Chemistry Teachers' Need on Enhancing Pedagogical Inquiry Competences

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Abstract

This study aims to determine the needs of chemistry teachers in programs aimed at enhancing their pedagogical inquiry competencies (PIC). In line with these objectives, this research was conducted as survey study. The convenience sampling technique was implemented. The survey was carried out by distributing questionnaires online. There were 63 chemistry teachers who filled out the questionnaire. Data were analyzed descriptively. Based on data analysis, it can be concluded that some teachers know inquiry and feel that they have applied this inquiry in their learning. However, it still needs to be improved on the understanding of the meaning of inquiry and how to implement their inquiry knowledge. Therefore, it is necessary to develop a teaching model to increase the PIC of chemistry teachers.

Keywords: inquiry, pedagogical inquiry competencies, chemistry teacher, survey, PCK

1. Introduction

Science, including chemistry, consists of three inseparable components those are knowledge or concept science, processes or methods and skills in doing science, and attitude (National Research Council, 2000) The attitude component includes scientific attitudes and attitudes toward science. Science is no longer just seen as a body of knowledge that must be mastered by students in the learning process (Lederman & Lederman, 2019). Moreover, science must also be ways of knowing, which means learning science will give students a method to learn about how to understand science and explain the nature phenomenon around them (Lederman & Lederman, 2019).

From this point of view, inquiry-based learning (IBL) to be the recommended approach in learning science (Pike et al., 2023a). IBL has been shown to be effective in increasing students' reasoning abilities and understanding of science concepts (Feyzioğlu & Demirci, 2021; Kocagül Sağlam & Şahin, 2017). The process in IBL encourages students to be active in exploring knowledge by using science process skills (Moon et al., 2016), such as observing, classifying, predicting, interpreting, and communicating (Idul & Caro, 2022). This means that students are not just passive recipients of information, but they are actively involved in the learning process and constructing their own knowledge (Feyzioğlu & Demirci, 2021). These skills are the main factor to scientific investigations and are transferable to other areas of life. Besides that, IBL also helps students develop scientific attitudes (Koksal & Berberoglu, 2014) such as curiosity, thoroughness, and responsibility. This attitude is essential for scientific inquiry and for developing a lifelong interest in science.

The application of IBL in the classroom itself is recognized as not such an easy thing. One of the main challenges in implementing inquiry-based learning is time constraints (Pike et al., 2023a). Inquiry-based learning requires more time than traditional teaching methods because students need time to explore and investigate scientific phenomena. This can be a challenge for teachers who are already struggling to cover the required curriculum within a limited time frame. Another challenge of inquiry-based learning is assessment (Spronken-Smith, 2005). Traditional assessment methods such as multiple-choice tests may not be suitable for assessing students' understanding of scientific concepts developed through inquiry-based learning. Teachers need to develop new assessment methods that are aligned with inquiry-based learning approaches (Kim et al., 2013). On the other hand, students' interest in science learning declined at the early age (Jocz et al., 2014). They may be used to traditional teaching methods where the teacher gives all the information, and they just memorize it. Teachers need to help students understand the benefits of inquiry-based learning and provide support to help them develop the necessary skills. The challenge that is also experienced by students is group work. Inquiry-based learning often involves group work, which can be challenging for some students. Teachers need to provide support and guidance to help students work effectively in groups and ensure that all students participate and contribute to the learning process. Meanwhile, a lack of funding for science equipment or limited access to technology and other tools that facilitate inquiry-based learning may also be a formidable obstacle for many teachers that keeps IBL from being implemented.

It should be realized that chemistry teacher has important role in the implementation of IBL in the classroom. Therefore, factors those are also important in implementing IBL in the classroom is coming from teacher. One of them is the curriculum load that teachers feel they have payload too much material. Teachers need to find ways to align inquiry-based learning with the required curriculum and ensure that students meet the required learning objectives. Especially, using an inquiry-based approach may be considered more challenging or time-consuming for some teachers. They may feel more comfortable with traditional learning methods and may hesitate to adopt new approaches (Pongsophon & Herman, 2017). The effective use of IBL requires teachers to have a solid background in science and professional development in teaching methods. Teachers who do not have the necessary knowledge and training may have difficulty implementing inquiry-based learning effectively (Pongsophon & Herman, 2017). Knowledge and skills about how to teach this inquiry is part of Pedagogical Content Knowledge (PCK)

PCK in relation to inquiry knowledge and skills refers to the specific knowledge a teacher has about how to teach a particular content area using inquiry-based methods effectively (Ekiz-Kiran et al., 2021). This involves understanding subject matter, knowing how to design and implement inquiry-based activities, and being able to assess and support student learning in inquiry contexts. This inquiry PCK is referred to as pedagogical inquiry competencies (PIC).

Absence or lack of teacher's PIC will make teacher does not apply the IBL. Recently, PIC has not been included as a provision for prospective chemistry teachers. Therefore, it is necessary to develop a program aimed at increasing the PIC of prospective teachers, especially how to form an appropriate learning model to equip chemistry teachers with PICs. As a first step to design and develop this learning model, it is necessary to know about field conditions on learning chemistry and teachers' need for learning models that equip them with PIC. Therefore, it is required a survey to analyze the needs of chemistry teachers towards learning models to improve their PIC.

Questions that must be answered in a needs analysis are as follows. 1. What happened now? 2. What should happen? 3. How wide is the performance gap between "as is" and "what should be?" 4. How significant is the performance gap? 5. How large is the performance gap caused by a lack of knowledge, skills, or attitude? 6. What solutions are cost-effective and feasible? 7. What are the unintended side effects of taking corrective action that can be predicted? (Rothwell et al., 2015). Therefore, this article will discuss research questions as follows.

Research Question 1 (RQ1) what are the gaps in the implementation of IBL in the fields compared to the theoretical IBL?

RQ2: what are the factors those cause these gaps?

RQ3: What are teachers' expectations for self-development related to inquiry?

2. Method

2.1 Procedure

This study is a questionnaire survey design. The survey was conducted online using the google-form platform. Participants were recruited through social media platforms, namely whatsapp groups. The survey was available for a period of one week, during which participants can access and complete it at their convenience.

2.2 Participants

Participants in this study were selected through the convenience sampling technique. This nonprobability sampling technique was used in which respondents, namely teachers in the provinces of Central Java and DI Yogyakarta were chosen based on their convenience and availability to completer the questionnaire (Creswell & Creswell, 2018). A total of 63 participants (14 males and 49 females) were involved in this study. The participants' teaching experience was between 1 and 25 years, with an average of 10.5 years.

2.3 Survey Instrument

The questionnaire consists of 35 questions to capture conditions that occur in the learning process carried out by the teacher. The needs analysis questionnaire has been validated by five chemistry education lecturers as experts. Validation is carried out by assessing indicators and questionnaire item developed. There are 40 questionnaire items derived from 20 indicator to be assessed by experts. Each expert assesses whether the indicator is important (1) or not important (0). The results show that all indicators are agreed to be important and can be developed into a questionnaire instrument. Meanwhile, 39 questions are declared valid. However, two experts suggested that it is needed to reduce the number of questionnaire items used. Therefore, the questionnaire was then rearranged to get 35 questions. The survey questions were divided into four sections: demographic information, teacher's condition related to inquiry, implementation of inquiry in learning, and expectations for self-development related to inquiry. The demographic section collects information about age, length of teaching chemistry and training experience related to the development of learning models. The inquiry-related teacher condition section includes a series of Likert scale items that measure knowledge of inquiry, learning models, and mentoring in learning. The implementation of inquiry in learning section assesses the implementation of inquiry and guidance in the classroom, which is usually done by respondents, including the obstacle faced by teachers. The respondent’s expectation section on self-development related to inquiry captures respondents' comments on learning models that consent on PIC improvement.

2.4 Data Analysis

Data obtained on this study were teachers’ attitude, perception, and opinion on their need to enhance their PIC. This data in line with survey design that provides a quantitative description of trends, attitudes, and opinions (Creswell & Creswell, 2018). From the respondents' answers collected, the data was evaluated to formulate results using descriptive analysis. Descriptive statistics are used to determine trends in data and provide an understanding of how these results stand to other (Creswell & Creswell, 2018). Data is displayed based on the frequency of respondents' choices and other trends shown by the data. Based on these results, the respondent's most preferred option can be determined.

3. Results

3.1 Demographics

A total of 63 participants completed the survey, with 14 males and 49 females. The teaching experience was between less than 1 and 25 years, with a mean of 10.3 years. Most of participants confess that they have implemented problem-based learning (70%), discovery learning (39%), project-based learning (36%), inquiry learning (24%), and some other learning models in their class.

3.2 Statistics and Data Analysis

RQ1: what are the gaps in the implementation of IBL in the fields compared to the theoretical PBI? RQ 1 revealed with several questions in the questionnaire, which were divided on related teacher understanding with inquiry, and IBL practice. Some data, i.e., their understanding is related to the definition of inquiry and sources knowledge inquiry can be shown in table 1.

Table 1. Respondents’ Understanding Relates to the Definition of Inquiry and Sources of the Knowledge

Indicator	Answer	frequency
Definition inquiry	Discovery Learning	42
	Question	5
	Curiosity _ _	16
	Hands on activity	3
Source of inquiry knowledge	Teacher Training	16
	University/College	38
	Teachers Association	23
	Professional Development.	19
	Explanation of the Principal	4

The overall data also includes respondents' perceptions of Inquiry Based Learning (IBL) implementation and guidance in the learning they do. From the data, it is known there are 11.1% of teachers who have never implemented IBL. Meanwhile, there were even more SPS assessments, namely 40.9% of teachers who had never implemented it SPS assessment. Other data, such as how implementation inquiry on each SPS according to the teacher, guidance, and assessment will be presented and discussed in the discussion session.

RQ2: what are the factors those cause these gaps? To answer RQ2, data were taken from question related with constraints faced by teachers in the field and their theoretical analysis. Data of constraints faced by teachers can be seen in table 2

Table 2. Data on Constraints Faced by Teachers

Constraint	Frequency
Not experiencing constraint	11
Have never applied IBL	7
Students are not focused	10
Student not enough motivation	24
Students are not active	33
Unsupported infrastructure _	17
Resources and media are not sufficient	20
More time needed _	31
Group activities do not work well	9

RQ 3: What are teachers' expectations for self-development related to inquiry? This RQ3 captures what self-development are required by teacher to improve IBL implementation. There are 6 questions related to RQ3. One of them is an open-ended question with the answer was summarized in the table 3.

Table 3. Expectations of Participants in Program Development to be Carried Out

Expected form of the program	Frequency
Developed program is given in the form of training to connect teachers and prospective teachers with IBL	17
Developed program gives materials to develop learning models (and methods). related to IBL	17
Developed program accompanied with implementation, not just theory	13
Developed program used to upgrade knowledge related to IBL and its mentoring	5
The program is not only for teachers, but also students so they can learn with IBL	4
Developed program can drive teachers to be more creative	3
Developed program can provide a training on how teachers administer IBL	2
Developed programs can be related with practicum	2

4. Discussion

4.1 RQ 1. What Are the Gaps in the Implementation of IBL in the Fields Compared to the Theoretical PBI?

Whole respondent stated that they knew about the term of inquiry. Even, inquiry learning was the fourth of the most learning models applied by chemistry teachers. Respondents also stated that they knew inquiry from college and development teaching profession programs. This indicates that inquiry is not a completely new term for chemistry teachers. This finding is contrast to those of Etahany's work (Eltanahy & Forawi, 2019) that teachers are still affected by the traditional way they were taught. Therefore, it is a big challenge for them to shift the teaching paradigm from a teacher-centered approach to a student-centered approach (Eltanahy & Forawi, 2019). However, most of teachers (67%) make an association between inquiry and discovery learning. Only a 7% of respondents connect inquiry with question - based learning. A learning that is focused on stimulating students' own curiosity (23%) has not become true inquiry because curiosity is just a beginning of questioning.

The explanation regarding to how the implementation of IBL is associated to laboratory shows that respondents did not understand implementation of IBL in class (Figure 1). Opinion that inquiry must be a free inquiry is attached to mind of big part of respondents (74.6%), this is supported with a fact that there are many opinions that IBL should constitute laboratory work (33.3%) and IBL is the synonym of hands on activity (27.0%). This finding in line with a study by (Strat & Jegstad, 2022) that found teacher educators expressed uncertainty about whether non-practical work, such as a literature search, could be labeled inquiry. Although, respondents understand that the teacher should be more active create atmosphere inquiry, not just has students more active (50.8%).

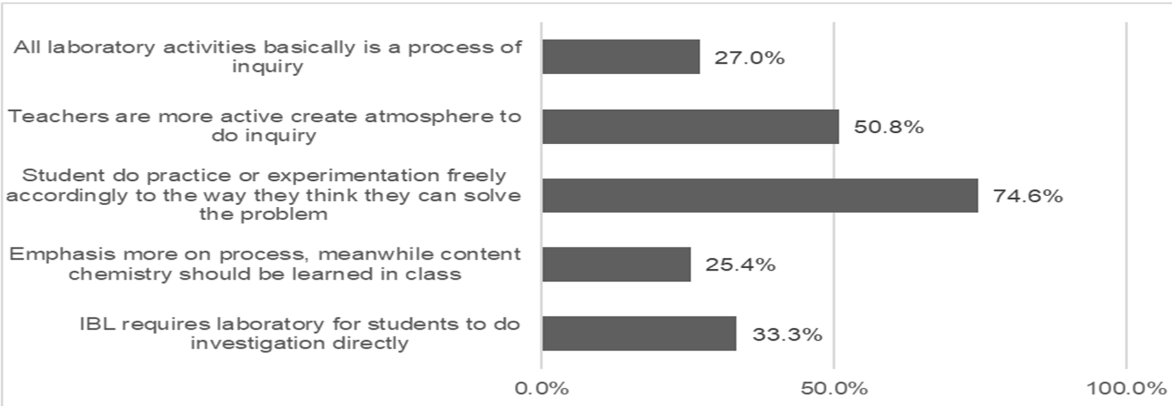


Figure 1. Respondents' Opinion about the Processes That Occur in Classes with IBLs

Observation skill is the earliest science process skills performed when do inquiry. From the responses given, almost whole respondent has known that observation skill is related by using five senses and another measuring tools to get the data (96.8%). However, at the same time, respondents stated that only watching videos displayed by the teacher (76.2%) and reading text (50.8%) is skill form of observation. These two activities are most carried out often by the teacher. Basically, this activity has not reached the point of observing if students cannot interact with to get the data. This data can be seen in Figure 2.

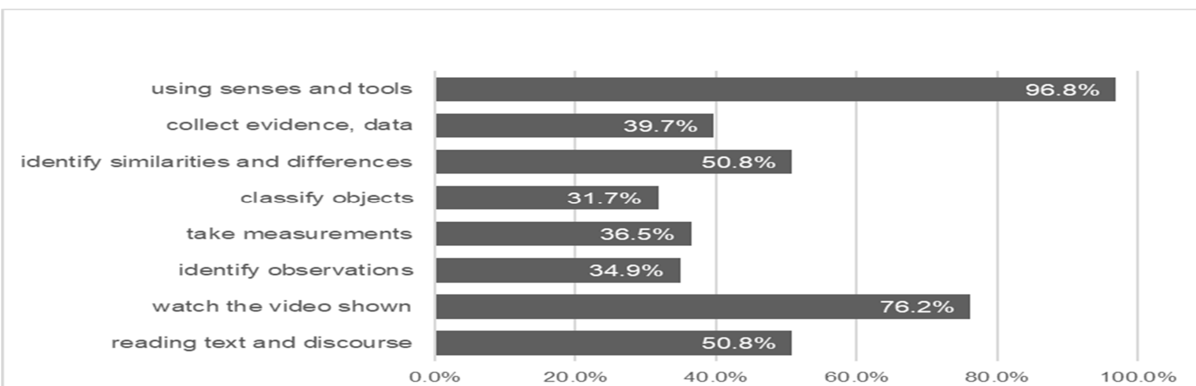
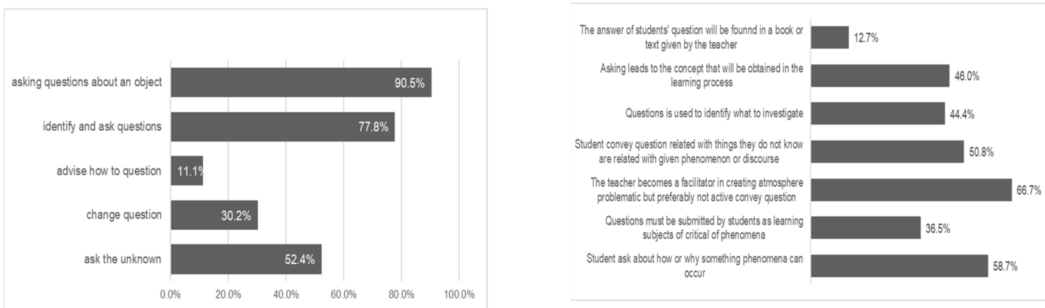


Figure 2. Respondents' Opinion About Observation Skill

Questioning skill appears after observation. Most of respondents (90.5%) have better understanding that questioning skills is asking question about an object (Figure 3a). The question in this inquiry process is more directed to what will be solved in the investigation process. There are only 44.4% of respondents who are aware of this condition (figure 3b). There are more respondents who have opinion that a question is asked for things they did not know (50.8%) and why something phenomena can occur (58.7%). These questions often do not lead to an open-ended investigation. Even if it is seen from frequently asked questions, students asked more knowledge question (figure 4), not an inquiry question.

In related to predicting skills, respondents' knowledge has indicated the correct understanding of this skill. Most of the respondents understand that predicts related to data patterns and the phenomena they observe (85.7%) (figure 5a). Although it brings up an uncertainty of the other options. This is revealed with implementation understanding of this skill in the class (figure 5b), there were only 39.7% of the respondents who remained answer same mode with their knowledge, in term of "students connect variables to explain thing that probably will happen". This means that 61.3% of respondents do not see prediction skill in same way with generated prior knowledge.



(a) (b)

Figure 3. Respondents' Opinion about Questioning Skill of (a) Knowledge, (b) Implementation in Class

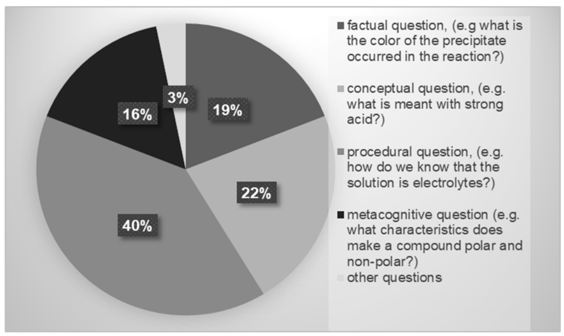
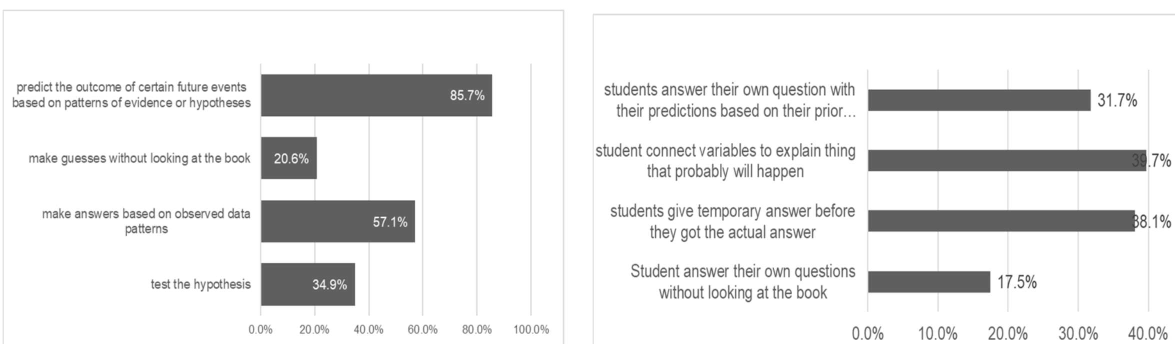


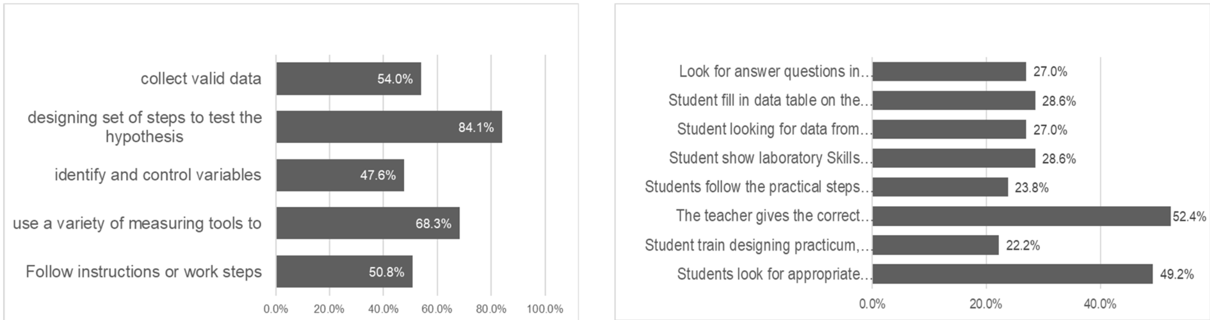
Figure 4. Forms of Frequent Questions Asked by Students



(a) (b)

Figure 5. Respondents' Opinion about Prediction Skill Reviewed of (a) Knowledge, (b) Implementation in Class

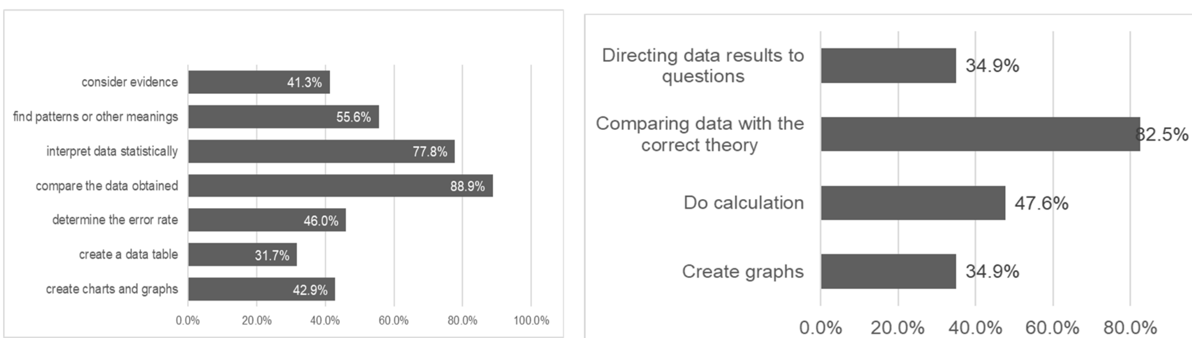
Respondents' understanding about planning and carrying out investigation skill seems to be only at designing work steps to test hypothesis. As many as 84.1% (figure 6a) choose this option. However, if this item is looked at further, it still is many of them (50.8%) chose "follow the instructions or work steps to get correct answer". It revealed that a mind about recipes book in the laboratory in traditional manner is still attached to the respondent. This evidence can be seen in Figure 6b which shows that more than half (52.4%) of teachers who only give recipe and almost half respondents (49.2%) asked student look for the procedures in the book.



(a) (b)

Figure 6. Respondents' Opinion About Planning and Carrying out Investigation Reviewed of (a) Knowledge, (b) Implementation in Class

Processing and analyzing data and information skill has been understood well by the respondents. This process is often carried out in research or practicum on campus. as shown in figure 7a, as many as 88.9% of respondents answered that data analysis is connected to "compare the data obtained" The main concern to be further explored is how students can learn further about data analyzing objective. From Figure 7b it is only a few teachers (34.9%) pay attention the need of the data analysis confirmation to the inquiry questions, not just compare the data with existing theory (82.5%)



(a) (b)

Figure 7. Respondents' Opinion About Processing, Analyzing Data and Information Skill Reviewed of (a) Knowledge, (b) Implementation in Class

Communicating skill is also a commonly performed skills by the respondents, since they were in college. Figure 8a shows that almost all respondents (93.7) agree that these skills are related with present the results of observations. Only a few (19.0%) of them realized that speaking with other people is also a communication skill. The classroom implementation section (figure 8b) shows that most of inquiry class do presentation in speaking in front of the class (79.4%) or in the form of writing reports (74.6%). This shows that forms of communication performance are needed to be improved. What also needs to be considered is the teacher's ability to choose time to dig deeper in the discussion and communication state to improve students' conceptual understanding (Ødegaard et al., 2014). Some study has revealed that IBL promoted collaborative learning (Rauschenbach et al., 2018) and communication skills ((Yenice & Özden, 2022), as students often work in groups to explore and solve complex problems.

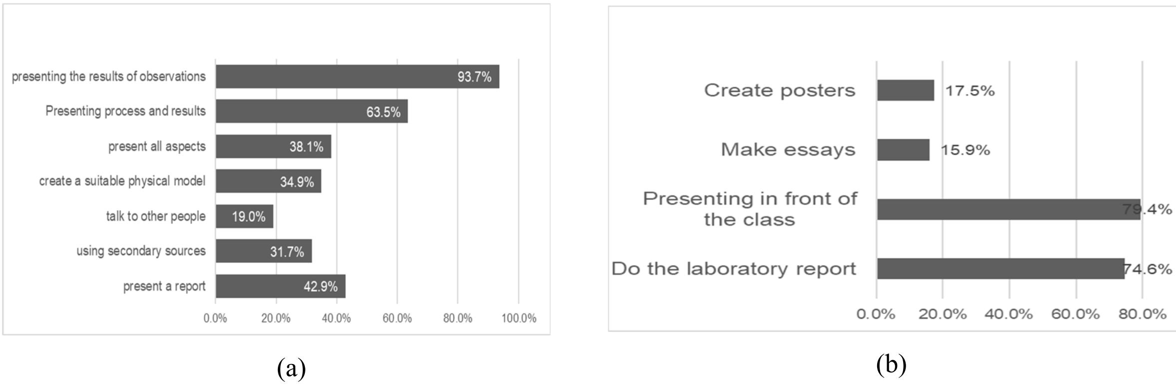


Figure 8. Respondents' Opinion About Communication Skill (a) Knowledge, (b) Implementation in Class

Based on the analysis of the understanding and implementation of IBL in the classroom, several outlines can be drawn. First, inquiry and IBL understanding is still needed to be improved. There are still many teachers who relate inquiry with discovery learning, as well associate inquiry to laboratory activities. Prospective chemistry teachers.

In case implementation in class, there are many of the inquiry steps not as they should be. Some misconceptions about inquiry Still held by chemistry teachers in the field. In line with Etahany's research (Eltanahy & Forawi, 2019) finding that teachers have misconceptions in some areas of inquiry.

4.2 RQ2. What Are the Factors Those Cause These Gaps?

Factors that cause gaps can be seen from several point of view. One of them is the obstacles faced by teachers in implementing IBL in the classroom. Data on the constraints faced by teachers in implementing IBL can be seen in Figure 9.

Figure 9. Constraints Faced in Implementing IBL

As shown on figure 9, there are 17.5% of respondents who feel that they have no constraints experienced on the application of IBL, although the results of the analysis show that there are many discrepancies between what is understood and done with what should be. This condition is in line with the study of Shahat et al., (2022) that teachers often perceived their own science teaching is highly successful inquiry, so are the findings of study conducted by Capps et al. (2016). This means that there are intrinsic obstacles within respondent to open their mind to new knowledge. This precisely is an issue that must be addressed in future program development.

The biggest constraint considered by respondents is that their students are not active learner (52.4%). A genuine interest in science is an important part of scientific literacy (Swarat et al., 2012), this less interested student is significant obstacle in the implementation of IBL. This condition can come from traditional teaching approaches applied by teachers. This is also related to other constraints felt by the respondents, namely student not enough motivated (38.1%), not focused on learning (15.9%), and unable to activate group work (Rothwell et al., 2015; Pike et al., 2023b). This was conveyed by (Wieselmann et al., 2021) that students are indeed more active in collaborating in a more structured learning process. Students habit to take information for granted is also reason of this obstacle appearance.

Time constraints is also felt by respondents. It is about half of respondents (49.2%) stated that teaching chemistry with IBL is time consuming(Strat & Jegstad, 2022). Moreover, the teacher highlighted the pre-service teachers' lack of background knowledge in science made them reluctant to implement IBL. On the other hand, inadequate learning resources, media, as well as facilities and infrastructure were also presented as obstacles on this implementation, the same as mentioned by Eltanahy and Forawi (2019) that teachers were found to be struggle with some barrier such as time limitation, a lack of the materials and tool required, and the heavy caseload of selected topics in the annual syllabus. Compared to a study by Spronken-Smith (2005) that mentioned timetable and room allocations as facilities barrier in IBL implementation, this study stressed on laboratory chemical and equipment.

The other factor that might be the cause of this gap is the source of inquiry knowledge obtained by most of respondent was originate from their college (60.3%) (see table 1). This is in line with Ramnarain's study (Ramnarain, 2016) that highlight teachers' lack of professional science knowledge in IBL implementation. Most of teacher education programs do not adequately prepare teachers to the complex and varied role required in IBL (Mckeown et al., 2016), as well as chemistry education department in Indonesia has not provided a specific subject on inquiry and its implementation in the classroom. Therefore, the lack of knowledge and skills can be seen as the main factor of the gap in the implementation of IBL in schools.

From the data analysis for RQ2, it can be concluded that Studies have shown that many chemistry teachers do not have or lack the necessary knowledge and understanding to implement IBL strategies effectively in their classrooms (Chichekian et al., 2016) . Apart from that, there are several other factors related to the implementation of IBL.

1. Limited Teacher Training. Many chemistry teachers receive minimal or no formal training in IBL during their pre-service education. As a result, they may lack the necessary pedagogical knowledge and skills to design and facilitate inquiry-based activities effectively (Ramnarain, 2016) .

2. Traditional Teaching Approach. Chemistry education has historically relied on traditional lecture-based instruction, which emphasizes content delivery rather than student-centered learning (Eltanahy & Forawi, 2019; Pongsophon & Herman, 2017). This traditional approach can hinder teachers' ability to adopt and implement IBL strategies.

3. Lack of Resources and Support. The application of IBL in chemistry classes requires access to appropriate resources, such as laboratory equipment, materials, and technology (Eltanahy & Forawi, 2019). However, the limited availability of these resources, coupled with inadequate support from school administration, can discourage teachers from using IBL (Orosz et al., 2023). Therefore, the availability of teachers with resources and training is needed to create meaningful inquiry experiences for students (Papanikolaou et al., 2014).

4. Assessment Challenge. Assessing student learning in inquiry-based settings is a complex process, as it requires teachers to move away from traditional summative assessment towards formative assessment methods (Spronken-Smith, 2005) that focus on process skills and critical thinking. The lack of knowledge and experience in designing and evaluating these assessments can be an obstacle for chemistry teachers.

4.3 RQ 3: What Are Teachers' Expectations for Self-Development Related to Inquiry?

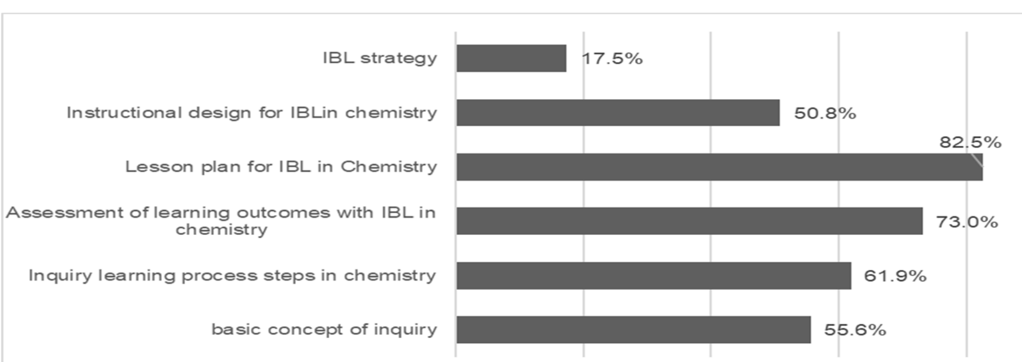


Figure 10. Respondents' Expectations of Materials That Need to Be Developed

The solutions that can be offered to overcome the gaps that can be considered from respondents' expectation on self-development related to inquiry. In the table 3, the most revealed expectation is the training that provides prospective teachers provisions of models and methods learning related to IBLs. Another respondents' expectation is that this training includes its application in class. On another question related to respondents' expectations of materials needed to be developed, can be seen in Figure 10.

The most program expected by participants is related to clear instructions on how to carry out inquiry in classroom. This can be seen that most of respondent choose the option of ability to make plans learning (82.5%), instructional material design (50.8%), and assessment (73.0%). Respondents' willing to get explanation about inquiry theoretically is massive also, especially related to basic concepts of inquiry (55.6%) and inquiry learning procedures (61.9%).

These expectations show the necessity of pedagogical content knowledge related to inquiry as equipment for prospect chemistry teachers. Pedagogical content knowledge (PCK) is a framework that describes the knowledge and skills teachers need to teach a particular subject effectively. In the context of chemistry education, PCK refers to the knowledge and skills needed by chemistry teachers to teach chemistry concepts effectively. PCK was first proposed by Shulman (1986) which offers a different kind of knowledge which is an amalgam of content and pedagogical knowledge. Furthermore, one of the earliest studies of PCK in chemistry education was conducted by (Gess-Newsome, 1999). They developed a framework for PCK in chemistry that includes knowledge of students' prior knowledge, common misconceptions, and effective teaching strategies. They found that teachers who had a strong PCK understanding were better able to help their students understand difficult chemistry concepts.

Since then, many studies have been conducted on PCK in chemistry education. For example, a study by (Taber & García-Franco, 2010) found that teachers who have a strong understanding of PCK are better able to help their students understand abstract concepts of chemistry. Another study by (Kind, 2014) also strengthens that teachers who have a strong PCK understanding are better able to help their students develop an in-depth understanding of chemistry concepts (Gess-Newsome, 1999). The direct effect of programs that focus on PCK is also known to improve teachers' ability to develop their PCK (Eilks & Markic, 2011; Park & Oliver, 2008) .

Despite the growing popularity of inquiry-based learning in chemistry education, there is limited understanding of how PCK can be effectively integrated into this instructional approach. Based on this, there is a need for professional development for chemistry teachers in developing their PCK for inquiry-based learning. Professional development programs that focus on improving teachers' PCK can play an important role in improving their learning practices. Knowledge in PCK also includes skill. Therefore, hereinafter it can be referred to as ability, and because it is related to inquiry as its content, this PCK is referred to as pedagogical inquiry competencies (PIC).

From the description above, it can be concluded that there are some good practices have to be offered as solution, namely

1. Professional Development related to Inquiry. It is suggested that teachers may face difficulties in managing the inquiry process, providing adequate support, and assessing student learning outcomes (Baan et al., 2023). Therefore, continuous professional development and support for teachers is essential to overcome the obstacles encountered and ensure the successful implementation of IBL.

2. Utilization of scaffolding in learning. Scaffolding is very important to support the student inquiry process (Levrini et al., 2019) that providing clear guidelines, modeling inquiry skills, and gradually reducing support can help students develop autonomy and become proficient in inquiry-based learning.

3. Creating a supportive classroom environment is very important. The study by (Pedaste et al., 2015) emphasize the importance of fostering safe and inclusive spaces where students feel comfortable asking questions, taking risks, and engaging in collaborative discussions. Teachers should also provide timely feedback and reflection opportunities to improve students' metacognitive skills(Kipnis & Hofstein, 2008)

In relation to this RQ3 answer, the development of learning or training models that target PIC is appropriate solutions to offer. It is congruent with Chichekian et al. (2016) that a teacher-education challenge is to scaffold new teachers to enact inquiry-based instruction. It is also suggested that academic teacher education programmes should not focus only on developing inquiry skills but also on how to apply these skills in the context of a school organization (Baan et al., 2023).

5. Conclusion

From the data analysis, it can be concluded that, 1) it is still needed to improve teachers' inquiry and IBL understanding. There are still many teachers who relate inquiry with discovery learning, as well associate inquiry to laboratory activities. In case of classroom implementation, there are many of the inquiry steps not as they should be. Some misconceptions about inquiry Still held by chemistry teachers in the field, 2) the lack of knowledge and skills can be seen as the main factor of the gap in the implementation of IBL in schools. 3) the development of learning or training models that target PIC is appropriate solutions to offer.

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Authors contributions

Sukisman Purtadi (SP) were responsible for study design, data collection, and data analysis. Prof. Suyanta Suyanta (SS) and Prof. Eli Rohaeti (ER) were responsible for supervising and revising. SP drafted original manuscript than supervised and revised by Prof SS and Prof ER. All authors have read and approved final manuscript and the published version of the manuscript.

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