

The Development of Beginner Teacher Professionalism in Student Involvement

Dandan Luhur Saraswati^{1,2*}, Ari Widodo¹

¹ Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam, Universitas Pendidikan Indonesia, Bandung, Indonesia.

² Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Indraprasta PGRI, Jakarta, Indonesia.

Received: June 14, 2023

Revised: October 19, 2023

Accepted: November 25, 2023

Published: November 30, 2023

Corresponding Author:

Dandan Luhur Saraswati

dandanluhur@gmail.com

DOI: [10.29303/jppipa.v9i11.4291](https://doi.org/10.29303/jppipa.v9i11.4291)

© 2023 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: Student involvement is a critical element in effective learning and has a positive impact on the dynamics of the teaching and learning process. This research aims to evaluate the extent to which novice teachers develop their abilities in involving students in learning. The method used was descriptive qualitative research. Research data was collected through three methods namely, observation, interviews, and documentation, all of which were carried out during the implementation of a training program that focused on student engagement techniques. The results of this research conclude that emotional relationships between teachers and students, as well as relationships between students, have a positive effect on students' social and academic development. Apart from that, the level of teacher education also contributes to their level of professionalism, especially in the context of techniques for involving students in learning. These findings emphasize the importance of creating strong emotional bonds between teachers and students and encouraging positive student interactions. In addition, teachers' level of education plays a key role in developing their skills, especially in efforts to engage students effectively in the learning process. This research provides valuable insights into the critical elements influencing teaching quality and teacher professional development.

Keywords: Beginning teacher; Student involvement; Teacher professionalism

Introduction

Student involvement is an important aspect of quality teaching and has a positive impact on the teaching process (Falcon et al., 2023; Ibnusaputra et al., 2023). For professional teachers, student involvement plays a central role because it allows them to actively participate in learning, thereby increasing motivation, understanding, and retention of teaching materials (Washauer et al. 2023; Falcon et al., 2023; Dasmo, 2020). When students feel enthusiastic about learning, they tend to be enthusiastic in learning, have better critical thinking skills, and develop social and collaborative skills (Triutama et al., 2023). Apart from that, teachers can create an inclusive learning environment and provide better learning outcomes (Howell, 2021; Alike & Radia, 2021; Arisa et al., 2021). Therefore, student engagement is at the core of effective teaching practice and the key to a teacher's professional success.

Teachers are professional educators who have important duties, obligations, and responsibilities in shaping people's lives (Homes et al. 2022). Professional teachers are expected to contribute to national development, excel in science and technology and have ethical morals and personalities (Zeng, 2023; Wang & Zhang, 2023). So, it can be said that the future of society, nation, and state is largely determined by teachers. Therefore, the teaching profession must be improved and developed proportionally according to the teacher's functional position. As educators, teachers must realize that they have duties and responsibilities in guiding students (Jamaludin & Batlolona, 2021). To achieve learning goals, a teacher must continue to develop himself and improve his competence. Teachers, school principals, and foundations are required to provide continuous professional development (PKB) to build their capacity (Caena & Redecker, 2019).

How to Cite:

Saraswati, D. L., & Widodo, A. (2023). The Development of Beginner Teacher Professionalism in Student Involvement. *Jurnal Penelitian Pendidikan IPA*, 9(11), 9300–9306. <https://doi.org/10.29303/jppipa.v9i11.4291>

One step in supervising PKB teachers is to carry out teacher performance assessments (PKG). This teacher evaluation aims to help teachers develop into professional educators (Alvianita et al., 2022; Zahara et al., 2022). So that teachers can provide educational services to students through quality learning activities. Law on Teachers and Lecturers Number 14 of 2005 states that teachers are professional educators. In their professionalism, teachers carry out educational tasks which are a series of teaching and learning processes that prioritize a teacher's professional competence. In the learning process, the teacher acts as a facilitator and instrument (Hapsari et al., 2021; Agustian et al., 2022; Munawir et al., 2022). Learners must try to gain understanding or knowledge about themselves so that changes in knowledge, behavior, and attitudes occur (Hamedinasab et al., 2023; Yanto, 2019). Pedagogical competence is the ability to understand students, plan and implement learning, assess learning outcomes, and make students fulfill various possibilities. The importance of a teacher's professional competence means that research is needed on the professional competence of teachers, especially physics teachers at the high school level. Teacher professional competence in physics learning is a requirement that teachers must have to improve their abilities and skills in providing teaching in the field of physics so that the teaching and learning process can run optimally (Batlolona & Jamaludin, 2022; Sorge, 2019; Usmeldi, 2016).

The demand to meet the needs of professional teachers is an essential requirement in efforts to improve the quality of education and the teaching and learning process in schools (Wang & An, 2023). Efforts to improve the quality of education and learning must be a continuous focus for the government and all parties involved in the process. Teachers who achieve professional status must have in-depth knowledge of teaching materials, student characteristics, teaching methods, and learning resources (Eßling, 2023; Susilawati et al., 2022). Thus, it cannot be denied that a teacher must have extensive knowledge of various learning materials, understand pedagogical theory and practice, and have a deep understanding of the curriculum and teaching methods. Given this context, this research emerged in response to the desire to understand the extent to which novice teachers have achieved their professionalism in terms of engaging students in the learning process.

Method

In this research, researchers used a descriptive qualitative approach. The qualitative approach is the most important approach to fulfill the social phenomena

and individual perspectives being studied (Hadi, 2021). The main aim is to describe, study, and explain the phenomenon, researchers are also involved in the situation of the phenomenon being studied. In the process of collecting research data, participants were given training regarding student involvement with stages as shown in Figure 1.

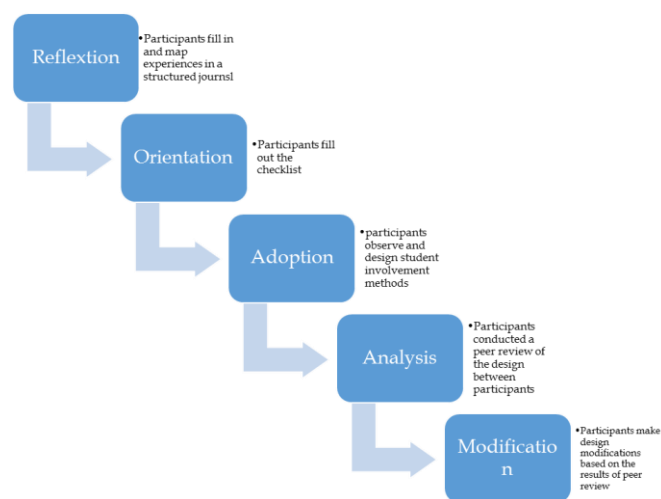


Figure 1. Flow of student involvement training as stages of research data collection

Result and Discussion

The quality of a teacher in the classroom is reflected through his or her qualifications, which emerge through the professional understanding and expertise required for teaching activities (Schwab, 2022). This qualification can be obtained through various pathways, including formal education or experience (Marjuni & Suban, 2020; Nadar & Hardiyanto, 2021). The basic concept of competency refers to abilities or skills that reflect the quality of an individual, both in qualitative and quantitative aspects, as explained by Damanik (2019).

Competency refers to an individual's knowledge, skills, and capabilities in carrying out various types of behavior, which include cognitive, affective, and psychomotor aspects, as well as possible. These are abilities that involve two main dimensions, namely intellectual abilities and physical abilities, which enable individuals to carry out various tasks required in the context of a particular job or situation. Success in the mental aspect refers to the ability to carry out tasks that require thinking activity, while success in the physical aspect involves the ability to carry out tasks that require endurance, dexterity, strength, and flexibility. Overall, competencies are understood as the basic attributes of individuals that influence their

performance effectively and superiorly in various work contexts and situations.

An engagement-based learning and teaching approach forms the basis for developing and strengthening student engagement and the overall learning process. This foundation is built through the application of specific principles, habits, skills, and strategies. In this framework, research by McKellar et al. (2020) identified three domains of student engagement, namely the cognitive domain which includes beliefs and values, the emotional domain which includes motivation and feelings, and the behavioral domain which includes habits and skills (Lancaster & Lundberg, 2019).

In facing the challenge of less-than-optimal student performance, teachers need to start reflecting on the factors that play a role in increasing student engagement (Salas et al., 2022). Teachers can directly control some of these aspects and work out necessary changes. However, to achieve more significant change, considerable time and effort are required, from both students and teachers, to develop new skills. Improvements in student engagement can depend largely on careful planning as well as efforts to find new solutions or make relevant changes at the school-wide level. The following is Table 1 of the results of filling out the initial activity questionnaire before the student involvement training was carried out:

Table 1. Results of Filling out the Initial Activity Questionnaire before Student Involvement Training is Implemented

| Indicator | Answer |
|---|---|
| Last education | 62,5% S1, 8,3 % PPG, and 29,2 % S2 |
| Teaching Experience | 60,7 % : 1-5 th, 14,3% : 6-10 th, 17,9% 11-15th, and 7,1% more than 15th |
| Previous training experience | Independent curriculum, ICT, ESQ, scientific literacy instructor, and never before |
| How to provide opportunities to students | <ul style="list-style-type: none"> - Usually, before I start class, I ask how the children are doing that day, as well as attendance... when the children are starting to enjoy it, then I review a little of the material that was taught at the previous meeting, and after that, I ask a few questions related to it and I give a break for The children pay attention and at the same time they prepare books, etc. - Ask how students are doing, and tell students to take out their science textbooks and put away other textbooks. - Ask students to study first from home so that they are ready to learn about the material that will be discussed. |
| How to know if students are ready to take lessons | <ul style="list-style-type: none"> - By checking the condition and equipment of students - Can answer short questions when I review the material before starting the lesson. - His sitting posture, his focus. |
| How to find out that students are having difficulty following lessons | <ul style="list-style-type: none"> - Doesn't follow lessons well, daydreams, falls asleep, and talks to friends. - Look at the condition of each student, because usually from their body gestures you can see that the student is experiencing difficulties. - Ask students about the difficulties they experience. |
| How to create two-way communication between students in learning | <ul style="list-style-type: none"> - Stimulate with questions by relating the concepts learned to their lives, call one or two people to answer, and ask others to comment. - Question and answer. |
| Active learning model used to attract students | <ul style="list-style-type: none"> - PBL - Discussion - Jigsaw - Peer tutor - Barcode games |



Research data was obtained through the use of three methods, namely observation, written and oral interviews, and documentation, all of which were carried out during the implementation of a training program focused on student engagement techniques. Apart from the eight indicators in Table 1, the

researcher also asked for initial knowledge regarding student involvement, for example, what are the characteristics of student involvement in learning, what are the examples, why is it necessary to involve students in learning, how to teach the material in the classroom and so on. The research results were then

analyzed by the researcher using a qualitative descriptive method, which means that the researcher described, explained, and provided an interpretation of all the data collected, to obtain a deep and comprehensive understanding of the research topic.

During the research process, from the initial 20 participants, only 12 high school physics teachers still participated in the research. They consist of eight female teachers and four male teachers from West Java, West Kalimantan, and West Sumatra. The educational backgrounds of research participants are very diverse, ranging from first-level, and second-level, to the Teacher Professional Education Program (PPG). Survey results show that teachers have participated in various types of training, including training in implementing the independent curriculum, scientific literacy, assessment, and information and communication technology (ICT) in learning. The interesting thing about filling out the questionnaire is that as many as 68.8% of teachers stated that they had involved students by the theory of dimensions of student involvement and as many as 31.3% had not done so. However, on the next question related to confirmation of the theory of dimensions of involvement, it was found that only 33% answered correctly. So based on these results, researchers believe that student involvement training is very important to carry out.

Table 2. Materials and Logbooks Used During Training

| | |
|---|--|
|  <p>Material</p> |  <p>Logbook</p> |
|---|--|

In the framework of this research, the participants have received training on how to implement the model developed by the researchers, known as the ROAdSiMo model. The ROAdSiMo model details the training process, including reflection, orientation, adoption, analysis, and modification. During the training process, participants engage in a series of activities that include reflection, orientation, adoption, analysis, and modification. Reflection is where participants are asked to record and map their experiences in a structured journal, to reflect on their experiences and learning. Orientation where they fill out a checklist designed to help them understand the basic concepts related to the ROAdSiMo model. Adoption When Participants pay attention and try to design student engagement methods based on the guidelines provided in the ROAdSiMo model. Analysis means that participants peer-review designs created by fellow participants, to provide feedback and evaluation of their approaches. This modification is a stage carried out by participants based on the results of peer review, participants can then modify their designs to improve and improve student engagement approaches. The ROAdSiMo model aims to provide a systematic framework for participants to engage students in the learning process, and the steps help them better understand, apply, and improve student engagement.

Based on the results of data analysis of 12 novice class teachers who took part in teacher professional development to involve students, it is known as follows:

Emotional Involvement

A teacher's efforts to help students' social and emotional development in the classroom through facilitating interactions between teachers, students, and fellow students is a key component in carrying out effective learning. Students who have a stronger emotional connection to their teachers and classmates often show positive development in social and academic aspects. This finding is supported by the results of research conducted by Schwab and his colleagues in 2022. Within this scope, this research focuses on behavioral interactions related to creating a conducive emotional climate, the level of teacher sensitivity to student needs, and the teacher's ability to appreciate the student's view.

Teaching with high sensitivity requires a teacher to have the ability to understand, process, and respond to various information simultaneously. For example, during a group learning session, a sensitive teacher may sequentially notice several children who

may not be fully focused, notice a student who is experiencing frustration about not understanding a particular question, and also notice a sad expression on a student who is usually cheerful. Teachers who have this high level of sensitivity are not only able to pick up on subtle signals from their students but also know those students well enough that they can respond in ways that help overcome problems that arise. The emotional support provided by teachers allows them to design learning and interactions based on student interests and motivation, thereby creating a more meaningful and immersive learning environment.

Interaction between Teachers and Students

Preliminary analyses have identified consistent support in predicting student achievement and social benefits across multiple levels of teacher-student interaction dimensions. In addition, it was found that the behavior of different teachers showed a significant degree of instability over time, which depended greatly on the type of activity taking place. In the context of relational and attachment theory, these findings emphasize the importance of conceptualizing and evaluating these interactions during the learning process in understanding the qualities of relationships that provide encouragement and reflect levels of engagement.

Several suggestions that can be implemented to improve relationships and interactions between teachers and students include increasing teachers' understanding and awareness of the dynamics of their interactions with students. In addition, it is important to have ongoing support for teachers in carrying out their role as learning facilitators in terms of student-teacher relationships. Individual feedback regarding teacher interactions with students is also a key factor in these improvement efforts. Intervention by teachers, implemented in a coordinated manner, is an important step in encouraging and sustaining this change, especially considering the systemic nature of the relationships and interactions between teachers and students in the classroom environment.

Student Involvement Skills

In terms of its ability to involve students, researchers evaluated the results of the lesson plans that had been created by prospective teachers. In a sample consisting of 12 prospective teachers, 8 of them have demonstrated adequate understanding in designing lesson plans that encourage student participation. Prospective teachers who already have this understanding usually have an undergraduate educational background and experience in the

Teacher Professional Education Program (PPG). Therefore, in the context of this research, the researcher raises the hypothesis that the academic level of prospective teachers plays an important role in developing their professionalism, especially in the technical aspects of involving students in the learning process.

Conclusion

The conclusion from the discussion above is that the emotional relationship between students and teachers as well as relationships with peers have a positive impact on students' social and academic development. The quality of interactions between teachers and students plays an important role in encouraging student engagement in learning. In addition, teachers' academic level also contributes to their professional development, especially in the context of student engagement techniques.

Acknowledgments

The researchers would like to thank Puspaldik for providing scholarship funds for further studies.

Author Contributions

D.L.S as a drafter and writer of the draft article. A.W. as instrument supervisor and validator.

Funding

The publication of this article was funded by Puslapdik.

Conflicts of Interest

In this article, the author declares that there is no conflict of interest.

References

- Agustian, Y., Mulyaningsih, N. N., & Saraswati, D. L. (2022). Developing Hots Test Instruments in Computer-Based Exams on Rotational Dynamics and Rigid Bodies. *JPP (Jurnal Pendidikan dan Pembelajaran)*, 28(2), 72-78. <http://dx.doi.org/10.17977/um047v28i22021p072>
- Alika, O., & Radia, E. H. (2021). Development of learning media based on cross-puzzle games in science learning to improve learning outcomes. *Jurnal Penelitian Pendidikan IPA*, 7(2), 173-177. <https://doi.org/10.29303/jppipa.v7i2.667>
- Alvianita, C., Tanti, T., & Hariyadi, B. (2022). Construction and Validation of Evaluation Instruments for Science Learning Programs Based on Context, Input, Process, And Product (CIPP) Models. *Jurnal Penelitian Pendidikan IPA*, 8(3), 1089-1095. <https://doi.org/10.29303/jppipa.v8i3.1369>

- Arisa, S. N., Khaldun, I., & Safrida, S. (2021). The Effect of Search, Solve, Create and Share Learning Models to Improve Students' Critical Thinking Skills on Acid and Basic Titration Materials. *Jurnal Penelitian Pendidikan IPA*, 7(2), 191. <https://doi.org/10.29303/jppipa.v7i2.625>
- Batlolona, J. R., & Jamaludin, J. (2022). Physics problem-solving skills with IBL-STEMWeb: Students on Small Islands in Maluku. *Jurnal Penelitian Pendidikan IPA*, 8(2), 592-598. <https://doi.org/10.29303/jppipa.v8i2.1344>
- Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st-century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, 54(3), 356-369. <https://doi.org/10.1111/ejed.12345>
- Damanik, R. (2019). Hubungan Kompetensi Guru dengan Kinerja Guru. *Jurnal Serunai Administrasi Pendidikan*, 8(2). <https://doi.org/10.37755/jsap.v8i2.170>
- Dasmo, D., Saraswati, D. L., & Okyranida, I. Y. (2020). Peningkatan Kompetensi Guru melalui Pembelajaran Peta Konsep (Mind Map). *Jurnal PkM (Pengabdian kepada Masyarakat)*, 3(2), 158-164. <http://dx.doi.org/10.30998/jurnalpkm.v3i2.4276>
- Eßling, I., Todorova, M., Sunder, C., Steffensky, M., & Meschede, N. (2023). The development of professional vision in pre-service teachers during initial teacher education and its relationship to beliefs about teaching and learning. *Teaching and Teacher Education*, 132, 104250. <https://doi.org/10.1016/j.tate.2023.104250>
- Falcon, S., Admiraal, W., & Leon, J. (2023). Teachers' engaging messages and the relationship with students' performance and teachers' enthusiasm. *Learning and Instruction*, 86, 101750. <https://doi.org/10.1016/j.learninstruc.2023.101750>
- Falcon, S., Alonso, J. B., & Leon, J. (2023). Teachers' engaging messages, students' motivation to learn and academic performance: The moderating role of emotional intensity in speech. *Teaching and Teacher Education*, 136, 104375. <https://doi.org/10.1016/j.tate.2023.104375>
- Hadi, A. (2021). *Penelitian kualitatif studi fenomenologi, case study, grounded theory, etnografi, biografi*. CV. Pena Persada.
- Hamedinasab, S., Ayati, M., & Rostaminejad, M. (2023). Teacher professional development pattern in virtual social networks: A grounded theory approach. *Teaching and Teacher Education*, 132, 104211. <https://doi.org/10.1016/j.tate.2023.104211>
- Hapsari, F., Desnaranti, L., & Wahyuni, S. (2021). Peran guru dalam memotivasi belajar siswa selama kegiatan pembelajaran jarak jauh. *Research and Development Journal of Education*, 7(1), 193-204. <http://dx.doi.org/10.30998/rdje.v7i1.9254>
- Holmes, A. F., Webb, K. J., & Albritton, B. R. (2022). Connecting students to the community: Engaging students through course-embedded service-learning activities. *The International Journal of Management Education*, 20(1), 100610. <https://doi.org/10.1016/j.ijme.2022.100610>
- Howell, R. A. (2021). Engaging students in education for sustainable development: The benefits of active learning, reflective practices and flipped classroom pedagogies. *Journal of Cleaner Production*, 325, 129318. <https://doi.org/10.1016/j.jclepro.2021.129318>
- Ibnusaputra, M., Wilujeng, I., & Kuswanto, H. (2023). Development of Electronic Worksheet Guided Inquiry to Reduce Misconceptions and Improve High School Students' Concept Mastery of Straight Motion Material. *Jurnal Penelitian Pendidikan IPA*, 9(5), 2653-2663. <https://doi.org/10.29303/jppipa.v9i5.2738>
- Jamaludin, J., & Batlolona, J. R. (2021). Analysis of Students' Conceptual Understanding of Physics on the Topic of Static Fluids. *Jurnal Penelitian Pendidikan IPA*, 7(SpecialIssue), 6-13. <https://doi.org/10.29303/jppipa.v7iSpecialIssue.845>
- Lancaster, J. R., & Lundberg, C. A. (2019). The influence of classroom engagement on community college student learning: A quantitative analysis of effective faculty practices. *Community College Review*, 47(2), 136-158. <https://doi.org/10.1177/0091552119835922>
- Marjuni, A., & Suban, A. (2020). Profil guru harapan masa depan. *Al asma: Journal of Islamic Education*, 2(1), 13-22. <https://doi.org/10.24252/asma.v2i1.13361>
- McKellar, S. E., Cortina, K. S., & Ryan, A. M. (2020). Teaching practices and student engagement in early adolescence: A longitudinal study using the Classroom Assessment Scoring System. *Teaching and Teacher Education*, 89, 102936. <https://doi.org/10.1016/j.tate.2019.102936>
- Munawir, M., Salsabila, Z. P., & Nisa, N. R. (2022). Tugas, Fungsi dan Peran Guru Profesional. *Jurnal Ilmiah Profesi Pendidikan*, 7(1), 8-12. <https://doi.org/10.29303/jipp.v7i1.327>
- Nadar, W., Yuni, Y., & Hardiyanto, L. (2021). Peningkatan kualitas kompetensi guru PAUD:

- Menjadi guru profesional. *Jurnal Abdimas Prakasa Dakara*, 1(1), 38-45.
<https://doi.org/10.37640/japd.v1i1.945>
- Salas-Pilco, S. Z., Yang, Y., & Zhang, Z. (2022). Student engagement in online learning in Latin American higher education during the COVID-19 pandemic: A systematic review. *British Journal of Educational Technology*, 53(3), 593-619.
<https://doi.org/10.1111/bjet.13190>
- Schwab, S., Markus, S., & Hassani, S. (2022). Teachers' feedback in the context of students' social acceptance, students' well-being in school and students' emotions. *Educational Studies*, 1-18.
<https://doi.org/10.1080/03055698.2021.2023475>
- Sorge, S., Kröger, J., Petersen, S., & Neumann, K. (2019). Structure and development of pre-service physics teachers' professional knowledge. *International Journal of Science Education*, 41(7), 862-889.
<https://doi.org/10.1080/09500693.2017.1346326>
- Susilawati, A., Yusrizal, Y., Halim, A., Syukri, M., Khaldun, I., & Susanna, S. (2022). The effect of using physics education technology (PhET) simulation media to enhance students' motivation and problem-solving skills in learning physics. *Jurnal Penelitian Pendidikan IPA*, 8(3), 1166-1170. <https://doi.org/10.29303/jppipa.v8i3.1571>
- Triutama, I. S., Dasmo, D., & Saraswati, D. L. (2023). Upaya Peningkatan Pemahaman Konsep Fisika Melalui Penerapan Model Pembelajaran Kooperatif Tipe Number Heads Together. *Schrodinger Jurnal Ilmiah Mahasiswa Pendidikan Fisika*, 4(1), 8-12.
<https://doi.org/10.30998/sch.v4i1.8500>
- Usmeldi, U. (2016). The Development of Research-Based Physics Learning Model With Scientific Approach To Develop Students' scientific Processing Skill. *Jurnal Pendidikan IPA Indonesia*, 5(1), 134-139.
<https://doi.org/10.15294/jpii.v5i1.5802>
- Wang, M., & Zhang, L. J. (2023). Understanding teachers' online professional learning: A "community of inquiry" perspective on the role of Chinese middle school teachers' sense of self-efficacy, and online learning achievement. *Heliyon*.
<https://doi.org/10.1016/j.heliyon.2023.e16932>
- Wang, N., & An, B. G. (2023). Improving teachers' professional development through professional learning community: Voices from secondary school teachers at Malaysian Chinese independent schools. *Heliyon*, 9(6).
<https://doi.org/10.1016/j.heliyon.2023.e17515>
- Warshauer, H. K., Herrera, C., Smith, S., & Starkey, C. (2023). Examining preservice teachers' noticing of equity-based teaching practices to empower students engaging in productive struggle. *The Journal of Mathematical Behavior*, 70, 101045.
<https://doi.org/10.1016/j.jmathb.2023.101045>
- Yanto, F. (2019). Development of problem-based student worksheet with authentic assessment to improve student's physics problem solving ability. In *Journal of Physics: Conference Series* (Vol. 1185, No. 1, p. 012075). IOP Publishing.
<https://doi.org/10.29303/jppipa.v9i5.2738>
- Zahara, S. R., Imanda, R., & Alvina, S. (2022). Development of assessment sheet for measuring students' scientific literacy level in the era of revolution 4.0. *Jurnal Penelitian Pendidikan IPA*, 8(3), 1096-1101.
<https://doi.org/10.29303/jppipa.v8i3.1169>
- Zeng, J. (2023). A theoretical review of the role of teacher professional development in EFL students' learning achievement. *Heliyon*.
<https://doi.org/10.1016/j.heliyon.2023.e15806>