JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

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EDUCATIONAL PRIORITIES FOR ENHANCING ELEMENTARY SCHOOL PRE-SERVICE TEACHERS' SCIENCE LESSON ENACTMENT COMPETENCE AFTER THE TEACHING PRACTICUM

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Abstract. *A persistent gap exists between university-based theoretical preparation and pre-service teachers' ability to enact science lessons in real classrooms. This study examined elementary school pre-service teachers' needs regarding science lesson enactment competence after the teaching practicum and identified priority areas for educational support. A questionnaire was developed from a literature review and interviews with pre-service teachers. The instrument consisted of two domains, eight subdomains, and 32 items. Data were collected from 100 pre-service teachers, and perceived importance and self-rated current performance were measured for each item. The data were analysed using paired-samples t-tests, the Borich needs assessment formula, and the Locus for Focus model. The results showed a statistically significant gap between perceived importance and self-rated current performance across all subdomains. Although participants regarded this competence as highly important, they rated their current performance substantially lower. Understanding learners, foundational knowledge, and facilitating inquiry and thinking were identified as the highest-priority areas, whereas educational materials preparation and lesson design showed lower relative priority. These findings indicate where teacher education programmes should provide stronger support after the practicum.*

Keywords: *needs analysis, pre-service teachers, science education, science lesson enactment, teaching practicum*

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Introduction

Teachers' competence in enacting science lessons strongly shapes the quality of science education. As contemporary science education has shifted from knowledge transmission towards the cultivation of students' scientific literacy, the teacher's role has broadened: teachers must now organise and facilitate students' inquiry and adapt to classroom situations as they unfold, rather than simply explain predetermined content. Science lesson enactment competence refers to the professional capacity to put science lessons into practice. It includes the ability to adapt scientific content to learners' levels and contexts, to organise lesson goals and activities, and to manage inquiry and classroom interactions in response to the varied situations that arise during teaching (Loughran et al., 2004; Shulman, 1987). What matters, in short, is not only what teachers know but how they put that knowledge to work in real science classrooms. This is especially critical in elementary school education, the stage at which students first develop their interest in science, their attitudes towards it, and their basic inquiry skills (Maltese & Tai, 2010; National Research Council, 2007).

Elementary school pre-service teacher education should therefore place greater emphasis on developing science lesson enactment competence. Pre-service teachers need support in turning the theoretical knowledge they acquire at university into actual classroom practice (Flores et al., 2014). The teaching practicum plays a particularly important role in this process. It is the first formal occasion on which pre-service teachers take up the teacher's role in a real setting, and a key context in which they can apply university knowledge in schools and develop their science lesson enactment competence (Jeong, 2019; Zeichner, 2010). The practicum is also a turning point at which pre-service teachers move beyond planning or imagining science lessons and begin teaching them to real pupils in real classrooms, enabling them to identify their strengths and limitations in concrete terms.

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

The teaching practicum is a core component of initial teacher education across many national systems, even though its structure varies considerably from one country to another in duration, timing, and organisation (Musset, 2010). In Finland, for example, primary teacher candidates complete practicums arranged in several blocks within a master's-level programme (Mankki et al., 2025); in Singapore, the final placement lasts around ten weeks (National Center on Education and the Economy, 2016); and in South Korea, elementary teacher education includes a practicum distributed across the four-year programme. Despite these differences, the practicum is commonly regarded as a key site where pre-service teachers begin to connect university-based theory with the realities of classroom practice.

Against this broader international background, difficulties in translating teacher education coursework into science lesson enactment have been reported in different practicum contexts. Davis et al. (2006) have shown that pre-service science teachers struggle across several areas, including science content knowledge, understanding learners, educational strategies, and guiding inquiry activities. Kim and Tan (2011) have similarly reported that, when teaching inquiry-based practical lessons, elementary school pre-service teachers face more than a simple lack of technical knowledge: tensions between their beliefs about science teaching and their actual practice further intensify these difficulties. Reviews of practicum research across different national contexts have likewise identified the gap between theoretical preparation and classroom practice as an enduring, shared challenge in initial teacher education (Livingston & Flores, 2017).

These difficulties are not simply a question of individual ability; they reflect a structural gap between university-based theoretical preparation and the realities of school classrooms (Im et al., 2016; Zeichner, 2010). These findings suggest that teacher education programmes need to provide more explicit support for helping pre-service teachers translate university-based learning into science lesson enactment in real classroom settings. A first step is to diagnose systematically where pre-service teachers feel they need support across different aspects of science lesson enactment in real classroom situations. After the practicum in particular, pre-service teachers tend to develop more realistic, context-sensitive views of what support they need, and identifying these needs is an important starting point for improving pre-service teacher education.

Existing studies on pre-service teachers' lesson enactment have either examined perceptions or needs before the practicum, in settings such as university coursework or microteaching, or focused narrowly on specific teaching approaches or skills. As a result, they have not fully captured the needs pre-service teachers face with science lesson enactment in real classroom contexts (Kim & Lim, 2022; Kim & Tan, 2011; Yoon et al., 2012). Other studies have approached pre-service science teachers' lesson enactment through lesson evaluations, classroom observations, or the views of cooperating teachers, rather than through the difficulties and support needs voiced by pre-service teachers themselves (Kim et al., 2010; Kim et al., 2021; Koh & Choi, 2013). Studies relying on simple questionnaires or descriptive statistics have also been unable to set priorities for educational support based on the gap between perceived importance and current performance (Amankwah et al., 2017; Balyer, 2017).

The present study therefore carries out a needs analysis of science lesson enactment competence among elementary school pre-service teachers who have experienced real school classrooms through the practicum. Needs analysis is a structured method for setting educational priorities by examining the gap between the present state (what is) and the desirable state (what should be) (Witkin & Altschuld, 1995). This approach does not simply show which competences pre-service teachers find difficult. It helps identify areas that they consider important but rate relatively low in their current performance. In this study, the Borich needs assessment formula and the Locus for Focus model were used together to determine which areas should receive priority in teacher education programmes. This provides a basis for bottom-up improvement of teacher education programmes by drawing on the voices and needs of pre-service teachers who have practised in schools, rather than relying on a top-down model of curriculum design. Although the study is situated in the Korean context, its findings may be of interest to teacher education contexts that face similar challenges in connecting university-based preparation with classroom practice. The research questions are as follows.

First, what differences exist between perceived importance and current performance in science lesson enactment competence among elementary school pre-service teachers after their practicum?

Second, which areas of science lesson enactment competence emerge as priorities in the Borich needs assessment and the Locus for Focus model?

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Research Methodology

Design

This study used a needs analysis design based on a structured questionnaire survey, supplemented by open-ended questions, to identify priority areas for educational support among elementary school pre-service teachers. The study was carried out in three stages: instrument development, data collection, and data analysis (Figure 1). In the first stage, prior literature was reviewed and interviews with pre-service teachers were conducted to inform questionnaire development. In the second stage, an online survey, including rating-scale and open-ended questions, was administered to pre-service teachers who had completed a practicum. After responses indicating insufficient engagement were excluded, the remaining data were retained for analysis. In the third stage, the rating-scale data were analysed using paired-samples *t*-tests, the Borich needs assessment, and the Locus for Focus model, while the open-ended responses were reviewed as supplementary data to contextualise the quantitative findings.

Figure 1
Research Procedure

1. Instrument Development	• Literature review and interviews with pre-service teachers for item development • Development of a preliminary questionnaire with two domains, eight subdomains, and 32 items • Content validity review by science education experts and practising teachers
▼	
2. Data Collection	• Administration of an online survey including rating-scale and open-ended questions • Selection of 100 participants for the final analysis after excluding insufficient responses • Examination of reliability using Cronbach's α
▼	
3. Data Analysis	• Paired-samples *t*-tests, Borich needs assessment, and Locus for Focus analysis • Review of open-ended responses to contextualise the quantitative findings • Derivation of priority areas and implications through synthesis of the findings

Sample Selection

The participants were pre-service teachers enrolled in elementary teacher education programmes at Gongju National University of Education (GNUE) and Korea National University of Education (KNUE) in South Korea. They had completed their teaching practicum in the second semester of 2025. In South Korea, elementary teacher education prepares students to teach Grades 1–6 in elementary schools and is separate from early childhood or kindergarten teacher education. Participants were recruited through convenience sampling, given the researchers' access to the target population. After being informed of the study's purpose and procedures, those who voluntarily agreed to participate completed an online survey. The survey was open for two weeks, from 10 to 24 November 2025, immediately after the practicum ended, so that participants' perceptions and needs would reflect their recent practicum experience.

During this fixed survey period, 106 responses were voluntarily submitted. Six responses were excluded because they showed signs of insufficient engagement, such as unrealistically short completion times or repetitive response patterns. Data from the remaining 100 participants were included in the final analysis. This sample size was deemed sufficient, as it provides adequate statistical power for paired-samples t-tests (Cohen, 1988) and is appropriate for conducting a context-specific needs assessment within a defined cohort (Witkin & Altschuld, 1995). Participants' demographic and background information is shown in Table 1.

In addition to the rating scales, the survey included two open-ended questions asking participants to describe difficulties they experienced during science lessons in the practicum and areas in which they wanted further support. These responses were used as supplementary open-ended data to help contextualise the quantitative needs assessment results; 65 of the 100 participants provided a response to at least one of the two questions.

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
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Table 1
General Characteristics of Participants

Background Characteristic	Category	*n*	%
Gender	Male	28	28
	Female	72	72
University	GNUE	67	67
	KNUE	33	33

Instrument Development and Data Collection Procedures

A questionnaire was developed to examine elementary school pre-service teachers' perceptions of, and needs regarding, science lesson enactment competence. Prior literature on science teaching, lesson enactment competence, and teacher professionalism was reviewed (Carlson et al., 2019; Kunter et al., 2013; Lee, 2024a; Loughran et al., 2004; National Research Council, 2012; Park et al., 2023). Semi-structured interviews were also conducted with six elementary school pre-service teachers during their teaching practicum to explore what they considered important for effective science lesson enactment, which teaching competences they perceived as necessary for future science teaching, what background knowledge was needed before teaching, what considerations went into lesson design, and what difficulties they encountered during actual lesson enactment.

Based on the literature review and interview data, questionnaire items on science lesson enactment competence were drafted and grouped by content similarity. The grouping was then reviewed for conceptual coherence and relevance to science lesson enactment competence. The resulting framework included two domains, Preparation for Lesson Enactment and Lesson Enactment, and eight subdomains: Foundational Knowledge, Understanding Learners, Lesson Design, Educational Materials Preparation, Concept Teaching, Facilitating Inquiry and Thinking, Supporting Participation and Interaction, and Lesson Management. The preliminary questionnaire contained 32 items, with three to six items per subdomain (Table 2). Each item was rated twice: once for perceived importance and once for current performance. Perceived importance indicated the extent to which participants considered the competence necessary, whereas current performance indicated how well they felt they currently performed it. Both ratings were made on a 5-point Likert scale from strongly disagree (1) to strongly agree (5).

To establish content validity, three science education experts and two practising elementary teachers reviewed the suitability of the items, the clarity of their wording, and how well they fit their assigned subdomains. Each item was rated on a four-point scale, and item-level content validity indices (I-CVIs) were calculated as the proportion of experts giving a rating of 3 or 4. The scale-level content validity index by the average method (S-CVI/Ave) was also calculated. I-CVI values ranged from 0.80 to 1.00 and the S-CVI/Ave was 0.94, indicating acceptable content validity. Drawing on the expert review and CVI results, redundant or ambiguous items were revised, and some terms were adjusted to suit elementary school pre-service teachers, producing the final questionnaire.

To check the reliability of the final instrument, Cronbach's α was calculated from the main survey data. Cronbach's α was .950 for the importance items and .942 for the current-performance items, indicating very high internal consistency. At the subdomain level, α ranged from .662 to .854 for importance and from .675 to .804 for current performance. A few subdomains had values in the mid-.60s, which can be considered marginally acceptable given the exploratory nature of the study and the small number of items in some subdomains. Overall, the instrument showed adequate internal consistency. Detailed values are shown in Table 2.

The two-domain, eight-subdomain structure was therefore employed as a theory- and content-based framework for diagnosing educational needs, following the Borich needs assessment approach (Borich, 1980), rather than as an empirically validated factor structure.

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
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Table 2
Items and Reliability of the Instrument

Domain	Subdomain	No.	Item	Cronbach's α	
				Importance Level	Current Level
Preparation for Lesson Enactment	Foundational Knowledge	1	I understand the nature of science (e.g., the tentativeness of scientific knowledge).	.780	.804
		2	I understand the educational necessity and importance of science as a school subject.		
		3	I understand the current science curriculum.		
		4	I possess core content knowledge in science.		
		5	I possess sufficient scientific background knowledge to respond to questions beyond the immediate scope of the lesson.		
		6	I know real-life examples and socio-scientific issues related to the science content.		
	Understanding Learners	7	I identify learners' levels of achievement in science.	.721	.804
		8	I identify learners' prior conceptions or misconceptions.		
		9	I identify learners' developmental stages and characteristics.		
		10	I identify learners' social and cultural backgrounds.		
	Lesson Design	11	I apply appropriate science teaching models that align with the lesson objectives and content.	.662	.688
		12	I organise lesson activities coherently, taking into account the overall flow of the lesson.		
		13	I design teaching and learning using digital technologies and tools (e.g., educational technology).		
	Educational Materials Preparation	14	I develop teaching and learning materials with consideration for educational effectiveness.	.854	.675
		15	I select media resources (e.g., photographs and videos) with consideration for educational effectiveness.		
		16	I prepare experimental equipment and become familiar with its use in accordance with the inquiry objectives.		
Lesson Enactment	Concept Teaching	17	I explain key content at an appropriate level for learners.	.759	.780
		18	I support learners in applying what they have learned to a range of contexts, including everyday life.		
		19	I support learners in constructing and expressing scientific concepts for themselves.		
	Facilitating Inquiry and Thinking	20	I facilitate scientific thinking, such as reasoning and prediction.	.849	.804
		21	I guide learners in monitoring and adjusting inquiry objectives and processes.		
		22	I teach inquiry skills such as observation, classification, and measurement.		
		23	I guide learners in organising inquiry results and linking them to scientific concepts.		
	Supporting Participation and Interaction	24	I provide tailored instruction that takes individual learners' characteristics into account.	.853	.797
		25	I provide appropriate feedback on learners' performance.		
		26	I promote communication among learners and between learners and teacher.		
		27	I stimulate learners' interest and engagement in order to increase their participation in the lesson.		
	Lesson Management	28	I allocate and use time appropriately for the effective management of the lesson.	.813	.756
		29	I manage disruptive behaviour and a disorderly classroom atmosphere appropriately.		
		30	I use the board to organise and present lesson content and pupils' ideas systematically.		
		31	I respond flexibly to unexpected experimental results or changing classroom conditions.		
		32	I provide guidance on laboratory safety and on the use of experimental equipment.		
Total				.950	.942

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Data Analysis

The analyses comprised paired-samples t-tests, the Borich needs assessment formula, and the Locus for Focus model. To examine pre-service teachers' perceptions of science lesson enactment competence, the means and standard deviations of importance and current performance for each item and subdomain were first calculated. Paired-samples t-tests were then run to test whether the differences between the two were statistically significant. The significance level was set at .001.

The Borich needs assessment formula was then applied to quantify the magnitude of need (Figure 2). For each item and subdomain, the gap between importance and current performance was weighted by importance, and the result was divided by the total number of cases to give the Borich need score. These scores were used to compare the relative priority of needs.

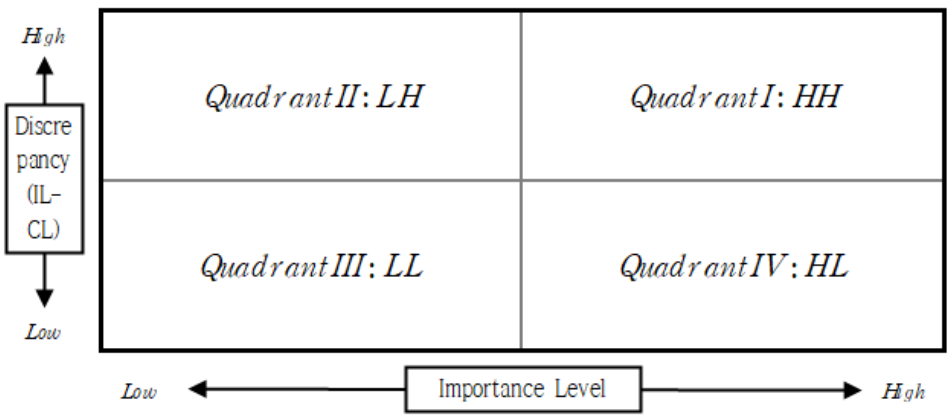
Figure 2
Borich's Needs Assessment Formula

$$Need = \frac{\sum (IL - CL) \times \overline{IL}}{N}$$

IL: importance level
CL: current level
$\overline{IL}$: mean importance level
N: total number of cases

Finally, the Locus for Focus model was used to plot importance on the horizontal axis against the importance–performance gap on the vertical axis. In this model, the first quadrant (HH), where both importance and gap are high, marks the highest-priority area for improvement; the fourth quadrant (HL), where importance is high but the gap is relatively small, is an area to maintain and strengthen; the second quadrant (LH), where importance is low but the gap is large, is a possible area for improvement; and the third quadrant (LL), where both are low, is a low-priority area (Mink et al., 1991) (Figure 3). Combining the quadrant positions in the scatter plot with the Borich need scores, we identified the urgency and priority of needs across the subdomains and drew educational implications from them. All statistical analyses were conducted using IBM SPSS Statistics 24.0. The open-ended responses were reviewed as supplementary data. Responses were read repeatedly and organised according to the questionnaire subdomains, and illustrative responses relating to the highest-priority subdomains were selected to help interpret the quantitative results. These responses were used only to support and contextualise the needs assessment findings, not as an independent qualitative analysis.

Figure 3
The Locus for Focus Model



https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Research Results

Perceived Differences and Needs Across the Subdomains of Science Lesson Enactment Competence

Perceived importance and current performance in science lesson enactment competence were analysed across the subdomains. In every subdomain, mean importance exceeded mean current performance, and all the differences were statistically significant (Table 3). Thus, although the pre-service teachers viewed all aspects of science lesson enactment as important, they rated their own current performance as falling short of that level.

Table 3
Perceived Differences and Needs Across the Subdomains of Science Lesson Enactment Competence

Domain	Subdomain	Importance Level		Current Level		Discrepancy		*t*	Borich Need Score	Priority
		M	*SD*	*M*	*SD*	*M*	*SD*			
Preparation for Lesson Enactment	Foundational Knowledge	4.28	0.47	3.31	0.61	0.98	0.65	15.06***	4.18	2
	Understanding Learners	4.36	0.49	3.38	0.74	0.98	0.79	12.36***	4.25	1
	Lesson Design	4.07	0.58	3.57	0.65	0.50	0.64	7.77***	2.04	8
	Educational Materials Preparation	4.41	0.55	3.91	0.61	0.51	0.61	8.26***	2.24	7
Lesson Enactment	Concept Teaching	4.36	0.51	3.66	0.67	0.71	0.65	10.81***	3.08	4
	Facilitating Inquiry and Thinking	4.34	0.55	3.55	0.64	0.79	0.66	11.93***	3.40	3
	Supporting Participation and Interaction	4.41	0.53	3.75	0.64	0.66	0.68	9.72***	2.91	5
	Lesson Management	4.34	0.53	3.72	0.62	0.62	0.61	10.10***	2.69	6

*** $p < .001$.

For the importance level, the mean scores for all subdomains were above 4.00, indicating that pre-service teachers showed a generally high level of perceived importance across all aspects of science lesson enactment competence. In particular, relatively high importance levels were found for Educational Materials Preparation (4.41), Supporting Participation and Interaction (4.41), Understanding Learners (4.36), and Concept Teaching (4.36), whereas Lesson Design (4.07) and Foundational Knowledge (4.28) showed relatively lower importance levels.

By contrast, the mean scores for the current level across the subdomains were generally in the low-to-mid 3-point range, indicating that they were consistently lower than the corresponding importance levels. More specifically, relatively higher current levels were observed for Educational Materials Preparation (3.91), Supporting Participation and Interaction (3.75), and Lesson Management (3.72), whereas relatively lower current levels were found for Foundational Knowledge (3.31) and Understanding Learners (3.38).

The results of the Borich needs assessment showed that Understanding Learners (4.25) and Foundational Knowledge (4.18) had the highest scores, indicating that these were the areas most in need of priority support. These were followed by Facilitating Inquiry and Thinking (3.40) and Concept Teaching (3.08), suggesting that competences related to teaching scientific concepts and deepening learners' thinking through inquiry activities also constitute important areas of need. By contrast, Supporting Participation and Interaction (2.91), Lesson Management (2.69), Educational Materials Preparation (2.24), and Lesson Design (2.04) showed relatively lower levels of need and were therefore classified as lower-priority areas in comparison with the other subdomains (Table 3).

The Locus for Focus Model of Science Lesson Enactment Competence

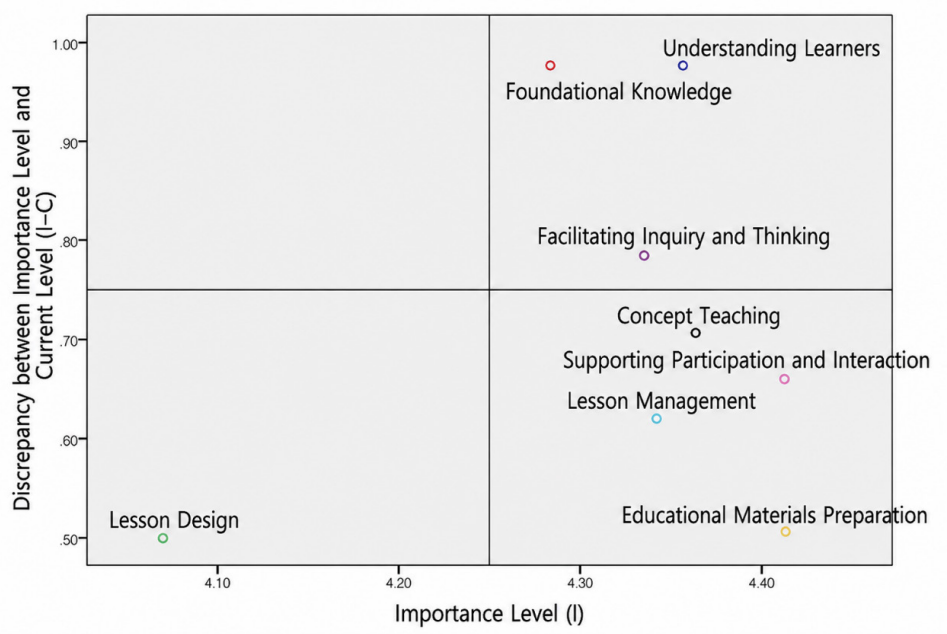
In order to identify the priority of needs relating to science lesson enactment competence visually, the Locus for Focus model was applied, with the importance level plotted on the horizontal axis and the discrepancy between the importance level and the current level plotted on the vertical axis. As a result, the eight subdomains of science

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

lesson enactment competence were distributed across four quadrants according to their levels of importance and the magnitude of the discrepancy (Figure 4).

Figure 4
Results of the Locus for Focus Model for Science Lesson Enactment Competence



The first quadrant (High importance–High discrepancy), in which both the importance level and the discrepancy were high, included Foundational Knowledge, Understanding Learners, and Facilitating Inquiry and Thinking. These subdomains may be interpreted as core areas for improvement, as pre-service teachers regarded them as important while also perceiving their current level to be insufficient in comparison, indicating both a high level of need and a high degree of urgency.

The fourth quadrant (High importance–Low discrepancy), in which the importance level was high but the discrepancy was relatively low, included Concept Teaching, Supporting Participation and Interaction, Lesson Management, and Educational Materials Preparation. These subdomains were also perceived by pre-service teachers as important, but the gaps between perceived importance and self-rated current performance were relatively smaller. They may therefore be regarded as areas with lower relative urgency in the present needs analysis.

The third quadrant (low importance, small gap) contained Lesson Design. Compared with the other subdomains, Lesson Design showed lower perceived importance and lower need and was therefore classed as a lower-priority area. No subdomain fell in the second quadrant (low importance, large gap), so no area was identified where importance was low, but the gap was nonetheless substantial.

Priority Areas of Science Lesson Enactment Competence

Priority areas for educational support were identified by considering the Borich need scores and the Locus for Focus results for each subdomain together. In the Borich assessment, the highest need scores, in descending order, were for Understanding Learners, Foundational Knowledge, Facilitating Inquiry and Thinking, and Concept Teaching, while Supporting Participation and Interaction, Lesson Management, Educational Materials Preparation, and Lesson Design showed lower need scores. In the Locus for Focus model, Foundational Knowledge, Understanding Learners, and Facilitating Inquiry and Thinking fell into the first quadrant, where both importance and the gap were high, and so emerged as the highest-priority areas for improvement. Concept Teaching, Supporting Participation and Interaction, Lesson Management, and Educational Materials Preparation were classed as areas to maintain and strengthen, while Lesson Design was classed as lower-priority.

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Table 4
Priority Areas of Science Lesson Enactment Competence

Method for Determining Priority	Preparation for Lesson Enactment				Lesson Enactment			
	Foundational Knowledge	Understanding Learners	Lesson Design	Educational Materials Preparation	Concept Teaching	Facilitating Inquiry and Thinking	Supporting Participation and Interaction	Lesson Management
Borich Need Score	4.18	4.25	2.04	2.24	3.08	3.40	2.91	2.69
Locus for Focus Model	Quadrant I	Quadrant I	Quadrant III	Quadrant IV	Quadrant IV	Quadrant I	Quadrant IV	Quadrant IV
Priority	Highest	Highest	Third	Third	Second	Highest	Third	Third

Combining the two analyses, the priority of needs across the subdomains was determined as follows (Table 4). The first-priority areas were Understanding Learners, Foundational Knowledge, and Facilitating Inquiry and Thinking. These subdomains can be seen as core areas for improvement, since they ranked high in both the Borich assessment and the Locus for Focus model. The second-priority area was Concept Teaching. It ranked relatively high in the Borich assessment but appeared as an area to maintain and strengthen in the Locus for Focus model. The third-priority areas were Supporting Participation and Interaction, Lesson Management, Educational Materials Preparation, and Lesson Design. Although these subdomains were generally seen as important, the gaps between importance and current performance were relatively small, and their Borich need scores were lower than those of the other subdomains. They were therefore treated as less urgent than the others.

Discussion

This study examined the educational needs of 100 elementary school pre-service teachers after their practicum and identified priority areas for strengthening science lesson enactment competence. The findings show that, although pre-service teachers rated the importance of this competence very high, they rated their self-perceived current performance after the practicum as considerably lower. The needs analysis also showed that Understanding Learners, Foundational Knowledge, and Facilitating Inquiry and Thinking were the highest-priority areas, while Educational Materials Preparation and Lesson Design showed lower levels of need. The following sections discuss what these findings mean in light of previous research.

The Discrepancy Between the Importance Level and the Current Level

A striking finding is that, in all eight subdomains, importance scores substantially exceeded current-performance scores. This points to a considerable gap between perceived importance and self-rated current performance. Since the survey took place right after the practicum, the relatively low current-performance scores most likely reflect perceptions shaped by challenges encountered during the practicum.

These findings echo the long-recognised theory–practice gap in pre-service teacher education and agree with previous studies (Allen, 2009; Sathasivam et al., 2024; Yin, 2019). Allen (2009) described the theory–practice gap as a central dilemma in teacher education, noting that university-taught pedagogical theories often fail to capture the full complexity of real school settings. Similarly, Yin (2019) reported that pre-service teachers struggle to apply theoretical knowledge from university coursework to actual classroom situations during the practicum.

Im et al. (2016), in their analysis of the South Korean pre-service science teacher education system, criticised the short four-week practicum and the theory-heavy university curriculum for offering only limited support for developing pre-service teachers' practical competence. Lee (2024b) similarly linked pre-service teachers' relatively low current performance, compared with their high ratings of importance, to a lack of practical experience within teacher education programmes. The high importance ratings in the present study suggest that university curricula may have helped participants recognise the value of this competence. However, as earlier studies have noted, structural limitations seem to have restricted pre-service teachers' opportunities to translate that understanding

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

into actual classroom practice. Teacher education programmes therefore need to move beyond transmitting theory and provide systematic opportunities for pre-service teachers to put that knowledge into practice in real classrooms (Phillips & Condy, 2023).

Highest-Priority Areas

(1) Understanding Learners

The fact that Understanding Learners showed the highest level of need suggests that pre-service teachers face practical limits in identifying pupils' prior conceptions, misconceptions, developmental stages, and levels of achievement. As in Kim and Lim (2022), where pre-service teachers saw lessons with rich, level-appropriate interaction as good lessons, the participants here also treated understanding learners as a core element of teaching. But the high level of need in this area suggests that they lacked the practical know-how to act on this understanding.

This interpretation was echoed in the open-ended responses. Several participants described difficulty in anticipating and responding to pupils' actual reactions during their lessons. One participant noted that pupils "gave a wider range of answers than I had expected, so it was difficult to respond to them," while another reflected that the lesson "would have been better if I had understood the pupils' levels and prior knowledge more fully before teaching." Such comments suggest that the high level of need in this area may have been related to concrete difficulties encountered with real pupils, rather than to a lack of awareness of its importance.

In science education, diagnosing pupils' alternative conceptions and using that information to shape instruction has long been seen as essential for effective teaching (Chhabra & Baveja, 2012; Tsai & Chou, 2002). Yet Sadler and Sonnert (2016) noted that, even when teachers have a reasonable grasp of science content, their ability to anticipate and respond to pupils' common errors and misconceptions is often limited. Otero and Nathan (2008) similarly reported that elementary school pre-service teachers often have a limited grasp of pupils' prior knowledge, sometimes reducing it to whether the relevant content has previously been taught.

One likely reason is that, before the practicum, pre-service teachers have few chances to interact directly with real elementary pupils in real educational settings. University lectures and microteaching usually rely on imagined or simulated learners, which structurally limits pre-service teachers' first-hand exposure to pupils' actual responses and thinking. Because the practicum lasts only a short time, there is also inevitably little room for pre-service teachers to gain a full sense of learners' characteristics and contextual factors and to plan or adjust their lessons accordingly (Jeong, 2019).

Teacher education programmes therefore need to go beyond emphasising the importance of understanding learners in theory; they should also deal explicitly with concrete ways of diagnosing pupils' achievement levels and of identifying and responding to prior conceptions and misconceptions. It may also help to offer follow-up coursework, linked to university classes, in which learner data and actual lesson cases gathered during the practicum are analysed. If such opportunities let pre-service teachers share and examine their own lesson cases and pupils' responses through case-based discussion, alongside structured expert feedback, they should help embed educational strategies for understanding and responding to diverse learners.

(2) Foundational Knowledge

The high level of need in Foundational Knowledge may reflect practicum experiences where pre-service teachers could not answer pupils' unexpected questions or explain textbook concepts accurately. This suggests that pre-service teachers recognise the importance of core scientific knowledge and feel a strong need for deeper scientific understanding, both for handling unexpected questions in lessons and for addressing pupils' misconceptions.

The open-ended responses pointed in the same direction. One participant described how "some experiment results came out differently from the textbook, and it was very difficult to explain that difference" during the lesson. Another recalled being unable to guide pupils properly because they had not known a specific practical detail, noting that they "could not teach it correctly because I did not know that the coating of the enamelled wire had to be stripped off for the current to flow" when making an electromagnet. These accounts illustrate how perceived limits in content knowledge became visible at the point of enactment, when pupils raised unexpected questions or experiments did not proceed as planned.

Difficulties with science content knowledge among elementary school pre-service teachers have been reported consistently in both Korean and international research. Appleton (2003), for example, found that elementary teachers struggle to enact science lessons because their grasp of science content, particularly in physics and chemistry, is not deep enough. In Korea, Kang et al. (2009) likewise reported gaps in elementary school pre-service teachers' basic

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

science knowledge, and Choi and Kim (2008) found that these teachers often felt anxious about science and had low self-efficacy in the subject. The present findings agree with these earlier studies and confirm that pre-service teachers' need for stronger science content knowledge remains an open issue for teacher education.

One reason may be that many elementary school pre-service teachers come from humanities or social science backgrounds rather than science-oriented ones (Lee, 2023). To address this, elementary teacher education programmes in Korea include science coursework aimed at strengthening pre-service teachers' science content knowledge, and official teacher qualification guidelines set minimum credit requirements for basic subject studies (Ministry of Education, 2022). Even so, the high need for science content knowledge in this study shows that the issue is not whether such courses have been completed, but whether pre-service teachers have developed deep enough understanding and the ability to adapt that knowledge to a level suitable for elementary pupils.

What is needed, then, is not just a quantitative response such as raising the credit requirement, but qualitative improvements: tiered instruction that takes pre-service teachers' prior science backgrounds into account, subject-matter courses redesigned around core concepts linked to the elementary curriculum, and ongoing mentoring and feedback throughout the practicum. Given that many pre-service teachers come from non-science backgrounds, differentiated strategies are needed that both lower the psychological barriers to science and ensure a solid grasp of essential content.

(3) Facilitating Inquiry and Thinking

The high level of need in Facilitating Inquiry and Thinking shows clearly how much of a challenge Inquiry-Based Science Education (IBSE) remains for pre-service teachers. This fits with earlier studies showing that, although inquiry-centred science education is widely acknowledged as effective, substantial barriers to putting it into practice in real classrooms remain (Constantinou et al., 2018; Qablan & DeBaz, 2015). For example, Yoon et al. (2012) found that pre-service elementary teachers struggled to draw out pupils' own ideas and curiosity, to help them design valid experiments, and to scaffold data interpretation and discussion during inquiry lessons. Inquiry-based lessons, in other words, are not just activity-centred lessons; they are highly complex forms of teaching that demand sophisticated guidance from the teacher.

This challenge was also reflected in the open-ended responses. One participant explained that, although pupils were meant to work through a process of cognitive conflict, "giving them too long to think on their own made them feel that the lesson was difficult, and it became hard to manage." Others mentioned difficulty in estimating the time needed for inquiry activities and in formulating questions that could prompt pupils' scientific thinking. These responses suggest that supporting genuine inquiry, rather than simply carrying out experiments, was experienced as demanding during the practicum.

Although inquiry lessons are meant to give pupils autonomy, pre-service teachers often feel considerable anxiety about classroom management and maintaining order (Nawanidbumrung et al., 2022). Science experiments carry safety risks, which can leave pre-service teachers torn between creating a relaxed atmosphere that encourages pupils' thinking and keeping tight control for safety reasons (Lotter, 2004). They may end up focusing mainly on completing experiments safely, while inquiry guidance is pushed into the background or becomes hard to carry out effectively.

Campbell et al. (2010), in a comparative observation study of science lessons in Korea and the United States, noted that Korean science lessons often display outward features of reform-oriented pedagogy but remain limited in genuinely pupil-centred inquiry and the promotion of thinking. Many pre-service teachers also grew up in transmissive educational settings and have rarely experienced genuinely open inquiry as learners themselves (Windschitl, 2003). Being asked to lead inquiry lessons without a model from their own experience to draw on can therefore put a considerable cognitive load on them.

Trna et al. (2012), proposing a model for integrating inquiry-based science education into pre-service teacher education, argued for a staged approach in which pre-service teachers first take part in inquiry activities as learners, then reflect on those experiences, and finally design and teach inquiry lessons themselves. It is important, then, for teacher education to provide pre-service teachers with opportunities to engage in scientific inquiry not just as something they will later teach, but as a learning experience in its own right, and to reflect metacognitively on its cognitive and affective sides.

Teacher education programmes therefore need to do more than teach the procedural models or theoretical principles of inquiry-based lessons; they should give pre-service teachers sufficient opportunities to go through the full inquiry process themselves. When this is paired with expert feedback after they teach inquiry lessons, allowing their questioning strategies and feedback techniques to be refined, pre-service teachers can build more stable practical competence in supporting students' scientific thinking in real classrooms (Windschitl, 2003).

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Lower-Priority Areas

Educational Materials Preparation and Lesson Design showed relatively lower levels of need compared with the other subdomains. This may indicate that participants perceived their current performance in these areas as relatively closer to their own standards of importance, rather than that these competences are already fully developed or sufficiently supported by teacher education programmes. Because the findings are based on self-reported perceptions, it is not possible to determine from this study alone why these areas received lower scores. The lower need scores may reflect a range of factors, including prior exposure to lesson planning and materials development in university coursework, the lower perceived complexity of these tasks relative to enacting lessons with real pupils, or limited awareness of the gap between current performance and the demands of actual teaching contexts.

Importantly, a lower need score should not be taken to mean that these competences are already fully developed. For Educational Materials Preparation, earlier studies suggest that novice teachers may be reasonably skilled at using multimedia materials but still need support in evaluating whether those materials fit the lesson objectives and learners' cognitive demands (Hughes et al., 2020). Teacher education programmes should therefore continue to help pre-service teachers evaluate and adapt educational materials in relation to lesson goals and learner characteristics.

A similar caution applies to Lesson Design. Although it was assigned a lower priority in this study, lesson design remains closely related to foundational knowledge, understanding learners, and teaching strategies. Writing a lesson plan is not the same as designing lessons that respond to classroom complexity or promote learners' thinking (Cevikbas et al., 2024; König et al., 2020). Teacher education should therefore go beyond formal lesson-plan writing and provide systematic opportunities for pre-service teachers to design lessons grounded in real classroom contexts and to reflect critically on those experiences.

Conclusions and Implications

This study examined the needs of elementary school pre-service teachers after their teaching practicum in relation to science lesson enactment competence. It also identified which areas should be given priority in teacher education programmes. For this purpose, a questionnaire was developed from a literature review and interviews with pre-service teachers. The questionnaire included two domains, eight subdomains, and 32 items. Data were collected from 100 pre-service teachers after the practicum. The analysis used paired-samples t-tests, the Borich needs assessment formula, and the Locus for Focus model. The main findings are as follows.

Across all eight subdomains, participants rated perceived importance higher than their self-rated current performance in science lesson enactment competence. This suggests that, after the practicum, pre-service teachers recognised the importance of this competence but still perceived difficulties in translating it into classroom teaching.

Combining the Borich needs assessment and the Locus for Focus model showed that, of the eight subdomains, Understanding Learners, Foundational Knowledge, and Facilitating Inquiry and Thinking were the first-priority areas for improvement. Teacher education programmes therefore need to provide pre-service teachers with practical experience in understanding learners during the practicum, strengthen subject-matter preparation in ways that support confidence in applying science knowledge, and expand opportunities for Inquiry-Based Science Education (IBSE) so that pre-service teachers gain sufficient experience in designing and teaching inquiry-oriented science lessons. At the same time, Educational Materials Preparation and Lesson Design showed lower relative priority. This lower priority should be understood only in comparison with the other subdomains, not as evidence that these areas are unimportant or require no further support.

The study has several limitations. First, the study used a convenience sample of 100 pre-service teachers from two elementary teacher education institutions in South Korea. The findings should therefore be interpreted within this specific institutional and national context. They cannot be directly generalised to all elementary school pre-service teachers in South Korea or to teacher education systems in other countries. Although the study may be of interest to contexts facing similar theory–practice challenges, its findings should not be read as evidence of universal needs across different teacher education systems. Future research should include participants from a wider range of teacher education institutions in Korea and conduct comparative studies across different national contexts.

Second, the two-domain, eight-subdomain structure of the instrument was established through theoretical literature, pre-service teacher interviews, and expert content validity review, rather than verified through exploratory or confirmatory factor analysis. Given the sample size of 100 participants relative to the 32 items, factor analysis at this stage would be unlikely to provide sufficiently stable evidence of structural validity. Future research aiming to

https://doi.org/10.33225/jbse/26.25.507

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

develop a generalisable measurement scale for science lesson enactment competence should therefore include construct validation procedures, such as exploratory or confirmatory factor analysis, with larger and more diverse samples.

Third, the study relied on self-reported questionnaire responses. The gaps between perceived importance and current performance should therefore be interpreted as perceived educational needs rather than as direct measures of actual classroom competence, and may partly reflect participants' confidence, anxiety, or self-perception after the practicum. Future needs analyses should therefore draw on additional data sources, such as classroom observations, lesson videos, lesson artefacts, mentor evaluations, or follow-up interviews, alongside survey data. Although the present study collected open-ended responses that were used to illustrate and contextualise the quantitative findings, these were used only as supplementary contextual data. Future research could incorporate a fuller qualitative component, designed from the outset, to explain more systematically why particular gaps between importance and performance arise.

This study makes a contribution by examining science lesson enactment competence through the perceptions of elementary school pre-service teachers after their practicum, and by systematically analysing their needs around lesson enactment in real classroom contexts. By focusing the needs analysis on the gap between perceived importance and self-rated current performance, the study points to directions for improving teacher education programmes aimed at strengthening science lesson enactment competence.

Declaration of Interests

The author(s) declared no conflicts of interests.

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Received: *April 08, 2026* Revised: *May 21, 2026* Accepted: *June 14, 2026*

Cite as: Kim, J., Kim, Y., Park, Y., Son, Y., & Lim, S. (2026). Educational priorities for enhancing elementary school pre-service teachers' science lesson enactment competence after the teaching practicum. *Journal of Baltic Science Education*, *25*(3), 507–521. https://doi.org/10.33225/jbse/26.25.507

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