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The Implementation of Science Process Skill (SPS)-based Matriculation to Equalize Scientific Literacy of Prospective Elementary Teacher

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Abstract: Elementary teachers play a crucial role in fostering students' scientific literacy; however, many prospective teachers still demonstrate only moderate levels. This study aimed to provide a comprehensive overview of Science Process Skills (SPS)-based matriculation program designed to enhance their scientific literacy. A mixed-method approach with a convergent parallel design was employed, in which quantitative and qualitative data were collected concurrently, analyzed separately, and subsequently integrated. The participants consisted of 24 first-semester of PGSD students, selected through purposive sampling. The results of the Wilcoxon test revealed a significant difference between pretest and posttest scores ($p < 0.001$), with an average increase of 16.9 points following the program. Further analysis using N-gain and t-test ($t(23) = -10.3$, $p < 0.001$) confirmed the effectiveness of the matriculation was indicated as a low-to-moderate level. Thematic analysis indicated that the program supported students in reconstructing their understanding, as well as increasing their interest and confidence in learning science. Nevertheless, several challenges were identified, particularly related to time constraints and the organization of physics concept delivery. In conclusion, the SPS-based matriculation program was effective in enhancing the scientific literacy of prospective elementary teachers with further refinement is required to optimize its outcomes.

Keywords: Matriculation; Prospective elementary teacher; Science process skill (SPS); Scientific literacy

Introduction

In 2015, the World Economic Forum already identified sixteen skills that individuals need to develop in this 21st century' global challenges. One of those skills is scientific literacy (World Economic Forum, 2015). It is a competency that enable individuals to make informed decisions and to deal with problems in daily life through their own scientific knowledge (Foster et al., 2011; Kähler et al., 2020; Norris et al., 2014; OECD, 2018). In general, it is defined as an ability to use scientific knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and construct conclusions based on existing facts (Jamilah et al., 2023). Those abilities are pretty needed to be developed as survival efforts to this era.

As part of the national education goals (Husna et al., 2022; Mulyani et al., 2025), scientific literacy has an important role in the development of science education in Indonesia. Childhood, especially at the elementary education level, is a potential period for the development of students' scientific concepts and skills (National Science Teachers Association, 2009). Science education encompasses both theoretical and practical aspects related to teaching and learning science,

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including the development of science process skills and understanding of the nature of science (Gizaw et al., 2023). Several countries, like US, England, and also Indonesia, have made science learning an essential part of their curriculum at the elementary education level (Vieira et al., 2016). It means that science learning is highly considered as one of competencies students have to involve in their class. The Indonesia government already stated how science learning should be implemented by school. Two kind of elements such as cognitive profile and process skill are obligately consisted in learning process (Badan Standar Kurikulum dan Asesmen Pendidikan, 2022).

Related to those aspects, another theory stated that scientific literacy is not just about understanding concept, but also the development of science process skills (SPS) (Zeidan et al., 2014). Science process skills (SPS) constitute an essential component of scientific literacy because they enable individuals to investigate phenomena, evaluate evidence, and construct scientific explanations based on empirical data (Jamilah et al., 2023). This is actually aligned with constructivist learning theory that knowledge is built through interactions between prior experiences and new evidence encountered during learning activities. Scientific understanding should be constructed by learners through direct engagement with scientific inquiry rather than through only passive reception of information (Driver et al., 1994). In this case, there will be skills trained in learning process and SPS is evolved.

Based on those statements, the role of elementary teachers in science education is very crucial for developing students' scientific literacy at that level. Teachers are expected to have a good understanding of science concepts and adequate scientific literacy (Chin, 2005; Osborne, 2007). In other words, teacher' scientific literacy will indicate the quality of students' scientific literacy in the future. However, based on various existing studies, the scientific literacy of prospective elementary teachers is still classified as moderate, aligned with other studies which have indicated that pre-service teachers still demonstrate limitations in their knowledge and inquiry skills (Koyunlu-Ünlü, 2020). Only a small number of students come from a science major at the secondary level, while the majority come from non-science majors (Mulyani et al., 2025). This phenomenon shows a gap in scientific literacy of prospective elementary teachers as they who were not coming from science major probably rare to experience such activities; observing phenomena, formulating hypothesis, collecting evidence, and drawing conclusions which facilitate them in the construction of meaningful scientific literacy. Consequently, the development of SPS-based science matriculation is considered a fundamental pathway for improving scientific literacy of prospective elementary teacher. Numerous studies have reported that teachers with inadequate science process skills (SPS) are less capable of implementing inquiry-based learning in their classrooms (Aka et al., 2010; Blanchard et al., 2009; Hume, 2009; Lotter et al., 2007; Marshall et al., 2009).

The implementation of SPS-based matriculation is also relevant to the current challenges faced by elementary teacher education programs. Prospective elementary teachers are expected not only to master scientific concepts but also to facilitate inquiry-oriented science learning in their future classrooms (Feiman-Nemser, 2001). However, differences in educational backgrounds often result in unequal readiness among students when entering teacher education programs. Without adequate intervention at the beginning of their studies, these disparities may affect their learning achievement, confidence in science learning, and ability to teach science effectively in the future. Therefore, an early intervention through SPS-based matriculation may serve as a strategic effort to strengthen scientific literacy, before students engage in more advanced science-related coursework.

This matriculation was aimed to equalize scientific literacy among prospective elementary teacher before they attend lectures in the first semester. According to Direktorat Pembinaan SMA in 2014, matriculation program is a package of activities to avoid the gap existence and to help students fulfilling any lack of learning content, substance, understanding, or experiences due to the curriculum difference in their previous study (Direktorat Pembinaan SMA, 2014). Similar to that aim, in matriculation, students will be served some courses to equip their basic competencies in some field (Fikri et al., 2025). The general purpose of matriculation program is equalizing student competencies in a field to help them in upcoming program that might be hard and different. Various studies show that matriculation can be effective in improving students' understanding in certain fields, such as physics and mathematics, with nearly 80% of students achieving the same level of understanding after participating in the program (Noviantari, 2021; Sopacua et al., 2024). It also supports students' future career as they had fulfilled all stages of main courses at that level without gap existence (Fikri et al., 2025).

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SPS-based matriculation focuses on developing basic scientific skills, including observing, classifying, predicting, hypothesizing, measuring, and interpreting both data and experimental results. It is according to the concept of Science Process Skill itself that is categorized into two level such as basic science process skills and integration science process skills (Darmaji, Kurniawan, et al., 2018). These skills are fundamental and essential in the process of equalizing scientific literacy for prospective elementary school teachers (Derilo, 2019; Mulyani et al., 2025; Prayitno et al., 2017). Science process skills are the ability need to proceed some scientific actions to build a scientific concept and thought (Darmaji, Maison, et al., 2018). It is also a provision to the scientific method that is beneficial in acquiring new knowledge and working for its development (Asrial et al., 2019). Science Process Skill is also helping individuals to construct information and knowledge, to think about problem and phenomena, and to solve some related problems (Zamista, 2016). In addition, improving the scientific literacy of prospective elementary teachers may generate long-term impacts on elementary science education. Teachers with stronger scientific literacy are more likely to implement meaningful science instruction, encourage scientific inquiry, and support the development of scientific literacy among their future students.

Previous studies about matriculation program in universities had been published, such as in physic education (Sopacua et al., 2024), mathematic education (Afrida et al., 2019; Noviantari, 2021), english education (Afrida et al., 2019), arabic education (Afaria, 2020), doctoral degree (Nguyen et al., 2022), engineering (Ohland et al., 2018), medical (Heck et al., 2017) and pharmacy (Awuonda et al., 2021). Although matriculation programs have been widely implemented across various disciplines, existing studies primarily focus on improving academic achievement and content mastery. Limited attention has been given to the development of scientific literacy through matriculation activities, particularly among prospective elementary teachers. Moreover, previous matriculation studies rarely incorporate Science Process Skills as the primary learning framework. As a result, there is insufficient evidence regarding whether an SPS-based matriculation program can effectively address disparities in scientific literacy among prospective elementary teachers with diverse educational backgrounds. Based on these considerations, this research was aimed to provide a comprehensive overview of scientific literacy of prospective elementary teachers after the implementation of SPS-based matriculation.

Method

This research used a mixed method with convergent parallel design, which is a combination of quantitative and qualitative approaches. It is aimed to obtain a comprehensive picture and to show a deeper understanding of the phenomenon (Cohen et al., 2007; Creswell et al., 2017). The quantitative approach is used to measure changes in scientific literacy, while the qualitative approach is used to understand the implementation of SPS-based matriculation. In this convergent parallel design, quantitative and qualitative data were carried out simultaneously but analyzed separately. The results of both data were then integrated to obtain a more in-depth interpretation (Cohen et al., 2007; Creswell & Creswell, 2017). Figure 1 show how the research was conducted.

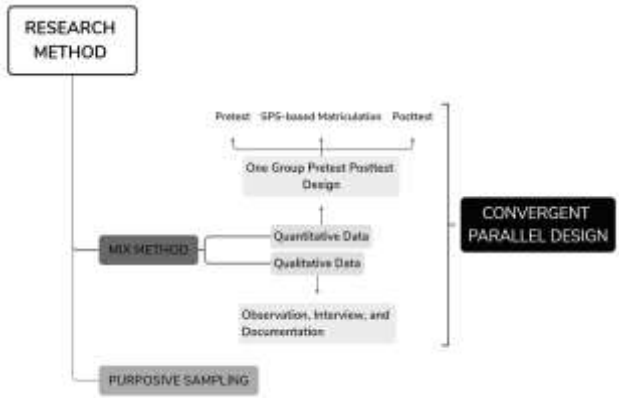

Figure 1. Research method

This research was conducted at PGSD (elementary teacher education) Study Program Universitas Perjuangan Tasikmalaya. The subject of this research was 24 students called as prospective elementary teachers enrolled in their first semester in PGSD. The subjects were selected using purposive sampling, considering that the selected students had diverse backgrounds previously. The research procedure included several stages designed to obtain quantitative and qualitative data in a structured and systematic manner. The procedures to be carried out were as follows: (1) research preparation, (2) quantitative data collection, (3) qualitative data collection, (4) data analysis (quantitative and qualitative) and (5)

integration of data results. Figure 2 show how the research was conducted.

Figure 2. Research flow

Research Preparation

Researcher decided many points in research preparation such as matriculation concept design, sources and media used, and research instruments. SPS-based matriculation held during five days and seven chapter of basic science material such as nature of science, measurement, life system, living thing characteristics, classification of materials, observation and microscope, and force and motion. A SPS-based module which already validated, was made and distributed to research subject to support their activities in this matriculation. Some instruments constructed such as pretest posttest question and question list of student interview and all of them had been validated by experts. The activities in SPS-based matriculation were aligned to the concept of two stage of Science Process Skill (SPS) which are basic SPS and integrated SPS. It actually included some process like observing, classifying, predicting and hypothesizing, inferring and investigating, constructing table and graph, describing relationship between variables, processing and analyzing data, and designing experiments (Darmaji et al., 2019).

Quantitative Data Collection

This research used one group pretest posttest design to gain quantitative data collection. Thirty five numbers of pretest and posttest questions were constructed based on content aspect of scientific literacy generated by PISA (Programme for International Student Assessment). The question focusing on biology and physic aspects. The result of pretest and posttest then descriptively analyzed by SPSS.

Qualitative Data Collection

Qualitative data collection was done after the SPS-based matriculation is officially done. Qualitative data was taken by interview to matriculants and asking about what actually they did during matriculation, how their feelings, benefit they take, and the whole responds to this matriculation.

Data Analysis and Integration of Data Results

Data were analyzed using both quantitative and qualitative approaches in accordance with the convergent parallel design. Quantitative data obtained from pretest posttest score processed using descriptive and inferential statistics through the SPSS software. Descriptive analysis included the calculation of means, standard deviations, and percentages, while inferential analysis was conducted using Wilcoxon tests to determine significant differences and relationships among variables. Qualitative data, on the other hand, were analyzed using thematic analysis. The interview transcripts were read several times to gain a deep understanding of students' experiences. Open coding was applied to identify meaningful result, which were then grouped into categories and resulted in thematic summary continuing to interpretation as a final result.

Result and Discussion

The results of this research reveal how the SPS-based matriculation program was implemented and how it contributed to enhance prospective elementary teacher scientific literacy. Table 1 show the descriptive statistic result of pretest and posttest score using SPSS software to find out the means, standard deviation, and maximum and minimum score.

Table 1. Descriptive Statistic Result of Pretest and Posttest Score

	Minimum score	Maximum score	Mean	Standard Deviation
Pretest	17.10	88.60	37.62	15.18
Posttest	31.40	88.60	54.53	13.66

The descriptive statistical results in Table 1 show an improvement in student performance after participating in SPS-based matriculation program. The mean score increased from 37.62 in the pretest to 54.53 in the posttest, indicating a notable enhancement in their scientific literacy. The minimum score also rose from 17.10 to 31.40, assuming that students with initially low performance benefited from this SPS-based matriculation. The standard deviation decreased slightly from 15.18 to 13.66, indicating that the variation in their scores became more consistent after the matriculation. These findings demonstrate that the SPS-based matriculation program not only improved student average performance of scientific literacy but also contributed to reduce learning disparities among them. Table 2 show the result of normality test of pretest-posttest score.

Table 2. Normality Test Result (Shapiro-Wilk) of Pretest and Posttest Score

	Statistic	df	Sig
Pretest	.866	24	.004
Posttest	.921	24	.060

Based on Table 2, the Shapiro–Wilk test results show that the pretest data have a significance value of 0.004, which is lower than 0.05, indicating that the pretest data are not normally distributed. Meanwhile, the posttest data have a significance value of 0.060, which is higher than 0.05, indicating that the posttest data are normally distributed. This Shapiro–Wilk test is then generally considered more reliable for small samples because the sample were just 24 (n < 50). Therefore, this result was used as the main reference for determining the normality of this data. The non-parametric test called Wilcoxon Signed-Rank Test was finally conducted to compare this pretest and posttest results. Table 3 show the result of Wilcoxon Signed-Rank Test.

Table 3. Result of Wilcoxon Signed-Rank Test

Total N	24
Test Statistic	269.000
Standard Error	32.799
Standardized Test Statistic	3.994
Asymptotic Sig. (2-sided test)	<.001

This Wilcoxon Signed-Rank Test at the end was conducted to determine the significant difference between the pretest and posttest score as the data did not fully meet the assumption of normality (Harris et al., 2013). Based on Table 3, a Z value of 3.994 with an Asymptotic Significance (2-tailed) of < .001, indicating a statistically significant difference between the pretest and posttest scores. This result suggests that the scientific literacy of prospective elementary teacher significantly improved after participating in the SPS-based matriculation. Table 4 show the result of N-gain analysis conducted to summarize the effectivity of this SPS-based matriculation.

The results of the N-Gain analysis presented in Table 4 show an average gain score of 0.25 with a standard deviation of 0.21, indicating a low-to-moderate level of the SPS-based matriculation effectiveness. The minimum and maximum N-Gain values ranged from -0.25 to 0.79, suggesting that while most students experienced notable progress, a few demonstrated limited or negative gains. This was assumed possibly due to differences in prior knowledge or engagement levels while having matriculation. According to Hake' classification, an N-Gain value below 0.3 falls into the low improvement category, while values between 0.3 and 0.7 are considered moderate (Hake, 1998). Therefore, the mean N-Gain of 0.25 indicates that the SPS-based matriculation program provided measurable but modest improvements in their scientific literacy. This result was aligned to another research result stated that a significant difference was found between the pretest and posttest scores of students' concept mastery after matriculation program was demonstrated (Abdurrahman et al., 2025). Students reported that they gradually adjusted to the learning process throughout the matriculation program. They also perceived the matriculation program could enrich their understanding of course content and facilitated their adaptation to the learning approaches (Lepertery et al., 2023).

Table 4. Descriptive Statistic Result of N-Gain

	Minimum	Maximum	Mean	Std. Deviation
Pretest	-8.60	42.90		
Posttest	-.25	0.79	.2467	.21552

Although the effectiveness of SPS-based matriculation was categorized as low, qualitative findings revealed that prospective elementary teacher gained greater motivation, new passion and confidence in learning science, new experience in doing experiment, and conceptual clarity of science and its phenomenon after completing the matriculation. Table 5 shows the interpretation of interview result of matriculants after they accomplished SPS-based matriculation.

The findings from the interviews provide valuable insights into the implementation of SPS-based matriculation and its role in equalizing the scientific literacy of prospective elementary teachers. Overall, the participants perceived this matriculation as beneficial in helping them reconnect to science learning, rebuild their confidence, and strengthen their conceptual understanding, although several challenges were also identified. The significant result observed in the Wilcoxon test aligned with the qualitative findings obtained from those student interviews. The changes in posttest as the increment in scientific literacy indicates that this matriculation had an effect in equalizing scientific literacy gap among them as there was better result after matriculation. This result was similar to the statement that participants in medical matriculation perform better than participants who were not covered (Schneid et al., 2022). Looking at many components worked in this SPS-based matriculation such as learning experiences with various method and media, kinds of experiment students did, lecture capabilities in delivering material, it was confirmed by the interview result that those aspects giving indirect impacts to their scientific literacy after matriculation. In another research result about matriculation in any field, it is stated that most matriculants stated that supporting components like infrastructure, lecturers, kind of material or content was actually giving huge supports for students to adapt into new academic life at the faculty (Lepertery et al., 2023).

Table 5. Interpretation of Interview Result of Matriculants toward Implementation of SPS-based Matriculation

Category	Thematic Summary	Interpretation Result
Readiness in attending science course	Different background in previous level of education made students a bit unready to attend science course	Students mostly came from different school and they learn deeply non-science major and rarely learning science. Students were not ready yet to fully attend science course with this background.
Passion in learning science	Different background in previous level of education made students have no passion in science learning	Students did not learn science for a long time and they also were not confident enough in attending science class. By having matriculation, students found their interest in science learning.
Implementation of SPS-based matriculation	Content of matriculation	Students thought that the content material delivered in matriculation was enough for them. Students got difficulties in learning physic than biology.
	Learning method in matriculation	Students thought that learning method applied in matriculation was quite varios such as experiment, discussion, presentation, direct observation, lecturing, and etc.
	Lecturer attending matriculation	Students thought that the lecturer who deliver the material was good enough in facilitating them in learning
	The duration of matriculation	Students thought that five days of matriculation was very enough for them to rebuild science understanding through matriculation Students felt that the time allocation for one session was not enough, especially when they had to accomplish their worksheet
	Learning material and media in matriculation	Students felt enjoyed with learning material and media used in matriculation as they could ease them in learning process
	Assessment in matriculation	Students thought that some questions could not be well-answered as they got difficulties in analyzing the questions, especially physic
	Module effectivity in some aspects	Students thought that the module should be improved in some aspects such as picture legibility, picture contrast, and procedure of activities
Benefit and impact of SPS-based matriculation	Students' reconnection to science concept	Students felt that they were reconnected to some science concept they already knew in this matriculation
	Motivation in learning science	Students felt this matriculation could motivate them to learn science
	Strengthening science concept	Students felt this matriculation could strengthen their science concept and understanding
SPS-based matriculation' difficulties	Science concept delivered is too much	Some students thought that the concept delivered in this matriculation was too much and they got difficulties
	Time allocation is quite minimum	While the science concept delivered was too much, but students didn't have much time to accomplish, for example when they had to fulfill the worksheet.

Based on the interview result, students said that they were lucky enough to be in SPS-based matriculation as it could reconnect and rebuild their perspective of science concept, strengthened their conceptual understanding, and built motivation to learn science more deeply. They also realized that their passions were started to rise after having matriculation. They got new experience in some experiment, using tools, looking forward the procedures, and it all motivate them to explore more in science. Besides, they also had more preparation to be ready in experience the first year of study, recognize how the process be conducted, adapt the new style of learning method in university and so on. These results were also in accordance with another research result that stated many students should be aware of the matriculation as

the beginning preparation to help them during the first year as so many knowledge provided regarding the subject they study later (Lepertery et al., 2023).

The implementation of the SPS-based matriculation was generally good for students, particularly in terms of the learning content, method, and facilitation by the lecturers. Students mentioned that the variety of learning methods helped them better engagement with the material and develop science process skills such as observing, hypothesizing, constructing table and graph, analyzing data, and communicating the results through many activities designed. Yet, looking at the descriptive result of N-Gain that summarized the effectivity of SPS-based matriculation, several challenges were identified. First, students' readiness to attend science courses actually affect to the effectivity of matriculation. Many students came from non-science majors during their previous studies, made diverse educational background in class, resulting in a lack of foundational scientific knowledge and confidence. This finding indicates the low-to-moderate effectivity of this matriculation affected by this aspect. It was actually aligned with the statement that academic readiness significantly affects the success of higher-level learning, particularly in scientific fields (Hanushek et al., 2020).

Second, regarding to students' passion and motivation in learning science, this SPS-based matriculation appeared to reignite their interest. Initially, most students lacked enthusiasm for science learning because they had not studied science for a long time. This indicated that students had low motivation and confidence in learning science and affect to their performance in scientific literacy. As other research result expressed, learning science and technology by participating active and hand-on experiment could stimulate individual confidence, interest, and desire toward science (Docherty-Skippen et al., 2020).

Third, some students reported challenges in understanding physics content compared to biology. They were involved in hands-on activity where they had to manage themselves not only in operating tools but also in calculating number in short and limited time. Besides, they were also to be active in analyzing and interpreting data, which probably a new thing yet turn into a cognitive load for them. The short duration of matriculation was also identified as both sufficient for review but insufficient for deep exploration, especially when completing worksheets or laboratory tasks.

Forth, in terms of learning materials and media, students appreciated the modules and visual aids, which they found helpful in clarifying science concepts. Nonetheless, they suggested several improvements, such as enhancing picture contrast and revising procedural instructions for better legibility and usability. Those aspects actually help them a lot when they have to learn independently by the existence of module. As stated by other research that a module has some benefits in learning process such as help teachers explain material more easily to understand, overcome the limitations of time, space and students' five sensory abilities, provide interesting learning materials and guides for students and train students' independent attitudes in learning (Yuniharto et al., 2024). Therefore, in this research, when a module is lack of legibility and usability, it might an aspect that affect the result of scientific literacy and the effectivity of matriculation.

In summary, the SPS-based matriculation program actually functioned as an effort to equalize prospective elementary teacher' scientific literacy by fostering readiness, motivation, and science conceptual reinforcement among students from diverse educational backgrounds. These findings reinforce other implementation of this kind of preparatory programs which consider to adjust duration, material complexity, and module effectivity. Besides, structured and contextualized approach used in SPS-based matriculation could be ensured to more equitable and comprehensive learning experiences. The integration of these findings suggests that the SPS-based matriculation program successfully initiated a positive learning trajectory, but continuous support and scaffolding are essential to sustain and strengthen prospective elementary teacher' scientific literacy.

Conclusion

This study explored the implementation of an SPS-based matriculation program for prospective elementary teachers, focusing on its role in equalizing scientific literacy. The quantitative results showed a significant increase in posttest scores compared to pretest scores, as indicated by the Wilcoxon Signed-Rank Test ($Z = 3.994$, $p < .001$). However, the mean N-Gain score of 0.25 reflected a low-to-moderate level of improvement, suggesting that further reinforcement is needed to achieve greater effectiveness. The qualitative findings complemented these results, revealing that participants experienced increased readiness, motivation, confidence, and engagement throughout the program, although some challenges were still encountered. Overall, the SPS-based matriculation program functioned as a preparatory activity to support the equalization of scientific literacy before students entered formal coursework. These findings suggest that such programs should be sustained and strengthened through follow-up enrichment activities, continuous support, and appropriate scaffolding to ensure more consistent learning gains. Future research is recommended to examine the long-term impact of SPS-

based matriculation when integrated into the broader curriculum to support scientific literacy enhancement.

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Conflicts of Interests
The authors declare no conflict of interest. The funding institution had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

Abdurrahman, Z., Abidin, M., & Yurisa, P. R. (2025). Pengaruh Program Matrikulasi Bahasa Arab terhadap Peningkatan Level Kognitif Bahasa Arab. *JIIP - Jurnal Ilmiah Ilmu Pendidikan*, *8*(10), 11673–11679. https://doi.org/10.54371/jiip.v8i10.9771

Afaria, Z. (2020). Pengaruh Program Matrikulasi terhadap Kemampuan Berbahasa Arab Mahasiswa Baru Pendidikan Bahasa Arab. *Tatsqifiy: Jurnal Pendidikan Bahasa Arab*, *1*(2), 101–111. https://doi.org/10.30997/tjpba.v1i2.2803

Afrida, N., Waty, S., & Hidayani, N. (2019). The Role of "Matriculation" As Influential Factor Contributing To the Students'English Performance. *Elite Journal*, *1*(2), 187–200. Retrieved from https://elitejournal.org/index.php/ELITE/article/view/24

Aka, E. I., Güven, E., & Aydoğdu, M. (2010). Effect of problem solving method on science process skills and academic achievement. *Journal of Turkish Science Education*, *7*(4), 13–25. Retrieved from http://www.tused.org/index.php/tused/article/download/533/459

Asrial, Syahrial, Kurniawan, D. A., Perdana, R., & Nugroho, P. (2019). Supporting Technology 4.0: Ethoconstructivist multimedia for elementary schools. *International Journal of Online and Biomedical Engineering*, *15*(14), 54–66. https://doi.org/10.3991/ijoe.v15i14.11365

Awuonda, M. K., Akala, E., Wingate, L. T., Weaver, S. B., Brown, K., Williams-Fowlkes, C., & Tofade, T. (2021). A Pre-matriculation Success Program to Improve Pharmacy Students' Academic Performance at a Historically Black University. *American Journal of Pharmaceutical Education*, *85*(6), 8214. https://doi.org/10.5688/ajpe8214

Blanchard, M. R., Southerland, S. A., & Granger, E. M. (2009). No silver bullet for inquiry: Making sense of teacher change following an inquiry-based research experience for teachers. *Science Education*, *93*(2), 322–360. https://doi.org/10.1002/sce.20298

Chin, C. (2005). First-year Pre-service Teachers in Taiwan—Do they enter the teacher program with satisfactory scientific literacy and attitudes toward science? *International Journal of Science Education*, *27*(13), 1549–1570. https://doi.org/10.1080/09585190500186401

Cohen, L., Manion, L., Lecturer, P., Morrison, K., & Lecturer, S. (2007). *Research Methods in Education*. Routledge is an imprint of the Taylor & Francis Group, an informa business.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Darmaji, D., Kurniawan, D. A., Parasdila, H., & Irdianti, I. (2018). Deskripsi Keterampilan Proses Sains Mahasiswa pada Materi Termodinamika. *Berkala Ilmiah Pendidikan Fisika*, *6*(3), 345. https://doi.org/10.20527/bipf.v6i3.5290

Darmaji, D., Kurniawan, D. A., & Suryani, A. (2019). Effectiveness of Basic Physics II Practicum Guidelines Based On Science Process Skills. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *4*(1), 1. https://doi.org/10.26737/jipf.v4i1.693

Darmaji, Maison, Astalini, & Rahayu, A. (2018). Model Problem Solving Development Physics Practical Guided Based on Science Process Skill Using Problem Solving. *Edusains*, *10*(1). https://doi.org/10.15408/es.v10i1.7248

Derilo, R. C. (2019). Basic And Integrated Science Process Skills Seventh-Grade Learners. *European Journal of Education Studies*, *6*(1), 281–294. https://doi.org/10.5281/zenodo.2652545

Docherty-Skippen, S. M., Karrow, D., & Ahmed, G. (2020). The Influence of Hands-On Experimentation and Inquiry-Based Learning in

Elementary Science and Technology (S&T) Education. *Brock Education Journal*, *29*(1), 24. https://doi.org/10.26522/brocked.v29i1.768

Driver, R., Asoko, H., Leach, J., Scott, P., & Mortimer, E. (1994). Constructing Scientific Knowledge in the Classroom. *Educational Researcher*, *23*(7), 5–12. https://doi.org/10.3102/0013189X023007005

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record*, *103*(6), 1013–1055. https://doi.org/10.1111/0161-4681.00141

Fikri, M., Kholid, N., Kholid, M. R., Raden, U., & Lampung, I. (2025). English Proficiency Matriculation Module Rejuvenation Based On Critical Digital Pedagogy. *Journal of English Language Teaching and Learning (JELTL)*, *6*(1), 27–34. https://doi.org/10.33365/jeltl.v6i1.366

Foster, J., & Shiel-Rolle, N. (2011). Building scientific literacy through summer science camps: a strategy for design, implementation and assessment. *Science Education International*, *22*(2), 85–98. Retrieved from http://www.icaseonline.net/sei/june2011/p1.pdf

Gizaw, G., & Sota, S. S. (2023). Improving Science Process Skills of Students: A Review of Literature. *Science Education International*, *34*(3), 216–224. https://doi.org/10.33828/sei.v34.i3.5

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1), 64–74. https://doi.org/10.1119/1.18809

Hanushek, E. A., & Woessmann, L. (2020). *The knowledge capital of nations: Education and the economics of growth*. MIT Press.

Harris, T., & Hardin, J. W. (2013). Exact Wilcoxon Signed-Rank and Wilcoxon Mann–Whitney Ranksum Tests. *The Stata Journal: Promoting Communications on Statistics and Stata*, *13*(2), 337–343. https://doi.org/10.1177/1536867X1301300208

Heck, A. J., Gibbons, L., Ketter, S. J., Furlano, A., & Prest, L. (2017). A Survey of the Design of Pre-matriculation Courses at US Medical Schools. *Medical Science Educator*, *27*(2), 229–236. https://doi.org/10.1007/s40670-017-0379-3

Hume, A. (2009). Authentic Scientific Inquiry and School Science. *Teaching Science*, *55*(2), 35–41. Retrieved from http://search.ebscohost.com.ezproxy.liv.ac.uk/login.aspx?direct=true&db=eric&AN=EJ871160&site=eds-live&scope=site%5Cnhttp://www.asta.edu.au/resources/teachingscience

Husna, N., Halim, A., Evendi, E., Syukri, M., Nur, S., Elisa, E., & Khaldun, I. (2022). Impact of Science Process Skills on Scientific Literacy. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 2123–2129. https://doi.org/10.29303/jppipa.v8i4.1887

Jamilah, Astuti, Y. P., & AR, M. M. (2023). Implementation of the Campus Teaching Program Batch 3 in Building Scientific Literacy in Elementary Schools. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 5140–5149. https://doi.org/10.29303/jppipa.v9i7.4049

Kähler, J., Hahn, I., & Köller, O. (2020). The development of early scientific literacy gaps in kindergarten children. *International Journal of Science Education*, *42*(12), 1988–2007. https://doi.org/10.1080/09500693.2020.1808908

Koyunlu-Ünlü, Z. (2020). Improving pre-service teachers' science process skills and views about scientific inquiry. *Journal of Theoretical Educational Sciences*, *13*(3), 474–489. https://doi.org/10.30831/akukeg.626165

Lepertery, J. W., Taihuttu, Y. M. J., & Titaley, C. R. (2023). Effectiveness Of Biomedical Matriculation Faculty Of Medicine (A Qualitative Study). *Jurnal Pendidikan Kedokteran Indonesia: The Indonesian Journal of Medical Education*, *12*(3), 305. https://doi.org/10.22146/jpki.82819

Lotter, C., Harwood, W. S., & Bonner, J. J. (2007). The influence of core teaching conceptions on teachers' use of inquiry teaching practices. *Journal of Research in Science Teaching*, *44*(9), 1318–1347. https://doi.org/10.1002/tea.20191

Marshall, J. C., Horton, R., Igo, B. L., & Switzer, D. M. (2009). K-12 science and mathematics teachers' beliefs about and use of inquiry in the classroom. *International Journal of Science and Mathematics Education*, *7*(3), 575–596. https://doi.org/10.1007/s10763-007-9122-7

Mulyani, H., Zulkarnaen, R. H., & Hernisa, Y. (2025). The Profile Analysis of Prospective Elementary Teacher' Scientific Literacy as an Initial Strategy to Conduct Science Courses. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 1215–1223. https://doi.org/10.29303/jppipa.v11i1.9822

Nguyen, M., Mason, H. R. C., Barrie, U., Jeffe, D. B., Cavazos, J. E., Ata, A., & Boatright, D. (2022). Association Between Socioeconomic Background and MD-PhD Program Matriculation. *Journal of General Internal Medicine*, *37*(7), 1794–1796. https://doi.org/10.1007/s11606-021-06962-8

Norris, S. P., Phillips, L. M., & Burns, D. P. (2014). Conceptions of Scientific Literacy: Identifying and Evaluating Their Programmatic Elements. In *International Handbook of Research in History, Philosophy and Science Teaching* (pp. 1317–1344). Springer Netherlands.

https://doi.org/10.1007/978-94-007-7654-8_40

Noviantari, I. (2021). Matriculation: A Program to Increase the Initial Ability of Mathematics Education Student. *Proceedings of the 2nd International Conference on Innovation in Education and Pedagogy (ICIEP 2020*, 85–87. https://doi.org/10.2991/assehr.k.211219.016

OECD. (2018). *PISA for Development Assessment and Analytical Framework: Reading, Mathematics and Science*. OECD Publishing.

Ohland, M., Brawner, C., Chen, X., & Orr, M. (2018). A Comparative Study of Engineering Matriculation Practices. *2014 ASEE Annual Conference & Exposition Proceedings*. https://doi.org/10.18260/1-2--19924

Osborne, J. (2007). Science Education for the Twenty First Century. *EURASIA Journal of Mathematics, Science and Technology Education*, *3*(3), 173–184. https://doi.org/10.12973/ejmste/75396

Prayitno, B. A., Corebima, D., Susilo, H., Zubaidah, S., & Ramli, M. (2017). Closing The Science Process Skills Gap Between Students With High And Low Level Academic Achievement. *Journal of Baltic Science Education*, *16*(2), 266–277. https://doi.org/10.33225/jbse/17.16.266

Schneid, S. D., Fricovsky, E. S., Loehr, P. G., & Kim, J. G. (2022). A pipeline for health systems science in postbaccalaureate premedical programmes. *Medical Education*, *56*(5), 568–569. https://doi.org/10.1111/medu.14757

Sopacua, V., & Sopacua, F. (2024). Improving the Ability to Analyze Kinematics Problems Through the Matriculation Program. *Journal of Science and Science Education*, *5*(2), 129–132. Retrieved from https://jppipa.unram.ac.id/index.php/jossed/article/download/9034/6168

Vieira, R. M., & Tenreiro-Vieira, C. (2016). Fostering Scientific Literacy and Critical Thinking in Elementary Science Education. *International Journal of Science and Mathematics Education*, *14*(4), 659–680. https://doi.org/10.1007/s10763-014-9605-2

Yuniharto, B. S., Pardimin, & Nisa, A. F. (2024). Innovation of Edupreneurship-based Science Literacy Module to Increase Independent Dimensions of Elementary School Students. *International Journal of Elementary Education*, *8*(2), 239–248. https://doi.org/10.23887/ijee.v8i2.68807

Zamista, A. A. (2016). Pengaruh Model Pembelajaran Process Oriented Guided Inquiry Learning Terhadap Keterampilan Proses Sains Dan Kemampuan Kognitif Siswa Pada Mata Pelajaran Fisika. *Edusains*, *7*(2). https://doi.org/10.15408/es.v7i2.1815

Zeidan, A. H., & Jayosi, M. R. (2014). Science Process Skills and Attitudes toward Science among Palestinian Secondary School Students. *World Journal of Education*, *5*(1), 13–24. https://doi.org/10.5430/wje.v5n1p13