful design activities. In an online learning environment, digital design platforms can facilitate collaborative production and enable students to develop visual materials that communicate complex subject matter (Azizan & Abu Shamsi, 2022).

Integrating DBL into ethnobotany education may be particularly valuable for interdisciplinary cohorts whose members have different levels of prior botanical knowledge and design experience. Digital poster development provides a structured task through which students can investigate flowering plants, identify relevant information, and communicate botanical characteristics alongside cultural contexts, reported uses, and conservation considerations. This approach creates opportunities to connect plant knowledge with everyday experiences while encouraging students to appreciate the ecological, cultural, and societal significance of plant resources.

The present study implemented DBL through a collaborative digital poster activity in a university-level ethnobotany course at Universiti Kebangsaan Malaysia. Students researched selected flowering plants and developed posters presenting their botanical characteristics, geographical and cultural contexts, reported applications, and conservation strategies. The activity integrated

digital communication with culturally contextualised plant learning, providing an opportunity to explore how students from interdisciplinary backgrounds engaged with ethnobotanical knowledge.

Accordingly, this exploratory study addressed two research questions:

i. How did students' end-of-course and recalled pre-course self-ratings differ for ethnobotany, cultural heritage, and sustainability?
ii. How did students evaluate the DBL activity, and how did their reflections describe its contribution to their awareness of plants and associated ethnobotanical knowledge?

By examining self-rated knowledge, student evaluations, and qualitative reflections, this study contributes to the discussion of digital approaches for communicating ethnobotanical knowledge in higher education. The study focuses on educational experiences and perceived learning outcomes; it does not evaluate the pharmacological properties, clinical effectiveness, or safety of the plants featured in the posters.

2. MATERIALS AND METHODS

2.1 Study Design and Participants

This exploratory mixed-methods pedagogical evaluation combined quantitative self-ratings and activity evaluations with qualitative reflections within an online ethnobotany course at Universiti Kebangsaan Malaysia (UKM) in 2026. The enrolled cohort comprised 97 students from a range of academic programmes. The course used synchronous online teaching, formative quizzes, collaborative group work, and a digital poster assignment. Complete reflections were received from 85 students, equivalent to 87.6% of the enrolled cohort; 12 students (12.4%) did not submit a complete reflection. The evaluation examined students' perceptions within this course rather than the effectiveness of DBL relative to another teaching approach.

2.2 Digital Poster Intervention

Students worked in groups of up to six and selected a flowering plant from a list provided by the lecturer. Seventeen groups produced three posters each, yielding 51 posters about 17 plant profiles (Table 1). Posters were created using Canva, and students were permitted to use generative artificial-intelligence tools to support drafting, text refinement, image generation, or layout. Students were expected to communicate the plant's scientific and common names, origin and socio-historical context, reported applications (including food, medicinal or health-related, beauty, and cultural uses), and strategies for conserving the plant and associated knowledge. The assignment was accompanied by a description and marking rubric, and groups presented their work during an online class. Plant selection formed part of the teaching assignment and was not designed to provide a representative sample of Malaysian ethnobotanical practices.

Assessment criteria covered the completeness and accuracy of introductory plant information, discussion of ethnobotanical applications, reflection and sustainability, visual communication, oral delivery, teamwork, and subject understanding. These criteria provided a framework for assessing the educational assignment; they do not, by themselves, establish independent verification of botanical identity or the scientific validity of reported medicinal uses. Accordingly, the posters are treated here as student-produced educational artefacts, not as validated ethnomedicinal records.

Table 1. The 17 flowering plant profiles included in the digital poster activity.

No.	English common name	Botanical name
1	Chinese hibiscus	Hibiscus × rosa-sinensis
2	Chrysanthemum	Chrysanthemum
3	Butterfly pea	Clitoria ternatea
4	Rose	Rosa
5	Ylang-ylang	Cananga odorata

No.	English common name	Botanical name
6	Arabian jasmine	Jasminum sambac
7	Torch ginger	Etlingera elatior
8	Singapore rhododendron	Melastoma malabathricum
9	Queen of the night	Epiphyllum oxypetalum
10	Lotus	Nelumbo nucifera
11	Orchid	Orchidaceae
12	Champak	Magnolia champaca
13	Coral vine	Antigonon leptopus
14	Spanish cherry	Mimusops elengi
15	Pansy	Viola tricolor or Viola × wittrockiana
16	Bougainvillea	Bougainvillea spp.
17	Carnation	Dianthus caryophyllus

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2.3 Measures and Analysis

At course end, students rated their current knowledge and retrospectively rated their knowledge before the course in three domains: the definition of ethnobotany, cultural heritage, and sustainability. Both sets of ratings were therefore collected at the same time, using a retrospective pre–post self-assessment design. The four-point response scale comprised 1 (no prior knowledge), 2 (limited knowledge), 3 (knowledgeable), and 4 (highly knowledgeable). These ratings represented students' perceptions of their knowledge rather than performance on an objective knowledge assessment.

The quantitative findings are presented descriptively using the previously reported domain means and response frequencies. Differences between current and recalled pre-course means are expressed in scale points. Percentages for the activity evaluation use the 85 evaluation respondents as the denominator. These descriptive comparisons do not establish statistical significance, the precision of change estimates, or the effectiveness of DBL relative to other teaching approaches. Students also evaluated the DBL activity on a four-point effectiveness scale ranging from 1 (ineffective) to 4 (highly effective). Ratings of 3 and 4 represented effective and highly effective, respectively. These evaluations measured perceived effectiveness of the activity.

In this case, the researchers reviewed the open-ended reflections, which provided qualitative accounts of students' experiences. The findings are organised around three broad themes: appreciation of plants and their cultural uses; perceived support from digital design tools in organising and communicating information; and responsibility for preserving ethnobotanical knowledge. The examples illustrate participants' perspectives and are not used to estimate the prevalence of each theme. The quantitative summaries and qualitative accounts are considered together in the interpretation to examine how students' ratings relate to their descriptions of learning and engagement.

3. RESULTS AND DISCUSSION

3.1 Production of Plant-Focused Educational Materials

The intervention generated 51 digital posters covering 17 flowering plant profiles. The posters combined plant identification with information about origin, cultural context, reported uses, and conservation. Eight groups were reported to have produced

posters that met all the stated instructional and design criteria. The 51 posters are group-level educational outputs, whereas the self-ratings and reflections concern individual students. Poster production does not by itself demonstrate improved botanical knowledge or public-health impact. The plant profiles listed in Table 1 included taxa commonly discussed in food, cultural, ornamental, and traditional-use contexts, such as butterfly pea (Clitoria ternatea), Singapore rhododendron (Melastoma malabathricum), torch ginger (Etlingera elatior), and hibiscus (Hibiscus × rosa-sinensis). Because the project was not designed as a systematic ethnobotanical survey, the plants and uses shown in the posters should not be interpreted as representative of Malaysian ethnomedicinal practice. Future iterations should record sources for each reported use, confirm unresolved plant identities and keep botanical names current, distinguish traditional reports from experimentally supported effects, and include cautions where safety or efficacy has not been established.

3.2 Changes in Self-Rated Knowledge

In the retrospective self-assessment, mean current ratings were higher than recalled pre-course ratings in all three domains (Figure 1). Mean recalled pre-course and current ratings were 2.02 and 3.81 for ethnobotany definitions, 2.68 and 3.89 for cultural heritage, and 2.33 and 3.80 for sustainability, respectively. The corresponding differences between the reported means were 1.79, 1.21, and 1.47 scale points. The largest descriptive difference concerned the definition of ethnobotany. These values represent perceived changes assessed at course end and do not establish objectively demonstrated learning gains or statistically significant differences.

The pattern is consistent with students reporting greater familiarity with the course topics. However, synchronous teaching, formative quizzes, and collaborative work also formed part of the course, so the contribution of the poster activity cannot be isolated. The assignment provided a context for exploring relationships between plants, cultural heritage, and environmental sustainability. This approach aligns with recent studies that emphasise the importance of plant awareness in botany education and the value of incorporating ethnobotanical perspectives into learning activities (Pany et al., 2024; Flores-Silva et al., 2024). Future studies could complement self-reported assessments with objective learning measures, such as plant identification tasks and activities that assess students' ability to distinguish traditional-use reports from scientifically validated evidence. Such assessments would provide further insight into how digital design-based learning can strengthen botanical literacy, promote the responsible communication of ethnobotanical knowledge, and encourage greater appreciation of plant resources.

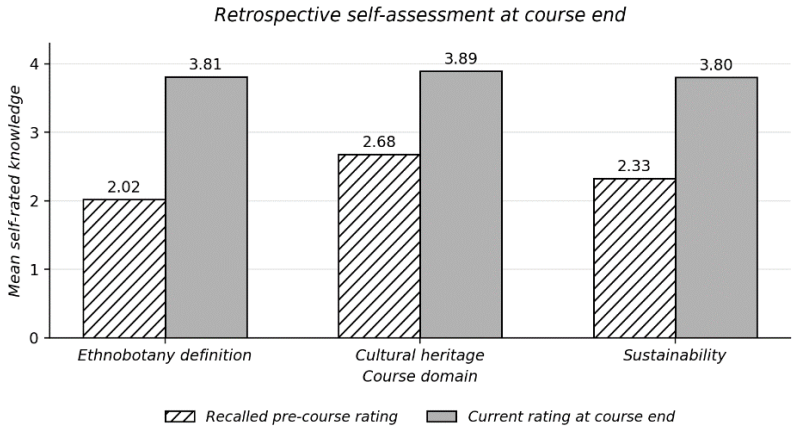


Figure 1. End-of-course retrospective self-assessments of knowledge across three ethnobotany domains (n = 85). Both current and recalled pre-course ratings were collected at course end. Ratings range from 1 (no prior knowledge) to 4 (highly knowledgeable). Values are descriptive means; uncertainty intervals are not shown.

3.3 Student Evaluation of the DBL Activity

Of the 85 respondents represented in the DBL evaluation, 67 (78.8%) rated the activity as highly effective and 18 (21.2%) rated it as effective. No respondents selected either of the two lower categories. All 85 respondents selected one of the two positive categories. Student reflections described the digital poster task as helping them organise information and communicate plant

knowledge in a more accessible format. One pharmacy student reflected that the course changed their view of plants from sources of active ingredients alone to resources connected with community knowledge. Another student described learning about the links between plants, culture, and everyday life. These comments illustrate perceived changes in perspective, although they cannot establish durable changes in behaviour or competence. The results are broadly compatible with research on ethnobotany-based learning and plant awareness, while highlighting the need for more systematic outcome measures (Rinto et al., 2023; Pany et al., 2024; Marsandi et al., 2025).

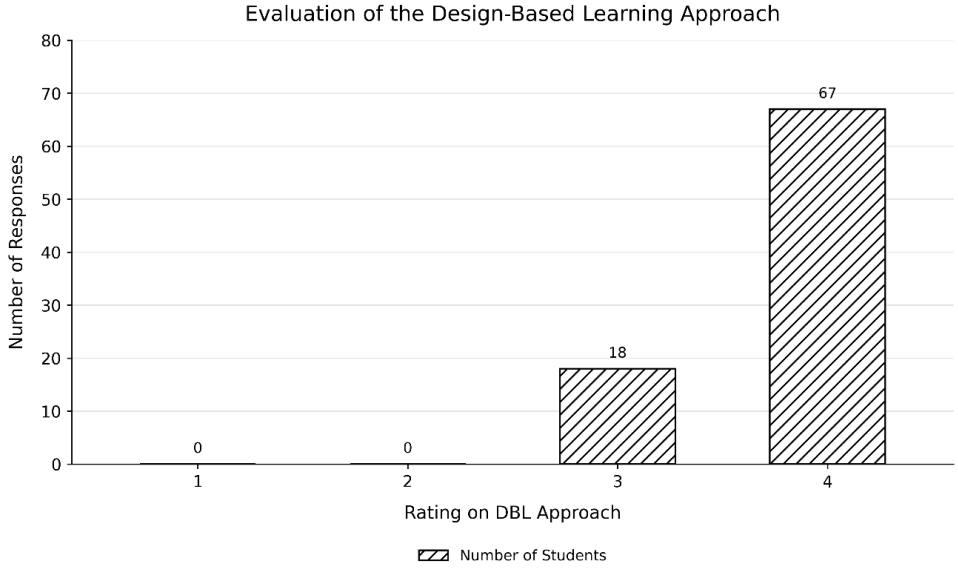


Figure 2. Student-rated effectiveness of the DBL activity (n = 85). Eighteen respondents (21.2%) selected 3 (effective), and 67 (78.8%) selected 4 (highly effective). No respondents selected ratings of 1 or 2.

3.4 Plant-Based Health Knowledge and Responsible Communication

The activity brought reported medicinal and health-related uses into the same educational task as plant identity, food, beauty, beliefs, and cultural practices. This organisation allowed students to explore the cultural contexts of plant knowledge. It did not assess the therapeutic effectiveness or safety of the plants discussed. Furthermore, ethnobotanical knowledge can inform scientific investigations into medicinal plants and their potential applications in human health. As highlighted by Silveira and Boylan (2023), continued research into medicinal plants and their phytochemical properties offers opportunities to strengthen the scientific understanding of plant-based resources. Distinguishing between traditionally reported uses, biological activities demonstrated through laboratory or preclinical studies, and efficacy and safety established through appropriate human studies can further enhance the scientific value and responsible communication of ethnobotanical knowledge. The student reflections and self-ratings support further investigation of digital DBL as a way to introduce ethnobotanical topics. However, they do not demonstrate preservation of community knowledge or improvements in health literacy, health-related decision-making, or public understanding.

3.5 Limitations and Future Research Directions

This single-course evaluation has several limitations. Self-rated knowledge and activity evaluations reflect participants' perceptions and may be influenced by social desirability or expectations associated with a course assignment. Because both knowledge ratings were collected at course end, recall and changes in students' understanding of what constituted knowledge may also have influenced the comparison. The recalled baseline was not a measurement obtained before teaching. Twelve of the 97 enrolled students did not submit complete reflections, creating the possibility of nonresponse bias. The findings from one university cohort may not transfer to other disciplines or educational settings. Without a comparison group, the effects of the poster activity cannot be separated from other course components. End-of-course means close to the upper limit of the four-point scale, also suggesting a possible ceiling effect.

The qualitative examples illustrate student perspectives but do not establish the prevalence of themes across the cohort. The educational outcomes do not establish the botanical or pharmacological validity of poster content. The study did not assess objective knowledge acquisition, long-term retention, behaviour, health literacy, clinical outcomes, public understanding of the posters, or preservation of community knowledge over time. The findings should therefore be interpreted as exploratory evidence of perceived learning and engagement. Therefore, future studies should combine self-ratings with objective plant-identification and evidence-appraisal tasks, use comparison designs, and assess retention after the course. Plant profiles and reported uses should undergo documented verification before public dissemination. Audience studies would then be needed to evaluate understanding, interpretation of uncertainty, and responsible communication of traditional plant knowledge.

4. CONCLUSION

This exploratory evaluation examined a digital DBL activity involving 97 students in a university ethnobotany course. Seventeen groups produced 51 posters featuring 17 flowering plant profiles. End-of-course self-ratings were higher than recalled pre-course ratings for ethnobotany definitions, cultural heritage, and sustainability in the retrospective assessment. All 85 evaluation respondents rated the activity as effective or highly effective, and reflections described appreciation of plants and their cultural uses. Together, these findings indicate that the activity was positively received by respondents and was associated with perceived learning within the course.

The evidence is limited to self-reported outcomes, reflections, and educational outputs. It does not demonstrate objective knowledge acquisition, long-term retention, preservation of community knowledge, or improvements in public understanding or health. Digital posters may provide a starting point for further ethnobotany education and outreach, provided that botanical information and reported plant uses are checked before dissemination. Objective assessment, documented content verification, and follow-up evaluation are needed to establish the educational value and wider applications of this approach.

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AUTHOR CONTRIBUTIONS

Syumi RA. Rahman: Conceptualization, Methodology, Investigation, Data Curation, Writing—Original Draft Preparation.
Muhamad SF. Rosley: Investigation, Data Curation, Writing—Review & Editing.
Nadzirah H.: Formal Analysis, Data Interpretation, Writing—Review & Editing.

Nurul A. Ramli: Data Interpretation, Writing—Review & Editing.
Asamuddin A. Hasan: Project Administration, Writing—Review & Editing.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICS STATEMENT

Participants provided written consent for the use of their information in this publication.

DATA AVAILABILITY STATEMENT

Primary data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to the privacy protection of the research participants

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