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The effectiveness of well-being-based learning devices on plant growth and development material to enhance students' life-long learning

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Abstract

In line with the implementation of the Merdeka Curriculum, science learning is expected to foster students' life-long learning skills through approaches that integrate well-being principles. However, learning on the topic of plant growth and development often remains theoretical and less meaningful for students. This study aimed to develop and examine the effectiveness of well-being–based learning devices in enhancing students' life-long learning skills, specifically complex thinking, information processing, collaboration, communication, and habits of mind. This research employed a Research and Development (R&D) approach using the ADDIE model. The implementation phase applied a pretest–posttest control group design involving 64 ninth-grade students of SMP Negeri 1 Pucakwangi in the 2024/2025 academic year. Data were collected through life-long learning skills tests, questionnaires, observations, and interviews. Instrument validity and reliability were tested prior to implementation. The experimental class showed an increase in mean scores from 60.59 to 77.28, with an N-Gain of 0.56 (moderate category). In contrast, the control class showed a slight, non-significant improvement (57 to 60; $p > 0.05$). Statistical analysis confirmed a significant improvement in the experimental group ($p < 0.05$). These findings indicate that well-being–based learning devices effectively enhance the specific measured indicators of students' life-long learning skills.

Abstrak. *Sesuai dengan implementasi Kurikulum Merdeka, pembelajaran sains diharapkan dapat mengembangkan keterampilan belajar seumur hidup siswa melalui pendekatan yang mengintegrasikan prinsip-prinsip kesejahteraan. Namun, pembelajaran tentang pertumbuhan dan perkembangan tumbuhan seringkali masih bersifat teoretis dan kurang bermakna bagi siswa. Penelitian ini bertujuan untuk mengembangkan dan menguji efektivitas perangkat pembelajaran berbasis kesejahteraan dalam meningkatkan keterampilan belajar seumur hidup siswa, khususnya pemikiran kompleks, pemrosesan informasi, kolaborasi, komunikasi, dan kebiasaan berpikir. Penelitian ini menggunakan pendekatan Penelitian dan Pengembangan (R&D) dengan model ADDIE. Fase implementasi menerapkan desain kelompok kontrol pretest–posttest yang melibatkan 64 siswa kelas IX SMP Negeri 1 Pucakwangi pada tahun ajaran 2024/2025. Data dikumpulkan melalui tes keterampilan belajar seumur hidup, kuesioner, observasi, dan wawancara. Validitas dan reliabilitas instrumen diuji sebelum implementasi. Kelompok eksperimen menunjukkan peningkatan skor rata-rata dari 60,59 menjadi 77,28, dengan N-Gain sebesar 0,56 (kategori moderat). Di sisi lain, kelompok kontrol menunjukkan peningkatan yang sedikit dan tidak signifikan (57 menjadi 60; $p > 0,05$). Analisis statistik mengonfirmasi peningkatan yang signifikan pada kelompok eksperimen ($p < 0,05$). Temuan ini menunjukkan bahwa perangkat pembelajaran berbasis kesejahteraan secara efektif meningkatkan indikator-indikator spesifik keterampilan belajar sepanjang hayat siswa yang diukur.*

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A. Introduction

Educational institutions in Indonesia are currently undergoing a transformation of learning that emphasizes character development, competencies, and student well-being (Maisaroh & Untari, 2024; Priatmoko, 2021). In line with the implementation of the *Merdeka Curriculum*, education today is not merely focused on content mastery but also on shaping students to become individuals who are faithful, of good character, competent, and capable of adapting to the challenges of the 21st century (Anwar et al., 2025; Putri et al., 2023).

Learning processes in schools are expected to contribute significantly by providing meaningful experiences, not only developing cognitive aspects but also nurturing students' affective, social, and emotional domains. Ideally, learning should be designed to be challenging, active, interactive, and collaborative, enabling students to develop their potential optimally (Murni, 2021; Pakaya & Ibrahim, 2020). However, the reality shows that science learning, particularly in the topic of plant growth and development, based on the results of the preliminary observations, the learning process in the topic of plant growth and development is still predominantly characterized by theoretical content delivery through lecture methods and written assignments.

Classroom activities tend to emphasize concept mastery and memorization of terms, while experimental activities, direct observations, and contextual projects that enable students to construct understanding through real-life experiences remain limited. This condition indicates that learning is often more focused on knowledge transfer (content delivery) rather than experiential learning. In fact, experiential learning approaches have the potential to enhance student engagement, curiosity, critical thinking skills, and the development of deeper and more meaningful learning experiences. As a result, students tend to memorize material without fully understanding its relevance to everyday life. A learning approach that emphasizes theoretical transmission alone may hinder students from recognizing the meaningfulness of learning, thereby reducing their motivation to explore further and limiting the development of higher-order thinking skills essential for long-term learning (Kurniawan et al., 2023; Sari, 2025; Safitri et al., 2025).

National education in Indonesia aims to shape learners who are faithful, pious, noble in character, healthy, knowledgeable, capable, creative, and independent (Mustofa & Rochman, 2023; Chanifudin et al., 2024; Mahfudoh & Rohmawati, 2020; Mursalim et al., 2025). National education in Indonesia aims to develop learners who are capable and adaptive in facing future challenges. One measurable manifestation of this goal is the development of life-long learning skills. These skills include complex thinking, information processing, collaboration, communication, and habits of mind, which are essential for responding to continuous changes in the 21st century (Aziz et al., 2025; Fahmi et al., 2025; Soleh et al., 2023; Tina et al., 2024).

To achieve this, learning devices play a crucial role. They serve as guides for teachers in planning, implementing, and evaluating learning processes. High-quality learning devices should not only contain material and activities but also provide strategies tailored to students' needs and aligned with contemporary developments (Aluf, 2024; Humairoh, 2020; Rahayu et al., 2023). Yet, many learning devices currently used in schools remain conventional, emphasizing only cognitive aspects and failing to fully accommodate student well-being in learning (Anwar et al., 2025).

Hence, there is a need to develop well-being–based learning devices that systematically integrate cognitive, emotional, social, and spiritual dimensions within the learning process. Such integration aims to create a supportive learning environment in which students feel safe, engaged, and motivated to participate actively. By embedding well-being principles into instructional design, learning activities can become more meaningful and conducive to positive student experiences. This approach is particularly relevant to the topic of plant growth and development, as the material offers strong opportunities to be connected with real-life contexts through practical activities, simple hydroponic projects, and direct observation. Through these experiential and collaborative activities, well-being–based learning devices are expected to support students' conceptual understanding while fostering measurable life-long learning skills, including complex thinking, information processing, collaboration, communication, and habits of mind. Through this process, students can cultivate the awareness that learning is a continuous journey that carries long-term benefits for their future lives. Accordingly, this study focuses on the development of well-being-based learning devices in the topic of plant growth and development to enhance students' life-long learning skills, which has not been previously implemented in junior high school science learning in Indonesia.

B. Material and method

This study employed a Research and Development (R&D) approach using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation) to develop well-being–based learning materials on the topic of plant growth and development. The development aimed to enhance students' life-long learning skills, specifically focusing on five measurable indicators: complex thinking, information processing, collaboration, communication, and habits of mind. The

implementation phase applied a quasi-experimental method with a pretest–posttest control group design. The study was conducted at SMP Negeri 1 Pucakwangi during the 2024/2025 academic year, involving 64 ninth-grade students divided into an experimental group and a control group, The sample comprised 32 students assigned to the experimental group (Class 9A) and 32 students assigned to the control group (Class 9C). The experimental group was taught using the well-being–based learning materials, while the control group received conventional instruction. The research instruments consisted of (1) a life-long learning skills test (pretest and posttest), (2) a student response questionnaire, (3) an observation sheet to assess the implementation of learning, and, (4) structured interviews with the science teacher. The life-long learning skills instrument was developed based on the five indicators measured in this study. Instrument validity was examined through content validation by experts and empirical validity testing using product–moment correlation. Reliability was tested using Cronbach's Alpha coefficient. Additionally, item analysis included difficulty index and discriminating power calculations. Data were collected through tests, questionnaires, observations, and interviews. The effectiveness of the learning materials was analyzed using N-Gain scores derived from pretest and posttest results. Hypothesis testing was conducted using an independent sample t-test after meeting the assumptions of normality (Kolmogorov–Smirnov test) and homogeneity (Levene's test).

C. Results and discussion

The analysis of test results was conducted to obtain a comprehensive overview of students' life-long learning after the implementation of well-being-based learning materials. This stage presents students' final achievements in life-long learning based on test results, explained quantitatively.

Pretest and posttest results

Based on the pretest results, the experimental class that received treatment using well-being-based learning materials to enhance students' life-long learning obtained a minimum score of 50.00, a maximum score of 70.00, and an average of 60.59. The control class pretest showed a minimum score of 45.00, a maximum of 65.00, and an average of 57.00. The posttest results of the experimental class indicated a minimum score of 70.00, a maximum of 90.00, and an average of 77.28. Meanwhile, the control class obtained a minimum score of 40.00, a maximum of 80.00, and an average of 60.00 in the posttest. The mean score was obtained by calculating the average of all students' pretest scores in each class. The formula used to calculate the mean. The comparison of the average pretest and posttest results of experimental and control classes is presented in Figure 1.

Based on the pretest results, the average scores of the experimental class (60.59) and the control class (57) were relatively comparable. The experimental class that utilized the well-being–based learning materials showed a significant increase, achieving an average score of 77.28, while the control class only reached 60. The greater improvement in the experimental class may be attributed to the integration of well-being principles that actively engaged students through collaborative activities, reflective practices, and meaningful learning experiences. These elements supported the development of complex thinking, communication, and habits of mind, which contributed to higher posttest performance. The improvement in the experimental class, by 16.69 points, was substantially higher compared to the control group, which increased by only 3 points. These findings strongly indicate that well-being–based learning materials are proven to be more effective in improving both learning outcomes and students' life-long learning competencies, as confirmed by the independent sample t-test ($p < 0.05$).

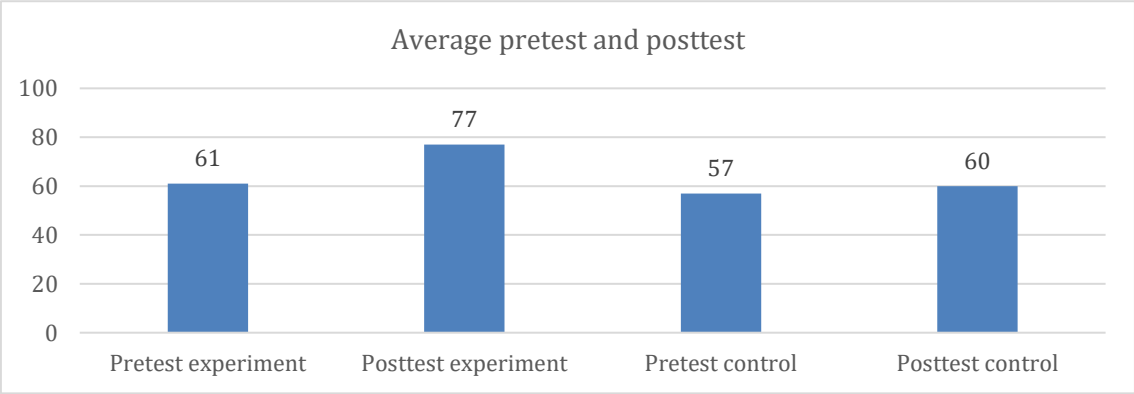

Figure 1 Average pretest and posttest

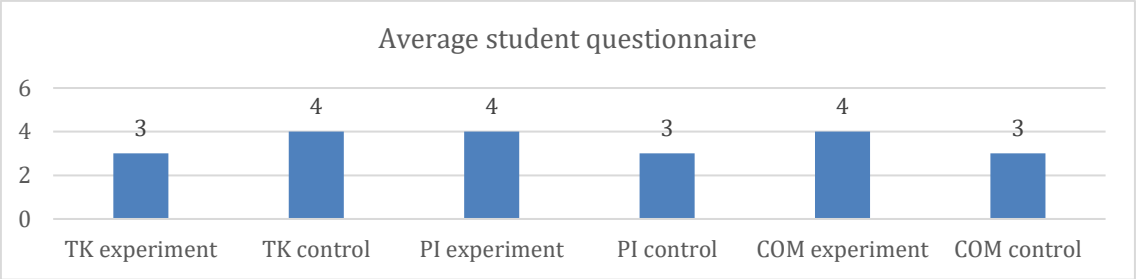

Figure 2 Average student questionnaire

Table 1 Observation results

Class	Life-long Learning				
	Complect thinking	**Processing information**	**Communication**	**Collaboration**	**Habits of mind**
Experiment	4	4	4	5	4
Control	2	3	2	3	3

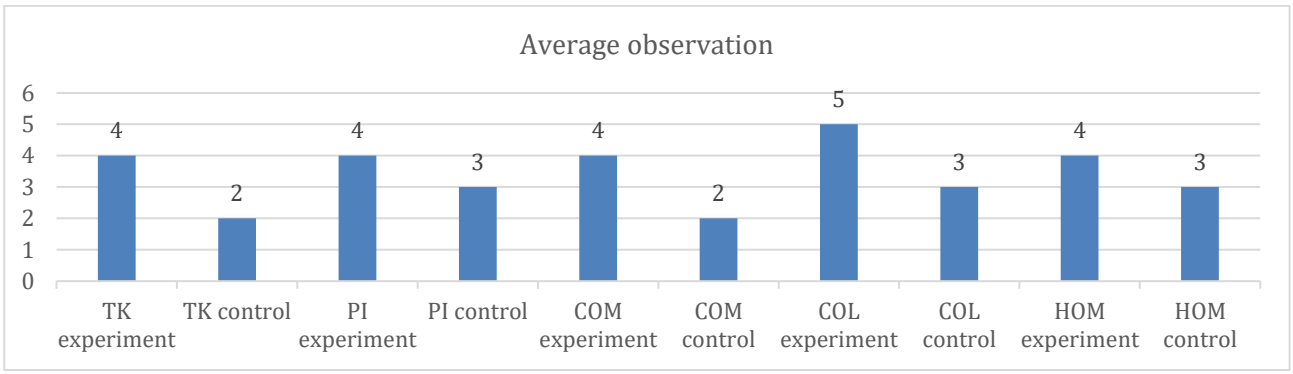

Figure 3 Average observation

Student questionnaire results

The results of the student questionnaire, which employed a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), revealed that the experimental class achieved the highest average score on the communication aspect, with a mean of 4.00. This score indicates that students generally agreed that the well-being–based learning materials effectively supported the development of their communication skills. In contrast, the control class rated the highest on the aspect of information processing, also with an average score of 4 in Figure 2.

Students in the experimental class who engaged in learning through well-being–based materials gave the highest ratings in the *communication* aspect, with an average score of 4 on a 5-point scale. Meanwhile, students in the control class provided their highest ratings in the *information processing* aspect, with the same average score of 4 on a 5-point scale. The results showed that the experimental class achieved a higher average score on the communication indicator, while the control class showed a slightly higher average score on the information processing indicator. These findings suggest different strengths between the two instructional approaches in supporting specific life-long learning competencies.

Observation result

The observation sheets were developed to assess students' life-long learning skills, including complex thinking, information processing, collaboration, communication, and habits of mind. In the experimental class, these skills were observed during the implementation of well-Being -based learning materials, whereas in the control class, they were assessed during conventional instruction. The average results of the life-long learning skill observations in both the experimental and control classes are presented in Table 1.

Based on Table 1, the average observation results in the experimental class show that the highest score was achieved in the *collaboration* aspect, with a perfect score of 5 on a 5-point scale. The lowest scores, averaging 4 out of 5, were observed in the indicators of *complex thinking*, *communication*, and *habits of mind*. In contrast, the control class obtained the highest scores in *collaboration* and *habits of mind*, each with an average of 3, while the lowest scores, averaging 2 out of 5, were recorded in the aspects of *complex thinking* and *communication*. The comparison of average observation scores on life-long learning skills between the experimental and control (see Figure 3).

Table 2 Normality test results of the control and experimental groups

Class		Kolmogrov-Smirnov[3]		
		Statistic	Df	Sig.
Result	Pretest experiment	.145	32	.087
	Posttest experiment	.154	32	.053
	Pretest control	.138	32	.129
	Posttest control	.097	32	.200

Table 3 Paired sample t-test results for the experimental class

t	df	Sig. (2-tailed)
-11.738	31	.000

Table 4 Paired sample t-test class control

t	df	Sig. (2-tailed)
-2.036	31	.050

Table 5 Paired sample statistics

	Mean	N	Std. deviation	Std. error mean
Pair1				
Pretest experiment	60.59	32	4.758	.84
Posttest experiment	77.28	32	6.017	1.064

Table 6 Homogeneity test results of the experimental and control groups

	Levene statistic	df1	df2	Sig.
Based on mean	1.451	1	62	.233
Based on median	1.179	1	62	.282
Based on median and with adjusted df	1.179	1	58.084	.282
Based on trimmed mean	1.505	1	62	.225

Table 7 N-Gain test results

	N	Minimum	Maximum	Mean	Std. deviation
NGainscore	32	.38	.77	.5636	.09980
NGainpersen	32	37.50	77.27	57.3595	.9.98020
Valid N (listwise)	32				

Normality test

At this stage, a normality test was conducted for both the control and experimental classes using the pretest and posttest data. The normality test in this study employed the Kolmogorov–Smirnov test. This test was used to determine whether the obtained data were normally distributed. The criterion applied was that if the significance value (*sig*) > 0.05, the data were considered normally distributed. The results of the normality test for both the control and experimental groups are presented in Table 2**.**

Based on Table 2, the data from both the experimental and control groups in the pretest and posttest indicated that the Kolmogorov–Smirnov significance values were greater than 0.05. Therefore, it can be concluded that the data were normally distributed. Consequently, the study could proceed with parametric statistical tests, namely the paired sample t-test, homogeneity test, and independent sample t-test.

Paired sample t-test

The paired sample t-test was conducted to address the first hypothesis, namely that learning devices based on the well-being concept are effective in enhancing students' life-long learning skills in science learning at SMP Negeri 1 Pucakwangi. This test was performed to determine whether there were significant differences between the pretest and posttest results of students in both the experimental and control groups. The results of the paired sample t-test for the pretest and posttest scores are presented in Table 3 and Table 4.

Based on the paired sample t-test output for the experimental group shown in Table 3, the significance value was 0.000 < 0.05. This indicates that there was a significant difference between the pretest and posttest results of the experimental class, demonstrating the effectiveness of the well-being–based learning devices in improving students' life-long learning skills. Meanwhile, the paired sample t-test results for the control group, presented in Table 4, showed a significance value of 0.050. Thus, it can be concluded

that there was no significant difference between the pretest and posttest mean scores in the control class. To provide a clearer picture of the mean learning outcomes before and after the implementation of well-being–based learning devices, the paired sample statistics are presented in Table 5.

Homogeneity test

Before conducting the independent sample t-test on the two research groups, it was necessary to meet the assumption of homogeneity between the experimental and control classes. In this study, homogeneity was tested using the Homogeneity of Variance test. The sample data were considered homogeneous if the significance value (sig) was greater than 0.05. If the data did not meet the homogeneity requirement (sig < 0.05), the subsequent analysis would be carried out using the Mann–Whitney test. The results of the homogeneity test for both the experimental and control groups are presented in Table 6.

Based on Table 6, the obtained significance value was 0.233. This indicates that the posttest variances of the experimental and control groups were equal or homogeneous. Therefore, the assumption required for conducting the independent sample t-test was fulfilled.

N-Gain calculation.

The N-Gain calculation was conducted to determine the effectiveness of using well-being–based learning devices in enhancing students' life-long learning skills. The N-Gain test was carried out by calculating the difference between posttest and pretest scores relative to the maximum possible improvement. The results of the N-Gain calculation are presented in Table 7.

Based on Table 7, the N-Gain value for the experimental class was 0.56, equivalent to 57.95%, which falls into the moderate or fairly effective category. The minimum N-Gain was 0.00 and the maximum was 0.80, indicating variation in the level of improvement among students. These findings suggest that the applied learning model enhanced students' life-long learning skills; however, some students did not demonstrate noticeable improvement, indicating the need for further refinement of the learning approach to ensure more evenly distributed impacts.

The results indicate that the well-being–based learning devices were effective in improving students' life-long learning skills on the topic of plant growth and development. The pretest scores showed that the experimental class (M = 60.59) and the control class (M = 57) had relatively comparable initial abilities. Following the intervention, the experimental class demonstrated a substantial increase, achieving a posttest mean score of 77.28, whereas the control class reached only 60. The gain score in the experimental class (16.69 points) was considerably higher than that of the control class (3 points), indicating a stronger learning improvement. This enhancement may be attributed to the integration of well-being principles that fostered active engagement, collaboration, reflection, and meaningful learning experiences. Based on the analysis of the measured indicators, supported by questionnaire data and statistical testing, the findings indicate that well-being–based learning devices contribute positively to students' communication skills. However, for the information processing indicator, the control class demonstrated relatively higher scores. Therefore, the contribution of well-being–based learning devices to meaningful learning experiences can be interpreted within the specific aspects measured in this study rather than as a universal effect across all life-long learning competencies, leading to positive impacts on student achievement. As explained by Jaoharoh and Putri (2024); Tengker et al. (2024), learning that accommodates students' well-being can provide more meaningful learning experiences, generate positive impacts on the learning process, and make a significant contribution to students' academic achievement.

Moreover, the questionnaire results support this finding. In the aspect of communication, the experimental class obtained the highest score with an average of 4 out of 5, indicating that the well-being-based learning device encouraged interaction, discussion, and skills in expressing ideas. Conversely, the control class scored higher in the aspect of information processing, with an average of 4 out of 5, suggesting that conventional learning tends to promote individual cognitive activities rather than social skills. This evidence demonstrates that well-being-based learning devices not only improve conceptual mastery but also strengthen 21st-century competencies, particularly communication as an integral component of life-long learning. As explained by Jufriadi et al. (2022); Lubis (2020) Well-being–based learning devices not only enhance conceptual mastery but also make a tangible contribution to the development of 21st-century skills. Among these skills, communication emerged as the most prominent after the implementation of well-being–oriented learning, reflecting its integral role as a component of life-long learning.

Observations in the experimental class revealed that collaboration achieved the highest score with an average of 5 on the scale, while other aspects such as complex thinking, information processing, communication, and habits of mind each obtained an average score of 4. These results indicate that well-being–based learning successfully created a learning environment that fosters cooperation, emotional engagement, and active student participation. As explained by Cahyono et al. (2021); Ernawati et al. (2022); Sholihah (2022). Learning that is safe, comfortable, and addresses students' well-being has a positive impact on learning outcomes while also fostering cooperation, emotional engagement, and active participation. Such conditions help cultivate

complex thinking, information processing, communication, collaboration, and habits of mind, thereby creating a more interactive and dynamic classroom environment. In contrast, the control class only achieved scores between 2 and 3 across all aspects, indicating that conventional learning provides limited opportunities for collaborative skills and the development of habits of mind. As explained by Ulum and Wahab (2025); Karimah et al. (2025); Mantau (2023), learning that relies on conventional approaches tends to provide limited support for collaborative skills and the full development of habits of mind, even though these two aspects are essential in preparing students to meet the demands of the 21st century.

Statistical analyses were conducted to examine the effectiveness of the intervention. The normality test confirmed that the data were normally distributed ($p > 0.05$), permitting the use of parametric tests. A paired sample t-test was employed to compare pretest and posttest scores within each group. The results showed a statistically significant improvement in the experimental class ($p = 0.000 < 0.05$), whereas the control class did not demonstrate a statistically significant improvement ($p = 0.050 \geq 0.05$). Furthermore, the homogeneity test indicated equal variances between groups ($p > 0.05$), meeting the assumption for the independent sample t-test. The independent t-test comparing posttest scores revealed a significant difference between the experimental and control classes ($p = 0.000 < 0.05$), with a mean difference of 15.875 points. These statistical results indicate that the well-being–based learning device led to significantly higher learning outcomes compared to conventional instruction within the scope of the measured indicators.

Furthermore, the N-Gain calculation for the experimental class reached 0.56 or 57.95%, categorized as moderate effectiveness. This indicates that the well-being–based learning device is sufficiently effective in enhancing students' life-long learning skills. However, there was variation in achievement across students, with a minimum score of 0.38 and a maximum of 0.77. This suggests that although most students experienced improvement, some still showed relatively low outcomes. This opens opportunities for further evaluation and refinement of instructional strategies, such as differentiated activities or individualized mentoring, to ensure more equitable enhancement of life-long learning skills.

Overall, the findings of this study indicate that the well-being–based learning device effectively enhances multiple aspects of students' life-long learning, particularly collaboration, communication, and habits of mind. This effectiveness aligns with the goals of 21st-century education, which emphasizes a balance of cognitive, affective, and social dimensions. In line with Lyna (2025); Mahrunnisya (2023) As stated by scholars, the goals of 21st-century education demand the integration of cognitive, affective, and social dimensions in the learning process. The integration of well-being concepts into teaching not only enhances students' conceptual understanding but also fosters an enjoyable learning atmosphere, cultivates intrinsic motivation, and equips learners with essential life-long learning skills.

D. Conclusion

The findings demonstrate that the developed learning device was effective, as indicated by the higher improvement in posttest scores in the experimental class compared to the control class. Based on questionnaire, observation, and statistical analysis results, the well-being–based learning device showed stronger contributions to the development of communication, collaboration, and habits of mind. However, for the information processing indicator, the control class obtained relatively higher scores. These findings indicate that the effectiveness of the well-being–based learning device is reflected in specific life-long learning aspects measured in this study, rather than uniformly across all indicators.

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