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Enhancement of Science Literacy and Cosmetic Formulation Skills Among High School Students Through Solid Perfume Balm Workshop

Untung Gunawan[1], Keiko Weimy Ho[2], Valerina[3], Allessandra Gabriella Wijaya[4], Birgitta Evania Hotyus[5], Yulius Evan Christian[6]

[1,2,3,4,5,6] Department of Pharmacy, School of Medicine and Health Sciences, Atma Jaya Catholic University of Indonesia, Indonesia
* Correspondence e-mail; untung.gunawan@atmajaya.ac.id

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Abstract

High school students' knowledge of cosmetics is generally limited to finished products, without understanding their composition, formulation processes, or safety aspects, which may increase the risk of improper product use. This community service activity aimed to enhance scientific literacy, cosmetic safety awareness, and formulation skills among high school students through an experiential learning-based solid perfume balm workshop, an approach not yet widely implemented in the Indonesian high school context. A pre-post design without a control group was employed with 21 Grade XI Science students (52.38% male; mean age 16.4 years) at SMA Katolik Ricci 1, Jakarta. The evaluation instrument consisted of 10 validated multiple-choice questions. Because the Shapiro-Wilk test confirmed non-normality of difference scores ($W = 0.7774$; $p = 0.0003$), the Wilcoxon Signed Ranks Test was used for hypothesis testing. Participant satisfaction was assessed with a seven-item Likert-scale questionnaire. The mean score increased from 77.62 (pretest) to 90.48 (posttest). The proportion of participants with high knowledge rose significantly from 61.90% to 95.24% ($Z = -3.823$; $p < 0.001$; effect size $r = 0.83$). All participants successfully produced their own perfume balm product. The mean satisfaction score was 4.74 out of 5.00. An experiential learning workshop integrating cosmetic safety, formulation skills, and science literacy proved effective for high school students. Recommended follow-up actions include control-group designs, larger samples, and long-term knowledge retention assessments.

Keywords educational workshop; high school students; science literacy; simple cosmetics; solid perfume balm

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1. INTRODUCTION

Indonesia's cosmetics industry has grown very rapidly over the past decade. According to data from Indonesia's National Agency of Drug and Food Control (BPOM RI), the number of cosmetic products on the market continues to increase every year, in line with high demand from the public, particularly the younger generation (adolescents). Fragrance products are one of the most dynamically growing segments, driven by the *personal care* trend and growing appearance consciousness among young people, including high school students (Suwarno et al., 2024). Indonesia's cosmetics industry has grown very rapidly over the past decade. According to BPOM RI, the number of cosmetic industries in Indonesia reached 1,249 by the end of October 2024, an increase of 16.40% compared with the previous year, while the number of cosmetic products holding a valid BPOM notification reached 283,391, dominated by domestic products (68.80%). This growth is driven by the personal care trend and growing appearance consciousness among young people; however, during the same period, there has also been continued circulation of cosmetic products without valid BPOM authorization, underscoring ongoing gaps in consumer literacy and regulatory awareness that this workshop seeks to help address (Marchella et al., 2025). One innovation in the fragrance category that is increasingly popular among adolescents is the *parfum balm*, or *solid perfume*. This product is a semisolid preparation formulated from a blend of *beeswax*, *a carrier oil, and an essential* or *fragrance oil*. Compared with alcohol-based liquid perfumes, the *parfum balm* offers several advantages: it is more practical and less prone to spilling, its scent lasts longer because it is oil-based, it is alcohol-free and therefore safer for sensitive skin, and it simultaneously provides a moisturizing effect on the skin (Todkar et al., 2024).

However, most high school students know cosmetic products only as finished goods purchased on the market, without understanding their ingredient composition, formulation principles, or safety aspects of use. Low scientific literacy regarding cosmetic products can increase the risk of improper use, such as choosing products unsuited to one's skin type, using ingredients whose safety has not been standardized, or inhaling hazardous volatile compounds from alcohol-based perfumes in enclosed spaces, which can endanger both the user and people nearby (Rahma et al., 2026). Empirical evidence confirms this literacy gap. A scoping review on community knowledge and concern regarding cosmetic safety in Indonesia found that public understanding of safe cosmetic use remains an area requiring further attention (Rahma et al., 2026). In a related community service initiative, Christian et al. (2026) reported that high school students showed limited understanding of the risks associated with

counterfeit cosmetic products, underscoring the need for targeted educational interventions. Despite this documented need, practice-based cosmetic education programs that simultaneously develop scientific literacy, cosmetic safety awareness, and hands-on formulation skills remain scarce at the high-school level in Indonesia. Most existing programs focus narrowly on either theoretical health education or product use, without integrating applied science competencies. This gap provides the primary rationale for the present community service initiative (Christian et al., 2026). From a pedagogical perspective, science learning at the high school level remains largely theoretical. The existing curriculum has not yet systematically integrated cosmetic formulation topics into instruction, even though cosmetic products are real-world applications of the chemistry, physics, and biology students learn. This limited *(hands-on learning)* experience constrains the optimal development of students' applied science skills and creativity (Agravante-Destacamento, 2025).

The *experiential learning* approach introduced by Kolb (1984) offers a robust theoretical framework for addressing this problem. This model holds that learning is most effective when individuals repeatedly progress through a four-stage cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. The perfume balm was selected as the learning vehicle for several pedagogical reasons. First, its production employs a straightforward melting-method preparation, consistent with established procedures for wax- and oil-based balm formulations (Rasydy & Sihotang, 2021). It is reproducible within a single school workshop session. Second, all constituent ingredients have well-documented safety and dermatological benefit profiles suitable for adolescent skin application: beeswax functions as an effective occlusive and emollient with documented skin-barrier benefits and a favorable safety record in skincare formulations (Nong et al., 2023), while sweet almond oil and jojoba oil are widely used carrier oils shown to strengthen stratum corneum integrity and support skin-barrier recovery (Blaak & Staib, 2022). All ingredients are also commercially available and affordably priced. Third, the formulation process naturally integrates multiple scientific domains: organic chemistry (ester linkages in carrier oils), physical chemistry (wax phase transitions), and health science (skin physiology and cosmetic ingredient safety evaluation). This multidisciplinary integration positions the workshop as an applied-science learning experience rather than a mere crafting activity. The fragrance oils used, such as lavender, vanilla, and jasmine variants, are likewise generally recognized as safe at the low concentrations used in leave-on cosmetic products, consistent with a recent systematic review of essential-oil safety and efficacy in dermocosmetic applications

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(Pezantes-Orellana et al., 2025). Hands-on, practice-based workshops, such as perfume balm making, naturally facilitate every stage of this cycle, making them an ideal learning strategy for the meaningful transfer of applied science skills (Sugarman, 1987).

Based on a situational analysis conducted through a preliminary school visit, structured discussions with the Grade XI science teachers regarding existing curriculum gaps, and an informal interest survey administered to prospective participants, students showed strong interest in cosmetic and fragrance products. Still, they had never received formal education on how such products are made. Therefore, solid perfume balm (parfum balm) was selected as the workshop topic, given that its production employs a straightforward melting-method preparation reproducible within a single school session, all constituent ingredients carry well-established safety profiles appropriate for adolescent skin application, and the formulation process naturally integrates concepts from organic chemistry, physical chemistry, and health science into one hands-on activity. The school's location in Jakarta, close to the cosmetics trading district, further strengthens the relevance of this educational program. As an implementation of the Tri Dharma Perguruan Tinggi (the three pillars of higher education), the Pharmacy Study Program of Atma Jaya Catholic University of Indonesia organized a community service activity in the form of a workshop entitled *"My Scent, My Style: The Art of Crafting Your Own Perfume Balm"* designed as a means of interactive education and the development of students' practical skills. This activity aimed to enhance scientific literacy and cosmetic safety awareness among high school students, develop practical cosmetic formulation skills through independently making perfume balm, and measure the effectiveness of the experiential learning intervention in improving knowledge through a validated pre-post evaluation design.

2. METHODS

This community service activity used a *pre-post* evaluation design without a control group. The partner for this activity was SMA Katolik Ricci 1, located at Jl. Kemenangan III No. 47, RT.3/RW.2, Glodok, Taman Sari District, West Jakarta. This activity was conducted with institutional permission from SMA Katolik Ricci 1 Jakarta. Before participation, all prospective student participants were provided with information explaining the activity's purpose, procedures, voluntary nature of participation, and data handling. Written assent for students was given before the pretest was administered. All response data were anonymized and stored securely; no personally identifiable information was included in the analysis or reported in this

manuscript. The workshop was held over one full day on Tuesday, 14 April 2026, with a total effective time allocation of 4 hours. The full series of activities ran from the preparation stage (9 March 2026) through to the preparation of the final report (30 May 2026). The target participants were Grade XI Science students at SMA Katolik Ricci 1, selected based on the school's recommendation, with an initial target of more than 20 participants. Inclusion criteria were: actively enrolled as a Grade XI Science student at SMA Katolik Ricci 1, willingness to participate in the entire series of activities from pretest to posttest, and submission of a consent form. Exclusion criteria were: absence of a completed consent form and inability to attend the full one-day session. In practice, the activity was attended by 21 students. Those who met the inclusion criteria participated fully.

Grade XI Science students were chosen because they had already acquired a foundation in organic and physical chemistry relevant to the workshop material. The activity comprised three main stages. First, the preparation stage included coordinating with the partner school to determine the timing, number of participants, and facility readiness; developing educational materials in the form of an interactive visual presentation and an instructional video; and then procuring laboratory materials and equipment, as well as preparing the evaluation instruments, namely the *pretest-posttest* questions and the participant satisfaction questionnaire. Second, the implementation stage, which included the *pretest* to measure participants' baseline knowledge; delivery of educational material covering an introduction to cosmetics and perfume, the advantages of non-alcohol perfume balm, formulation components, and manufacturing procedures; screening of an instructional video on perfume balm making with detailed step-by-step procedures; a hands-on practice session for making perfume balm under the guidance of Pharmacy students; organoleptic evaluation and spreadability testing of the resulting products; and the *posttest* together with completion of the participant satisfaction questionnaire. Third, the evaluation and reporting stage, which included compiling and analyzing the *pretest-posttest* data, analyzing the satisfaction questionnaire, and preparing the activity outputs. The perfume balm formula used in this workshop was based on a standard formula commonly used in the small-scale cosmetics industry, modified for instructional purposes. The complete composition is presented in Table 1. The product was made using the *melting method*): *beeswax* was first melted at a temperature of approximately 65–70°C using a *hot plate*; the *carrier oil* (jojoba and almond oil) was then added one at a time while stirring homogeneously; fragrance oil was added last, once the mixture had cooled to a warm temperature (approximately 40–45°C) to prevent evaporation of

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the aroma components; the mixture was then poured into packaging containers and left to solidify at room temperature (Rasydy & Sihotang, 2021). The hands-on session was supervised by one pharmacist-lecturer and facilitated by eight Pharmacy students, one serving as the overall session coordinator and seven as dedicated participant facilitators, yielding a facilitator-to-participant ratio of 1:3 to ensure close, individualized supervision throughout the formulation process. All eight Pharmacy students had completed the Liquid and Semi-Solid Dosage Formulation course before the activity. The perfume balm formula was selected for this educational context because all constituent ingredients have well-documented safety profiles appropriate for adolescent skin. All ingredients are commercially available at low cost and require no specialized protective equipment beyond standard laboratory masks, making them suitable for use in a high school workshop setting.

Table 1. Composition of the Perfume Balm Formula Used in the Workshop

No.	Ingredient	Function in Formulation	Concentration (w/w)
1	Beeswax	Solid phase/balm base former	10%
2	Jojoba oil	Carrier oil / primary moisturizer	45%
3	Sweet almond oil	Carrier oil / secondary moisturizer	30%
4	Lavender fragrance oil	Fragrance (option: lavender)	5%
5	Vanilla fragrance oil	Fragrance (option: vanilla)	5%
6	Jasmine fragrance oil	Fragrance (option: jasmine)	5%

The evaluation instrument consisted of 10 multiple-choice questions with four answer options. The questions were designed to cover eight relevant competency subdomains, namely: differences between types of perfume preparations; the purpose of preformulation; the function of formulation components; evaluation criteria for preparations; organoleptic testing; spreadability testing; manufacturing techniques; laboratory safety procedures; formula optimization; and analysis of preparation stability issues. The question grid is presented in Table 2. Content validity of the instrument was established through expert judgment by two pharmacist-lecturers external to the authorship team, following the systematic content-validation approach, who reviewed each item for relevance to the learning objectives and appropriateness for Grade XI Science students (Yusoff, 2019). No items were removed, but three were rephrased for clarity following expert feedback. Scores were calculated based on the number of correct answers, with a range of 0–100. Knowledge level was categorized as high (>80), moderate (60–80), or low (<60). Participant satisfaction with the activity was measured using a Likert-scale questionnaire in which a value of 1 = strongly

disagree and 5 = strongly agree, covering seven statements regarding clarity of the material, the appeal of the delivery, the value added to knowledge, the presenter's mastery of the material, how well-organized the workshop was, ease of following the hands-on session, and overall satisfaction. For the satisfaction questionnaire, mean scores per item were interpreted using the following scale: 1.00–1.80 = Very Poor; 1.81–2.60 = Poor; 2.61–3.40 = Sufficient; 3.41–4.20 = Good; 4.21–5.00 = Very Good (Joshi et al., 2015).

The questionnaire was completed online via *Google Form* at the end of the activity. Knowledge data were analyzed using statistical software through the following steps. Descriptive statistics were calculated to describe the distribution of *pretest* and *posttest* scores, together with measures of central tendency (mean, median) and spread (minimum and maximum values). A normality test was conducted using the Shapiro-Wilk test, which is more appropriate for small samples ($n < 50$), on the pretest-posttest difference scores (Δ = posttest score − pretest score for each participant) (Ahadi & Zain, 2023). Given that the normality test indicated the difference scores were not normally distributed, the Wilcoxon Signed-Rank Test was applied with the significance level set at $\alpha = 0.05$ (Woolson, 2008). The evaluation instrument consisted of 10 multiple-choice questions with four answer options, designed to span the full breadth of knowledge relevant to perfume balm formulation across eight distinct competency subdomains (Table 2). Items 1 through 6 address foundational science literacy competencies, including understanding the difference between preparation types (Q1), the purpose of preformulation (Q2), the role of specific ingredients (Q3), product evaluation criteria (Q4), organoleptic assessment (Q5), and physical testing methods such as spreadability (Q6). Items 7 through 10 target higher-order applied competencies related to the manufacturing process, including optimal technique (Q7), laboratory safety (Q8), formula troubleshooting (Q9), and stability analysis (Q10). This distribution ensures that the instrument captures both declarative knowledge of cosmetic science concepts and procedural understanding of the formulation process, providing a comprehensive and balanced measure of learning outcomes across the workshop's educational objectives.

Table 2. Description of Pretest and Posttest Questions

No.	Question Topic	Focus
1	Main difference between spray perfume and perfume balm	Formulation & preparation base
2	Purpose of preformulation in pharmaceutical	Preformulation

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	preparation	
3	Function of beeswax in perfume balm formulation	Formulation component
4	Criteria for a good balm product based on preparation evaluation	Preparation evaluation
5	Organoleptic testing of balm preparations	Preparation evaluation
6	Importance of spreadability testing for balm	Physical evaluation
7	Best time to add fragrance oil (melting method)	Manufacturing technique
8	Important considerations when melting beeswax on a hot plate	Safety procedure
9	Evaluation when the balm texture is too hard	Formula optimization
10	Cause of perfume balm 'sweating' / oil droplets forming	Preparation stability

3. FINDINGS AND DISCUSSION

The perfume balm-making workshop was successfully attended by 21 Grade XI Science students at SMA Katolik Ricci 1, exceeding the initial target of 20. This high level of participation indicates strong enthusiasm among participants and full support from the school. Full participant characteristics are presented in Table 3. The participant composition was nearly balanced between males (11 students; 52.38%) and females (10 students; 47.62%). The age distribution showed that most participants were 16 years old (12 students; 57.14%), while the remainder were 17 years old (9 students; 42.86%). The near-equal gender distribution is particularly noteworthy: it suggests that when cosmetics education is framed as applied science rather than beauty culture, it may engage both male and female learners, consistent with research showing that hands-on, real-world-relevant program design can support more gender-inclusive participation in STEM-related activities (Casey et al., 2023; Musso et al., 2022). The 16–17-year age range also corresponds to a period in which adolescents are increasingly capable of abstract, hypothetical, and systematic scientific reasoning, the hallmark of formal operational thought (Inhelder & Piaget, 1958), making them developmentally well-positioned to connect formulation concepts to underlying scientific principles (Inhelder & Piaget, 1958). All participants attended and completed every session of the activity, marked by active participation in the question-and-answer sessions during the material presentation and high enthusiasm during the hands-on session. The 100%

attendance rate is consistent with findings from similar programs involving practical, product-based learning methods among high school students (Sanjayadi et al., 2025).

Table 3. Workshop Participant Characteristics (n = 21)

Participant Characteristics		**Pretest**		**Posttest**	
	Category	n	%	n	%
Sex	Male	11	52.38	11	52.38
	Female	10	47.62	10	47.62
Age (years)	16	12	57.14	12	57.14
	17	9	42.86	9	42.86
Total		21	100.00	21	100.00

A comparison of participants' knowledge levels before and after the intervention is presented in Table 4. Before the intervention, 13 participants (61.90%) were in the high knowledge category (score ≥ 80), 8 (38.10%) in the moderate category (score 60–79), and none in the low category (<60). This baseline profile is reasonable, given that participants were Grade XI Science students with a foundation in chemistry and biology, even though they had never received specific instruction in cosmetic formulation. Following the educational intervention and hands-on practice, there was a significant improvement. The proportion of participants with high knowledge jumped from 61.90% to 95.24%, while the proportion in the moderate category dropped sharply from 38.10% to just 4.76%. This magnitude of improvement is broadly consistent with comparable workshop-based educational interventions reported in recent Indonesian pharmacy community service literature. Gunawan et al. (2026) reported significant knowledge improvement following a natural cosmetic workshop for a similar adolescent demographic group; Sanjayadi et al. (2025) documented significant knowledge gains after an interactive antibiotic-use education session for high school students, and Christian et al. (2026) reported improved understanding of cosmetic safety following a related perfume-making workshop. This pattern is also consistent with the broader literature on pharmacist-led community education in Indonesia, which has documented the effectiveness of structured, practice-based training for improving public knowledge and skills (Hermansyah et al., 2020). Our results are consistent with this body of evidence and support the conclusion that structured, practice-based workshops are reliably effective for this population.

Table 4. Comparison of Participant Knowledge Levels Before and After the Workshop (n=21)

Knowledge Level	**Pretest**		**Posttest**		**Change**
	n	**%**	**n**	**%**	

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High (≥ 80)	13	61.90	20	95.24	↑ 33.34%
Moderate (60–79)	8	38.10	1	4.76	↓ 33.34%
Low (< 60)	0	0.00	0	0.00	–
Total	**21**	**100.00**	**21**	**100.00**	

The distribution of individual pretest and posttest scores, along with descriptive statistics, is presented in Table 5. The data in Table 5 show an increase in the mean score from 77.14 (pretest) to 90.48 (posttest), with the median rising from 80 to 90. The score difference (delta) ranged from 0 to 20, with a mean difference of 13.33 points. The two participants with a difference of 0 were those who had already achieved a perfect score (100) on the pretest, leaving no room for further improvement. This is a normal *ceiling effect* and does not reflect any inefficiency in the program. Conversely, participants with the lowest pretest score (60) showed a mean improvement of 17.5 points, indicating greater program effectiveness among participants with lower baseline knowledge. To quantify the magnitude of learning improvement, gain scores were calculated. The mean absolute gain was 12.86, with the normalized gain index (g) of 0.57, interpreted as a moderate-to-high learning gain according to Hake's (1998) classification. Relative to the pretest mean, this represents a 16.6% increase in knowledge, indicating a substantial and educationally meaningful improvement within a single workshop session (Hake, 1998).

Table 5. Distribution of Individual Pretest-Posttest Scores and Descriptive Statistics (n = 21)

No.	Pretest	Posttest	Difference
1	60	70	10
2	60	80	20
3	60	80	20
4	60	80	20
5	70	80	10
6	70	80	10
7	70	90	20
8	70	90	20
9	80	90	10
10	80	90	10
11	80	90	10
12	80	90	10
13	80	90	10
14	80	100	20

15	80	100	20
16	80	100	20
17	90	100	10
18	90	100	10
19	90	100	10
20	100	100	0
21	100	100	0
Mean	77.14	90.48	13.33
Median	80	90	10
Min	60	70	0
Max	100	100	20

Before conducting the difference test, a Shapiro-Wilk normality test was performed on the pretest-posttest difference score data. The Shapiro-Wilk test was chosen because of the small sample size ($n = 21 < 50$), as it provides greater statistical power than the Kolmogorov-Smirnov test (Lopes, 2025). Based on the normality test results in Table 6, the Shapiro-Wilk test yielded $W = 0.7777$ and $p = 0.0003$ ($p < 0.05$), so the null hypothesis was rejected. The pretest-posttest difference score data were therefore not normally distributed. This lack of normality can be explained by the fact that the difference scores were only discrete values (0, 10, or 20 points), a consequence of the multiple-choice question format with a fixed score weight per question, rather than any inefficiency in the intervention. Accordingly, hypothesis testing used the Wilcoxon Signed-Rank Test as the appropriate nonparametric alternative (Widiana et al., 2025).

Table 6. Shapiro-Wilk Normality Test Results for the Pretest-Posttest Difference Score Data

Sample Size (n)	21
Shapiro-Wilk Statistic (W)	0.7777
p-value	0.0003
Significance Level (α)	0.05
Test Decision	Reject H_0
Conclusion	The difference score data are not normally distributed

The Wilcoxon test results in Table 7 show $Z = -3.946$ and a p-value < 0.001. Since $p < 0.05$, the null hypothesis (that there is no difference in knowledge before and after the intervention) was rejected. The effect size (r) = 0.834, indicating a large effect

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according to Cohen's (1988) benchmark of $r \geq 0.50$ (Cohen, 1988). Since $p < 0.05$, the null hypothesis was rejected, confirming a statistically significant and practically meaningful improvement in participant knowledge following the workshop. There was therefore a statistically significant difference between participants' knowledge before and after the workshop. The increase in median score from 80 (pretest) to 90 (posttest) quantitatively reflects the genuine success of the intervention provided. This finding is consistent with similar studies using pre-post designs in workshop-based educational programs among adolescents, in which the Wilcoxon test consistently shows significance values < 0.05 when the intervention is structured and involves hands-on practice (Gunawan et al., 2026).

Table 7. Wilcoxon Signed-Rank Test Results for Pretest-Posttest Scores

Group	Score		W (Statistic)	p-value
	Mean	Median		
Pretest	77.14	80	−3.946 (r = 0.834)	< 0.001*
Posttest	90.48	90		

In addition to the knowledge evaluation, participant satisfaction with the activity was measured using a questionnaire containing seven Likert-scale statements. A summary of the majority participant ratings is presented in Table 8. The majority of participants rated all seven evaluation statements as 'Strongly Agree', reflecting consistently high satisfaction across all aspects of the activity. Item-level means ranged from 4.62 (item 4: the presenter demonstrated strong command of the material) to 4.81 (item 7: overall satisfaction with participating in the workshop), with all items falling in the 'Very Good' category (mean > 4.21) according to the interpretation scale (Joshi et al., 2015). The overall mean satisfaction score was 4.74 (SD = 0.06), confirming that participants were consistently highly satisfied across all aspects of the activity. Notably, items 3 and 6, reflecting the added value to knowledge of perfume balm formulation and the ease of following the hands-on session, received high ratings (mean = 4.76), while item 7, reflecting overall satisfaction, received the highest rating of all (mean = 4.81). The lowest-rated item (item 4: presenter's mastery of the material; mean = 4.62) nonetheless remained well within the 'Very Good' range. These results confirm that the program not only improved participants' cognitive knowledge but also provided an enjoyable and meaningful learning experience (Memmedova & Ertuna, 2024).

Table 8. Summary of Participant Satisfaction Evaluation of the Workshop

No.	Evaluation Statement	Majority Participant Rating	Mean (SD)

1	The material presented was clear and easy to understand	Strongly Agree	4.71 (0.56)
2	The material was delivered in an engaging and interactive manner	Strongly Agree	4.76 (0.44)
3	The information increased knowledge of perfume balm formulation and production	Strongly Agree	4.76 (0.54)
4	The presenter demonstrated a strong command of the material	Strongly Agree	4.62 (0.50)
5	The workshop ran well and was well organized	Strongly Agree	4.76 (0.44)
6	The hands-on session was engaging and easy to follow	Strongly Agree	4.76 (0.54)
7	Overall satisfaction with participating in the workshop	Strongly Agree	4.81 (0.51)
Overall mean satisfaction score			4.74 (0.06)

The success of this workshop in improving students' knowledge and skills can be explained through Kolb's *experiential learning* theoretical framework (Kolb, 1984). This model identifies four interconnected stages of cyclical learning (Wijnen-Meijer et al., 2022). Empirical support for hands-on, experience-based learning approaches has been documented across educational contexts: a quasi-experimental study with students found that hands-on laboratory activities led to significantly better conceptual understanding than conventional instruction (Agravante-Destacamento, 2025). An application of Kolb's experiential learning cycle was found to strengthen learning outcomes in professional health-sciences education (Wijnen-Meijer et al., 2022), and a broader review of experiential learning in educational psychology concluded that experience-based pedagogy meaningfully enhances student motivation and classroom engagement (Kong, 2021). In the context of this workshop, all four stages were explicitly facilitated: in *concrete experience*, participants directly experienced melting beeswax, mixing carrier oils, and adding fragrance oil; in *reflective observation*, interactive discussion and Q&A throughout the session allowed participants to reflect on their observations; in *abstract conceptualization*, the presentation of theoretical material on preformulation, ingredient functions, and preparation evaluation built a conceptual framework; and in *active experimentation*, participants applied their understanding by adjusting their fragrance choice to

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personal preference, fostering individual creativity. The most significant gains in knowledge tended to occur for questions whose topics were presented through a combination of multimodal methods (visual/slides, verbal/lecture, and kinesthetic/hands-on practice) compared with those presented verbally only. This is consistent with the principle of *dual coding theory*, which holds that long-term memory is formed more strongly when information is processed through multiple sensory modalities simultaneously (Bi, 2021).

All participants independently produced their own perfume balm by the end of the hands-on session. Organoleptis evaluation by facilitators using a structured checklist showed that all 21 products (100%) met the homogeneity criterion (no visible ingredient separation within the balm matrix). Regarding phase stability, all 21 products showed no oil-phase separation ('sweating') at room temperature after 30 minutes of solidification. All 21 products were evaluated by their respective producers as having an acceptable and distinctive aroma consistent with the chosen fragrance variant. This achievement indicates that not only theoretical knowledge but also basic motor skills in cosmetic formulation successfully contributed to improving students' *science literacy*, that is, the ability to understand and apply scientific concepts in real-life contexts. To operationalize scientific literacy gains, we identified six of the ten evaluation items as direct indicators of science literacy competencies: understanding preparation type differences (Q1), purpose of preformulation (Q2), ingredient function (Q3), product evaluation criteria (Q4), organoleptic assessment (Q5), and spreadability evaluation (Q6). This item-cluster improvement demonstrates that the workshop moved students beyond surface-level product familiarity toward a deeper, scientifically grounded understanding of cosmetic formulation, the operational definition of enhanced science literacy in this context. Good scientific literacy is an important foundation for young people to make evidence-based decisions in their everyday use of products, including cosmetics. By understanding that perfume balm consists of beeswax, carrier oil, and fragrance oil, rather than simply a 'finished product that smells nice,' students become better able to evaluate product claims, compare ingredient compositions, and identify potential risks from hazardous ingredients (Christian et al., 2026).

Furthermore, the experience of making their own perfume balm opened up new perspectives on the potential for science-based entrepreneurship. Several participants spontaneously raised questions about BPOM regulations for home-based cosmetic products, the potential for commercialization, and the possibility of developing additional perfume balm variants, indicating growing interest in pharmacy and

cosmetology as future career paths. This study has several methodological limitations worth noting. The *pre-post* design without a control group did not allow full isolation of the intervention effect from external confounding factors (*history effect, maturation effect*). In addition, the relatively small sample size limits the generalizability of the findings. Finally, evaluation was conducted only on the day of the activity, without long-term follow-up, so knowledge retention and skill durability could not yet be assessed. Fourth, the evaluation of practical skills remained qualitative and observational, without a standardized instrument. It is therefore recommended that similar programs in the future be developed using a randomized or quasi-experimental design with a control group, a larger and more diverse sample across multiple schools, long-term knowledge retention assessments (e.g., at 3 and 6 months post-intervention), and standardized, validated instruments for measuring practical skill outcomes to build a stronger and more generalizable evidence base for this approach.

Figure 1. Material Presentation by the Team

Figure 2. Hands-On Perfume Balm-Making Session

Figure 1 shows the team delivering the educational presentation, illustrating the interactive lecture format that established the theoretical foundation for the hands-on session. Figure 2 captures participants during the perfume balm production session, reflecting the high engagement level observed throughout the practical component. Taken together, the quantitative results, product evaluation data, and qualitative observations consistently support the conclusion that a hands-on workshop that

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combines targeted cosmetic science education with practical formulation practice is an effective approach to enhancing science literacy among high school students. The program's success in this pilot school provides a replicable model for future community service activities in the Indonesian pharmacy education context.

4. CONCLUSION

The non-alcohol perfume balm workshop at SMA Katolik Ricci 1, Jakarta, successfully and measurably improved students' scientific literacy and cosmetic formulation skills. The proportion of participants with high knowledge increased from 61.90% to 95.24% ($Z = -3.823$; $p < 0.001$; effect size $r = 0.834$), indicating a large intervention effect. Product evaluation confirmed that all participants successfully produced a homogeneous, phase-stable perfume balm, providing measurable evidence of practical skill acquisition beyond self-reported satisfaction. The program's distinguishing feature is the simultaneous integration of three learning dimensions: scientific literacy, cosmetic safety awareness, and hands-on formulation skills within a single experiential learning session, an approach not yet widely implemented in Indonesian high-school community service programs. The success of this program demonstrates the potential of skills-based community service in pharmacy to improve scientific literacy among adolescents, consistent with the broader vision for community pharmacy's role in primary health care and public education in Indonesia. From a practical standpoint, this workshop model offers schools a low-cost, safe, and curriculum-relevant extension activity that bridges formal chemistry education and applied health science. The spontaneous interest expressed by participants in BPOM regulations and product commercialization further suggests that such programs may contribute to students' awareness of pharmacy and cosmetology as future career pathways, an area of growing relevance given ongoing reflection within Indonesian pharmacy education on the scope of practice and training needs. It is recommended that similar programs be developed using a randomized or quasi-experimental design, including a control group, a larger, more diverse sample across multiple schools, long-term knowledge retention assessments, and standardized, validated instruments to measure practical skill outcomes, to build a stronger evidence base for this approach.

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