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Analysis of Science Learning Local Context (SeLoC) with Entrepreneurship Orientation for Life-Long Learning of Junior High School Students

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ABSTRACT
This study aims to explore how the implementation of Science Learning Local Context (SeLoC) with an entrepreneurial orientation can support the development of lifelong learning (LLL) skills in junior high school students. The study used a descriptive method with a mixed methods approach. This study involved 10 schools in Kupang as well as 20 science teachers and 200 students/ Instruments used included questionnaires, in-depth interviews, and observations. Data were collected through interviews with teachers and students, observations of the implementation of SeLoC in class, and questionnaires to measure student and teacher perceptions. Qualitative data analysis was carried out thematically to identify patterns of student engagement and entrepreneurship integration, while quantitative data were analyzed using descriptive statistics. The results of interviews with teachers showed that SeLoC integration was viewed positively because it was able to improve practical skills and student engagement in science learning. However, the implementation of SeLoC is still limited to extracurricular projects. From the results of student interviews, they felt more interested in science learning that was relevant to everyday life. Observations revealed that SeLoC had not been fully integrated into the formal curriculum. The results of the questionnaire showed the majority of respondents (50%) agreed that SeLoC encourages innovation in learning, 45% agreed that science results can be used for new products, and 50% agreed that SeLoC develops an entrepreneurial and ethical mindset. In lifelong learning skills, 45% of respondents agreed that science learning supports learning continuity, increases adaptation, motivation, and 40% agreed that it supports independent learning. This study recommends further development of the SeLoC curriculum and specific training for teachers.

Keywords:*science learning, local context, entrepreneurship, life-long learning*

INTRODUCTION

The high unemployment rate in East Nusa Tenggara (NTT) highlights a significant problem: the mismatch between available job opportunities and the skills of the local population(Mangi & Marseto, 2023). Most of the unemployed in NTT are secondary school graduates, highlighting that formal education has not adequately equipped them with the skills needed in the world of work. One of the main reasons for this is the lack of integration of life skills, such as lifelong learning (LLL), in secondary school curricula, especially in science education(Biao, 2015; Ceschi et al., 2021; Umbu Djuma Mone Mangi, 2023).

Science education at the junior high school (SMP) level generally still focuses on theoretical concepts but fails to equip students with practical skills that are relevant to everyday life and the modern world of work(Hilton & Pellegrino, 2012). As the world continues to globalize and digitize, skills such as LLL are becoming increasingly important to help students remain adaptable in an ever-changing environment. However, existing literature shows that science education still emphasizes mastery of concepts rather than preparing students for real-life challenges. Entrepreneurship education has emerged as a potential solution to address the unemployment crisis by equipping students with life skills that go beyond traditional academic learning(Bridge, Hegarty, & Porter, 2010). Entrepreneurship education provides the practical experience and essential skills needed to manage resources or even start a business(Kirkwood, Dwyer, & Gray, 2014). However, research on the integration of entrepreneurship in science education is still limited, especially in less developed areas such as (NTT). This gap reflects a lack of alignment between the existing literature on entrepreneurship education and the practical needs observed in these areas, highlighting the urgency for curriculum innovation(Jones & English, 2004).

This problem is becoming increasingly pressing due to the large number of students who graduate from high school without the necessary skills to contribute to the workforce or create independent employment. High school graduates in NTT, a region abundant with natural resources, find themselves trapped in a cycle of unemployment due to a lack of entrepreneurship education. The latest literature review demonstrates that integrating an entrepreneurship-based curriculum with science learning can effectively equip students with real-life practical skills(Pittaway & Edwards, 2012; Saputri, Yulastri, Yuliana, Saputra, & Fiandra, 2024). However, this study also reveals a lack of research on the integration of entrepreneurship into science education in remote regions like NTT, highlighting a research gap that requires attention.

The Science Learning Local Context (SeLoC) introduces a novel approach that integrates entrepreneurship into science education, taking into account local contexts. This model strives to cultivate Lifelong Learning (LLL) skills by integrating science education deeply into the student's social and cultural surroundings(Amalu et al., 2023; Annan-Diab & Molinari, 2017; Sholeh, Mohamed, Sokip, & Syafi'i, 2024). By engaging the local context, SeLoC not only increases students' interest in science but also equips them with practical life skills that are critical for surviving in the world of work and life.

Furthermore, SeLoC promotes students' comprehension of the potential inherent in natural resources and local knowledge, enabling them to identify entrepreneurial opportunities that can be developed through scientific understanding(Acton, Salter, Lenoy, & Stevenson, 2017; Boldureanu, Ionescu, Bercu, Bedrule-Grigoruţă, & Boldureanu, 2020; Mazzocchi et al., 2018; McKim, 2017; Sjöström & Eilks, 2018). Through a localized approach, students acquire theoretical scientific concepts and use this knowledge in practical activities pertinent to their life. This is anticipated to cultivate an innovative and sustainable entrepreneurial ethos, hence enhancing students' competitiveness in both local and global job markets. SeLoC serves a crucial function in connecting theoretical scientific education with the practical necessity for pertinent living skills in contemporary society.

In addition, previous research focused more on the application of technical and conceptual skills in science learning without emphasizing the importance of local wisdom or real-life relevance for students(Burns, 2020; Cummins & Kunkel, 2015; Wahyuni, Sari, Palittin, & Henukh, 2023). This research will fill this gap by exploring how the SeLoC concept can provide a learning approach that is more contextual and relevant to the needs of students in NTT. Thus, this research not only seeks to provide a solution to the problem of unemployment through entrepreneurship education but also to develop LLL skills that enable students to continue to adapt and contribute to the ever-changing world of work.

This research fills a critical gap by investigating the implementation of SeLoC, an entrepreneurship-focused approach, in junior high school science education at NTT. This research will analyze how this approach can provide students with the skills necessary to identify and exploit opportunities in their local environment. Previous research, primarily focusing on theoretical or limited applications of entrepreneurship education, has not sufficiently explored these aspects. This study aims to explore how the implementation of Science Learning Local Context (SeLoC) with an entrepreneurial orientation can support the development of lifelong learning (LLL) skills in junior high school students.

METHODOLOGY

This research uses a mixed methods method with an exploratory design(Doyle, Brady, & Byrne, 2016; McKim, 2017). This approach consists of two main stages: qualitative exploration and quantitative instrument development. In the initial stage, this research aims to explore the topic of SeLoC through field studies, literature studies, in-depth interviews, and observations. The research subjects comprised 200 students and ten science teachers from 10 schools selected purposively in Kupang. This study's population includes students and teachers who participate in science learning in secondary schools. Sample selection was carried out by taking into account demographic characteristics and educational background. Qualitative data from interviews and observations will be analyzed using a thematic analysis approach to identify the main patterns underlying learning behavior and entrepreneurship orientation. Qualitative findings from the exploration phase will be used to develop quantitative instruments. The instruments developed include a questionnaire designed to measure teachers' and students' perspectives regarding entrepreneurship-oriented SeLoC. In addition, observation and interview instruments will also be developed to validate quantitative findings. In general, the flow chart of this research method can be seen in image 1 below.

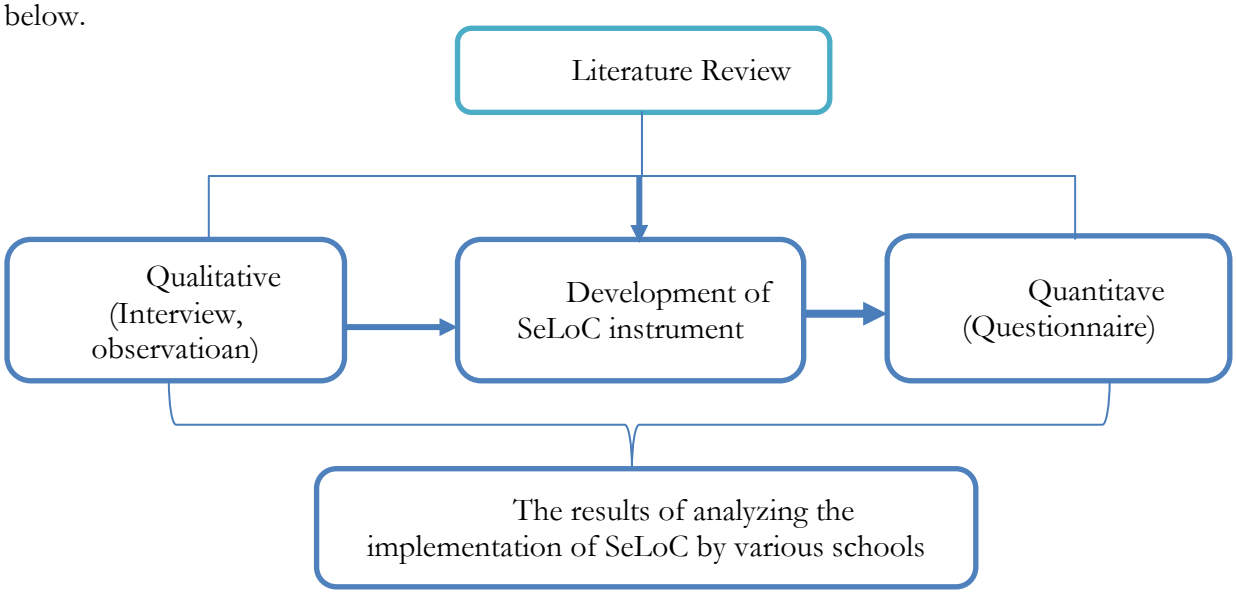

Figure 1. Flow chart of SeloC research

The research instrument consists of questionnaires, interviews, and observation sheets(Elangovan & Sundaravel, 2021). The instrument's validity is tested through expert validation(Astra, Aminudin, & Henukh, 2021; Astra, Henukh, & Algiranto, 2021; Henukh & Astra, 2021). The questionnaire instrument was developed based on qualitative findings and focused on measuring aspects of lifelong learning, entrepreneurship orientation, and students' science learning experiences. Qualitative data was collected through interviews and observations and then analyzed

thematically. In the next stage, quantitative data was obtained through questionnaires and processed using descriptive statistical techniques.

RESULT AND DISCUSSION

The first stage conducted in this study was interviews with science teachers and students. These interviews aimed to identify teachers' views and experiences in implementing SeLoC in schools, including the challenges faced and the impact on student engagement. In these interviews, teachers were asked to answer several questions that focused on how entrepreneurship can be integrated into science learning, lifelong learning skills developed through SeLoC, and the forms of support needed to improve SeLoC implementation.

These interviews provided in-depth insights into how teachers view the importance of SeLoC in science learning and the obstacles they face in this integration process. Thus, this table presents a summary of the answers from the interviewed teachers regarding various aspects relevant to the implementation of SeLoC in their schools. The results of interviews with science teachers can be seen in Table 1 below.

Table 1. Results of Interviews with Science Teachers

No	Question	Answer
1	What is your view on the integration of entrepreneurship into science education through SeLoC?	*Teachers generally view this integration as positive, as it increases students' practical skills and their interest in science by connecting theory with real-world applications.*
2	What challenges did you face in implementing SeLoC with an entrepreneurial focus?	*Challenges include limited resources, lack of specific training for teachers on entrepreneurship integration, as well as limited time in the curriculum.*
3	How would you rate student engagement and interest in SeLoC compared to traditional science learning?	*Most teachers report increased student engagement, especially when local context and entrepreneurship are integrated into lessons.*
4	How has SeLoC been implemented in your school so far?	*Implementation is still minimal, because SeLoC has not been fully integrated into the official science curriculum. Most teachers use SeLoC in extracurricular projects or selectively in lessons.*
5	What are the reasons why SeLoC is not fully integrated into the science curriculum at your school?	*SeLoC has not been formalized in the curriculum due to a lack of alignment between the entrepreneurial focus and existing national science standards.*
6	What specific LLL (Life-Long Learning) skills do you feel are developed through SeLoC?	*Critical thinking, problem solving, and adaptability were mentioned as key LLL skills developed through SeLoC.*
7	What additional support do you think is needed to improve SeLoC implementation at your school?	*Teachers suggested further training, better materials and resources, and increased collaboration with local entrepreneurs to provide real-world examples and opportunities.*

The results of interviews with science teachers about incorporating entrepreneurship into science education through SeLoC (Science Education Learning on Context) revealed a positive response. Teachers typically believe that this integration improves students' practical abilities as well as their enthusiasm in science by connecting theory to real-world applications. The incorporation of entrepreneurship into science education gives a meaningful context, which is thought to stimulate more active student participation(Bevan, 2017; Saputri et al., 2024).

However, some problems have been noted in integrating SeLoC with an entrepreneurial mindset. instructors identified inadequate resources, a lack of professional training for instructors on entrepreneurship integration, and a lack of time in the curriculum as the key impediments (Daniel, 2016; Dinc, 2019). These difficulties impede efforts to optimally apply SeLoC in classroom settings(Dinc, 2019). The majority of instructors agree that including local context and

entrepreneurship into science education boosts student engagement(Juuti et al., 2021). They also observed that student participation in SeLoC learning was higher than in traditional science learning, particularly when entrepreneurship-related activities were included. Unfortunately, SeLoC is still not fully integrated into the official curriculum, and it is only used in extracurricular activities or specific lessons. Teachers also highlighted that SeLoC promotes the development of life-long learning (LLL) abilities such as critical thinking, problem solving, and flexibility. To improve implementation, teachers advocate extra support, such as more training, better resources, and tighter collaboration with local entrepreneurs to provide students with real-world examples and opportunities in business.

Next, interviews were conducted with students. These interviews sought to explore students' views on the relevance of science learning to everyday life and how SeLoC influenced their understanding of science and the development of entrepreneurial skills. Through these interviews, students were asked to share their experiences in using science knowledge to solve local problems, their views on the importance of science after learning with the SeLoC approach, and the new skills they developed(Jufrida, Basuki, Kurniawan, Pangestu, & Fitaloka, 2019; Ramdani, Jufri, Gunawan, Fahrurrozi, & Yustiqvar, 2021). The interviews also asked about the challenges they faced in this learning process, and how they overcame these challenges. Table 2 presents a summary of students' responses that provide insight into how SeLoC influenced their engagement in science learning and the development of entrepreneurial skills.

Table 2. Results of Interviews with Students

No	Question	Answer
1	How do you feel about studying science with an entrepreneurial focus through SeLoC?	*Students express increasing interest in science because it is more relevant to their lives and offers practical skills they can use in the future.*
2	Can you tell about a lesson or activity where you applied science knowledge to solve a local problem?	*Many students described projects in which they used science to address environmental problems in their communities, such as waste management or water purification.*
3	How did learning through SeLoC change your view of science and the importance of science?	*Students generally report that science now seems more useful and applicable in everyday life, rather than just theoretical knowledge.*
4	What new skills did you learn through SeLoC, and how do you think these skills will help in the future?	*Students mentioned that they learned entrepreneurial skills such as resource management and problem solving, which they believed would help them start small businesses or improve their livelihoods.*
5	How has SeLoC been applied to your science learning so far?	*SeLoC is only applied in certain projects and activities outside regular class hours. Students feel this has not been fully integrated into their science curriculum.*
6	What are the challenges of integrating SeLoC into your regular science lessons?	*Students feel that the current science curriculum is still too theoretical, and they do not have enough opportunities to explore the practical applications of science in local contexts.*
7	What challenges did you face while learning science through SeLoC, and how did you overcome them?	*Challenges include understanding the complex scientific concepts needed to address real problems, but many students find group discussions and teacher support very helpful.*

The findings of interviews with students on learning science with an emphasis on entrepreneurship through SeLoC reveal that students are more interested in science because it is more relevant to their life and provides practical skills that will be beneficial in the future. Students recognize that this learning allows them to apply their science knowledge in real-world contexts, which helps them comprehend the relevance of science in solving problems around them (Akben, 2020; Sutaphan & Yuenyong, 2019). Most students described how they used science knowledge to alleviate environmental challenges in their communities, such as waste management and water purification programs. They believed that these efforts not only enhanced their understanding of science, but also made a significant contribution to society. This demonstrates how SeLoC learning

enables students to connect theory with practical applications that they may have previously found impossible to envision(Darling-Hammond, Flook, Cook-Harvey, Barron, & Osher, 2020)

Furthermore, students remark that through SeLoC learning, they no longer regard science as a field focused solely on theory, but rather on practical applications in everyday life. They believe that the entrepreneurial skills they gain, such as resource management and problem solving, will benefit them in the future, whether they establish a small business or raise their standard of life(Kim, Raza, & Seidman, 2019). These abilities are regarded as invaluable in a world that increasingly values creativity and sustainability.

Students feel that SeLoC learning is still limited to projects and activities outside regular class hours. They considered that SeLoC had not been fully integrated into their science curriculum. Students also felt that the existing science curriculum was too theoretical and did not provide enough opportunities to explore practical applications of science in local contexts, which posed a major challenge in connecting theory with practice. Some of the other challenges students face in SeLoC learning include understanding the complex scientific concepts needed to solve real problems. However, they found that group discussions and support from teachers were very helpful in overcoming these challenges. Thus, despite the obstacles, students felt that the learning experience through SeLoC could strengthen their understanding of science while providing direct benefits to their communities(Lai, 2023; Maison, 2023)

The next step taken was observation aimed at seeing the extent to which SeLoC had been practically implemented in the classroom, how it was related to the formal science curriculum, and what obstacles teachers and schools faced in integrating SeLoC into daily learning. The results of the observation provided in-depth information on how SeLoC was implemented in different school environments, including variations in implementation between more advanced schools and schools that were still in the early stages. Observations also noted obstacles such as lack of resources, facilities, and official guidance needed to support SeLoC implementation. Table 3 summarizes the results of this observation, showing the level of SeLoC integration in schools, the level of adaptation in the curriculum, and special notes related to the needs and challenges faced by teachers and schools.

Table 3. Results of Observations at schools on the implementation of SeLoC

School name	Implementation of SeLoC in Science Learning	Integration in the Curriculum	Special Notes
SMP A	SeLoC has not been implemented systematically, only occasionally applied in environmentally related student projects.	Not yet integrated into the formal science curriculum.	Further training is needed for teachers to understand the application of SeLoC.
SMP B	SeLoC has not yet been implemented, although some teachers are starting to explore the possibility of linking learning to local contexts.	Not integrated in the curriculum.	There needs to be an official guide for implementing SeLoC in the classroom.
SMP C	SeLoC implementation has not been carried out. Learning still focuses on scientific theory without many local context-based activities.	There is no integration in the formal curriculum.	Lack of resources and facilities hinders the implementation of SeLoC.
SMPD	not implemented, teachers only use traditional teaching methods that focus on theory.	There has been no attempt to integrate SeLoC in the curriculum.	Support from school policy is needed for implementing SeLoC.
SMP F	SeLoC was only introduced in class discussions about local utilization, but there has been no practical application.	The science curriculum does not include SeLoC implementation.	Need more practical projects that involve students' surroundings.

School name	Implementation of SeLoC in Science Learning	Integration in the Curriculum	Special Notes
SMP E	SeLoC is not implemented, learning still focuses on theoretical concepts without any entrepreneurial or local context.	Not integrated in the science curriculum.	Teachers show interest in learning more about SeLoC, but still need guidance.
SMP G	SeLoC is not implemented. Science learning still focuses on theoretical concepts and there are no local context-based activities.	There is no integration in the formal curriculum.	A policy from the school principal is needed to encourage the implementation of SeLoC.
SMP H	There is no implementation of SeLoC yet, but there is interest from some teachers to start introducing local problem-based learning.	SeLoC has not been integrated into the formal science curriculum.	The curriculum needs to be adapted to include local context-based learning.
SMP I	SeLoC is not implemented, teachers still focus on textbook-based teaching without linking learning to the local context.	Not yet integrated into the curriculum.	More examples and training for teachers on implementing SeLoC are needed.
SMP J	SeLoC has not been formally implemented, although there have been several attempts by teachers to link lessons to local entrepreneurship.	Not integrated in the curriculum.	There needs to be collaboration with local entrepreneurs and increased facilities for implementing SeLoC.

The findings of observations on the implementation of SeLoC (scientific Education Learning on Context) in many schools indicate that the majority of schools have not systematically adopted SeLoC in scientific learning. SeLoC is only used in a restricted number of students' environmental projects at SMP A, and it is not part of the official curriculum. Teachers at this school require additional training to comprehend the use of SeLoC in learning. Although some teachers at SMP B are exploring the idea of tying learning to the local context, SeLoC has yet to be substantially adopted. This school, like SMP A, has not yet integrated SeLoC into its curriculum, and official guidance is required to help instructors use this method in the classroom. Observations at SMP C also reveal that learning continues to rely on theory rather than local context-based activities, and a lack of resources and facilities remains the primary impediment to adopting SeLoC. Similar problems were discovered at other institutions, including SMP D and SMP E. Science education is still dominated by theory, and there has been no significant effort to include SeLoC into the curriculum. Teachers are interested in learning more about SeLoC, but they require further instruction and help to properly implement it(Kimmons, Graham, & West, 2020). Although instructors at numerous schools, including SMP H and SMP I, are interested in adopting local problem-based learning, the formal implementation of SeLoC has yet to occur. The existing curriculum is regarded overly theoretical and should be revised to incorporate local context-based learning(Dolfing, Prins, Bulte, Pilot, & Vermunt, 2021). Various efforts have been made at SMP J to link teachings with local entrepreneurship, SeLoC is still not part of the official curriculum, and engagement with local businesses as well as more sufficient facilities are required to facilitate its implementation.

The final step is to fill out a questionnaire designed to measure respondents' views on several important aspects, including innovation and creativity in learning methods, utilization of scientific results to produce new products, and development of an entrepreneurial mindset and ethics. Image 2 displays a data visualization from respondents that includes their opinions regarding the effectiveness of entrepreneurship integration in science. This graph shows the proportion of respondents who agree, strongly agree, disagree, and disagree with each category. Thus, Image 2

helps to visually illustrate respondents' perceptions of the extent to which entrepreneurship integration in science supports innovation, utilization of science, and the formation of an entrepreneurial mindset. This visualization provides a more understandable view of the majority of respondents' opinions regarding the implementation of SeLoC.

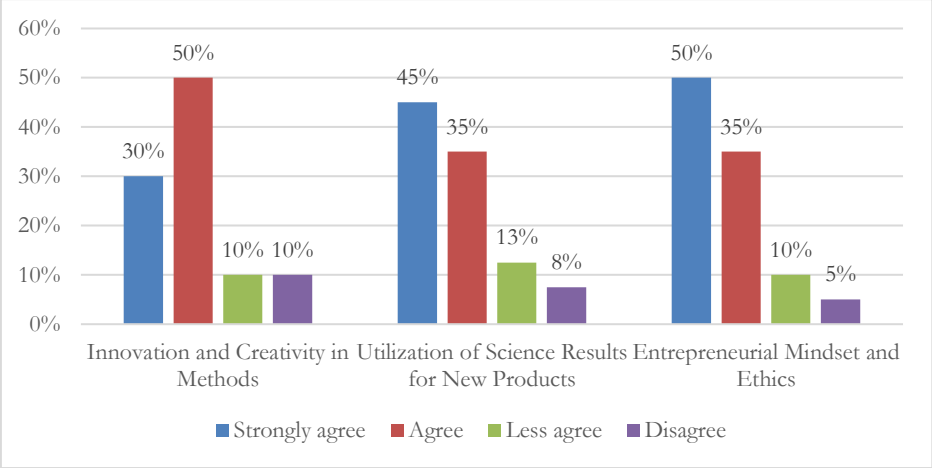

Figure 2. The Results of The Analysis Link Science and Entrepreneurship

The questionnaire results related to the integration of science and entrepreneurship show a variety of respondents' views. In the category of innovation and creativity in methods, the majority of respondents (50%) agree, indicated by the color red, while 30% strongly (orange). Only 10% of respondents disagree (green) and another 10% disagree (purple). This shows that most respondents feel that current science learning methods do not support innovation and creativity in terms of entrepreneurship.

In the category of utilizing science results for new products, 45% of respondents agree that science can be utilized to produce new products, while 35% strongly agree. Only 12.5% disagree, and only 7.5% disagree. This indicates that most respondents believe that science learning results can be applied directly in making new products, on the other hand there is still a lack of real experience or examples of applications(Dyrberg, Treusch, & Wiegand, 2017)

In the aspect of entrepreneurial mindset and ethics, the majority of respondents (50%) agree that science learning can build an entrepreneurial mindset and ethics, while 35% strongly agree. Only 10% agree and 5% strongly agree. These data show that respondents generally feel that the integration of entrepreneurship and ethics in science learning is still not optimal or the impact is less visible. Overall, the respondents' views indicate that there is satisfaction regarding the effectiveness of the integration of science and entrepreneurship in schools. The majority of respondents see the implementation of SeLoC will provide significant benefits from this integration in terms of innovation, utilization of science results, and development of an entrepreneurial mindset. For this reason, strengthening is needed in terms of teaching methods, application examples, and training for teachers to ensure that this integration can run effectively and relevantly for students(Kimmons et al., 2020). Further support from schools and the education system is also needed to ensure that entrepreneurship can be better integrated into science learning.

The results of the questionnaire analysis related to lifelong learning (LLL) skills in the context of science learning through Science Learning Local Context (SeLoC) are shown in Image 3. Image 3 presents a data visualization that includes respondents' responses to various categories related to LLL, such as sustainability in learning and adaptability and motivation in the context of entrepreneurship. This graph shows the proportion of respondents who agree, strongly agree, disagree, and disagree with key statements regarding the effectiveness of SeLoC in supporting lifelong learning. This visualization helps clarify how the majority of respondents perceive the

impact of SeLoC-based science learning on their LLL skills, as well as providing insight into aspects that need to be improved in supporting these skills in the future.

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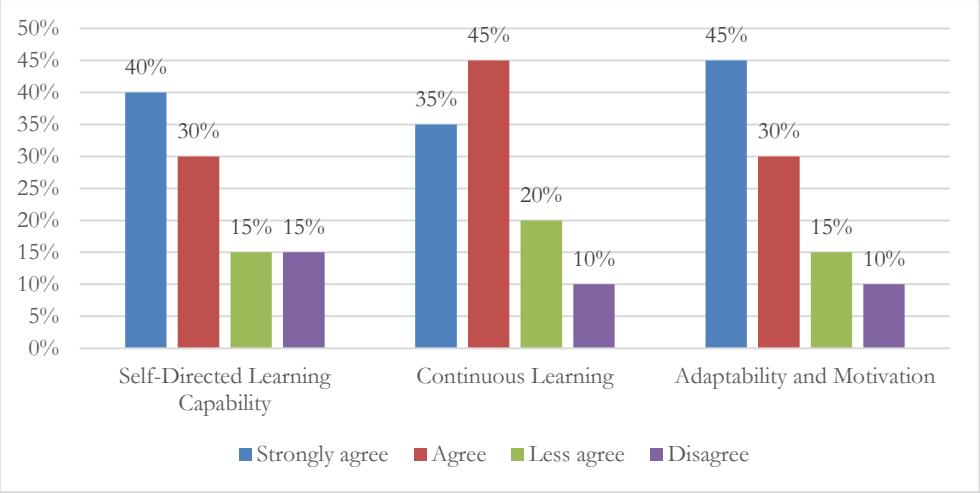

Figure 3. Lifelong Learning Analysis Results in Science Learning

In the continuous learning category, 45% of respondents agreed that current science learning supports sustainable learning, with another 35% strongly agreeing. Only 15% of respondents said they disagreed, and 15% of respondents disagreed with this statement. These results indicate that the majority of respondents believe that science can facilitate the development of sustainable or long-term learning abilities.

In the aspect of adaptability and motivation, 45% of respondents agreed that current science learning helps develop students' adaptation and motivation, while another 30% strongly agreed. As many as 15% of respondents disagreed, and only 10% disagreed with this statement. This shows that the majority of respondents feel that science learning is quite effective in building students' adaptability and learning motivation.

Overall, the majority of respondents had a critical view of the ability of science learning to support the development of lifelong learning skills, such as independence, sustainability, and adaptability and motivation. The high percentage of respondents who agree or strongly agree indicates that there is a need to improve and improve teaching methods in science learning to make them more relevant and support long-term learning skills(Kim et al., 2019).

To increase the effectiveness of science learning in supporting lifelong learning, there needs to be improvements in teaching strategies that further encourage student learning independence, continuous involvement, and adaptability. This can be done through a more interactive, contextual and applicable approach in science learning, so that students are more motivated and able to learn independently outside the classroom.

CONCLUSION

This study concludes that the integration of Science Learning Local Context (SeLoC) with entrepreneurial orientation has a positive impact on student engagement and the development of lifelong learning (LLL) skills, although it still faces various challenges. The interview results showed that teachers and students support the implementation of SeLoC, but its implementation is still limited to extracurricular projects due to lack of resources, teacher training, and time constraints in the curriculum. Based on the questionnaire data, the majority of respondents (50%) agreed that SeLoC encourages innovation in learning methods, 45% agreed that science results can be used to produce new products, and 50% agreed that SeLoC helps develop an entrepreneurial mindset and

ethics. In terms of lifelong learning skills, 45% of respondents agreed that science learning supports the sustainability of learning, 45% agreed that this learning helps improve adaptation and motivation, and 40% of respondents agreed that SeLoC supports independent learning skills. The results of observations in several schools showed that SeLoC has not been implemented systematically and is only used in several student projects, with most schools not integrating SeLoC into the formal curriculum. Therefore, further development is needed through teacher training, curriculum adjustments, and policy support to integrate SeLoC more effectively into science learning.

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REFERENCES

Acton, R., Salter, P., Lenoy, M., & Stevenson, R. (2017). Conversations on Cultural Sustainability: Stimuli for Embedding Indigenous Knowledges and Ways of Being Into Curriculum. *Higher Education Research & Development*, 36(7), 1311–1325.

Akben, N. (2020). Effects of The Problem-Posing Approach on Students' Problem Solving Skills and Metacognitive Awareness in Science Education. *Research in Science Education*, 50(3), 1143–1165.

Amalu, E. H., Short, M., Chong, P. L., Hughes, D. J., Adebayo, D. S., Tchuenbou-Magaia, F., … Oikonomou, T. I. (2023). Critical Skills Needs and Challenges For STEM/STEAM Graduates Increased Employability and Entrepreneurship in The Solar Energy Sector. *Renewable and Sustainable Energy Reviews*, 187, 113776.

Annan-Diab, F., & Molinari, C. (2017). Interdisciplinarity: Practical Approach to Advancing Education for Sustainability and for The Sustainable Development Goals. *The International Journal of Management Education*, 15(2), 73–83.

Astra, I. M., Aminudin, D., & Henukh, A. (2021). Enhancing Students' Learning Activities Using Problem-Based Learning Model on Temperature and Heat Concept. In *Journal of Physics: Conference Series* (Vol. 2019). IOP Publishing Ltd. Retrieved from https://doi.org/10.1088/1742-6596/2019/1/012025

Astra, I. M., Henukh, A., & Algiranto. (2021). Implementation of Think Pair Share Model in Physics Learning to Determine Cognitive, Affective and Psychomotor Learning Outcomes and Student Responses. In *Journal of Physics: Conference Series* (Vol. 1876). IOP Publishing Ltd. Retrieved from https://doi.org/10.1088/1742-6596/1876/1/012064

Bevan, B. (2017). The Promise and The Promises of Making in Science Education. *Studies in Science Education*, 53(1), 75–103.

Biao, I. (2015). Lifelong Learning as An Instrument for Human Capital Development in Benin. *International Review of Education*, 61(5), 631–653.

Boldureanu, G., Ionescu, A. M., Bercu, A.-M., Bedrule-Grigoruţă, M. V., & Boldureanu, D. (2020). Entrepreneurship Education Through Successful Entrepreneurial Models in Higher Education Institutions. *Sustainability*, 12(3), 1267.

Bridge, S., Hegarty, C., & Porter, S. (2010). Rediscovering Enterprise: Developing Appropriate University Entrepreneurship Education. *Education+ Training*, 52(8/9), 722–734.

Burns, R. (2020). *Adult Learner at Work: The challenges of lifelong education in the new millenium*. Routledge.

Ceschi, A., Perini, M., Scalco, A., Pentassuglia, M., Righetti, E., & Caputo, B. (2021). Foster Employability and Fight Social Exclusion through The Development of Lifelong Learning (LLL) Key-Competences: Reviewing Twenty Years of LLL policies. *European Journal of Training and Development*, 45(6/7), 475–511.

Creswell. (n.d.). *Designing and Conducting Mixed Method Research*.

Cummins, P., & Kunkel, S. (2015). *A Global Examination of Policies and Practices for Lifelong Learning*.

Dacre Pool, L., & Sewell, P. (2007). The Key to Employability: Developing A Practical Model of Graduate Employability. *Education+ Training*, 49(4), 277–289.

Daniel, A. D. (2016). Fostering an Entrepreneurial Mindset by Using A Design Thinking Approach in Entrepreneurship Education. *Industry and Higher Education*, 30(3), 215–223.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for Educational Practice of The Science of Learning and Development. *Applied Developmental Science*, 24(2), 97–140.

Dinc, E. (2019). Prospective Teachers' Perceptions of Barriers to Technology Integration in Education. *Contemporary Educational Technology*, 10(4), 381–398.

Dolfing, R., Prins, G. T., Bulte, A. M. W., Pilot, A., & Vermunt, J. D. (2021). Strategies to Support Teachers' Professional Development Regarding Sense-Making in Context-Based Science Curricula. *Science Education*, 105(1), 127–165.

Doyle, L., Brady, A.-M., & Byrne, G. (2016). An Overview of Mixed Methods Research–Revisited. *Journal of Research in Nursing*, 21(8), 623–635.

Dyrberg, N. R., Treusch, A. H., & Wiegand, C. (2017). Virtual Laboratories in Science Education: Students' Motivation and Experiences in Two Tertiary Biology Courses. *Journal of Biological Education*, 51(4), 358–374.

Elangovan, N., & Sundaravel, E. (2021). Method of preparing a document for survey instrument validation by experts. *MethodsX*, 8, 101326.

Henukh, A., & Astra, I. M. (2021). The Use Of Google Classroom as ICT Literacy to Improve Physics Students Collaboration Skill in Industrial Revolution 4.0. In *AIP Conference Proceedings* (Vol. 2331). American Institute of Physics Inc. Retrieved from https://doi.org/10.1063/5.0041660

Hilton, M. L., & Pellegrino, J. W. (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. National Academies Press.

Jones, C., & English, J. (2004). A contemporary approach to entrepreneurship education. *Education+ Training*, 46(8/9), 416–423.

Jufrida, J., Basuki, F. R., Kurniawan, W., Pangestu, M. D., & Fitaloka, O. (2019). Scientific literacy and science learning achievement at junior high school. *International Journal of Evaluation and Research in Education*, 8(4), 630–636.

Juuti, K., Lavonen, J., Salonen, V., Salmela-Aro, K., Schneider, B., & Krajcik, J. (2021). A teacher–researcher partnership for professional learning: Co-designing project-based learning units to increase student engagement in science classes. *Journal of Science Teacher Education*, 32(6), 625–641.

Kim, S., Raza, M., & Seidman, E. (2019). Improving 21st-century teaching skills: The key to effective 21st-century learners. *Research in Comparative and International Education*, 14(1), 99–117.

Kimmons, R., Graham, C. R., & West, R. E. (2020). The PICRAT model for technology integration in teacher preparation. *Contemporary Issues in Technology and Teacher Education*, 20(1), 176–198.

Kirkwood, J., Dwyer, K., & Gray, B. (2014). Students' reflections on the value of an entrepreneurship education. *The International Journal of Management Education*, 12(3), 307–316.

Lai, W. F. (2023). Integrating sociocultural perspectives into a university classroom: A case study of students' experience. *Heliyon*, 9(6). Retrieved from https://doi.org/10.1016/j.heliyon.2023.e17228

Maison, L. M. (2023). Beyond Western and Indigenous Perspectives on Sustainability: Politicizing Sustainability With the Zapatista Rebellious Education. *Journal of Transformative Education*, 21(1), 41–58. Retrieved from https://doi.org/10.1177/15413446221079595

Mangi, A. U. D. M., & Marseto, M. (2023). Pengaruh Tingkat Pengangguran, Inflasi, dan Pertumbuhan Ekonomi terhadap Kemiskinan di NTT. *Equilibrium: Jurnal Penelitian Pendidikan Dan Ekonomi*, 20(02), 257–265.

Mazzocchi, F., Simandan, D., Demneh, M. T., Morgan, D. R., Ghazinoory, S., Saghafi, F., & Mirzaei, M. (2018). Why 'Integrating'Western science and Indigenous knowledge is not an easy task: What lessons could be learned for the future of knowledge. *Journal of Futures Studies*, 22(3), 19–34.

McKim, C. A. (2017). The value of mixed methods research: A mixed methods study. *Journal of Mixed Methods Research*, 11(2), 202–222.

Pittaway, L., & Edwards, C. (2012). Assessment: Examining Practice in Entrepreneurship Education. *Education+ Training*, 54(8/9), 778–800.

Ramdani, A., Jufri, A. W., Gunawan, G., Fahrurrozi, M., & Yustiqvar, M. (2021). Analysis of students' critical thinking skills in terms of gender using science teaching materials based on the 5E learning cycle integrated with local wisdom. *Jurnal Pendidikan IPA Indonesia*, 10(2), 187–199.

Saputri, A., Yulastri, A., Yuliana, Y., Saputra, H. K., & Fiandra, Y. A. (2024). Entrepreneurship-Based School Management Model to Increase Entrepreneurship Interest of Vocational Education Students. *Al Qalam: Jurnal Ilmiah Keagamaan Dan Kemasyarakatan*, 18(5), 3238–3255.

Sholeh, M. I., Mohamed, M. R. A. A., Sokip, S., & Syafi'i, A. (2024). The Application of Entrepreneurial Models in the Development of Educational Management Curriculum. *Al-Aghniya: Journal of Syariah Business Management*, 1(1), 33–42.

Sjöström, J., & Eilks, I. (2018). Reconsidering different visions of scientific literacy and science education based on the concept of Bildung. *Cognition, Metacognition, and Culture in STEM Education: Learning, Teaching and Assessment*, 65–88.

Sutaphan, S., & Yuenyong, C. (2019). STEM education teaching approach: Inquiry from the context based. In *Journal of Physics: Conference Series* (Vol. 1340, p. 012003). IOP Publishing.

Umbu Djuma Mone Mangi, A. (2023). Equilibrium: Jurnal Penelitian Pendidikan dan Ekonomi Pengaruh Tingkat Pengangguran, Inflasi, Dan Pertumbuhan Ekonomi Terhadap Kemiskinan Di NTT, 20, 2. Retrieved from https://journal.uniku.ac.id/index.php/Equilibrium

Wahyuni, S., Sari, J., Palittin, I. D., & Henukh, A. (2023). Development of Student Worksheets Based on Etno-STEM on Sound Waves. *Physics Education Journal*, 6(1), 37–45. Retrieved from http://jurnal.unipa.ac.id/index.php/kpej