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Strengthening Science and Biology Teachers' Professional Competence Through Milk Processing Training as a Biotechnology Learning Resource

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ABSTRACT

Malang Regency is known as the largest producer of dairy cow milk in East Java. This potential not only impacts the economic sector but can also be leveraged in education. Teachers need to possess professional competencies to optimize this potential as a learning resource. The objective of this community service project is to provide guidance on the production of dairy products as a learning resource for biotechnology, with the aim of enhancing teachers' professional competencies in applying deep learning through the utilization of Malang Regency's potential. The community service activities were conducted from October 2025 to April 2026. The partners for these activities were 10 science teachers and 10 biology teachers who are members of the Malang Regency Teachers' Working Group. The community service activities included presenting instructional materials, hands-on practice in producing dairy products using conventional biotechnology, and analyzing the potential of these products as learning resources. Data collection to evaluate the success of the community service activities utilized a non-test method (self-assessment). The instrument used was a valid and reliable self-assessment form. The results of the community service program showed an increase in teachers' professional competencies after participating in the activities, with an N-gain score of 0.56 (moderate category) for science teachers and 0.62 (moderate category) for biology teachers. In addition, participants successfully produced biotechnology-based dairy products (yogurt and butter) and conducted an analysis of the potential for utilizing dairy cow milk as a learning resource for biotechnology.

Keywords: deep learning, local potential, merdeka curriculum, professional teachers, teacher competencies

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INTRODUCTION

A curriculum is a set of plans and guidelines for objectives, content, instructional materials, and methods that guide the organization of learning activities aimed at achieving specific educational goals. In Indonesia, starting in 2025, the Ministry of Basic and Secondary Education will begin implementing a deep learning approach in education (Ainiyah et al., 2025). The deep learning approach is a learning method focused on deep understanding, enabling students not only to memorize information but also to internalize knowledge through a comprehensive, meaningful learning experience. This approach fosters students' emotional and cognitive engagement, allowing them to interpret the subject matter in a more constructive way (Haryanti et al., 2025). Haryanti et al. (2025) and Rahayu et al. (2025) added that the implementation of deep learning is an effort to shift the educational paradigm from one focused on the delivery of content to learning based on conceptual understanding and real-world applications.

In addition to applying a deep learning approach, efforts to maximize real-world learning can be achieved by integrating local resources as sources of contextual learning. According to Verawati & Wahyudi (2024) integrating local resources into science education provides students with relevant and meaningful learning experiences. This approach not only fosters appreciation and preservation of local heritage but also enhances students' understanding of and interest in science. Malang Regency, in East Java Province, is known as a dairy-producing region. The Village Unit Cooperative reports that approximately 1.000 liters of milk can be produced daily from all the dairy cows in the area. Since 2017, the dairy cattle population in Malang Regency has shown steady growth. This aligns with the policy direction in the Malang Regency Medium-Term Regional Development Plan for 2021–2026, which identifies dairy farming as one of the region's key potential sectors (Hutasoit et al., 2023). In the context of education, this potential can be harnessed as a resource for contextual learning in biotechnology. Fresh milk, a product of livestock farming, is not only valuable economically and nutritionally but can also be processed into various derivative products through simple biotechnological processes relevant to learning (Mulyati et al., 2025).

The application of deep learning and the utilization of local resources in education require teachers as the primary facilitators of learning to be able to design lessons that are contextual, creative, and relevant to the students' surrounding environment (Atstsaury et al., 2024). In fact, based on interviews with 10 science teachers in Malang Regency, it was found that 70% of science teachers still face challenges in implementing deep learning. These challenges primarily arise during the lesson planning stage, as teachers still struggle to design instructional materials aligned with the principles of deep learning. In addition to science teachers, interviews with 10 biology teachers from Malang Regency revealed that 65% still face challenges in implementing deep learning, particularly in preparing deep learning instructional materials. Representatives of science teachers in Malang Regency require in-depth training on deep learning concepts and ongoing guidance in developing deep learning-based instructional materials. Representatives of biology teachers stated that they need a better understanding of the concepts and principles of deep learning in an educational context. This situation indicates that teachers still need to strengthen their competencies in designing deep learning approaches for science and biology instruction. This finding is also consistent with the findings by Putra & Rizqi (2024) that teachers in Indonesia still face challenges in applying deep learning in the classroom. Findings by Kumalasani et al. (2026) teachers in Malang City also face challenges in implementing deep learning in the classroom; these challenges are not only related to teachers' limited understanding of the concept of deep learning, but also to the difficulty of integrating it with differentiated instruction.

In addition to the application of deep learning, interviews with 10 junior high school science teachers and 10 high school biology teachers in Malang Regency revealed that, in the science and biology learning process, teachers have not yet optimally utilized the local potential of Malang Regency as a learning resource. For example, dairy products which could serve as learning resources for biotechnology lessons have not been fully utilized by teachers due to limited understanding of how to link biotechnology concepts to existing local resources. Teachers also noted that there is a lack of references and concrete examples for integrating dairy products into lessons aligned with the principles of deep learning. As a result, biotechnology instruction remains limited to procedures outlined in textbooks, leaving little room for students to explore, analyze, and connect concepts to real-world phenomena in their surroundings. Teachers require training and guidance in identifying, integrating, and developing the local dairy potential of Malang Regency into locally contextualized instructional materials and activities.

In this regard, teachers, as the key drivers of successful learning, need to be equipped with adequate competencies as mandated by Law No. 14 of 2005 on Teachers and Lecturers (Hariyasasti, 2025). One of the competencies in question is professional competence. Professional teachers can implement learning strategies, present material effectively and engagingly, and focus not only on academic achievement but also on the process of nurturing students' potential, encompassing cognitive, affective, and psychomotor aspects (Mia & Sulastri, 2023). Baumgartner (2022) and Lorensius et al. (2022) it also adds that teachers' professional competence is related to their ability to master knowledge in the fields of science, technology, the arts, and culture. This mastery encompasses a broad and in-depth understanding of the subject matter in accordance with the educational unit program standards and subject clusters. Therefore, professional competence is one of the most important competencies for teachers because it determines the quality of instruction (Kusumawati & Umam, 2025). Teachers with strong professional competencies can gain a deep understanding of the learning material, including how to apply a deep learning approach and link it to local resources as a source of contextual and meaningful learning. Learning is not merely theoretical; it is also relevant to students' lives, thereby enhancing their understanding, skills, and character more effectively (Fitrianto & Farisi, 2025; Zainuddin, 2025).

This situation indicates that an intervention is needed in the form of a community service program that provides systematic guidance to enhance teachers' professional competencies, particularly in utilizing local resources in Malang Regency as a source of biotechnology learning to support the implementation of deep learning. The results of the community service program indicate that guidance on utilizing local resources as a learning medium is effective in enhancing teachers' competencies to incorporate local resources into language instruction. The results of the community service program indicate that Agustin et al. (2025) that mentoring activities for teachers on how to utilize local wisdom in effective teaching and learning help improve teachers' pedagogical competencies. Findings by Adoe & Abolla (2026) that mentoring activities focused on utilizing local potential are also effective in enhancing teachers' ability to develop teaching materials based on local potential. In addition to having a positive impact on teachers' competence in utilizing local potential and local wisdom, these mentoring activities also have a positive impact on junior high school teachers' ability to understand and apply the deep learning approach in the learning process (Hamdani et al., 2025). Results of the community service project by Anjariyah et al. (2025), that mentoring activities also have a positive impact on improving teachers' competence in implementing deep learning. Several previous community service activities have shown that mentoring and training programs have a positive impact on improving teachers' competence in

implementing the deep learning approach and utilizing local potential and wisdom as learning resources. However, there are still very few community service activities that integrate the implementation of deep learning with the utilization of local potential and wisdom in learning.

It is important to note that the integration of these two aspects has the potential to result in learning that is more meaningful, contextual, and relevant to the students' environment. This is particularly important given that Malang Regency has enormous potential in the dairy sector as one of Indonesia's major milk-producing centers. This potential can be leveraged as a contextual learning resource to connect biological concepts with real-world phenomena found in the students' immediate surroundings. Therefore, a mentoring program is needed that specifically supports teachers in designing and implementing deep learning-based instruction that utilizes local potential as a learning context. This mentoring is expected to equip teachers with the knowledge and skills to process milk into various simple biotechnology products, such as yogurt or cheese, which can be integrated into biotechnology lessons, so that deep learning can be implemented more effectively through contextual, practical activities that are closely tied to students' daily lives. Students will not only understand concepts theoretically but will also be able to relate them to the biotechnology processes involved in local food products. Therefore, the objective of this community service activity is to provide guidance on the production of dairy products as a learning resource for biotechnology, with the aim of enhancing teachers' professional competencies in applying deep learning through the utilization of local resources in Malang Regency.

METHODS

Time and Location of Community Service

This community service program, which involves intensive training and mentoring in the biotechnology-based processing of milk into dairy products, aims to enhance teachers' professional competencies in applying the deep learning approach within the Merdeka Curriculum. The program will be held from October 2025 to April 2026.

Community Service Participants

The community service partners for this project are junior high school (or equivalent) science teachers and high school (or equivalent) biology teachers in Malang Regency, East Java, Indonesia. These community service partners consist of 10 science teachers and 10 biology teachers from Malang Regency who are members of the Subject Teachers' Council (Table 1) . The criteria for participant eligibility in this program include: 1) being an active science or biology teacher, 2) being from a school in the Malang Regency area, 3) a commitment to participating in the entire community service program until its conclusion, (4) a willingness to implement the training outcomes in classroom instruction during the second and third years, 5) an interest in developing innovative teaching methods based on local potential and deep learning, and 6) priority given to teachers who have not previously attended a workshop on deep learning.

Table 1. Demographics of community service participants

Partner	Characteristics		N
Science teachers	School Status	Public Junior High Schools	4
		Private Junior High Schools	6
		Total	10
	Teaching experience	< 5 years	2
		> 5 years	8
		Total	10

Partner	Characteristics		N
Biology teachers	School Status	Public High Schools	5
		Private High Schools	5
		Total	10
	Teaching experience	< 5 years	2
		> 5 years	8
		Total	10

Data Collection Techniques and Data Collection Instruments

The data collected in this community service activity pertains to teachers' professional competencies. Data collection was conducted using non-test techniques via a self-assessment instrument. Data on teachers' professional competencies in this community service activity was collected through a Google Form. The Google Form was distributed to teachers via WhatsApp before the first meeting (presentation of material on the concepts of biotechnology and learning resources, as well as teaching materials) to obtain pre-test data. Post-test data was obtained via Google Forms after the teachers had compiled all the final products of this community service activity, namely an analysis of local potential as a source of biotechnology learning resources.

The instrument developed is designed to measure teachers' professional competence in integrating local resources (milk from Malang Regency) into biotechnology instruction that is applied, contextual, and innovative, in an effort to support the implementation of deep learning in the classroom. The instrument, in the form of a self-assessment sheet for teachers' professional competencies, was developed by the community service team based on indicators of teachers' professional competencies. Since this instrument was developed by the community service team, it was validated by experts before being used in the community service program. Expert evaluation of this instrument was conducted using an expert evaluation sheet, employing a 1–5 Likert scale. The experts involved were two Biology Education lecturers from University of Muhammadiyah Malang. The results of the evaluation of the instrument to measure the achievement of this community service activity are as follows (Table 2).

Table 2. Results of the expert evaluation of the teacher professional competency instrument

Aspects	Expert 1	Expert 2
Content	80%	82%
Construction	75%	78%
Language	85%	80%
Average	80%	80%
Criteria	Good	Good

After expert review, the instrument underwent a limited pilot test. The pilot test was conducted with 36 science and biology teachers in Malang Regency. The results of the pilot test were used to analyze the quality of the instrument's items. Item quality analysis was conducted through validity and reliability tests. Validity was assessed using Pearson's product-moment correlation, with the decision criterion being that if the significance level of the Pearson correlation was < 0.05, the item was considered valid. Conversely, if the significance level of the Pearson correlation was > 0.05, the item was considered invalid (Yusup, 2018). From the 12 items formulated by the community service team, valid items were identified (Table 3). Next, the valid items were subjected to an instrument reliability test. The reliability test used Cronbach's alpha. The

recommended reliability value, according to (Yusup, 2018) above 0.70. The reliability test result for the teacher professional competency instrument was 0.875.

Table 3. Results of the validity test for the teacher professional competency instrument

Indicator	Item	Significance Value	Description
Mastering scientific structures and methods	1	< 0.00	Valid
	2	< 0.00	Valid
	3	< 0.00	Valid
Developing instructional materials	4	< 0.00	Valid
	5	< 0.00	Valid
	6	< 0.00	Valid
Continuously developing professionalism through reflective practice	7	0.045	Valid
	8	< 0.00	Valid
	9	< 0.00	Valid
Using information and communication technology for personal development	10	< 0.00	Valid
	11	< 0.00	Valid
	12	< 0.00	Valid

Program Implementation Process

Intensive mentoring and training activities for science and biology teachers in Malang Regency were carried out in stages (Figure 1). Broadly speaking, the activities consisted of the following stages: preparation, outreach, implementation, and evaluation. The preparation stage generally consisted of conducting surveys of partners to determine the baseline conditions and developing instruments to measure the success of the community service program. The socialization phase generally consists of reaching out to partners, introducing the program to them, and establishing agreements with them. Implementation activities include a pre-test, presentation of material on the concept of learning resources, presentation of material on biotechnology, milk processing practice, learning resource analysis practice, activity monitoring, and a post-test. The evaluation phase is conducted internally through progress and final reports by the UMM Research and Community Service Institute team.

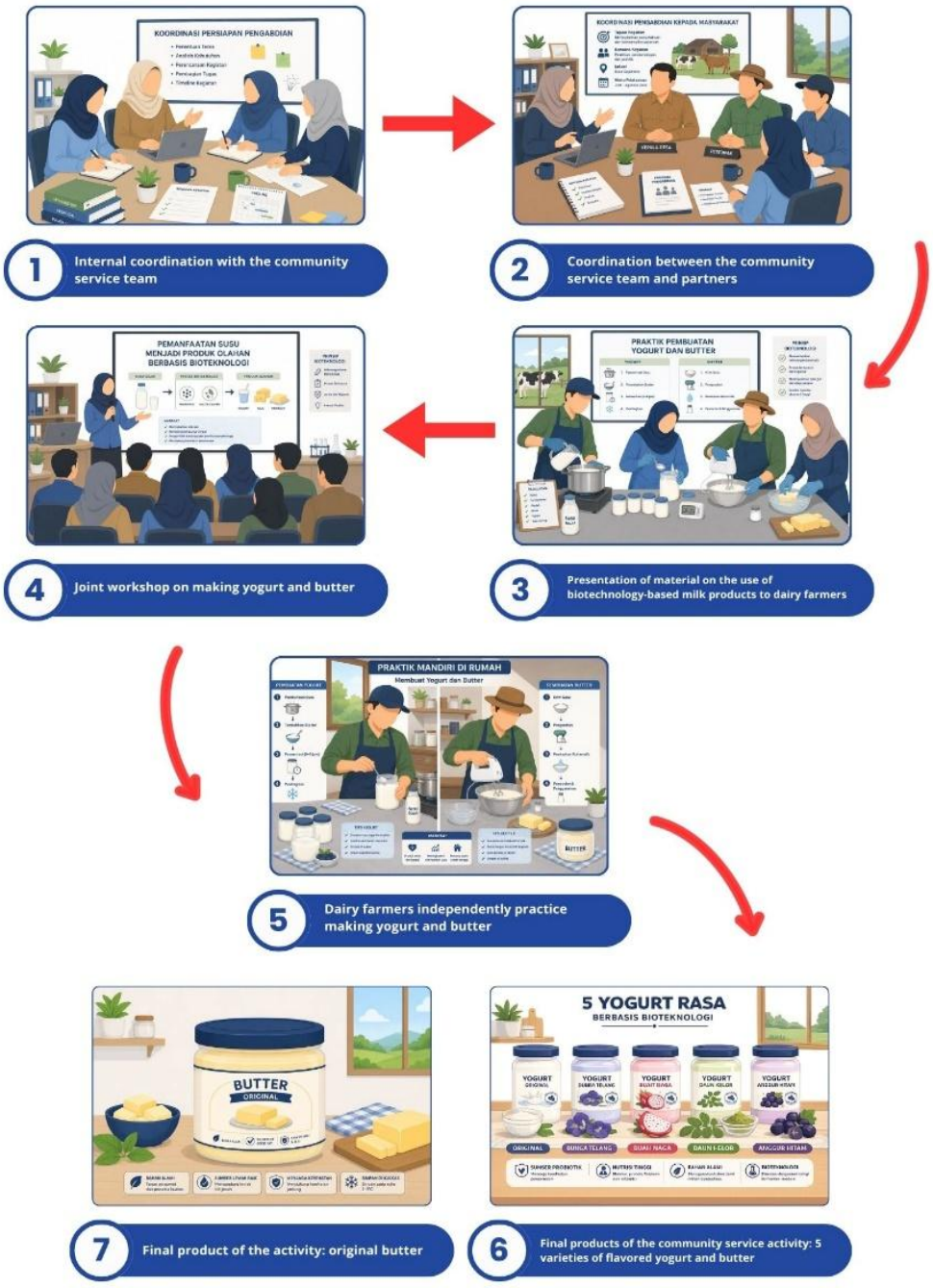


Figure 1. Program Implementation Process

Preparation Phase

The preparatory phase involved interviews and surveys to assess the partners' circumstances. The interviews aimed to identify the challenges and needs of science and biology teachers in Malang Regency, particularly regarding their professional competence in utilizing the potential of cow's milk from Malang Regency to create processed products that could serve as learning resources for practical biotechnology lessons. The community service team conducted interviews with several science and

biology teachers. In addition to the interviews, the team also conducted a survey at the Village Unit Cooperative Susu in South Pujon, Malang Regency, which serves as the primary supplier of milk used by teachers as a practical material for making biotechnology-based dairy products.

Outreach Phase

The outreach phase was conducted to facilitate initial coordination and introduce the program over the coming weeks with the Science Teachers' Working Group and the Biology Teachers' Working Group in Malang Regency.

Implementing Community Service Activities Phase

The following is a detailed description of the implementation stages of the community service program.

a. The community service activity began with a pre-test to assess the teachers' professional competencies
b. Presentation of material on biotechnology and the use of milk as a biotechnology product
c. Presentation of material on the use of milk as a learning resource for biotechnology
d. Practical session on making biotechnology-based milk products
e. Presentation of material regarding the use of milk as a learning resource for biotechnology material
f. Practical session on analyzing the use of milk as a learning resource for biotechnology material
g. Administration of a post-test to assess teachers' professional competencies

Monitoring and Evaluation Phase

Monitoring activities were carried out by a team from the Research and Community Service Institute at University of Muhammadiyah Malang and the community service team working with the partner organization. The community service team conducted evaluations by tracking the progress of activities based on the monitoring results. Monitoring was carried out in a flexible manner. Daily monitoring was conducted via WhatsApp, which served as the primary communication channel for tracking the progress of teacher mentoring activities, ensuring effective coordination, and addressing any challenges that arose.

Data Analysis Techniques

Data on teachers' professional competencies, obtained through self-assessment forms, were analyzed using quantitative descriptive methods. Competency scores were calculated using the following formula (1) :

$$\text{Teacher professional competency scores} = \frac{score\ obtained}{\text{maximum score}} \text{x } 100 \qquad (1)$$

Next, the pre-test and post-test scores were analyzed using Normalized Gain (N-Gain) to determine the extent of improvement in teachers' professional competencies and to measure the effectiveness of the community service activities that had been carried out. The program was deemed successful if the N-Gain analysis results fell at least within the "moderately effective" category, indicating an increase in participants' competencies after participating in the community service activities (Table 4).

Table 4. Interpretation of N-Gain scores

Criteria	N-gain
High	$g > 0.7$
Moderate	$0.3 < g \leq 0.7$
Low	$g \leq 0.3$

Source : Citra & Wirman (2024)

Program Success Indicators

The success indicators for this community service program are determined based on two main aspects: the improvement of teachers' professional competencies and their ability to develop an analysis of local potential as a biotechnology learning resource based on the deep learning approach. The improvement in teachers' professional competencies is measured by comparing pre-test and post-test results, which are analyzed using the N-gain score to determine the program's effectiveness. Meanwhile, teachers' ability is assessed based on their success in developing a relevant analysis of the local potential of milk from Malang Regency that can be integrated as a biotechnology learning resource in the classroom. The program is deemed successful if there is an improvement in teachers' competencies, as indicated by an N-gain score in the moderate category, and if the majority of participants are able to produce an analysis of local potential in accordance with the established criteria.

Table 5. Program success indicators

Indicator	Criteria
Enhancing Teachers' Professional Competence in Analyzing Local Potential as a Resource for Biotechnology	a. a. The average post-test score increased compared to the pre-test score. b. The N-gain test results were at least in the moderate category.
Teachers' Ability to Develop Analyses of Local Potential as a Resource for Biotechnology Learning Based on a Deep Learning Approach	At least 80% of participants are able to assemble and collect products in accordance with the established criteria

RESULT AND DISCUSSION

In general, the intensive mentoring program on dairy product production as a learning resource for biotechnology through the application of deep learning includes the stages of preparation, outreach, implementation, monitoring, and evaluation (Table 6). This program was conducted both online and offline from October 2025 to April 2026. The community service partners consist of 10 science teachers and 10 biology teachers who are members of the Malang Regency Subject Teachers' Association. Activities were conducted both online and offline, depending on the circumstances of the partners and the community service team. The presentation of materials was conducted online via Zoom, while the practical training in the production of biotechnology-based dairy products was conducted offline at the Food Technology Laboratory, University of Muhammadiyah Malang.

Table 6. Schedule for community service activities

Date	Activities
October 26, 2025	Site survey of milk supplier partners in Malang Regency
November 2, 2025	Coordination with the Malang Regency Science and Biology Teachers' Working Group
December 6, 2025	Presentation of the first lesson on the concept of biotechnology

Date	Activities
January 18, 2026	Presentation of the second lesson on the use of milk in Malang Regency as a learning resource for biology and science
February 7, 2026	Practical session on making yogurt from dairy cows in Malang Regency
March 1, 2026	Presentation of the third module on the use of dairy cow milk as a learning resource in *deep learning*
March 2 – April 10, 2026	Practical session on analyzing the local potential of dairy cow milk in Malang Regency as a learning resource

The outreach activities began with a survey of milk collection sites from dairy farmers at the Sae Village Unit Cooperative in South Pujon, Malang Regency, to source the primary raw material for biotechnology products developed in collaboration with teachers (Figure 2). The next step involved coordinating with members of the Science and Biology Teachers' Working Group from Malang Regency. The community service team also confirmed the exact number of teachers who could participate in the training until its completion and presented the activity plan and schedule for both online and in-person mentoring sessions. This activity aims to ensure that future community service efforts proceed in a focused and structured manner and yield optimal results.

Figure 2. Site survey at the Milk Sae Village Unit Cooperative

Training in dairy product manufacturing as a learning resource for biotechnology

The intensive training and mentoring program for science and biology teachers began with a pre-test to assess the teachers' professional competencies. Following the pre-test, the program continued with a presentation of foundational material on biotechnology. The biotechnology session was held online via Zoom (Figure 3). The biotechnology material was presented by the Head of the Food Technology Laboratory, Mrs. Sri Winarsih, S.TP, M.P. The material covered the basic concepts of biotechnology, its application in milk processing, and the potential for developing milk into biotechnology-based products at the school level. The outreach team for this activity provided teachers with the opportunity to actively participate in the meeting through a question-and-answer session with the presenter. In addition to presenting the biotechnology material, the presenter showcased several examples of biotechnology-based processed milk products produced through activities at the Food Technology Laboratory.

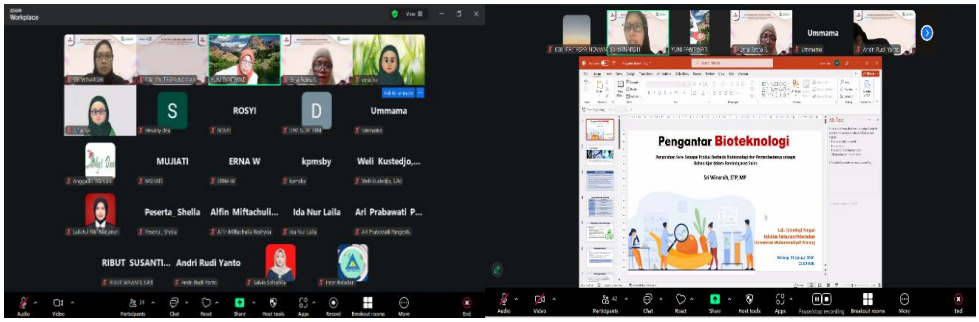


Figure 3. Presentation of the first session on biotechnology

The next training activity involved presenting material on the use of dairy products processed through biotechnology as a learning resource for junior high and high school students in their biotechnology curriculum. The presentation was held online via Zoom (Figure 4). Prof. Dr. Yuni Pantiwati, MM., M.Pd led the session. The topics covered included the concept of learning resources, the criteria for effective learning resources, methods for analyzing local potential as a learning resource, and the application of biotechnology-based dairy products as contextual learning resources.

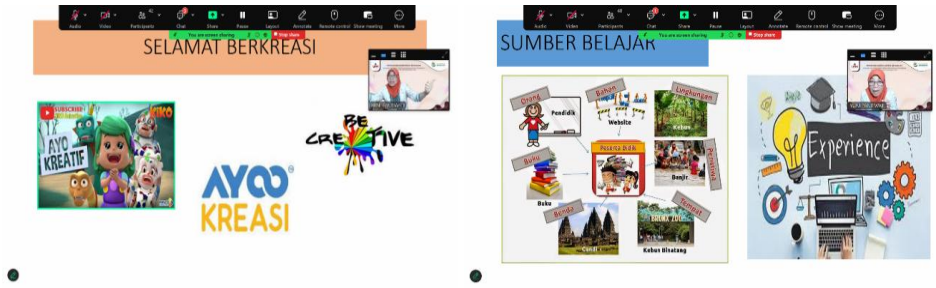


Figure 4. Presentation of the second session on learning resources

Following the presentation on biotechnology and learning resources, the next activity involved a hands-on session with teachers to create biotechnology-based dairy products. The practical session was held in person at the Food Technology Laboratory, University of Muhammadiyah Malang. Ms. Sri Winarsih, S.TP, M.P., Head of the Food Technology Laboratory, led the session (Figure 5). During this session, the teachers directly practiced the yogurt-making process, guided by the Community Service Team, from milk fermentation to the addition of flavor variations such as fruits. This practical activity aimed to strengthen participants' understanding of biotechnology concepts while providing hands-on experience that could be used as a classroom learning resource.

Figure 5. Practical training in biotechnology-based milk processing

The next series of training activities involved a presentation on the steps for analyzing learning resources based on the results of a practical exercise in making yogurt from cow's milk to support the implementation of deep learning. The presentation was delivered by Prof. Dr. Yuni Pantiwati, MM., M.Pd, with Dr. Erna Retno Rahadjeng, MM serving as moderator. The session was conducted online via a Zoom meeting. The material covered included the analysis of learning outcomes, learning objectives, the availability of potential resources, the alignment of these resources with science/biology content, and the steps for conducting a learning resource analysis (Figure 6).

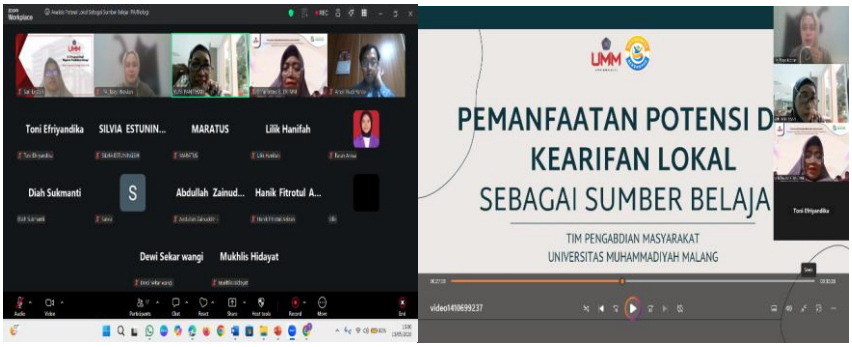
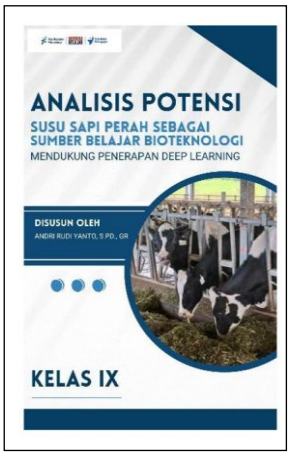
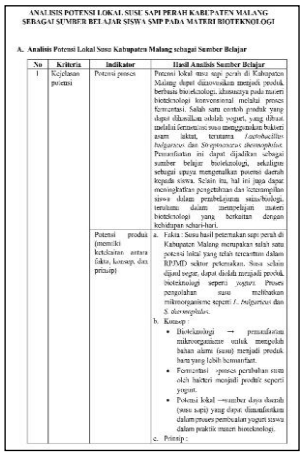
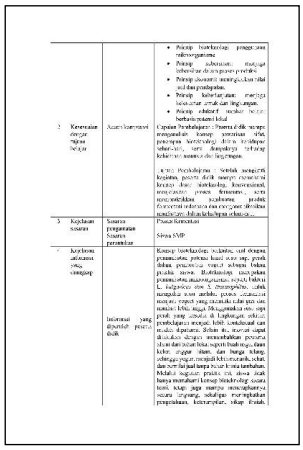
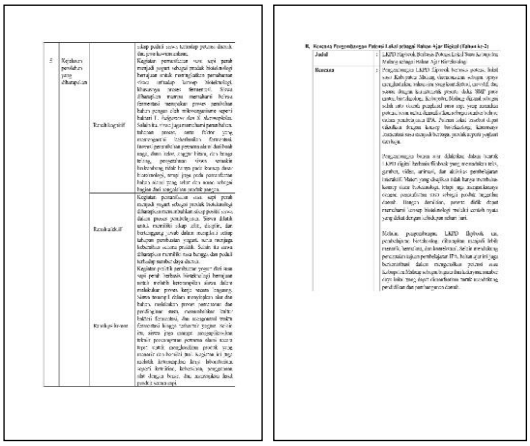


Figure 6. Presentation of material on the analysis of local resources as a learning resource

The final activity in this program is a practical exercise in analyzing the use of milk as a learning resource for biology and science. In this activity, teachers are required to develop and compile the results of their analysis of the local potential of milk as a biotechnology learning resource that supports the implementation of deep learning-based instruction (Table 7). There are criteria for analyzing local potential that teachers must consider, including indicators of the potential's clarity, alignment with learning objectives, clarity of learning targets, clarity of the information presented, and clarity of expected learning outcomes. In addition, teachers are also asked to develop a follow-up plan for utilizing this local potential in the learning process, such as the development of e-modules, worksheets, teaching materials, and others (Table 7).

Table 7. Examples of products resulting from teachers' analysis of local potential

Example	Example	Example
		



Enhancing teachers' professional competencies in the implementation of deep learning

Based on Table 8, the results of the descriptive test of science teachers' professional competencies indicate a significant improvement following the implementation of the community service activities. The average pre-test score for teachers' professional competencies was 63, while the average post-test score was 83.7. Overall, there was an increase in the average score of 20.7 points from the pre-test to the post-test (Table 8). This increase indicates that the community service activities carried out were effective in improving the professional competencies of science teachers.

Table 8. Results of the descriptive assessment of science teachers' professional competencies

Results	Mean	Median	Std. Deviation	Minimum	Maximum	Range
Pre-test	63	63	2.1	60	67	7.00
Post-test	83.7	84.5	2.7	79	88	9.00

The results of the community service activity indicate that the professional competencies of biology teachers improved significantly after participating in the program. The average pre-test score for the professional competencies of biology teachers was 63, while the average post-test score was 86.2, representing an increase of 23.2 points (Table 9).

Table 9. Results of the descriptive test of professional competence for biology teachers

Results	Mean	Median	Std. Deviation	Minimum	Maximum	Range
Pre-test	63	63	1.41	60	65	5.00
Post-test	86.2	86	1.31	84	88	4.00

In addition to descriptive analysis, the results of the community service activities were also supported by N-gain tests. The N-gain calculations in Table 10 show that the N-gain values for science teachers and biology teachers fell into the moderate improvement category. These findings indicate that the community service program was quite effective in improving the professional competencies of both groups of teachers. Although biology teachers showed slightly higher N-gain values than science teachers, both groups

remained in the same category, namely moderate. This suggests that the mentoring provided was able to yield consistent improvements, although there is still room for optimization so that competency improvements can reach the high category in future implementations.

Table 10. Results of the N-Gain test on the professional competence of science teachers and biology teachers

Partner	N-gain	Category
Science Teachers	0.56	Moderate
Biology Teachers	0.62	Moderate

Based on the results of the N-gain test in Table 10, this community service activity was found to have a moderate effect on improving teachers' professional competence in analyzing the local potential of milk in Malang Regency as a biotechnology learning resource in the application of deep learning. In addition to the N-gain test, the average post-test scores for science and biology teachers' competencies also showed an increase compared to the pre-test results (Table 8 and Table 9). The results of this community service program are also supported by findings from (Sriyati et al., 2023) that mentoring activities effectively improve science teachers' competencies in planning lessons based on local wisdom and potential. Findings by Busyairi et al. (2022) that training activities on utilizing local resources in teaching broaden science teachers' perspectives and knowledge in using local resources as learning materials to create contextual lessons that are relevant to students' learning environments. In addition to local resources, the results of the community service Putra & Rizqi (2023) that the intensive mentoring provided to teachers has helped improve their competencies, particularly in developing lesson plans for the implementation of deep learning in the Merdeka Curriculum over a 6-month period. Findings by Deviv et al. (2025) that deep learning workshops for teachers are effective in improving teachers' ability to develop deep learning teaching modules.

This community service program consisted of two components: a lecture and a hands-on session. The lecture served as an introductory foundation on the concept of biotechnology and the utilization of local resources as learning materials in the application of deep learning. It also provided teachers with insights on how to integrate local resources into deep learning. The ability to relate scientific concepts to the surrounding environment demonstrates the development of professional competencies in terms of subject mastery and the development of learning resources (Akhyar et al., 2024; Meyvita et al., 2025). Thus, these training sessions not only enhance teachers' knowledge but also expand their capacity to design learning experiences that support the implementation of deep learning that is, learning that emphasizes deep understanding, connections between concepts, and relevance to real life.

In addition to presenting course material, the community service activities also included hands-on activities. The practical activities included hands-on training in the production of biotechnology products, guided by experts in food technology and the community service team, as well as practical analysis of local resources as potential biology learning resources, conducted in stages with intensive guidance from the community service team. Through these practical activities, teachers not only gained experience in producing biotechnology products but were also trained to identify and analyze local resources that could be utilized as learning resources. According to Wulanndari et al. (2024) training activities that include hands-on practice provide a more meaningful learning experience because participants are directly involved in applying the knowledge they have acquired. Through this experience, teachers' competencies can

develop optimally, particularly in professional aspects (Reski & Bawawa, 2022). Teachers become better able to relate scientific concepts to local conditions and develop learning resources that are contextual and relevant to students.

Despite the results achieved, this community service activity still has several limitations. First, the evaluation instrument used was a self-assessment form. The use of self-assessment forms carries the potential for subjective bias because teachers evaluate themselves; therefore, the results obtained must be interpreted with caution. This situation stems from the limited time available for face-to-face activities, which has not yet allowed for a more in-depth evaluation. Nevertheless, the success of this program is not measured solely by the improvement in teachers' professional competencies as reflected in the self-assessment results, but also by the quality of the final products created by the teachers namely, analyses of local resources as sources for biotechnology education. Second, the community service activities carried out are still limited to the practical stage of analyzing the local potential of milk in Malang Regency as a learning resource for biotechnology. Subsequent stages, such as the development of modules or teaching materials based on local potential and their implementation in the classroom learning process, have not yet been carried out. This is due to time constraints in implementing the community service program, given that the program was designed to be carried out over three years. Therefore, this year's activities focus on enhancing teachers' understanding and skills in identifying and developing local potential as a learning resource for biotechnology. It is hoped that in subsequent years, the next phase the development of modules or teaching materials based on the local potential of milk in Malang Regency, as planned by the teachers in the first year can be carried out and implemented in the classroom learning process with students.

CONCLUSION

The implementation of a training program on dairy product manufacturing as a learning resource for biotechnology took place from October 2025 to April 2026. The results of this community service initiative had a positive impact on the professional competencies of science and biology teachers in Malang Regency regarding the application of deep learning in the Merdeka Curriculum. This impact was evident in the increase in post-test scores compared to pre-test scores for teachers' professional competencies. The average pre-test score for science teachers' professional competencies was 63, and the average post-test score was 83.7. Meanwhile, biology teachers achieved an average pre-test score of 63 and a post-test score of 86.3. These results were further supported by N-gain test results, with science teachers achieving a score of 0.56 (moderate effectiveness) and biology teachers a score of 0.62 (moderate effectiveness). Additionally, at the conclusion of the community service activity, science and biology teachers successfully produced dairy products using conventional biotechnology and presented an analysis of the potential for utilizing dairy cows from Malang Regency as a learning resource for biotechnology material.

Teachers' professional competencies play a crucial role in mastering subject matter and developing contextual learning resources. When presenting local resources as learning resources for biotechnology, teachers are not only required to identify the existence of such resources but also to analyze their suitability in relation to learning outcomes, subject characteristics, and student needs. Therefore, not all local resources can be directly used as learning resources. The results of this community service project indicate that providing guidance on the analysis of local resources can be one strategy for enhancing teachers' professional competencies. Through this activity, teachers not only gain a deeper understanding of biotechnology concepts but also develop the ability to identify, select, and analyze relevant local resources for integration into instruction. These

competencies are an essential part of professional competence because they relate to mastery of subject matter, the development of learning resources, and the ability to connect scientific concepts to real-life contexts. Enhancing these competencies also supports the implementation of the deep learning approach by utilizing local resources as a learning context relevant to students' lives. Consequently, students not only understand biotechnology concepts theoretically but are also able to relate them to real-world phenomena in their surroundings.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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