



IMPLEMENTATION OF THE INDEPENDENT CURRICULUM: PJBL BIOTECHNOLOGY FOR ENTREPRENEURIAL SKILLS OF JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

This study analyzes the implementation of the Merdeka Curriculum in developing students' entrepreneurial skills through biotechnology-based Project-Based Learning (PjBL) at SMP Negeri 1 Kasembon. Driven by the low proportion of young entrepreneurs in Indonesia, this research employs a qualitative descriptive design to examine PjBL stages and student entrepreneurship characteristics. The findings indicate that integrating PjBL into the curriculum significantly enhances self-confidence, creativity, leadership, and product planning. Utilizing projects like processing banana peel waste into liquid organic fertilizer provides contextual learning experiences that clarify real business processes. This study concludes that combining the Merdeka Curriculum with biotechnology-based PjBL effectively fosters entrepreneurial skills among junior high students, serving as an innovative instructional model for secondary education.

INTRODUCTION

Education serves to develop students' potential through the mastery of knowledge and functional skills, as well as the formation of attitudes and personalities in harmony with societal and cultural values. According to Hidayat et al. (2021), the implementation of education plays a role in shaping the young generation with

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character in accordance with Pancasila, resilience, and resilience to the challenges of globalization. Education, therefore, needs to continue improving its quality and quantity to prepare competent, adaptable human resources (HR) (Kristiana et al., 2023).

The urgency of strengthening the quality of human resources is getting stronger as Indonesia enters the demographic bonus era. Based on the 2020 Population Census, Indonesia's population is recorded at around 270 million people (Central Statistics Agency, 2022), with a large proportion of the population in the productive age, which is both an opportunity and a development challenge (Ministry of Health of the Republic of Indonesia, 2018). However, this opportunity can turn into a burden if it is not followed by an increase in the younger generation's competence, competitiveness, and economic independence. One indicator is the low proportion of entrepreneurs in Indonesia compared to other countries. This condition further underscores the need for education to provide a learning space that develops productive skills, including entrepreneurial skills, from the school level.

Entrepreneurial skills are not only about producing products, but also about making decisions, managing resources, and planning for the future. Avlijaš et al. (2014) emphasize the importance of teaching financial literacy early because it influences how a person makes financial decisions, manages income and expenses, and conducts financial planning. In line with that, Ariyanti (2017) emphasized that entrepreneurship education in the current era demands creativity and innovation; students need to be instilled with an entrepreneurial spirit from an early age so that they are not only oriented toward being workers but also have an opportunity-creating mentality. In schools, teachers play an important role as designers and implementers of learning, including adapting to technology and managing a supportive learning environment (Ramadhan et al., 2022).

One approach considered relevant for developing 21st-century skills while strengthening the entrepreneurial spirit is Project-Based Learning (PjBL). PjBL provides students with a learning experience that demands planning, collaboration, problem-solving, and the production of real products as learning outputs. Previous research has shown that PjBL increases learning creativity in certain contexts (for example, in geography subjects) (Khairah Aga Ashari & Febriandi, 2024). However, the findings still generally emphasize learning outcomes or creativity, rather than

specifically describing how PjBL, within the framework of the Independent Curriculum, is implemented to build students' entrepreneurial skills through projects that are truly product-oriented and economically valuable, especially at the junior high school level and on the theme of biotechnology.

On the other hand, biotechnology provides a context for learning because it is closely linked to environmental issues and community needs. SMP Negeri 1 Kasembon, for example, utilizes a biotechnology project to process banana peel waste into liquid organic fertilizer. This project not only emphasizes the understanding of science (for example, the use of organic materials and processing processes), but also has the potential to be a vehicle for the formation of entrepreneurial skills: identifying environmental problems (waste), turning them into products, determining production processes, packaging, calculating simple costs, and thinking about marketing strategies. Banana peels were chosen because of their high availability and nutrient content (e.g., potassium and phosphorus), which are beneficial for soil fertility. In addition, based on an initial survey of food sellers (especially fried foods) around Kasembon District, bananas are a frequently used ingredient, so banana peel waste is relatively abundant and, so far, tends to be thrown away.

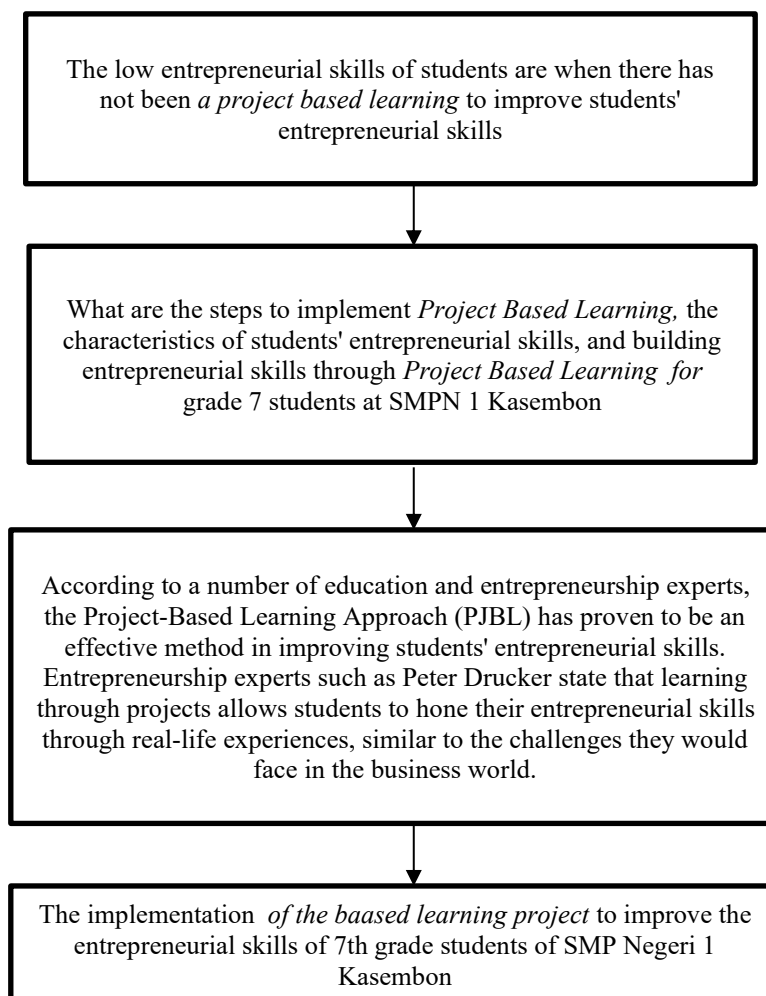
Research Gap

In this study, there is a lack of studies that are specific: (1) examining the implementation of PjBL biotechnology in the Independent Curriculum at the junior high school level, (2) photographing the process of forming entrepreneurial skills in real terms from upstream to downstream (from project planning, production, to potential selling value/usefulness), and (3) identifying supporting and inhibiting factors at the school level (role of teachers, facilities, school culture, etc.) and the surrounding environment) that affect the success of entrepreneurship-oriented project-based learning. By closing this gap, the research becomes relevant and important because it provides a practical picture of how schools can harness the momentum of the demographic bonus through learning that shapes productive, creative, and competitive generations.

Based on this description, this study aims to explore in greater depth the implementation of PjBL biotechnology to develop students' entrepreneurial skills at SMP Negeri 1 Kasembon, using a descriptive qualitative research design. The research

focuses on the project implementation strategy, the form of entrepreneurial skills that develop in students, and the conditions that support the program's success, so that it can serve as a reference for the development of similar practices in other schools.

Reaseach Mindset



Curriculum

Zais stated that "the curriculum comes from the Latin (Ansyar, 2015) Currere, which means running on the field of competition (race course)" (Ansyar, 2015). Zais defines the curriculum as a "competition arena," a place where students "compete" to master one or more skills and reach the "finish line," marked by the awarding of diplomas, bachelor's degrees, or other forms of recognition.

According to , "the curriculum is a learning program that students are expected to have under the responsibility of the school in order to achieve learning goals, so that students must also have goals to achieve. The curriculum contains the programs

that must be provided and strategies for implementing the program."According to Law Number 20 of 2003 concerning the National Education System (UU Sisdiknas), the curriculum is a set of plans and arrangements regarding the content and subject matter, as well as the methods used, serving as a guideline for the implementation of teaching and learning activities. From the definitions above, there are many similarities in the curriculum. The similarity is that the curriculum is closely aligned with efforts to develop students, in line with the goals to be achieved. (Nurdin&Sibaweh, 2015)

Independent Learning Curriculum

Explained by the Head of the Communication and Public Service Bureau, Merdeka Belajar marks the beginning of efforts to improve the national education system, which is perceived as monotonous. Merdeka Belajar is one of the programs to create a happy learning atmosphere in schools, a happy, happy atmosphere for both students and teachers (GTK Secretariat, 2020). With the implementation of the Freedom of Learning policy, many changes have occurred, especially in the learning system. The learning system, currently implemented only in the classroom, will be redesigned to be as comfortable as possible and to facilitate interaction between students and teachers. One of them is learning with an outing class, which states that " (Husamah, 2013) Outing class learning is a learning that is carried out outdoors or in a classroom that aims to equip students with skills and develop their abilities. This learning can be carried out in open courtyards or other tourist attractions". Outing classes are also a fun learning method that teaches students to get closer to nature and their surroundings.

During learning using this method, teachers and students will be able to build familiarity, relax, and, of course, have more fun. The learning system will be designed to foster students' character rather than focus on a ranking system, which, according to some studies, is unsettling not only for teachers but also for children and their parents.(Baro'ah&Qonita, 2020)

Implementation is the effort to achieve, realize, create, or strive toward the completion of what is intended. The simple language of implementation is the evaluation of the implementation or application of something based on policy. Implementation is usually associated with an institution or agency that launches

policies to achieve a goal. The simple language of implementation is the evaluation of the implementation or application of something based on policy. The implementation of the curriculum to support the success of an educational institution must be underpinned by the following. First, the existence of competent personnel. Second, there are adequate facilities. Third, the existence of auxiliary facilities as support. Fourth, the presence of educational support personnel, including administrative staff, supervisors, librarians, and laboratory staff. Fifth, the existence of adequate funds. Sixth, there is good management. Seventh, the preservation of culture that supports religious, moral, national, and other values. Eighth, visionary, transparent, and accountable leadership. (Pramono, 2020) (Barlianandal, 2022)

The Ministry of Education and Culture's Freedom of Learning Policy aims to explore the full potential of teachers and students and to improve the quality of learning by giving teachers the freedom to choose how to deliver the curriculum or teach in accordance with their students' competencies. Freedom of Learning is a policy to restore the essence of assessment. The concept of Freedom of Learning returns education to its essence, giving schools the independence to assess the curriculum's basic competencies through their own assessments. (Ministry of Education and Culture, 2020) (Kusumaryono, 2020)

According to the Ministry of Education and Culture, Freedom of Learning provides educational institutions with autonomy and freedom from bureaucratization. The core of Freedom of Learning is that schools, teachers, and students have the freedom to innovate, free to learn independently and creatively. (Mayandal, 2022) (Wulandari&Augmented, 2022)

Project-based Learning

Goodman & Stivers define Project-based Learning (PjBL) as a teaching approach that builds on real-world learning activities and tasks that present daily-life challenges for students to solve in groups. Meanwhile, project-based learning is a student-centered model that provides a meaningful learning experience. Both student learning experiences and concepts are built on the products produced in the project-based learning process. (Ambiyaret al., 2020) (Afrianaet al., 2016)

(Lailatunnahar, 2021) Define project-based learning as a student-centered learning model to conduct an in-depth investigation of a topic. Students deepen

learning constructively through a research-based approach to weighty, real, and relevant problems and questions. Meanwhile, it stated that the Project-Based Learning model provides educators with opportunities to manage classroom learning through project-based work. Project work involves complex tasks based on very challenging questions and problems, leading students to design, solve problems, make decisions, and conduct investigative activities, and providing opportunities for independent work. (Sweeney, 2020)

(Johnson & Lamb, 2019) states that: Project-based learning focuses on creating a product or artifact through problem- and inquiry-based learning, depending on the depth of the driving question. There is a relationship between problem-based learning (PBL) and inquiry-based learning (IBL) in PjBL. PBL focuses on solving real-world problems, and inquiry learning focuses on problem-solving skills, while PjBL focuses on creating projects or products in building concepts. PjBL and PBL are student-centered learning, teachers as facilitators, and students work in groups.

According to "Project Based Learning, or PjBL, is a learning model that aims to focus students on complex problems that are needed in conducting investigations and understanding lessons through investigation. This model also aims to guide students in a collaborative project that integrates various curriculum subjects (materials), provides opportunities for students to explore content (material) using various ways that are meaningful to them, and conduct experiments collaboratively.(São Paulo, 2014)

During learning, students feel good about doing projects, trying something different, and feeling knowledgeable and valued. In line with the above opinion, Hosnan in Ariyanti (2019) reveals several benefits that can be taken from project-based learning, including: 1) acquiring new knowledge and skills in learning; 2) improving students' ability in problem solving; 3) make students more active in solving complex problems with real products in the form of goods or services; 4) develop and improve students' skills in managing resources/materials/tools to complete assignments; and 5) increase student collaboration, especially in project-based learning in groups.

Anggraini and Wulandari (2019) explained that PjBL has the goal to: 1) provide broad insight for students when facing problems directly; and 2) develop critical thinking skills and expertise in dealing with problems that are received directly. In

general, the purpose of applying this learning model is to hone students' critical thinking skills and equip them with the habits needed to solve the problems they encounter. In addition, this model can help develop students' insights.

METHOD

Given the research objectives and the nature of the existing problems, this research focuses on analyzing and describing the cultivation of entrepreneurial values at SMPN 1 Kasembon. Thus, this research can be categorized as qualitative research using a qualitative descriptive method. With this approach, it is hoped that understanding and interpretation of the meaning, reality, and relevant facts can be obtained. Observation, interview, and documentation study techniques will be used for research data collection.

Conceptual Definition

The cultivation of entrepreneurial values is a form of value that must be instilled well by schools. Thus, students have personalities that reflect entrepreneurial values in their daily lives. Entrepreneurial values include independence, creativity, the willingness to take risks, action-oriented leadership, hard work, honesty, discipline, innovation, responsibility, cooperation, perseverance, realism, curiosity, communication, and a strong motivation to succeed.

Research Variables	Dimensions	Indicator	Data Source	Instruments
Independent Curriculum	Policy and Implementation	Learning flexibility, diagnostic assessment, P5	Principal, Teacher	Interviews, Observations
Project Based Learning	PjBL Steps	Planning, implementation, evaluation, presentation	Teachers, Students	Interviews, Observations
Entrepreneurial Skills	Features	Confidence, leadership, future orientation, task orientation	Students, Teachers	Interviews, Observations

Research Variables	Dimensions	Indicator	Data Source	Instruments
Biotechnology	Practical Projects	Utilization of banana peel waste, product results	Students, Teachers	Interviews, Documents

Table 1. Interview Guidelines Grid

Data Triangulation

Data triangulation in this study was used to increase the credibility (validity) of the research results by employing multiple approaches to verify the data, thereby minimizing bias and ensuring more accurate findings. Triangulation is done by combining multiple sources, methods, or data collection times to ensure consistency and correctness of findings.

Transferability Test

Transferability is an external validity criterion in qualitative research, indicating the extent to which a study's results can be applied to other contexts or populations. The steps taken include:

1. The researcher provided an in-depth description of SMPN 1 Kasembon, including the school's characteristics (location, resources, number of students), the implementation of the Independent Curriculum, and the PjBL biotechnology project (producing organic fertilizer from banana peels).
2. Contextual generalizations were carried out by the researcher by explaining that findings, such as PjBL's success in improving entrepreneurial skills, could be relevant for other junior high schools that implement the Independent Curriculum and have access to local resources (organic waste).

A practical step is to include demographic data and environmental context in research reports, so that other schools can compare similar contexts to apply the findings. It is known that Kasembon District has many fried-food sellers who generate banana peel waste. The researchers also suggested replicating biotechnology projects in schools with fibrous natural resources.

Confirmability Test

Confirmability is a test of research objectivity that ensures results are based on the data collected rather than the researcher's subjective opinion. Because confirmability is similar to dependability, the tests are often performed simultaneously. The steps include:

Data and Process Audits

The researcher provides an audit trail that shows the relationship between the raw data (interview transcripts, observation notes, documentation photos) and the final findings. In this case, the researcher observed students' enthusiasm for the project and validated it with photos of the fertilizer manufacturing process.

Separating Data and Interpretation

The researcher ensures that interpretations of the findings, such as improvements in entrepreneurial skills, are supported by concrete data (e.g., the principal's statement on the policy and observations of student product outcomes).

Data Analysis Techniques

The techniques used in qualitative research include analysis and flow models. The steps used in this model are data collection, data reduction, data presentation, and conclusion drawing.

Data Collection

The researcher records data collected through observations, interviews, and documentation studies, which constitute field records related to the research question or objective.

Data Reduction

The data analysis process begins by examining all available data from various sources, including observations, interviews, and documentation. After reading and studying, the next step is to reduce the data. This step is closely related to the processes of selecting, focusing, simplifying, abstracting, and transforming the raw data obtained from the research. Data reduction was carried out during the study. This step is done before the data is actually collected. Researchers already know

which data were collected for the research.

Data Presentation

Data presentation is a qualitative data analysis technique. Data presentation is an activity in which a set of information is compiled to enable conclusions to be drawn. Qualitative data are presented as narrative text (field notes), grids, graphs, networks, and charts.

Conclusion

Drawing conclusions is one of the qualitative data analysis techniques. Drawing conclusions is the result of an analysis that can be used to take action.

RESULT AND DISCUSSIONS

Result

The steps to implement Project-Based Learning (PjBL) as a whole at SMPN 1 Kasembon within the framework of the Independent Learning Curriculum are carried out systematically and adaptively, starting with strengthening teachers' competence as the foundation. This process includes: (1) initial assessment through diagnostic assessment and understanding of students' needs personally through questionnaires and interviews; (2) student-centered project planning, with teachers as facilitators who apply the TPACK model for technology integration and differentiated learning according to phase D; (3) the implementation of collaborative projects, namely the processing of banana peel waste into liquid organic fertilizer, which involves creativity, cooperation, communication, and critical thinking of students; (4) evaluation and reflection through product assessment and collaboration between school elements (students, teachers, principals); and (5) continuous innovations, such as mindset changes from teacher-centered to student-centered, which emphasize students' freedom of expression and intrinsic motivation. Students are encouraged to study the learning materials independently and to present their findings directly as a step toward locking in the material learned. These measures not only support the development of entrepreneurial skills but also create learning that is fun and relevant to the local context, as evidenced by the students' enthusiasm and teachers' commitment.

Nevertheless, implementing PjBL faces several challenges, especially regarding resources and student dynamics. First, the limitations of teachers' initial understanding of the Independent Curriculum innovations, such as differentiated learning, which requires adaptation from conventional patterns. Second, technological barriers and facilities, where teachers emphasize the need to learn more about TPACK to make learning more interactive in the digital era. Third, internal student challenges, such as lack of confidence, neglect of responsibility, or time constraints in group collaboration, can affect the quality of the final product. Fourth, limited access to external resources, such as capital loans for larger project scales or collaboration with local business actors. These challenges, although they can be addressed through teacher training and regular mentoring, underscore the need for ongoing support from the government and the community to maximize the effectiveness of PjBL in developing students' entrepreneurial skills.

After participating in the biotechnology Project Based Learning (PjBL) in the Merdeka Learning Curriculum, SMPN 1 Kasembon students show characteristics of holistic and adaptive entrepreneurial skills, including high confidence in managing local resources (such as banana peel waste into organic fertilizer), collaborative leadership through the involvement of the student-teacher-principal team, future orientation with an understanding of long-term provisions, and resilience in face challenges such as limited knowledge or access to capital. Students reflect on the practical enthusiasm that distinguishes this learning from the conventional, leading to increased creativity, communication, and problem-solving, in line with the Pancasila Student Profile. Despite the cultural and resource challenges, the school's collaboration has turned them into a strength, shaping independent and innovative graduates ready to contribute to a sustainable economy.

Overall, this effort strengthens students' entrepreneurial skills by integrating PjBL biotechnology into the curriculum, where students learn from failure as part of the innovation process, resulting in a more mature and competitively ready character. SMPN 1 Kasembon has made comprehensive efforts in building entrepreneurial skills through Project Based Learning (PjBL) biotechnology in the Independent Learning Curriculum, which includes: (1) instilling early awareness through the introduction of the concept of entrepreneurship as a learned skill, not an innate talent; (2) collaborative strategies involving principals, teachers, and students in authentic projects such as processing banana peel waste into organic fertilizer; (3) providing

continuous motivation through entrepreneurial success stories and direct support in times of difficulty; and (4) the integration of school policies that support innovation, mutual cooperation, and differentiated learning to form independent and creative students. This effort succeeded in creating meaningful learning aligned with the Pancasila Student Profile, where students not only produce products of economic value but also develop emotional resilience and adaptability. However, implementing these efforts faced key challenges, such as a lack of student confidence and responsibility, which led to neglect of product quality or boredom during the project, as well as technical limitations, such as access to materials and tools, despite overall control. These challenges often arise among early adopters, who require quick responses from teachers as motivators, as well as potential external barriers, such as the limitations of training workshops in deepening biotechnology knowledge. While it can be addressed through collaboration, this challenge emphasizes the need for further teacher training and external resource support to maximize the impact of biotechnology PjBL in shaping a resilient generation of entrepreneurs.

Discussions

Based on the research findings, Project-Based Learning (PjBL) has been implemented systematically in SMPN 1 Kasembon within the Independent Learning Curriculum since the curriculum was established by the government. The steps of implementing PjBL include project planning that focuses on student needs, project implementation with a student-centered approach, and evaluation based on diagnostic assessment. Teachers as facilitators play an important role in creating a conducive, creative, and effective learning environment. According to the informant (NZ), teacher competence, especially personality and professional competence, is key in creating fun learning and supporting students' entrepreneurial skills. In addition, the use of technology, such as the TPACK (Technological Pedagogical Content Knowledge) learning model, is a strategic step to increase students' interest in learning.

The theory that supports these findings is the concept of PjBL, according to Thomas (2000), which states that PjBL is a student-centered learning model in which students engage in authentic projects to solve real problems. The steps of PjBL include: (1) determination of key questions or issues, (2) project planning, (3) scheduling, (4) project implementation and monitoring, (5) outcome assessment,

and (6) reflection. The findings at SMPN 1 Kasembon align with this theory, in which teachers design relevant biotechnology projects, such as the manufacture of biotechnology-based products, to increase students' creativity and entrepreneurial skills. Relevant research by Wena (2011) also confirms that PjBL is effective in developing 21st-century skills, such as critical thinking, collaboration, and creativity, as evidenced by student activities in biotechnology projects at SMPN 1 Kasembon. As such, PjBL's measures at this school have been aligned with theory and best practice, with an emphasis on innovation and flexibility in learning.

To carry out PjBL effectively and efficiently, teachers must master a set of core competencies that support their role as facilitators rather than just knowledge imparters. Key competencies include mastery of TPACK, which integrates technological knowledge, pedagogy, and subject content to design adaptive, digital-based projects, as emphasized in research on PBL e-learning platforms that show TPACK is essential for addressing implementation challenges such as project management and virtual collaboration. In addition, teachers need to develop digital pedagogic competencies and project management skills, including scaffolding skills to guide students through iterative processes, such as the use of visual aids, models, and copies, which help maintain focus and address the needs of diverse students, including those with learning difficulties.

These competencies also include entrepreneurial attitudes, such as tolerance for ambiguity, curiosity, and the ability to facilitate personalized learning in a blended environment, enabling teachers to respond to classroom dynamics in real time. Research by Condliffe et al. (2017) adds that ongoing professional training and administrative support, such as educational curricula and teacher collaboration, are crucial to building these competencies, ensuring that the implementation of PjBL is not only effective in improving the skills of 21st-century students but also efficient in managing school resources. At SMPN 1 Kasembon, the mastery of this competency is reflected in the ability of teachers to integrate biotechnology projects with diagnostic assessments, which ultimately strengthens the overall effectiveness of learning.

Characteristics of Students' Entrepreneurial Skills at SMPN 1 Kasembon

The study's findings show that students at SMPN 1 Kasembon exhibit entrepreneurial skills, including the ability to manage resources at hand to produce

economically valuable products, such as organic fertilizers, through biotechnology projects. Students demonstrate creativity, cooperation, communication, and critical thinking through their collaboration on the PjBL project. According to the Principal, entrepreneurship education at SMPN 1 Kasembon aims to form students who are independent and able to face real-world challenges. Students express enthusiasm for entrepreneurial learning because it offers practical experience distinct from conventional classroom learning.

Entrepreneurship theory, according to Zimmerer et al. (2008), states that entrepreneurial skills include the ability to identify opportunities, manage risks, innovate, and communicate effectively. This characteristic aligns with the findings at SMPN 1 Kasembon, where students are trained to manage raw materials, process them, and market the products. Relevant research by Sari and Setiawan (2020) shows that entrepreneurship education in secondary school can increase students' motivation and independence through practical activities such as PjBL. However, challenges such as lack of confidence and neglect of responsibility by some students, as expressed by the informant, are also consistent with the findings of the study by Kurniawan (2019), who mentioned that internal factors of students, such as motivation and discipline, can be an obstacle to the development of entrepreneurial skills. Therefore, the characteristics of students' entrepreneurial skills at SMPN 1 Kasembon reflect a combination of strong potential and challenges that require teacher support.

Building Entrepreneurial Skills through Biotechnology-Based Learning Project in the Independent Student Learning Curriculum at SMPN 1 Kasembon

The application of Project-Based Learning Biotechnology in the Independent Learning Curriculum to build students' entrepreneurial skills, with a focus on collaborative projects. The main activities in this activity include: (1) Processing of banana peel waste into liquid organic fertilizer as a major biotechnology project, which trains students in sustainable innovation and utilization of local resources; (2) Market observation to understand consumer needs and real economic dynamics; and (3) Manufacturing and sales of products in school cooperatives, which includes integration with subjects such as Crafts, Cultural Arts, and English.

The Independent Learning Curriculum Approach, according to the Ministry of Education and Culture (2022), emphasizes project-based learning to develop the Pancasila Student Profile, including creative, independent, and critical reasoning dimensions. PjBL Biotechnology at SMPN 1 Kasembon supports this theory by providing space for students to experiment and produce real products, in line with the goals of the Independent Curriculum to create life-relevant learning. Relevant research by Pratama and Widodo (2021) shows that PjBL in biotechnology can improve students' entrepreneurial skills through practical activities that involve innovation and resource management. However, weaknesses such as students' lack of confidence, as expressed by the informant, require additional strategies such as continuous motivation and differentiated learning approaches. Thus, PjBL Biotechnology at SMPN 1 Kasembon has become an effective means of building students' entrepreneurial skills, supported by relevant theories and practices.

CONCLUSIONS

The implementation of the Independent Learning Curriculum through Biotechnology Project-Based Learning (PjBL) at SMPN 1 Kasembon has proven effective in holistically building students' entrepreneurial skills. PjBL is implemented systematically through student-centered planning, collaborative implementation, and continuous evaluation, with teachers acting as facilitators who integrate technology using the TPACK approach. This learning encourages students' independence, creativity, cooperation, communication, and resilience in producing products of economic value, although there are still internal obstacles, such as confidence, responsibility, and resource limitations, that require more intensive assistance.

Referring to the findings regarding the obstacles to fermentation failure and lack of mastery of marketing technology by teachers, it is suggested that schools focus TPACK training specifically on aspects of production risk management and digital marketing strategies. In addition to overcoming the limitations of laboratory facilities that limit production scale, schools need to initiate strategic partnerships with local MSME practitioners. This assistance not only serves as access to capital but also as external validation to build student resilience (mental resilience). The goal is not to give up easily when facing failure in the trial of biotechnology products.

REFERENCES

- Afriana, J., Permanasari, A., & Fitriani, A. (2016). The application of STEM integrated learning project-based learning to improve students' science literacy is reviewed from a gender perspective. *Journal of Science Education Innovation*, 2(2), 202. <https://doi.org/10.21831/jipi.v2i2.8561>
- Ambiyar, A., Syahri, B., Adri, J., Nurhaliza, N., & Islami, S. (2020). Application of the Project-Based Learning Model in the Subject of Sketch Drawing Training. *Journal of Education: Learning Innovation Research*, 4(1), 125–138. <https://doi.org/10.21831/jk.v4i1.22353>
- Aminuyati. (2017). Management of early childhood education units. *Journal of Sociology and Humanities Education*.
- Ansyar, M. (2015). Curriculum: Essence, foundation, design, and development (pp. 24–25). Jakarta, Indonesia: Prenada Media Group.
- Ariyanti, E. H. (2017). Management of course learning in fostering entrepreneurial skills of graduates of computer graphic design courses at LKP IKMA Majalaya.
- Avlijaš, G., Avlijaš, R., & Heleta, M. (2014). FINANCIAL LITERACY AS A FACTOR IN REDUCING ENTREPRENEURIAL RISK. *Proceedings of the 1st International Scientific Conference - FINIZ 2014*, 112–114. <https://doi.org/10.15308/finiz-2014-112-114>
- Central Statistics Agency. (2022). Indonesian Statistics 2022. Central Statistics Agency.
- Barlian, U. C., Solekah, S., & Rahayu, P. (2022). The implementation of the independent curriculum in improving the quality of education.
- Baro'ah, S., & Qonita, S. M. (2020). Planting CiLi (Love for the Environment) in students through the school environment program without plastic waste.
- Hidayat, N., A. S. N, & Dewi, D. A. (2021). Increasing the awareness of the younger generation towards the implementation of Pancasila values in the era of globalization. *EduPsyCouns: Journal of Education, Psychology and Counseling*.
- Husamah. (2013). Outdoor learning. *Achievements of Pustaka Raya*.
- Husnawati, Astutik, I. Y., & Ambarsari, L. (2020). Characterization and Bioactivity Test of Pectin from *Musa balbisiana* Peel Extracted using Various Acid Solvents. *Current Biochemistry*, 6(1). <https://doi.org/10.29244/cb.6.1.1>

- Johnson, L., & Lamb, A. (2019). Problem-based learning and project-based learning. Teacher Tap: Professional Development Resources for Educators.
- Ministry of Health of the Republic of Indonesia. (2018). Data and information: Indonesia Health Profile 2018.
- Ministry of Education and Culture. (2020). Independent learning explores the greatest potential of teachers and students. Ministry of Education and Culture.
- Khairah Aga Ashari, S., & Febriandi, F. (2024). The application of the Project Based Learning learning model based on volcano miniatures on disaster mitigation materials on the Geography learning outcomes of grade XI students at SMA Negeri 16 Padang.
- Kristiana, H., Wesa Atmaja, I. W., & Triwahyuni, E. (2023). The Influence of the Discovery Learning Model on the Ability to Find Intrinsic Elements in Short Stories. *Journal of Education Technology and Inovation*, 6(1), 77–84. <https://doi.org/10.31537/jeti.v6i1.1412>
- Kusumaryono, R. S. (2020). Freedom of Learning.
- L. R. Mardiyanti, I. Imran, I. Ramadhan, N. Asriati, R. Al Hidayah, & S. Suriyanisa. (2023). Analysis of the implementation of Google Classroom-based blended learning model.
- Lailatunnahar, T. (2021). The application of the Project Based Learning learning method to improve science learning outcomes during the Covid-19 pandemic in grade VII.1 students at the Special Fostered State Junior High School in Dumai City.
- Marodama, E. (2021). STUDENT PERCEPTION ON THE IMPLEMENTATION OF THE CURRICULUM OF THE MASTER OF SOCIOLOGY EDUCATION PROGRAM. *Journal of Sociology and Humanities Education*, 12(1), 37. <https://doi.org/10.26418/j-psh.v12i1.46327>
- May, A., Naja, F., & Gus, J. (2022). Implementation of the "Independent Learning, Independent Campus" policy in private universities: Survey of History Education of the University of Flores.
- Mulyasa, H. E. (2014). Development and implementation of the 2013 Curriculum.
- Nurdin, D., & Sibaweh, I. (2015). Education management: From theory to implementation (p. 127).

Pramono, J. (2020). Implementation and evaluation of public policies. Unisri Press.

Ramadhan, I., Firmansyah, H., & Wiyono, H. (2022). Face-to-Face Learning Implementation Strategy Limited in the Covid-19 Pandemic Era. *Journal of Basicedu*, 6(4), 6042–6056. <https://doi.org/10.31004/basicedu.v6i4.2939>

Wayne, M. (2020). Contemporary innovative learning strategies: An operational conceptual review (Cet. to-?).

Wulandari, W., & Fauziati, E. (2022). Freedom of Learning in the perspective of liberating education Paulo Freire.