Jurnal Pendidikan Kimia
FKIP Universitas Halu Oleo

p-ISSN : 2503-4480
e-ISSN : 2721-2963

Vol. 11, No. 2, August 2026 DOI: https://doi.org/10.36709/jpkim.v11i2.244

ACHIEVEMENT OF STUDENTS' SCIENTIFIC PERFORMANCE THROUGH PROJECT-BASED WORKSHEETS IN SOLID SOAP FORMULATION LEARNING

Vidia Agustin Altasia[1*], Saepudin Rahmatullah[1], Citra Deliana Dewi Sundari[1], Muhammad Ali Nurdin[1], Nayla Haraswati Arifin[1]

[1]Department of Chemistry Education, Faculty of Tarbiyah and Teacher Training, State Islamic University of Sunan Gunung Djati Bandung, Jl. A.H. Nasution No. 105, Cibiru, Bandung 40614, West Java, Indonesia.

*Corresponding Author: vidiaa88@gmail.com

ARTICLE INFO

Received :
21 July 2026
Revised :
11 August 2026
Accepted :
12 August 2026
Published:
31 August 2026

Keywords:
scientific performance; project-based worksheets; project-based learning; solid soap.

Kata Kunci:
kinerja ilmiah; lembar kerja berbasis proyek; project-based learning; sabun padat.

ABSTRACT

Abstract: Scientific performance is an important competency in chemistry learning. Project-based worksheets provide structured learning experiences through contextual laboratory activities. This study aimed to describe the implementation of project-based worksheets and students' scientific performance in solid soap formulation using avocado seed extract and butterfly pea flower (*Clitoria ternatea*). This quantitative study employed a pre-experimental One-Shot Case Study design involving 60 fourth-semester Chemistry Education students selected through total sampling. Data were collected using observation sheets and assessment sheets. The instruments were reviewed by two expert validators, with an aggregated Aiken's V coefficient of 0.828, indicating high content validity. Data were analyzed descriptively. Student activity and worksheet completion reached 97.3% and 93.1%, respectively, both categorized as very good. Students' scientific performance reached 93.7%, with the highest scores in problem formulation, hypothesis construction, and experimental design (100%), and the lowest in experiment execution and data collection (87.5%). These findings indicate high scientific performance following the implementation of project-based worksheets. Further research is recommended to employ a design with a pretest and control group to provide stronger evidence of changes in students' scientific performance.

Abstrak: Kinerja ilmiah merupakan salah satu kompetensi penting dalam pembelajaran kimia. Lembar kerja berbasis proyek memberikan pengalaman belajar yang terstruktur melalui kegiatan laboratorium yang kontekstual. Penelitian ini bertujuan untuk mendeskripsikan penerapan lembar kerja berbasis proyek dan kinerja ilmiah mahasiswa pada formulasi sabun padat menggunakan ekstrak biji alpukat dan bunga telang (*Clitoria ternatea*). Penelitian kuantitatif ini menggunakan metode pre-eksperimental dengan desain *One-Shot Case Study* yang melibatkan 60 mahasiswa Pendidikan Kimia semester IV yang dipilih melalui teknik total sampling. Data dikumpulkan menggunakan lembar observasi dan lembar penilaian. Instrumen divalidasi oleh dua validator ahli dengan koefisien Aiken's V agregat sebesar 0,828, yang menunjukkan validitas isi yang tinggi. Data dianalisis secara deskriptif. Aktivitas mahasiswa dan penyelesaian lembar kerja masing-masing mencapai 97,3% dan 93,1%, yang keduanya berada pada kategori sangat baik. Kinerja ilmiah mahasiswa mencapai 93,7%, dengan skor tertinggi pada perumusan masalah, penyusunan hipotesis, dan perancangan percobaan (100%), serta skor terendah pada pelaksanaan percobaan dan pengumpulan data (87,5%). Hasil penelitian ini menunjukkan kinerja ilmiah yang tinggi setelah penerapan lembar kerja berbasis proyek. Penelitian selanjutnya disarankan menggunakan desain dengan pretest dan kelompok kontrol untuk memperoleh gambaran yang lebih kuat mengenai perubahan kinerja ilmiah mahasiswa.

How to Cite:
Altasia, V. A., Rahmatullah, S., Sundari, C. D. D., Nurdin, M. A., & Arifin, N. H. (2026). Achievement of Students' Scientific Performance through Project-Based Worksheets in Solid Soap Formulation Learning. *Jurnal Pendidikan Kimia FKIP Universitas Halu Oleo*, 11(2), 282–297. https://doi.org/10.36709/jpkim.v11i2.244

INTRODUCTION

Scientific performance is one of the important competencies in chemistry learning because it encompasses the ability to formulate problems, design and conduct experiments, analyze data, and communicate results based on the scientific method. In addition to promoting conceptual comprehension, mastery of scientific performance gives students the critical thinking, problem-solving, and evidence-based decision-making skills necessary for both education and the workplace. Therefore, chemistry learning needs to be designed so that it is capable of providing learning experiences that encourage the sustained achievement of students' scientific performance.

However, various studies show that students' scientific thinking abilities, science process skills, and scientific literacy still require reinforcement through the application of more active and contextual learning models. Furthermore, the application of project-based learning is also reported to be associated with students' critical thinking, problem-solving, and active involvement in chemistry learning, thereby contributing to stronger scientific competencies. Therefore, chemistry learning does not only demand conceptual mastery, but also the ability to apply concepts through laboratory activities that can comprehensively engage students' scientific performance (Sari et al., 2025; Pratiwi et al., 2024; Delima et al., 2025).

The Project-Based Learning (PjBL) model is one of the learning approaches that provides students with the opportunity to solve projects based on real problems through investigation activities, experiments, data analysis, up to the presentation of results. PjBL implementation in chemistry learning has also been reported to be associated with critical

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026 DOI: https://doi.org/10.36709/jpkim.v11i2.244

thinking skills, science process skills, learning outcomes, and students' active involvement in solving projects collaboratively (Wahyudiati et al., 2022; Pratiwi et al., 2024; Hakim, 2024). Various studies show that the application of PjBL is associated with students' critical thinking skills, scientific literacy, science process skills, and problem-solving abilities in chemistry learning (Nelson & Tarigan, 2022; Munawwarah et al., 2025).

The success of PjBL strongly relies on the availability of structured learning instruments, one of which is the project-based student worksheet (LKM) that functions as a systematic guide for students in executing every stage of the experiment. The development of Project-Based Learning (PjBL)-based worksheets has been proven to have high levels of validity and practicality so that it can support a more active, systematic, and student-centered learning process (Batubara et al., 2024; Nurkhasanah et al., 2024). Various studies show that the implementation of the Project-Based Learning model is associated with learning outcomes, critical thinking skills, and students' engagement in chemistry learning (Munawwarah et al., 2025; Putri et al., 2025).

One of the relevant applied chemistry contexts to be integrated with project-based learning is solid soap making through saponification reaction, which is an important concept in organic chemistry and applied chemistry. Innovation in soap formulation can be carried out by utilizing natural ingredients that possess biological activity. Avocado seed (Persea americana Mill.) extract is known to contain secondary metabolite compounds such as flavonoids, phenolics, tannins, and saponins that have potential as antioxidants and antibacterials, thereby having the potential to be utilized as active ingredients in cosmetic preparations (Setyawan et al., 2021). In addition, butterfly pea flower (Clitoria ternatea L.) contains anthocyanins and flavonoids which have high antioxidant activity and have the potential to increase the functional value of soap products (Marpaung, 2020).

Research addressing students' scientific performance through project-based worksheets has been reported previously (Febriyanti et al., 2025; Khairunnisa et al., 2025), but research that specifically describes the implementation of project-based worksheet/Lembar Kerja Mahasiswa (LKM) while simultaneously describing students' scientific performance in making organic chemistry products, particularly solid soap made from avocado seed extract and butterfly pea flower, is still limited. More importantly, most of these prior studies have concentrated on establishing the worksheet's validity, practicality, and general effectiveness during its

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026 *DOI: https://doi.org/10.36709/jpkim.v11i2.244*

development, while relatively few have examined in detail how students' scientific performance manifests at each stage of worksheet implementation, that is, which specific indicators are more readily achieved and which require further reinforcement. The saponification-based context in this study also requires students to formulate hypotheses about the effect of natural-ingredient composition, adjust experimental procedures accordingly, conduct multiple product-quality tests, and compare their product against commercial standards, engaging each scientific performance indicator around a single integrated product rather than isolated exercises, a context that remains undescribed in project-based worksheet research conducted mostly in acid-base or hand cream formulation settings. Therefore, this study aims to (1) describe the implementation of project-based worksheets in learning solid soap formulation from avocado seed extract and butterfly pea flower (Clitoria ternatea), and (2) describe students' scientific performance at each stage of the project-based worksheet implementation.

METHOD

Research Design

This study utilized a quantitative approach with a pre-experimental method and a One-Shot Case Study design, which involved giving a treatment in the form of applying project-based worksheet/Lembar Kerja Mahasiswa (LKM), then the results were obtained through observation and assessment after the treatment was given (Arikunto, 2021). The independent variable in this study was the application of project-based worksheets in solid soap making with the addition of avocado seed extract and butterfly pea flower, while the dependent variables were student activities and scientific performance. The research design is presented in Table 1.

Table 1. ***One Shot Case Study Design***

Treatment	Observation
X	O

Note:
X = learning using project-based LKM
O = observation/assessment after the application of project-based worksheet (LKM)

As this design does not include a pretest or a control group, the results of this study describe students' scientific performance and activity after the

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026 DOI: https://doi.org/10.36709/jpkim.v11i2.244

implementation of project-based worksheet (LKM), rather than measuring change relative to a baseline.

Participants

This research was conducted on May 21, 2026, at the Integrated Laboratory of UIN Sunan Gunung Djati Bandung. Participants were selected using a total sampling technique, involving all 60 fourth-semester students from two classes of the Chemistry Education Study Program who were enrolled in and present for the Organic Chemistry 2 Practicum course. Students were divided into four groups, then each group carried out a solid soap formulation practicum using variations in the composition of avocado seed (*Persea americana* Mill.) extract and butterfly pea flower (*Clitoria ternatea*) according to predetermined formulations. Student activities and worksheet completion were observed by four observers (fellow students trained on the observation sheet and assessment rubric), each assigned to monitor one group throughout the practicum.

Research Instruments

The research instruments included: (1) project-based worksheet (LKM) designed based on six stages of Project-Based Learning (PjBL), namely analyzing the problem, designing the project, carrying out research, compiling product drafts/prototypes, assessing products, as well as finalization and product publication; (2) student activity observation sheets; (3) scientific performance assessment sheets covering the stages of formulating problems, constructing hypotheses, designing experiments, conducting experiments, interpreting data, and communicating; and (4) rubrics for assessing products, posters, and presentations.

All instruments were evaluated by two expert validators using a five-point rating scale to assess their content validity across four stages of the project-based worksheet. The validation results showed percentages of 90% for Stage 1 and 85% for Stages 2–4. Based on the aggregated validator scores, the Aiken's V coefficients were 0.875 for Stage 1 and 0.813 for Stages 2–4, with an overall Aiken's V coefficient of 0.828. These results indicate a high level of content validity, and the instruments were used after revisions were made according to the validators' recommendations.

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026
DOI: https://doi.org/10.36709/jpkim.v11i2.244

Data Analysis

Data on student activities, project-based worksheet (LKM) completion, and scientific performance were analyzed using descriptive statistics. For data having detailed scores per group (activities and LKM completion at each stage), the mean value, standard deviation (SD), minimum value, and maximum value between groups were calculated, while for scientific performance data recorded at the class level (aggregate per indicator), the mean, SD, minimum, and maximum between indicators were calculated. All scores were then interpreted based on category criteria: very good (80–100%), good (70–79%), sufficient (60–69%), poor (50–59%), and very poor (≤49%) (Arikunto, 2021).

RESULTS AND DISCUSSION

Implementation of Project-Based Worksheets

The implementation of project-based worksheet (LKM) was carried out through two meetings, namely an offline meeting in the laboratory and an online meeting via WhatsApp for the product finalization and publication stage. Student activities at each learning stage were observed using observation sheets. The results of student activity assessments per group are presented in Table 2, while the descriptive statistics of student activities at each stage are presented in Table 3.

Table 2. Results of Student Activity Assessment at Each Stage of Project Learning

Group	1	2	3	4	5	6
1	93.3	100	100	95	86.6	100
2	100	100	100	100	93.3	100
3	100	93.3	100	100	93.3	100
4	93.3	93.3	100	100	93.3	100
Overall Average	96.6	96.6	100	98.7	92.3	100

Note: 1) Analyzing problems; 2) Designing projects; 3) Carrying out research; 4) Compiling draft/prototype products; 5) Assessing products; 6) Finalization and publication.

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026
DOI: https://doi.org/10.36709/jpkim.v11i2.244

Table 3. Descriptive Statistics of Student Activities at Each Stage of Project Learning

Stages	Mean (%)	Standard Deviation (SD)	Min (%)	Max (%)	Description
Analyzing Problem	96.7	3.87	93.3	100	Very Good
Designing Projects	96.7	3.87	93.3	100	Very Good
Carrying out Research	100	0.00	100	100	Very Good
Compiling draft/prototype	98.8	2.50	95	100	Very Good
Assessing Products	91.6	3.35	86.6	93.3	Very Good
Finalization and Publication	100	0.00	100	100	Very Good
Overall Average	**97.3**	**3.85**	**86.6**	**100**	**Very Good**

Based on Table 3, the average student activity in implementing project-based LKM reached 97.3% (SD = 3.85) in the very good category. The carrying out research stage and the finalization and publication stage obtained the highest and most consistent scores between groups (average 100%; SD = 0.00), while the assessing products stage obtained the lowest score (average 91.6

%; SD = 3.35) because several groups had not fully explained and compared the resulting products with commercial soaps. The relatively small standard deviation (SD) value indicates that student involvement at each learning stage tended to be homogeneous. This indicates that project-based worksheets were associated with more evenly distributed active participation during the learning process (Munawwarah et al., 2025; Wahyudiati et al., 2022). The documentation of student activities in the solid soap project is presented in Figure 1.

Figure 1. Student Activities in the Solid Soap Making Project

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026
DOI: https://doi.org/10.36709/jpkim.v11i2.244

In addition to activities, students' ability to complete project-based LKM was also analyzed using assessment rubrics embedded in each stage. The recapitulation of values per group is presented in Table 4, while its descriptive statistics are presented in Table 5.

Table 4. Recapitulation of Group Scores at Each Stage of Project-Based Worksheets

Stages	1	2	3	4
Analyzing Problems	100	91.6	100	100
Designing Projects	100	91.6	100	91.6
Carrying out Research	100	100	75	75
Compiling Draft/Prototype	91.6	75	100	100
Assessing Product	75	100	100	100
Finalization and Publication	97.1	97.1	74.8	98.5

Table 5. Descriptive Statistics of Project-Based LKM Completion at Each Stage

Stages	Mean (%)	Standard Deviation (SD)	Min (%)	Max (%)	Description
Analyzing Problems	97.9	4.20	91.6	100	Very Good
Designing Projects	95.8	4.85	91.6	100	Very Good
Carrying out Research	87.5	14.43	75	100	Very Good
Compiling Draft/Prototype	91.7	11.79	75	100	Very Good
Assessing Products	93.8	12.5	75	100	Very Good
Finalization and Publication	91.9	11.4	74.8	98.5	Very Good
Overall Average	**93.1**	**9.97**	**74.8**	**100**	**Very Good**

Overall, students' ability to complete project-based LKM reached an average of 93.1% (SD = 9.97) in the very good category. The analyzing problems stage obtained the highest and most consistent average score of 97.9% (SD = 4.20) because every group was able to write down problem statements, hypotheses, and experimental principles completely, while the

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026
DOI: https://doi.org/10.36709/jpkim.v11i2.244

carrying out research stage had the highest SD (14.43) which indicates the largest achievement variation between groups, mainly because groups three and four had not completely filled out observation data (score 75). Viewed by group, group four obtained the highest average (94.8%), while group three obtained the lowest average (89.2%) because they had not fully completed the observation data and experimental procedures.

This conclusion is in line with studies that found using project-based LKM was linked to learning activities being completed more methodically through defined project stages (Batubara et al., 2024; Oktaviara et al., 2024; Khairunnisa et al., 2025). These results are supported by Pratiwi et al. (2024) who reported that project-based worksheets demonstrated good levels of validity, practicality, and effectiveness in supporting students' science process skills and collaboration during learning — though, as in the present study, that finding was based on a single-group implementation rather than a comparative design. However, at the initial stage of learning, particularly when designing projects and compiling working procedures, students still required guidance from the lecturer so that each stage could be executed properly.

Achievement of Students' Scientific Performance

The achievement of students' scientific performance was analyzed based on the relationship between project-based LKM stages and five scientific performance stages, namely formulating problems and constructing hypotheses, designing experiments, conducting experiments, interpreting data, and communicating. The score at each stage was recorded at the class level (aggregate of all groups), so the descriptive statistics in Table 7 were calculated between indicators, not between groups.

Table 6. Relationship Between Worksheet Stages and Student Scientific Performance Indicators

Stages	Scientific Performance Indicator	Score (%)	Category
Analyzing Problems	Formulating Problems and Constructing Hypotheses	100	Very Good
Designing Projects	Designing Experiments	100	Very Good
Carrying out Research	Conducting Experiments	87.5	Very Good

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026
DOI: https://doi.org/10.36709/jpkim.v11i2.244

Stages	Scientific Performance Indicator	Score (%)	Category
Compiling Draft/Prototype and Assessing Products	Collecting Data	87.5	Very Good
Finalization and Publication	Communicating	93.7	Very Good

Table 7. Descriptive Statistics of Student Scientific Performance Scores (Between Indicators)

Statistic	Score
Mean (%)	93.7
SD	6.25
Min (%)	87.5
Max (%)	100
Category	Very Good

These results show that LKM do not merely function as practicum guides, but also provide a structured process through which students demonstrate scientific performance at each project stage. Activities such as formulating problems, designing experiments, conducting experiments, processing data, up to presenting results provide learning experiences that encourage students to apply scientific processes as a whole. This finding is in line with Wahyudiati et al. (2022) and Sari et al. (2025) stating that project-based learning is associated with strong scientific thinking abilities, problem solving, and students' scientific literacy.

In the analyzing problems stage, students were instructed to formulate problems, construct hypotheses, and explain saponification reaction principles based on the discourse in the worksheet. The scientific performance score for the formulating problems and constructing hypotheses indicator reached 100%, indicating that all groups were able to state problem formulations and hypotheses completely and accurately. In the designing projects stage, students determined objectives, tools, materials, and experimental procedures, thereby demonstrating the ability to design experiments with a score of 100%, indicating that all groups were able to compile complete and systematic experimental procedures.

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026 DOI: https://doi.org/10.36709/jpkim.v11i2.244

In the carrying out research stage, students conducted solid soap making experiments according to the designed procedures. This stage reflected students' ability to conduct experiments with a score of 87.5%, as some groups had not recorded observation data completely during the experiment. In the compiling draft/prototype products and product assessment stages, students conducted soap quality tests including pH value, organoleptic test, free alkali test, and flavonoid test, then recorded test data and compared products with commercial products. This stage reflected students' data collection abilities with a score of 87.5%, which shows that some groups were not fully complete in recording and presenting testing data in tabular or narrative forms linked to relevant theories.

Meanwhile, in the finalization and product publication stage, students presented the LKM and the resulting products, which reflected students' communicating skills with a score of 93.7%, as several groups had not fully elaborated their discussion when presenting their results.

Based on Table 7, overall scientific performance indicators were in the very good category with an average of 93.7% (SD = 6.25), with the highest scores on the formulating problems and constructing hypotheses and designing experiments indicators (100%), and the lowest scores on the conducting experiments and collecting data indicators (87.5%, tied). A Standard Deviation (SD) of 6.25 indicates a relatively small variation in achievement between indicators. This shows that students were capable of formulating problems and designing experimental procedures very well, but still needed strengthening in skills related to executing experiments precisely, recording data completely, and presenting results systematically.

The consistently high scores across most indicators can be partly attributed to the active guidance provided by the course lecturer throughout the practicum, particularly during the earlier stages of designing experiments and analyzing problems, where students required clarification on procedural steps before proceeding independently. This suggests that the very good scientific performance observed in this study reflects not only students' individual capability, but also the scaffolding effect of structured lecturer supervision embedded within the project-based learning process — a factor that should be considered when interpreting these results, as scientific performance achieved under guided conditions may differ from performance achieved with greater student autonomy.

In addition, because scientific performance scores were recorded at the group level, the relatively even task distribution among group members

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026 DOI: https://doi.org/10.36709/jpkim.v11i2.244

— as each group divided the workload across all stages of the worksheet — likely contributed to the consistency of scores observed between groups (SD = 6.25). This even distribution suggests that the high scores reflect a shared group effort rather than the performance of a few dominant members, which strengthens the credibility of the group-level scores as a reasonable proxy for collective scientific performance. Nevertheless, because assessment was conducted at the group rather than the individual level, this study cannot determine whether all students within each group achieved scientific performance to the same extent; individual-level variation may still exist despite the even task distribution.

This finding is consistent with various studies reporting that the application of Project-Based Learning (PjBL) and project-based worksheets is associated with strong scientific skills, science process skills, as well as students' active engagement during practicum activities (Wahyudiati et al., 2022; Batubara et al., 2024; Sari et al., 2025). A common factor underlying these consistent findings appears to be the structured, stage-by-stage format of project-based worksheets, which breaks down complex scientific processes into manageable, guided steps — reducing the cognitive demand on students compared to open-ended, unstructured project tasks.

However, unlike studies that reported improvement through pretest-posttest or quasi-experimental comparisons (Wahyudiati et al., 2022), the present study describes scientific performance achieved after a single implementation without a baseline comparison; therefore, while the direction of the finding is consistent with prior research, the present results should be interpreted as descriptive evidence of achievement level rather than confirmation of improvement. The ability to process, interpret, and present practicum data still requires reinforcement through continuous guidance and practice, particularly in the conducting experiments and collecting data stages, which obtained the lowest scores (87.5%) in this study. Examples of solid soap products and project-based LKM produced by students are presented in Figure 2.

Jurnal Pendidikan Kimia
FKIP Universitas Halu Oleo
p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026
DOI: https://doi.org/10.36709/jpkim.v11i2.244

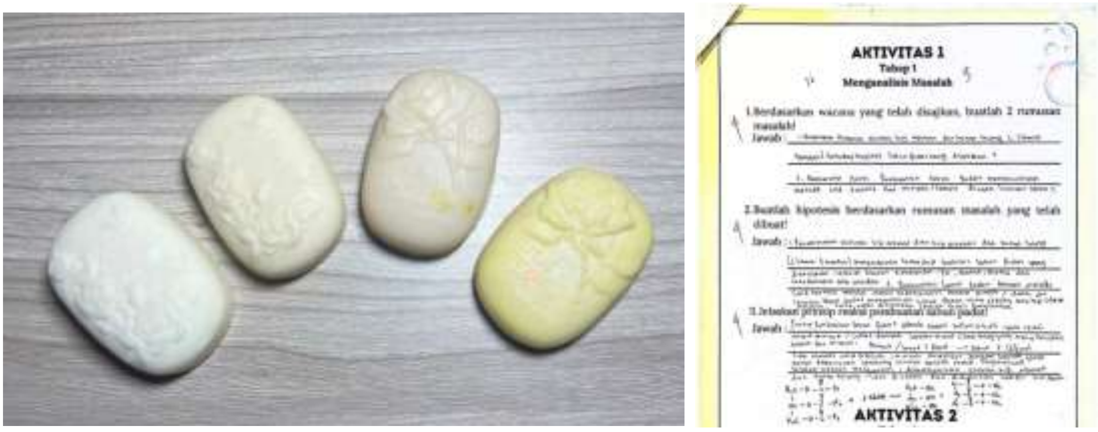

Figure 2. Examples of Solid Soap Products and Project-Based LKM Produced by Students

Thus, project-based worksheets provided students with learning experiences that engaged them in formulating problems, designing and executing experiments, collecting and interpreting data, and communicating project results scientifically — through which students demonstrated high scientific performance across each stage. In addition to promoting students' active involvement, project-based worksheets also served as a structured learning instrument that guided students through each stage of scientific practice systematically.

CONCLUSION

This study describes students' activity and scientific performance achieved through the implementation of LKM in solid soap formulation learning. Students' scientific performance reached an average of 93.7% (SD = 6.25), in the very good category. Each stage of the LKM engaged students in carrying out scientific processes systematically, starting from formulating problems, designing and conducting experiments, collecting data, to communicating results. Furthermore, the implementation of LKM was also carried out very well, as shown by student activity of 97.3% and worksheet completion of 93.1%. The highest activity was found in the carrying out research and finalization and publication stages, while the assessing products stage still required reinforcement, particularly in comparing products with commercial standards.

Formulating problems and constructing hypotheses, and designing experiments, obtained the highest scientific performance scores (100%), while conducting experiments and collecting data obtained the lowest

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026 *DOI: https://doi.org/10.36709/jpkim.v11i2.244*

scores (87.5%, tied). These findings show that students found it easier to formulate problems and design experimental procedures than to record and present testing data completely and systematically.

These findings should be interpreted with several limitations in mind. As this study employed a One-Shot Case Study design without a pretest or control group, the results describe the level of scientific performance achieved after the implementation of LKM, rather than demonstrating a causal improvement relative to a baseline. In addition, scientific performance was assessed at the group level by a single observer per group, so inter-rater reliability could not be established, and instrument validation involved two expert validators, which meets a minimum threshold for content validity.

This research is still limited to one practicum context involving two classes, and scientific performance analysis was conducted at the class level; future research is therefore recommended to employ experimental designs with a pretest and a control group, involve multiple independent observers to enable inter-rater reliability testing, and engage a larger number of validators, so that the effect of LKM on students' scientific performance can be evaluated more rigorously.

ACKNOWLEDGMENTS

VAA expresses gratitude to the Department of Chemistry Education UIN Sunan Gunung Djati Bandung and the Integrated Laboratory of UIN Sunan Gunung Djati Bandung for academic support, provision of research facilities, and various forms of assistance provided throughout this research.

REFERENCES

Arikunto, S. (2021). *Prosedur Penelitian: Suatu Pendekatan Praktik (Edisi Revisi)*. Jakarta: Rineka Cipta.

Batubara, N., & Siregar, N. (2024). Pengembangan Lembar Kerja Peserta Didik Berbasis Project Based Learning pada Materi Asam Basa. *Jurnal Pendidikan Kimia*, *9*(3), 220–231. https://doi.org/https://doi.org/10.36709/jpkim.v9i3.91

Delima, D., Windayani, N., Aisyah, R., Sunarya, R. R., & Sukmawardana, Y. (2025). Application of Project Based Worksheet to Develop Students' Scientific Performance through Making Hand Cream from Black Rice Kefir. Jurnal Pendidikan MIPA, 15(2). DOI:

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026
DOI: https://doi.org/10.36709/jpkim.v11i2.244

https://doi.org/10.37630/jpm.v15i2.2853

Febriyanti, A., & Siregar, A. D. (2025). Analisis Kesulitan Belajar Siswa dalam Penerapan Kurikulum Merdeka Pada Pembelajaran Kimia Kelas X di SMA Negeri 1 Kerinci. *Jurnal Riset Pendidikan Kimia (JRPK)*, *15*(April), 69–76. https://doi.org/https://doi.org/10.21009/JRPK.151.07

Hakim, F. (2024). Project-Based Learning-Oriented Worksheet Based on Local Wisdom and Green Chemistry. *Journal of Educational Chemistry*, *6*(1), 27–36. https://doi.org/10.21580/jec.2024.6.1.20117

Khairunnisa, H. H., Sari, & Sukmawardana, Y. (2025). Application of Project-Based Worksheets on the Utilization of Rice Husk Charcoal Adsorbent to Reduce Groundwater Hardness in Develoving Students ' Scientific Performance. *International Journal of Chemistry Education Research*, *9*(2). https://doi.org/10.20885/ijcer.vol9.iss2.art1

Marpaung, A. M. (2020). Tinjauan Manfaat Bunga Telang (Clitoria ternatea l.) bagi Kesehatan Manusia. *Journal of Functional Food and Nutraceutical*, *1*(2), 47–69. https://doi.org/10.33555/jffn.v1i2.30

Munawwarah, & Side, S. (2025). The Effectiveness of Project-Based Learning on Science Process Skills in Chemistry Education: A Research Findings Perspective. *Journal of Educational Sciences*, *9*(2), 513–525. https://doi.org/10.31258/jes.9.2.p.513-525

Nelson, & Tarigan, I. L. (2022). Pengembangan Lembar Kerja Mahasiswa Berbasis Project Based Learning Pada Kuliah Analisis Makanan dan Obat Program Studi Analis Kimia. *JEP (Jurnal Eksakta Pendidikan)*, *6*(November). https://doi.org/10.24036/jep/vol6-iss2/682

Nurkhasanah, N., Purwanto, B. E., & Basukiyatno. (2024). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Model Project Based Learning dalam Peningkatan Kemampuan Berpikir Kreatif Pada Pembelajaran IPA Kelas VIII SMP. *Journal of Education Research*, *5*(3), 3672–3687. https://doi.org/10.37985/jer.v5i3.1464

Oktaviara, O., Serevina, V., & Budi, E. (2024). Lembar Kerja Peserta Didik (LKPD) Berbasis Project Based Learning pada Materi Fluida Statis. *Prosiding Seminar Nasional Fisika*, *XII*, 85–94. https://doi.org/10.21009/03.1201.PF13

Pratiwi, E. A., & Ikhsan, J. (2024). Project Based Learning (PjBL) in Chemistry Learning : Systematic Literature and Bibliometric Review

p-ISSN : 2503-4480
e-ISSN : 2721-2963
Vol. 11, No. 2, August 2026
DOI: https://doi.org/10.36709/jpkim.v11i2.244

2015 - 2022. *Jurnal Penelitian Pendidikan IPA*, *10*(6), 343–354. https://doi.org/10.29303/jppipa.v10i6.7017

Pratiwi, H., Walanda, D. K., Napitupulu, & D, N. (2024). Development of LKPD on Project-Based Learning to Improve Science Process Skills and Collaboration Skills for Junior High School Students. *International Journal of Education, Humaniora, and Social Studies*, *1*(2), 45–52. https://doi.org/10.63895/j30321271.2024.v1.i2.pp45-52

Putri, N. M., Hakim, L. El, & Ristanto, R. H. (2025). Studi Literatur Penerapan Project-Based Learning (PjBL) pada Pembelajaran Kimia. *Ideguru: Jurnal Karya Ilmiah Guru*, *10*(1), 433–442. https://doi.org/10.51169/ideguru.v10i1.1251

Sari, S. A., Dewi, R. S., Saputra, K., Kembaren, A., Hasibuan, H., & Talib, C. A. (2025). Integration of Analytical Chemistry Flipbooks Based on Project-Based Learning in Improving Critical Thinking Skills and Scientific Literacy to Support SDG-4. *Jurnal Pendidikan IPA Indonesia*, *14*(1), 59–69. https://doi.org/10.15294/jpii.v14i1.21038

Setyawan, H. Y., Sukardi, S., & Puriwangi, C. A. (2021). Phytochemicals properties of avocado seed : A review. *International Conference on Green Agro-Industry and Bioeconomy*. https://doi.org/10.1088/1755-1315/733/1/012090

Wahyudiati, D., Irwanto, I., & Ningrat, H. K. (2022). Improving Pre-service Chemistry Teachers' Critical Thinking and Problem-Solving Skills using Project-Based Learning. *World Journal on Educational Technology : Current Issues*, *14*(5), 1291–1304. https://doi.org/10.18844/wjet.v14i5.7268