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Research Article

Development of teacher professionalism in inquiry learning through learning community

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ABSTRACT

Mechanisms for motivating and involving teachers in learning and working together with their colleagues are currently quite scarce. This study aims to explore the conditions that support teacher professional development in inquiry based learning through learning communities and examine how teacher professional development will impact students learning outcomes. The five teachers selected were a group of teachers who were members of the lesson study community at SMP Negeri 11 Bengkulu city and participated in this study. The qualitative results in this study reveal that the interactive domain, in which the teacher's professional learning community works collaboratively by sharing teaching experiences and developing assessment tools, plays an important role in promoting teacher professional development. These results reinforce the understanding that conditions and important supporting mechanisms that must be possessed by an effective model for teachers professional development can lead to improved students learning outcomes.

Keywords: teacher professional development; inquiry; learning community

1. INTRODUCTION

Inquiry-based learning that uses a scientific inquiry process, or what is known as the inquiry process, is a way of learning that can help students construct their knowledge independently. In addition, inquiry-based learning is a student -centred teaching and learning approach driven by a passion for inquiry. Inquiry-based learning can also stimulate and reflect the work of a scientist among students (Archer-Kuhn et al. 2022; Kang 2022). Inquiry-based learning is one of the learning models recommended by the Indonesian government, as stated in the 2013 curriculum. Furthermore, scientific investigation is a crucial component of the Program for International Student Assessment (PISA), a literacy framework (OECD 2016; Report et al. 2006). However, the result of the study shows that teachers use incomplete inquiry concepts or there are still errors in applying them (Krämer, Nessler, and Schlüter 2015; Lakin and Wallace 2015). Therefore, teachers need support to implement continuous inquiry learning. The result shows that effective strategies for promoting the professional development of inquiry-based learning teachers will require on-going support from experts by providing explicit support in learning, also by developing teacher beliefs about the importance of enculturation in scientific practice and argumentation skills, as well as encouraging teachers to review and change assessment activities carried out (Alhendal, Marshman, and Grootenboer 2016; Harrison 2014; Lin et al. 2016; Wallace and Kang 2004). Although the result of the study found that teachers had changed the learning activities carried out through professional development programs, several other researchers indicated that inquiry-based learning was rarely adopted by teachers and several teachers provided testimonies about the difficulties and challenges faced in implementing inquiry learning (Gillies and Nichols 2015; Krämer et al. 2015).

To emphasize the efficiency of teacher professional development programs, several researchers argue that it is necessary to identify the conditions that support and understand teachers in the process of developing teacher professionalism (Clarke and Hollingsworth 2002; Popova et al. 2022; Wilson 2013). There are still very few clear mechanisms to motivate and involve teachers in learning and working collaboratively. This research intends to explore the conditions that support it in order to contribute to the advancement of teacher professional development in inquiry-based learning. The concept of a teacher professional development community has developed rapidly in recent years. It provides an opportunity for teachers to reflect on the learning activities and also provides an overview of the teacher's ability to teach (Cooper et al. 2022; Vescio, Ross, and Adams 2008). The teacher professionalism development community also has

characteristics as collaborative learning and provides a shared learning environment for teachers to discuss curriculum and student-involved learning. In the end, the teacher professionalism development community contributes in increasing teacher's knowledge about the quality of learning (Furtak and Heredia 2014; Lakshmanan et al. 2011; Pischetola 2022).

Existing literature shows that the effective teacher professionalism development community programs to increase teacher knowledge about learning activities are largely facilitated by collaborative research between schools and tertiary institutions, which allows learning-communities to develop. Several studies have been conducted to investigate the efficiency of community teacher professional development programs (Risnanosanti, Syofiana, and Asmara 2021). (Marshall, Smart, and Alston 2017; Reyes and Aliazas 2022) shows that limited community research on teacher professionalism can link teacher learning activities with student learning outcomes. Thus, the purpose of this research is to expand the school-based teacher professional development community program to explore the conditions that support the advancement of teacher professional development. Many community teacher professional development programs focus mostly on measuring student learning outcomes (Wilson 2013). Therefore, our research is focused on exploring the impact of teacher-led learning activities. The main question in this research is: how can mutual learning mechanisms in a community support and contribute to the professional development of teachers through inquiry-based learning.

2. RESEARCH METHOD

The main objective of this study is to identify the supporting condition and mechanism that can enhance teacher professional development in inquiry-based learning from mutual learning communities. The research design used is qualitative research. This research activity was carried out in the mathematics teacher community at SMPN 11 Bengkulu-City; the subjects were five mathematics teachers. All teachers act as model teachers and voluntarily run learning communities that organize learning activities independently. All five have good expertise in inquiry-based teaching. Four of the teachers had master's degrees in mathematics with more than ten years of teaching experience. The essential scientific competency explains phenomena scientifically, evaluate and design scientific inquiry, and interpreting scientifically defined data and evidence (OECD 2016) are used as the main construct for community teacher professional development programs (Antinluoma, Ilomäki, and Toom 2021; Brodie 2020, 2021).

Unit lessons and student study sheet samples were developed and provided by teachers who focus on inquiry-based learning. The teacher community sets the same goal to promote inquiry-based learning in the classroom in order to improve students' scientific competence (Chai, Koh, and Tsai 2013; Chin et al. 2022). Four levels of continuous transformation (confirmation, structured, assistance, and open inquiry) are used in this study. In this study, one of the teachers became a model in promoting guided inquiry to become an example for other teachers. All teachers in the community meet at least four times a semester to discuss different topics. This community of mutual learning in teacher groups uses small group discussions to encourage members to share their knowledge and teaching experiences (Dingyloudi and Strijbos 2020). The researcher acts as a participant as well as an observer in the learning community, is responsible for making field notes and meeting minutes, interviewing teachers, collecting all documentation related to teaching materials (inquiry-based lesson plans or assessment items), and recording videos in each meeting.

To identify the supporting condition and mechanism that can enhance teacher professional development, qualitative data were analysed through thematic analysis, following the following analysis procedure. Firstly, the data is analysed and synthesized to generate code through three resources:

1. Researcher's field notes: various activities carried out by the teacher in class are coded into appropriate supporting categories. For example, the activity showing how to integrate inquiry-based learning about finding the locus of a point in the field in class and discussing in detail the interactive experience during reflection is coded as 'sharing teaching experiences'.
2. Interview transcript: the support activities mentioned by the teacher during the interview were coded in the same category as 'sharing teaching experience'. For example, the teacher states 'after I demonstrate an example in everyday life, I ask my students to modify the example with an incident the student has experienced during the interview, and it is coded accordingly to the same category.
3. Lesson plan design and inquiry test questions: all teachers who distribute their student worksheets are given the appropriate code. For example, teacher A hands out the worksheet 'position of a dot in the field' and is coded as 'sharing teaching experience'.

These three sources of qualitative data were used for cross-analysis and methodological triangulation to provide a credible and valid way to answer the research question. Secondly, the researcher combines the codes into various themes to cover them and then identifies patterns among them. It then generates a list of themes to embrace the code list. For example, the theme 'Provide external resources or information about inquiry-based learning' was created to illustrate the following codes:

a. Introduce and share scientific competence.
b. Share pedagogical knowledge about learning activities.
c. Share teaching experiences on a particular topic.
d. Share about how to motivate students to ask scientific questions, and how to conduct experiments through demonstrations in learning.

In addition, an interconnected domain model(Clarke and Hollingsworth 2002) was adopted to interpret all the themes into related domains in understanding the mechanics of professional development through an interconnected model. For example, the theme 'Providing external sources or information about inquiry-based learning' in this study corresponds to the 'external domain' in the interconnected model (i.e. sources of information, stimuli or support). In the end, the researcher

is responsible for reviewing all themes and ensuring that the resulting themes can be representative of the existing data. Thus, the researcher has a perfect code of thematic analysis.

Table 1. Topics of Teacher Discussion in Learning Community

No.	Activity
1.	Community Building: The researcher introduced the community and negotiated about the scheduled and topics of each meeting
2.	The community shared about knowledge of learning based on inquiry
3.	One of the teacher shared a lesson plan
4.	Community members involved in the discussion of teacher lesson plan
5.	Community members involved in the discussion about how to develop a project in they class
6.	One of the teacher introduced the assessment framework
7.	Community members involved in developing inquiry-based learning
8.	Community members shared and refined their draft of assessment

3. RESULTS AND DISCUSSION

Three Conditions that Support the Teacher Community

Qualitative analysis is used to reveal three supporting conditions as mentioned in the research method section. This data provides external sources or information about inquiry-based learning, organizes an interactive environment for members of the community, and inspires community members to integrate learning materials or assessments in their classrooms.

Three conditions that support the teacher community

Table 2. Three Identified Categories that Support Inquiry Learning

Domain	Category	Example
External Domain	Providing external sources of information	Introducing and sharing standard competencies, sharing experiences
Interactive Domain	Organizing an interactive environment	Working collaborative
Practice Domain	Inspiring community members	Sharing teaching practice and adopting an innovative teaching method

These enabling conditions were found to be consistent with the three domains-external, interactive, and activity-of inquiry-based learning. The following subsections describe and provide examples for each of the enabling conditions.

The external domain of inquiry-based learning

Table 2 illustrates how presenting information about advancement in mathematics education and the sharing of teaching experiences by experts are the key activities that took place in the community. All enabling conditions (e.g. 'information, stimulus and support' to enhance teacher professional development) are categorized as external domains of inquiry-based learning. For example, the teacher community invites a mathematics education expert to socialize lesson study for the learning community as a way of developing teacher professionalism on an on-going basis. This information is stated as support for teachers in teaching practice. Various activities are presented in group meetings. Teachers in the community unanimously agreed to emphasize that students should have the opportunity to plan their own experimental procedures as they build understanding of a particular concept (Meesuk, Wongrugsa, and Wangkaewhiran 2021). The results of the discussion in planning activities were then practiced in class. Transcripts from the interviews are used to represent another way of validating what has been done as a case study in the community. The following excerpts from interviews conducted with teachers describe the interactions and enabling conditions.

Researcher : what is the way to organize a community? Please provide some concrete examples.
Teacher : Well, we need to provide and discuss learning tools before learning process is carried out. If the tools are appropriate then those can be used by all community members in their respective classes.
[Researcher's reflection note: Sharing teaching experiences, providing teaching tools and lesson plans.]

This quote provides additional evidence that teacher groups emphasize sharing teaching experiences through inquiry activities. This type of experience that focuses on introducing new information or pedagogical knowledge is beyond the everyday teacher's routine. Thus, this experience is a condition that supports the improvement of teachers' professional knowledge and is categorized as the 'external domain of inquiry-based learning'.

Inquiry-Based Learning Interactive Domain

The second regular activity in the community is involving all members in designing learning collaboratively, including teaching activities, student worksheets, and assessments. Group discussions provide a reflective environment for teachers to think about the learning activities being carried out, namely reflection on actions (Voogt et al. 2011). Thus, this interactive experience provides opportunities for teachers to develop their professional development. Research results may identify experience as a new domain entitled 'interactive domain of inquiry-based science teaching', which is extended from the interconnected model (Clarke and Hollingsworth 2002).

The results of observations in meeting activities in the teacher community;

One of the teachers (teacher A) stated: 'after I demonstrated the inquiry activity in front of the class, I asked my students to modify the examples given with the student's own experiences.
[after teacher A shared his experience in a community meeting]

Another teacher (teacher B) said that she demonstrated the same activity in her class and engaged her students to understand the correct concept. Next, teacher B distributed the modified lesson plan and worksheets from the inquiry activity in the community meeting and asked other members to provide feedback or suggestions. At other community meetings, the teacher revealed that community members could design test items with other members through in-depth discussions. The activities in the community meetings support the conditions of the study group so that they can provide a platform for members to share what they know and what they have learned. Thus, such an interactive domain can be categorized as a 'mediation domain' between the external and the practice domain.

The domain of Inquiry-Based Learning Practices

The third regular activity in the community is to involve every member in integrating lesson plans and scientific competency assessment into learning activities in their classes. Community members also discussed procedures for integrating inquiry-based learning in their classes.
The Role of Interactive Domains in Enhancing the Development of Teacher Professionalism

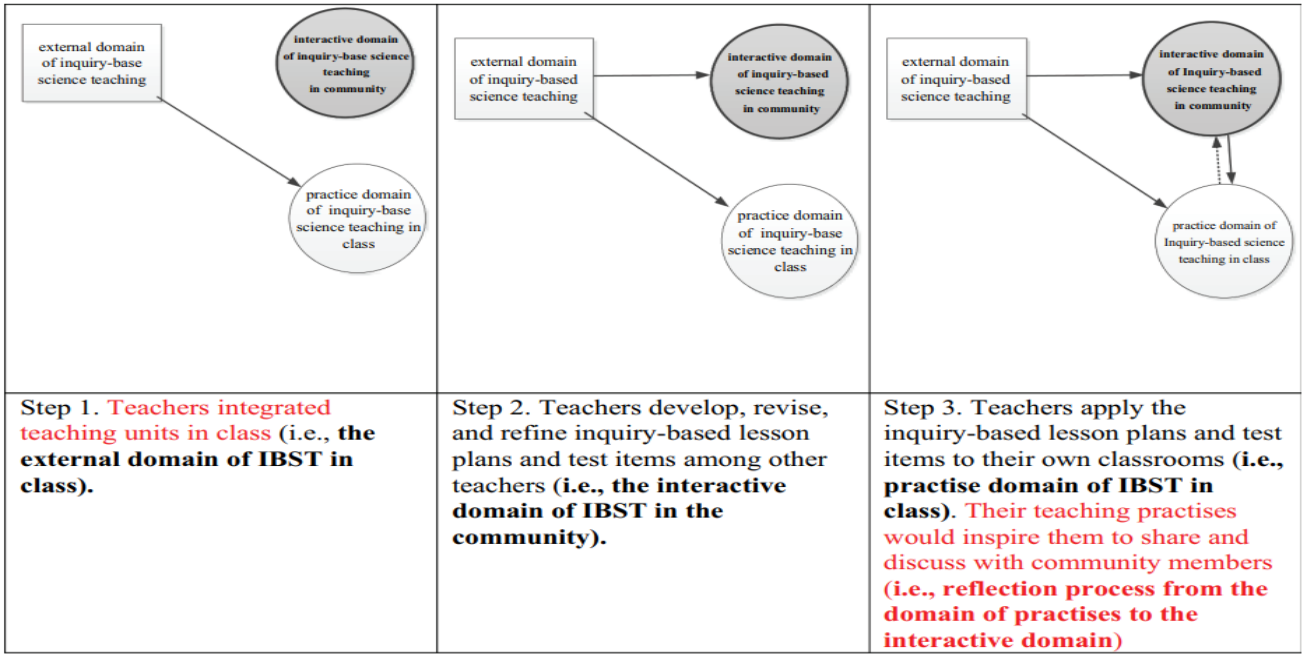

Figure 1. Process of expanding the Clarke and Hollingsworth (2002) Interconnected Model

Based on initial results from the community, additional interactive domains of inquiry-based learning in the community were added and expanded in the interconnection model using a 3-step process (Figure 1). The first step focused on teachers receiving information on how to develop inquiry-based teaching strategies and test items as they participate in the community (i.e. the external domain), then they directly integrate those teaching units in the classroom (i.e. the practice domain). Furthermore, after teachers have built an understanding of the basic knowledge of inquiry-based learning and scientific competency assessment frameworks, they develop, share, revise and refine inquiry-based lesson plans with members (i.e. inquiry-based learning interactive domains). Finally, as teachers discuss, revise and refine the design of inquiry-based lesson plans and test items, they implement these lesson plans in their classrooms (i.e. practice domain). It extends the interconnection model (Clarke and Hollingsworth 2002) by adding an interactive domain of inquiry-based science teaching in the community; it provides opportunities for teachers to interact with experts and other educational colleagues when developing inquiry-based lesson plans and test items.

Data analysis provides a better understanding that the addition of interactive domains in the learning community model gives the teachers a way to collaborate on how to successfully implement inquiry-based learning and assessment in their classrooms. This component acts as a mediating domain that enhances the effectiveness of teacher professional development in providing teachers with opportunities to develop their knowledge of how to implement inquiry-based learning and assessment strategies in their classrooms. Figure 2 shows how these mediating domain components fit into the extended interconnection model.

This study focused on identifying conditions that support inquiry-based learning to develop teacher-teaching practices through professional learning communities. The literature review shows that the professional learning community is a

potentially effective program for the professional development of teachers (Anwar 2020). However, the conditions and mechanisms that support the professional learning community for teacher professionalism development in inquiry-based learning have not been studied. The impact of the teaching of participating teachers on the scientific competence of their students has also not been fully explored. Three important findings were revealed in this study. First, there are three main enabling conditions that contribute to teacher teaching practice in inquiry-based learning, namely the external domain, the interactive domain, and the practice domain. The interactive domain of the inquiry-based learning component introduced in this study extends the four-domain model (Clarke and Hollingsworth 2002; Krämer et al. 2015) by providing a new way to measure how interactions between teachers in the professional learning community affect their professional domain knowledge and how this knowledge influences student learning outcomes. Therefore, we propose that this component of the interactive domain can be understood as an important component of the mediating domain.

(Avalos 2011) says that 'mediation provides impetus to move one point to another'. This new component plays an important role in encouraging interaction and collaborative learning among teachers during teacher professional development activities. In addition, the mediation domain component provides a new approach to implementing effective teacher professional development programs in inquiry-based learning with an emphasis on providing an interactive environment for members in the community. This approach involves the teacher as a co-learner in accordance with the desired inquiry-based teaching and learning, not as a passive recipient. In short, interactive collaborative learning environments inspire teachers to implement inquiry-based teaching practices in their classrooms. (Wilson 2013) shows that teacher learning models must take into account the coherence of teacher professionalism development programs. Thus, the expansion of the interconnection model (Figure 2) widens and strengthens the understanding of how to enhance teacher professionalism development programs through professional learning communities.

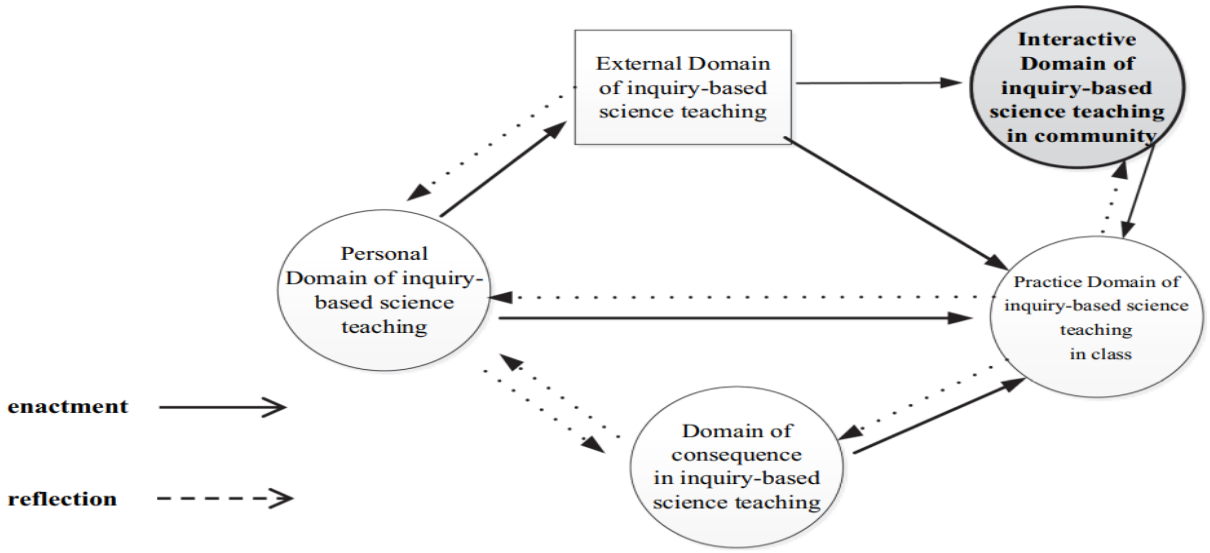

Figure 2. The Addition of the Interactive Domain of Inquiry-Based Science Teaching in Community Component to Clarke and Hollingsworth (2002) Interconnected Model

The second important finding is the impact of the teaching practices of model teachers and members of the professional learning community on the performance of their students' scientific competence. These results suggest that teachers, who lead, make a positive difference in student learning outcomes. On the other hand, it may take longer for teachers in the professional learning community to practice their professional development to have significant impact on the scientific competence of their students. Although the main reason for this finding requires further investigation in future studies, the evidence presented here highlights how the level of professional development of teachers in inquiry-based learning impacts their students' learning of scientific competence over an extended period.

The third important finding is assessment of students' ability to engage in scientific practice rather than scientific facts. (Wilson 2013) noted that there is still very little research in teacher professional development that investigates students' ability to engage in scientific practice. (Nichols, Burgh, and Kennedy 2017) found that providing teachers with interventions in inquiry pedagogy along with the curriculum and involving them in teacher professional development had a significant impact on students' inquiry behaviour. In this study, the result of the competency test provides empirical evidence of student learning outcomes after they are involved in inquiry practices such as formulating questions, making hypotheses, planning problem-solving procedures and interpreting data and test results. Indeed, these participating students are encouraged to work actively as scientists so long as they engage in scientific inquiry practice. Meanwhile, students taught by teachers outside the professional learning community are mostly engaged in learning from traditional lecture practice with limited inquiry activities. Preliminary result of student engagement from our classroom observations and teacher interviews encourage those interested in promoting inquiry-based science teaching methods during teacher professional development learning activities. The result, which shows students taught by model teachers performed significantly better in scientific competence than those taught by professional learning community and non-professional learning community

teachers, provides additional insight that longer engagement in teacher professional development has the potential to increase positive learning outcomes among students in class.

Scientific inquiry is one of the critical learning outcomes in national and international curriculum standards and has been included in the PISA international assessment framework. Therefore, the professional development of teachers in inquiry-based learning practices is becoming increasingly important. Such interests have resulted in a growing effort to identify which specific factors motivate teachers to develop a personal interest in promoting inquiry-based learning in their classrooms. This research investigation allows us to go beyond the interconnected models and previous investigations by exploring the conditions and mechanisms underpinning it in the teacher professional development learning community and presenting interactive domain components that enhance the interconnected models in new and important ways. Readers are notified that there is a limitation of the small number of test items that assess student learning outcomes on scientific competence, preliminary quantitative result from this study indicates that students taught by model teachers from professional development learning communities are significantly higher than those who don't. This result provides additional evidence on how taking an active leadership or supporting roles in teacher professional development activities and programs have the potential to positively impact student learning outcomes in the classroom. The results of this study also strengthen our understanding of the essential components of an effective model for developing a teacher's professional learning community.

4. CONCLUSION

Overall, this article presents a successful attempt to support the professional development of teachers by engaging them to discuss and reflect on sample lessons and teaching practices through the interactive domain of learning communities. There are two important implications for teachers: first, providing an interactive environment with supportive resources for members of the professional learning community plays an important role in promoting teacher professional development. The results of this study also suggest that if the teachers engage in collaborative and interactive learning activities that teach the development of inquiry-based learning, the shared innovative learning experiences, along with interactive discussion and reflection, can open up opportunities to affect changes in their teaching practices. Secondly, engaging teachers in developing context-based scientific competency assessment items opens additional opportunities to increase their awareness and understanding of how other learning practices can enhance their inquiry-based teaching and assessment. While this study provides effective strategies and empirical evidence for the feasibility and potential benefits of teacher professional learning communities in developing inquiry-based learning, readers are encouraged to consider addressing the following limitations in future research. Despite our efforts to pay special attention to the common understanding of various valid and reliable sources of data, each professional learning community in this study has their own unique ways of studying and processing the information presented to them. Therefore, future investigations using the strategies presented in this study in other teacher professional development learning communities may lead to new and uniquely valuable findings.

AUTHOR'S CONTRIBUTIONS

All authors discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

REFERENCES

Alhendal, Dalal, Margaret Marshman, and Peter Grootenboer. (2016). "Kuwaiti Science Teachers' Beliefs and Intentions Regarding the Use of Inquiry-Based Instruction." *International Journal of Science and Mathematics Education* 14(8):1455–73. doi: 10.1007/s10763-015-9671-0.

Antinluoma, Markku, Liisa Ilomäki, and Auli Toom. (2021). "Practices of Professional Learning Communities." *Frontiers in Education* 6. doi: 10.3389/feduc.2021.617613.

Anwar, Aep Saepul. (2020). "Pengembangan Sikap Profesionalisme Guru Melalui Kinerja Guru Pada Satuan Pendidikan Mts Negeri 1 Serang." *Andragogi: Jurnal Pendidikan Islam Dan Manajemen Pendidikan Islam* 2(1). doi: 10.36671/andragogi.v2i1.79.

Archer-Kuhn, Beth, Yeonjung Lee, Jennifer Hewson, and Victoria Burns. (2022). "Growing Together: Cultivating Inquiry-Based Learning in Social Work Education." *Social Work Education* 41(3):333–53. doi: 10.1080/02615479.2020.1839407.

Avalos, Beatrice. (2011). "Teacher Professional Development in Teaching and Teacher Education over Ten Years." *Teaching and Teacher Education* 27(1):10–20. doi: https://doi.org/10.1016/j.tate.2010.08.007.

Brodie, K. (2020). "Professional Learning Communities in Mathematics Education." in *Encyclopedia of Mathematics Education*. Springer, Cham.

Brodie, Karin. (2021). "Teacher Agency in Professional Learning Communities." *Professional Development in Education* 47(4):560–73. doi: 10.1080/19415257.2019.1689523.

Chai, Ching Sing, Joyce Hwee Ling Koh, and Chin Chung Tsai. (2013). "A Review of Technological Pedagogical Content Knowledge." *Educational Technology and Society* 16(2):31–51.

Chin, Joseph M., Gregory S. Ching, Fides del Castillo, Tzu-Hsing Wen, Yu-Chen Huang, Clarence D. del Castillo, Jenny L. Gungon, and Sheilla M. Trajera. (2022). "Perspectives on the Barriers to and Needs of Teachers’ Professional Development in the Philippines during COVID-19." *Sustainability* 14(1).

Clarke, David, and Hilary Hollingsworth. (2002). "Elaborating a Model of Teacher Professional Growth." *Teaching and Teacher Education* 18(8):947–67. doi: https://doi.org/10.1016/S0742-051X(02)00053-7.

Cooper, A. C., K. M. Southard, J. B. Osness, and M. S. Bolger. 2022. "The Instructor's Role in a Model-Based Inquiry Laboratory: Characterizing Instructor Supports and Intentions in Teaching Authentic Scientific Practices." *CBE—Life Sciences Education* 21(1): doi: 10.1187/cbe.21-07-0177.

Dingyloudi, Filitsa, and Jan-Willem Strijbos. (2020). "Community Representations in Learning Communities." *Scandinavian Journal of Educational Research* 64(7):1052–70. doi: 10.1080/00313831.2019.1640788.

Furtak, Erin Marie, and Sara C. Heredia. (2014). "Exploring the Influence of Learning Progressions in Two Teacher Communities." *Journal of Research in Science Teaching* 51(8):982–1020. doi: https://doi.org/10.1002/tea.21156.

Gillies, Robyn M., and Kim Nichols. (2015). "How to Support Primary Teachers' Implementation of Inquiry: Teachers' Reflections on Teaching Cooperative Inquiry-Based Science." *Research in Science Education* 45(2):171–91. doi: 10.1007/s11165-014-9418-x.

Harrison, C. (2014). "Assessment of Inquiry Skills in the SAILS Project." *Science Education International* 25(1):112–22.

Kang, Jingoo. (2022). "Interrelationship Between Inquiry-Based Learning and Instructional Quality in Predicting Science Literacy." *Research in Science Education* 52(1):339–55. doi: 10.1007/s11165-020-09946-6.

Krämer, Philipp, Stefan H. Nessler, and Kirsten Schlüter. (2015). "Teacher Students' Dilemmas When Teaching Science through Inquiry." *Research in Science & Technological Education* 33(3):325–43. doi: 10.1080/02635143.2015.1047446.

Lakin, Joni M., and Carolyn S. Wallace. (2015). "Assessing Dimensions of Inquiry Practice by Middle School Science Teachers Engaged in a Professional Development Program." *Journal of Science Teacher Education* 26(2):139–62. doi: 10.1007/s10972-014-9412-1.

Lakshmanan, Aruna, Barbara P. Heath, Aaron Perlmutter, and Michael Elder. (2011). "The Impact of Science Content and Professional Learning Communities on Science Teaching Efficacy and Standards-Based Instruction." *Journal of Research in Science Teaching* 48(5):534–51. doi: https://doi.org/10.1002/tea.20404.

Lin, Sheau-Wen, Yu Liu, Shin-Feng Chen, Jing-Ru Wang, and Huey-Lien Kao. (2016). "Elementary School Students' Science Talk Ability in Inquiry-Oriented Settings in Taiwan: Test Development, Verification, and Performance Benchmarks." *International Journal of Science and Mathematics Education* 14(7):1199–1214. doi: 10.1007/s10763-015-9663-0.

Marshall, Jeff C., Julie B. Smart, and Daniel M. Alston. (2017). "Inquiry-Based Instruction: A Possible Solution to Improving Student Learning of Both Science Concepts and Scientific Practices." *International Journal of Science and Mathematics Education* 15(5):777–96. doi: 10.1007/s10763-016-9718-x.

Meesuk, Parinya, Angwara Wongrugsa, and Thipwimol Wangkaewhiran. (2021). "Sustainable Teacher Professional Development Through Professional Learning Community: PLC." *Journal of Teacher Education for Sustainability* 23(2):30–44. doi: doi:10.2478/jtes-2021-0015.

Nichols, Kim, Gilbert Burgh, and Callie Kennedy. (2017). "Comparing Two Inquiry Professional Development Interventions in Science on Primary Students' Questioning and Other Inquiry Behaviours." *Research in Science Education* 47(1):1–24. doi: 10.1007/s11165-015-9487-5.

OECD. (2016). "PISA 2015 Results (Volume I): Excellence and Equity in Education." *PISA, OECD.*

Pischetola, Magda. (2022). "Teaching Novice Teachers to Enhance Learning in the Hybrid University." *Postdigital Science and Education* 4(1):70–92. doi: 10.1007/s42438-021-00257-1.

Popova, Anna, David K. Evans, Mary E. Breeding, and Violeta Arancibia. (2022). "Teacher Professional Development around the World: The Gap between Evidence and Practice." *The World Bank Research Observer* 37(1):107–36. doi: 10.1093/wbro/lkab006.

Reyes, Angelo, and John Vincent Aliazas. (2022). "Online Integrative Teaching Strategies: Thematic and Focus Inquiry for Improved Science Process Skills." *International Journal of Science, Technology, Engineering and Mathematics* 1(1):19–38. doi: 10.53378/352854.

Risnanosanti, Risnanosanti, Mardiah Syofiana, and Adi Asmara. (2021). "Lingkungan Belajar Berbasis Lesson Study for Learning Community Untuk Mahasiswa Calon Guru Matematika." *Jurnal Elemen* 7(2):254–66. doi: 10.29408/jel.v7i2.2825.

Vescio, Vicki, Dorene Ross, and Alyson Adams. (2008). "A Review of Research on the Impact of Professional Learning Communities on Teaching Practice and Student Learning." *Teaching and Teacher Education* 24(1):80–91. doi: https://doi.org/10.1016/j.tate.2007.01.004.

Voogt, J., H. Westbroek, A. Handelzalts, A. Walraven, S. McKenney, J. Pieters, and B. de Vries. (2011). "Teacher Learning in Collaborative Curriculum Design." *Teaching and Teacher Education* 27(8):1235–44. doi: https://doi.org/10.1016/j.tate.2011.07.003.

Wallace, Carolyn, and Nam-Hwa Kang. (2004). "An Investigation of Experienced Secondary Science Teachers' Beliefs about Inquiry: An Examination of Competing Belief Sets." *Journal of Research in Science Teaching* 41:936–60. doi: 10.1002/tea.20032.

Wilson, Suzanne M. (2013). "Professional Development for Science Teachers." *Science* 340(6130):310–13. doi: 10.1126/science.1230725.