



Literature Review Regarding PCK of Chemistry Teachers and Prospective Chemistry Teachers

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Abstract: This research aims to provide an overview of the research methodology used in conducting a literature review of 21 journals indexed by Scopus and included in the Q1 category during the 2013-2022 period. This research uses a literature review method, this method is a scientific approach that provides a comprehensive picture of the development of a research topic. Through this literature review, researchers can obtain information regarding the year of publication, research methods applied, instruments used in each journal, and the focus of studies conducted by each journal. At the results and discussion stage, this research details the concept of Z score as a statistical value, factor analysis, correlation between factors, and coding analysis in the context of qualitative research. The concept of in-depth analysis which includes an in-depth examination of a subject or phenomenon is also discussed in detail. In addition, various research methods such as constant-comparative, person map items, PCS, TSPCK rubric, questionnaires, interviews, observation, and documentation are explained in depth. The importance of pedagogical competence in implementing the educational process is in the main spotlight, and analysis of the literature in the journal "Chemistry Education Research and Practice" shows the dominance of the use of qualitative methods in 2020. Interviews are recognized as an irrelevant method. only flexible but also in-depth, supported by the application of observation and analysis of supporting factors.

Keywords: Chemistry Teachers; Literature Review; PCK.

Introduction

Education is an activity that is deliberately carried out on students with the aim of producing results in accordance with predetermined goals (Purwanto, 2011). This statement is in accordance with the National Education System, which emphasizes that education is a right for every Indonesian citizen. In constitutional law, this principle is documented in the constitution. 1945 Chapter XIII article 31 which reads "every citizen has the right to receive instruction". 1 Then with the revision of Law No. 2/1989 concerning the national education system (Sisdiknas). 2 No. 20 of 2003, education is a deliberate and planned effort to create a learning atmosphere that allows students to actively develop various potentials, including spiritual aspects, self-

control, personality, intelligence, morality, and skills necessary for the benefit of the individual, society, nation, and state.

The role of education is very crucial in improving the quality of human resources and is the main determining factor in progress or setbacks in life. (Bahriah, 2013). The competencies referred to in this regulation include: pedagogical competence, personality competence, social competence and professional competence (Regulation of the Minister of National Education of the Republic of Indonesia Number 16 of 2007).

Based on this, the importance of pedagogical competence in carrying out the educational process has been illustrated. Based on research conducted by Lestari & Mulianingsih (2020), the results presented show that

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teachers in Bawen sub-district's understanding of pedagogical and professional competence is still inadequate, and this is caused by several internal and external factors. Even though schools have made efforts to improve and develop teacher competency, challenges remain. Therefore, a literature study was carried out to find out the years of publication, the methods used, the instruments contained in the journals and the focus of the study in each journal.

Method

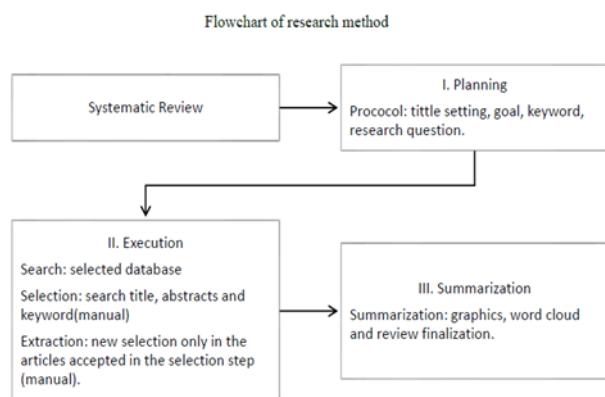


Figure 1. Flow Chart of research method

This research uses a literature review. A literature review is a scientific study that focuses on a particular topic. A literature review will provide an overview of the development of a particular topic. A literature

review will enable a researcher to identify a theory or method, develop a theory or method, identify gaps that occur between a theory and its relevance in the field/research results (Rowley & Slack, 2004; Bettany-Saltikov, 2012) Carrying out a literature review is the same as carrying out activities: 1) collecting data/information, 2) evaluating data, theory, information or research results, and 3) analyzing the results of publications such as books, research articles or others related to research questions that have been prepared.

Previous The literature review method can involve a systematic process of searching and collecting literature, as well as analyzing and synthesizing the findings found. Referring to the format of review articles, the Publication Manual (American Psychological Association, 2001) simply states that "review article components, unlike parts of empirical study reports, are organized by relationships rather than chronology."

Result and Discussion

Focus Research

A summary of publication years from 2013 to 2020 can be found in Table 1, which includes information about the author's name as well as year, journal title and research focus

Table 1. Authors, Title, Focus Research

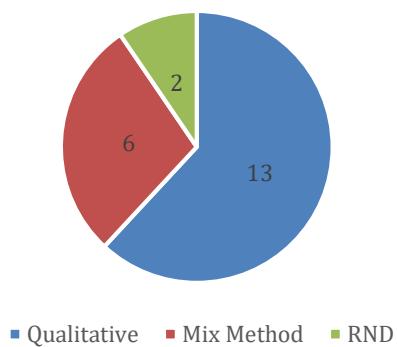
Authors	Title	Focus Research
(Alvarado et al., 2015)	Canonical pedagogical content knowledge by CoRes for teaching acid-base chemistry at high school	The focus of this study was to find out how the teachers designed, prepared and organized their classes inside and outside the classroom, which would then develop a series of learning sequences, essentially to train new teachers.
(Aydin-Gunbatar & Akin, 2022)	The nature of integration among PCK components: A case study of two experienced chemistry teachers	The research focus in this article is to examine how the nature of integration among the components of PCK for two experienced chemistry teachers in teaching the topics of redox reactions and electrochemical cells
(Aydin et al., 2014)	Examination of the topic-specific nature of pedagogical content knowledge in teaching electrochemical cells and nuclear reactions	The purpose of this study was to examine experienced chemistry teachers' pedagogical content knowledge (PCK) for two different topics in chemistry to better understand how PCK is specific to topic, including whether all components of PCK are topic-specific and to what degree.
(Chen & Wei, 2015)	Examining chemistry teachers' use of curriculum materials: in view of teachers' pedagogical content knowledge	This paper aimed to explore how pedagogical content knowledge (PCK) of teachers influenced their adaptations of the curriculum materials of the new senior secondary chemistry curriculum, a standards-based science curriculum, in China.
(Demirdögen & Uzuntiryaki-Kondakçı, 2016)	Closing the gap between beliefs and practice: Change of pre-service chemistry teachers' orientations during a PCK-based NOS course	The purpose of this case study was to investigate how pre-service chemistry teachers' science teaching orientations change during a two-semester intervention designed to enhance their pedagogical content knowledge (PCK) for teaching the nature of science (NOS).

Authors	Title	Focus Research
(Hale et al., 2016)	The development of a tool for measuring graduate students' topic specific pedagogical content knowledge of thin layer chromatography	Investigating the development of topic-specific pedagogical content knowledge among chemistry graduate student teaching assistants (GTAs).
(Kotul'áková, 2020)	Identifying beliefs held by preservice chemistry teachers in order to improve instruction during their teaching courses	The research focuses on determining (a) how prospective chemistry teachers understand learning, (b) what they target to modify in student learning, (c) how they understand knowledge, and (d) how they see their role in science education.
(Lutter et al., 2019)	Unpacking graduate students' knowledge for teaching solution chemistry concepts	The goal of this study was to understand more specifically how chemistry graduate students develop teaching knowledge at the topic level using a direct measure.
(Rodríguez-Becerra et al., 2020)	Developing technological pedagogical science knowledge through educational computational chemistry: a case study of pre-service chemistry teachers' perceptions	This research focuses on developing the Science Pedagogical Technology Knowledge (TPASK) of pre-service chemistry teachers through a new computational chemistry module.
(Schafer & Yezierski, 2021)	Investigating high school chemistry teachers' assessment item generation processes for a solubility lab	This study focuses on identifying the role of PCK and characterizing the processes used by teachers to enact their PCK during designing planned chemistry formative assessments.
(Supprakob et al., 2016)	Using the lens of pedagogical content knowledge for teaching the nature of science to portray novice chemistry teachers' transforming NOS in early years of teaching profession	This study investigated the PCK for NOS of six novice chemistry teachers with various educational backgrounds.
Uzuntiryaki-(Bektas et al., 2013)	Exploring the complexity of teaching: the interaction between teacher self-regulation and pedagogical content knowledge	This study investigates whether there is a relationship between probationary chemistry teachers' self-regulation of teaching and their PCK in the context of teaching gas law in grade 9 during practicum.
(Wei & Liu, 2018)	An experienced chemistry teacher's practical knowledge of teaching with practical work: the PCK perspective	The research focused on how the participant's teaching orientations and relevant contextual factors shaped his practical knowledge of teaching with practical work
(Cetin-Dindar et al., 2018)	Development of pre-service chemistry teachers' technological pedagogical content knowledge	The focus of this study was to examine the effectiveness of a course designed to develop pre-service chemistry teachers' Technological Pedagogical Content Knowledge (TPACK) framework.
(Ekiz-Kiran & Boz, 2020)	Interactions between the science teaching orientations and components of pedagogical content knowledge of in-service chemistry teachers	The purpose of this study was to examine interactions between in-service chemistry teachers' science teaching orientation and other components of pedagogical content knowledge (PCK).
(Aydin-Gunbatar & Akin, 2022)	Pre-service chemistry teachers' use of pedagogical transformation competence to develop topic-specific pedagogical content knowledge for planning to teach acid-base equilibrium	The focus of the study aimed to examine the extent to which participants underwent pedagogical transformation and developed topic-specific pedagogical content knowledge (PCK) for planning to teach acid-base balance.
(Wu & Yezierski, 2022)	Pedagogical chemistry sensemaking: a novel conceptual framework to facilitate pedagogical sensemaking in model-based lesson planning	This research develops the Pedagogical Chemistry Sensemaking (PedChemSense) framework to support chemistry teachers' learning planning by utilizing sensemaking constructs, Johnstone's triangle, and perspective models. Its effectiveness is illustrated through an example lesson from the VisChem Institute.
(Aydin-Gunbatar et al., 2020)	Pre-service chemistry teachers' pedagogical content knowledge for integrated STEM development with LESMeR model	This study tested pre-service teachers' pedagogical knowledge regarding STEM through 13 training courses. The new model, LESMeR, includes Learning, Experience, Learning with a Mentor, and Reflection on Personal Development and Learning was coined as the name of this model.
(Dorfman et al., 2019)	Teachers personalize videos and animations of biochemical processes:	The aim of this study was to develop and evaluate an approach to increase chemistry and biology teachers'

Authors	Title	Focus Research
(Miheso & Mavhunga, 2020)	results from a professional development workshop	Technology Pedagogical Content Knowledge (TPACK) and their self-confidence regarding the use of video and animation in the classroom, which is necessary for effective implementation.
(Rodríguez-Becerra et al., 2020)	The retention of topic specific PCK: A longitudinal study with beginning chemistry teachers	This research explored TSPCK retention in seven pre-service chemistry students in a case study leading to a BEd degree, with data collection at three time periods: pre-intervention, post-intervention, and delayed post-intervention (two years later).
	Developing technological pedagogical science knowledge through educational computational chemistry	This study focuses on developing pre-service chemistry teachers' Technological Pedagogical Knowledge (TPASK) through a new computational chemistry module.

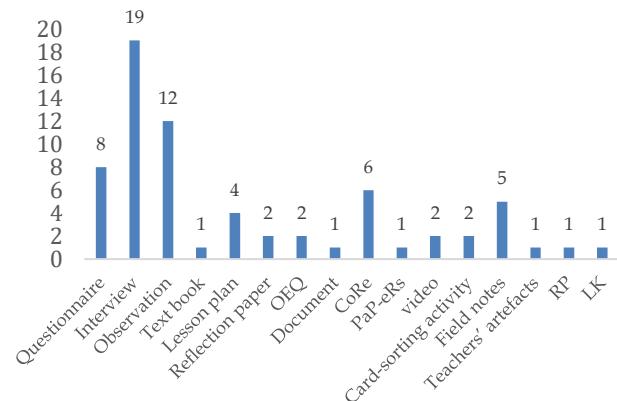
**Figure 2.** Year of Research

Based on the 21 journals studied, it shows that in 2020 the largest number was four journals published by "Chemistry Education Research and Practice".

**Figure 2.** Research Type

The research instruments used to determine the PCK of chemistry teachers include questionnaires, interviews, observations, textbooks, lesson plans, reflection papers, OFQ (open-ended questions), documents, CoRe (Content Representation), PaP-eRs (professional-experience repertoires), videos, card-sorting activities, field notes, teacher artifacts, RP (Reflection paper), and LK(Lokal karya). Interview instruments are most widely used to find out the

teacher's PCK, because interviews get the data directly from the research subject.

**Figure 3.** Instrument

A questionnaire is a tool used to collect data in the form of written answers from respondents. Questionnaires can be used for a variety of purposes, depending on the particular research or information gathering need. Interviews, whether formal or informal, are data collection methods that involve direct interaction between researchers or interviewers and respondents or research participants. Observation is a data collection method that involves direct and systematic observation of certain behaviors, events, or phenomena. This method can be used for various purposes in the context of research, development and evaluation. A text book or textbook is a source of written information designed to assist the learning and teaching process in various fields of knowledge. A lesson plan is a document that details the learning activities that will be carried out by a teacher or instructor during a session or learning period. Lesson plans are used for several important purposes in the context of teaching and learning, including: teaching plans, organizing time, planning learning activities and so on.

Open-ended questions are questions designed to encourage more complete and in-depth responses from respondents, without providing limited answer options. Documentation is the process or act of recording, storing

and compiling information in written or digital form. The use of documentation varies greatly depending on the context. Content representation is a way of organizing, presenting and describing information or learning material. This involves arranging content elements so that they can be better understood and accessed by users or learning participants.

Professional experience repertoire is a collection of experiences and professional skills that a person has or developed during his career. It includes a variety of projects, tasks, roles, and accomplishments that reflect the knowledge and skills possessed by an individual in the context of their work. Video is used to record direct observations of an event or interaction. This allows the researcher to examine and analyze details that may have been missed during direct observation or to re-examine observational data. Card-sorting activity is a method used in various contexts, especially in user experience (UX) design, computer science, and user behavior research. Field notes are written or digital notes made by researchers or observers during data collection in the field.

Teacher artefacts refer to various materials or products produced by teachers as part of their teaching practice. These artifacts can include a variety of forms, such as lesson plans, assessments, teaching materials, and teaching portfolios. Reflection papers are a type of writing in which someone reflects or outlines their personal thoughts, experiences or views related to a particular topic or experience. Local research works that use the concept of "local works" aim to investigate or analyze certain aspects of local production, local economy, local arts and culture, or local community development initiatives.

The Figure 3 shows that the interview technique is most often used, apart from researchers being able to get answers directly from the source directly, several advantages of the interview technique as data collection are explained by Fadhallah (2021):

1. Interview answers are more accurate because they give the interviewer the opportunity to ask in more detail.
2. The interviewer can observe nonverbal reactions, which can provide additional information.
3. Open opportunities for the interviewer to explore the test results and place them in a more meaningful context.
4. Flexible.

Data Analysis Method

Data analysis methods used to determine the PCK of chemistry teachers include Z-score, factor analysis, CBA (Correlation Between Factors), QCA (qualitative content analysis), coding, in-depth analysis, deductive analysis, inductive analysis, enumerative approach,

constant-comparative, item peson map, PC, TSPCK rubrics.

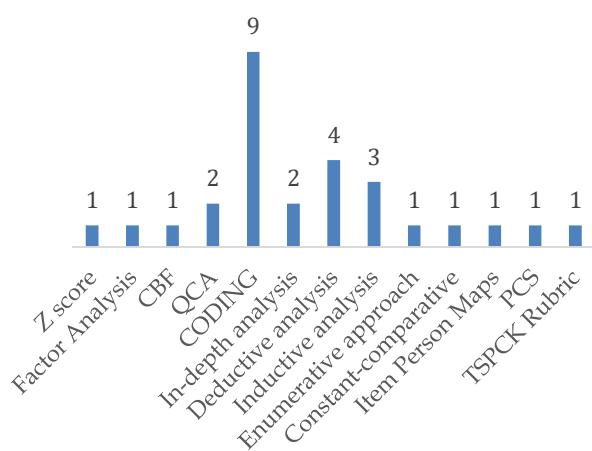


Figure 4. Data Analysis Method

Z score is a statistical value that measures the extent to which an individual value or observation is from the population average, measured in standard deviation units. It provides information about how far the value is from the mean in units of standard deviation, allowing comparison of the relative position of the values in the data distribution. A positive Z value indicates a value above the average, while a negative Z value indicates a value below the average.

Factor analysis is a statistical method used to identify patterns in the relationships between measured variables, and to reduce data complexity by grouping these variables into fewer factors. Correlation between factors (CBF) refers to the relationship or correlation between factors identified through factor analysis. Factor analysis attempts to identify the factors underlying variation in a data set. Correlation between factors measures the extent to which the factors are related to each other.

The coding analysis method in the context of qualitative research refers to the process of organizing and analyzing qualitative data through assigning labels or categories to data units. The coding analysis method is used to organize, group, and interpret qualitative data in research. In-depth analysis refers to an approach or method that involves in-depth examination and understanding of a subject or phenomenon. This analysis is carried out by exploring in detail certain aspects, exploring important details, and understanding the broader context. The purpose of in-depth analysis is to gain comprehensive, in-depth, and often contextual insight into the phenomenon being researched.

Deductive analysis is an analytical approach that begins with the application of a predetermined theoretical framework or hypothesis. Deductive analysis is used to test or confirm a previously established

hypothesis or theoretical framework. Enumerative approach An enumerative approach is used to examine the integration of Pedagogical Content Knowledge (PCK) components based on the framework. Constant-comparative is used in qualitative research, especially when researchers want to understand and explore social phenomena or human behavior in depth. Person maps items relate to tests or measurements in the context of psychometric tests or educational evaluations.

PCS "Pedagogical chemistry sensemaking" can be interpreted as a conceptual framework that focuses on the sensemaking process in the context of chemistry learning. Sensemaking refers to the process of constructing meaningful or relevant understanding from received information, "pedagogical" indicating its relationship to education or teaching.

TSPCK (Technological Pedagogical and Content Knowledge) Rubric is a framework that integrates three types of knowledge to support teaching and learning with technology. TSPCK combines knowledge of technology (TK), pedagogical knowledge (PK), and content knowledge (CK). To help evaluate and develop the TSPCK, a rubric (a criteria-based evaluation tool) can be used.

Conclusion

This research uses a literature review method, with 21 journals indexed by Scopus Q1 in 2013-2022. scientific studies that provide an overview of the development of a topic. Through a literature review, researchers can identify the years of publication, the methods used, the instruments contained in the journals and the focus of the study in each journal. The results and discussion involve an explanation of the Z score as a statistical value, factor analysis, correlation between factors, coding analysis in the context of qualitative research, and the concept of "in-depth analysis" which involves an in-depth examination of a subject or phenomenon. In addition, several research methods such as constant-comparative, person map items, PCS, TSPCK rubric, questionnaires, interviews, observation, and documentation are explained. The importance of pedagogical competence in implementing the educational process is highlighted, and a literature study of the journal "Chemistry Education Research and Practice" shows the dominance of the use of qualitative methods in 2020. Interviews are recognized as a more flexible and in-depth method, with observation and factor analysis as their support.

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Author Contributions

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Conflicts of Interest

The authors declare no conflict of interest

References

Alvarado, C., Cañada, F., Garritz, A., & Mellado, V. (2015). Canonical pedagogical content knowledge by CoRes for teaching acid-base chemistry at high school. *Chemistry Education Research and Practice*, 16(3), 603–618. <https://doi.org/10.1039/c4rp00125g>

Aydin-Gunbatar, S., & Akin, F. N. (2022). Pre-service chemistry teachers' use of pedagogical transformation competence to develop topic-specific pedagogical content knowledge for planning to teach acid-base equilibrium. *Chemistry Education Research and Practice*, 23(1), 137–158. <https://doi.org/10.1039/d1rp00106j>

Aydin-Gunbatar, S., Ekiz-Kiran, B., & Oztay, E. S. (2020). Pre-service chemistry teachers' pedagogical content knowledge for integrated STEM development with LESMeR model. *Chemistry Education Research and Practice*, 21(4), 1063–1082. <https://doi.org/10.1039/d0rp00074d>

Aydin, S., Friedrichsen, P. M., Boz, Y., & Hanuscin, D. L. (2014). Examination of the topic-specific nature of pedagogical content knowledge in teaching electrochemical cells and nuclear reactions. *Chemistry Education Research and Practice*, 15(4), 658–674. <https://doi.org/10.1039/c4rp00105b>

Bahriah, E. S. (2013). Meningkatkan Literasi Sains Peserta Didik pada Aspek Proses Sains melalui Pembelajaran Berbasis Multimedia Interaktif. In *Prosiding Seminar Nasional Pendidikan IPA-Pengembangan Profesi Guru Sains melalui Penelitian dan Karya Teknologi yang Sesuai Tuntutan Kurikulum*.

Bektas, O., Ekiz, B., Tuysuz, M., Kutucu, E. S., Tarkin, A., & Uzuntiryaki-Kondakci, E. (2013). Pre-service chemistry teachers' pedagogical content knowledge of the nature of science in the particle nature of matter. *Chemistry Education Research and Practice*, 14(2), 201–213. <https://doi.org/10.1039/c3rp20177e>

Cetin-Dindar, A., Boz, Y., Yildiran Sonmez, D., & Demirci Celep, N. (2018). Development of pre-

service chemistry teachers' technological pedagogical content knowledge. *Chemistry Education Research and Practice*, 19(1), 167-183. <https://doi.org/10.1039/C7RP00175D>

Chen, B., & Wei, B. (2015). Examining chemistry teachers' use of curriculum materials: In view of teachers' pedagogical content knowledge. *Chemistry Education Research and Practice*, 16(2), 260-272. <https://doi.org/10.1039/c4rp00237g>

Demirdögen, B., & Uzuntiryaki-Kondakçı, E. (2016). Closing the gap between beliefs and practice: Change of pre-service chemistry teachers' orientations during a PCK-based NOS course. *Chemistry Education Research and Practice*, 17(4), 818-841. <https://doi.org/10.1039/c6rp00062b>

Dorfman, B. S., Terrill, B., Patterson, K., Yarden, A., & Blonder, R. (2019). Teachers personalize videos and animations of biochemical processes: results from a professional development workshop. *Chemistry Education Research and Practice*, 20(4), 772-786. <https://doi.org/10.1039/c9rp00057g>

Ekiz-Kiran, B., & Boz, Y. (2020). Interactions between the science teaching orientations and components of pedagogical content knowledge of in-service chemistry teachers. *Chemistry Education Research and Practice*, 21(1), 95-112. <https://doi.org/10.1039/c9rp00092e>

Hale, L. V. A., Lutter, J. C., & Shultz, G. V. (2016). The development of a tool for measuring graduate students' topic specific pedagogical content knowledge of thin layer chromatography. *Chemistry Education Research and Practice*, 17(4), 700-710. <https://doi.org/10.1039/c5rp00190k>

Indonesia, M. P. N. R., Di Lingkungan, P. P. T. N., Yang, D. P. N., & Badan, M. P. K. (2009). Peraturan menteri pendidikan nasional republik indonesia.

Kotul'áková, K. (2020). Identifying beliefs held by preservice chemistry teachers in order to improve instruction during their teaching courses. *Chemistry Education Research and Practice*, 21(3), 730-748. <https://doi.org/10.1039/c9rp00190e>

Lestari, W., & Mulianingsih, F. (2020). Analisis pemahaman kompetensi pedagogik dan kompetensi profesional pada guru ips di kecamatan bawen kabupaten semarang. *Harmony: Jurnal Pembelajaran IPS dan PKN*, 5(1), 60-72.

Lutter, J. C., Hale, L. V. A., & Shultz, G. V. (2019). Unpacking graduate students' knowledge for teaching solution chemistry concepts. *Chemistry Education Research and Practice*, 20(1), 258-269. <https://doi.org/10.1039/c8rp00205c>

Miheso, J. M., & Mavhunga, E. (2020). The retention of topic specific pck: A longitudinal study with beginning chemistry teachers. *Chemistry Education Research and Practice*, 21(3), 789-805. <https://doi.org/10.1039/d0rp00008f>

Purwanto (2011). *Evaluasi Hasil Belajar*. Yogyakarta: Pustaka Pelajar.

Rodríguez-Becerra, J., Cáceres-Jensen, L., Díaz, T., Druker, S., Bahamonde Padilla, V., Pernaa, J., & Aksela, M. (2020). Developing technological pedagogical science knowledge through educational computational chemistry: A case study of pre-service chemistry teachers' perceptions. *Chemistry Education Research and Practice*, 21(2), 638-654. <https://doi.org/10.1039/c9rp00273a>

Schafer, A. G. L., & Yezierski, E. J. (2021). Investigating high school chemistry teachers' assessment item generation processes for a solubility lab. *Chemistry Education Research and Practice*, 22(1), 93-104. <https://doi.org/10.1039/d0rp00121j>

Supprakob, S., Faikhamta, C., & Suwanruji, P. (2016). Using the lens of pedagogical content knowledge for teaching the nature of science to portray novice chemistry teachers' transforming NOS in early years of teaching profession. *Chemistry Education Research and Practice*, 17(4), 1067-1080. <https://doi.org/10.1039/c6rp00158k>

Undang-undang Republik Indonesia, No. 2 Tahun 1989 tentang Sistem Pendidikan Nasional dan Penjelasanya, Departemen Pendidikan dan Kebudayaan Republik Indonesia, 1989.

Wei, B., & Liu, H. (2018). An experienced chemistry teacher's practical knowledge of teaching with practical work: The PCK perspective. *Chemistry Education Research and Practice*, 19(2), 452-462. <https://doi.org/10.1039/c7rp00254h>

Wu, M. Y. M., & Yezierski, E. J. (2022). Pedagogical chemistry sensemaking: a novel conceptual framework to facilitate pedagogical sensemaking in model-based lesson planning. *Chemistry Education Research and Practice*, 23(2), 287-299. <https://doi.org/10.1039/d1rp00282a>