

Preservice teachers' perceptions of the knowledge, skills, and support they need for inquiry-based learning

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Summary

This study explores Estonian preservice teachers' perceptions of the knowledge, skills, and support needed for inquiry-based learning (IBL). Forty-one undergraduate students enrolled in an IBL course completed a questionnaire on four aspects of IBL: teaching, experimentation, assessment, and differentiation. Descriptive statistics of Likert scale items revealed that students strongly agreed that teacher education should address the advantages, challenges, and examples of IBL for each of the four aspects. Content analysis of open-ended questions indicated that with respect to the first aspect, teaching in IBL, it is important to structure lessons and create authentic tasks, and balance guidance with learner autonomy to take responsibility for their own learning process rather than relying on the teacher to direct every step. Qualitative analysis of the second aspect, experimentation, showed that the participants viewed it as important to ensure safety in experimentation and to adapt to unpredictable outcomes. For the assessment aspect of IBL, preservice teachers viewed it as important that assessment be process-oriented, fair, formative, and include

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peer and self-assessment. The differentiation aspect was considered essential in IBL teacher education because it was seen as ensuring equitable access by supporting struggling learners while offering meaningful challenges to gifted students. The differentiation aspect was regarded as essential in IBL teacher education because it was seen as ensuring accessibility for all learners, with struggling students receiving appropriate support, while gifted students are offered more demanding challenges. Across all four aspects, preservice teachers identified a need for support in the form of teaching materials, clear examples, mentoring, and collaborative opportunities. The findings suggest that effective teacher education in IBL requires linking theory with practical strategies and providing future teachers with the skills to balance direct instruction with less guided approaches when implementing IBL.

Introduction

Inquiry-based learning (IBL) aligns with modern conceptions of how science should be taught and has an important role in many countries' curricula. Estonia's national curricula for both basic and upper secondary schools state:

“In all natural science subjects, students develop inquiry skills, which include observing objects and phenomena, defining problems, collecting and analysing background information, formulating research questions and hypotheses, planning and conducting experiments, collecting reliable data, analysing and interpreting them, and drawing valid conclusions. The broader goal of acquiring inquiry skills is to use them in everyday life, helping students make smart and well-considered decisions in their personal lives.” (PRÖK, 2011, Annex 4; GRÖK, 2011, Annex 4)

Inquiry-based learning (IBL) is often described as a cycle of phases led either by teachers or learners, blending student inquiry with direct instruction. Research shows these approaches are not opposites but can be complementary when guidance is well-matched to learners' needs (de Jong et al., 2023; Lazonder & Harmsen, 2016). Effective IBL balances freedom with support, adapting guidance to prior knowledge, task complexity, and learning goals.

Baur et al. (2022) highlight four core dimensions of effective IBL: teaching, experimentation, assessment, and differentiation. Experimentation lets learners investigate authentic questions and generate evidence. Assessment reveals both process and outcomes, supporting feedback and improvement. Differentiation ensures accessibility by addressing diverse abilities, interests, and knowledge levels. Together, these foster deep conceptual understanding and transferable problem-solving skills.

Despite its potential, teacher education faces challenges in preparing future teachers for IBL. Strat et al. (2024) note persistent issues, including unclear definitions, limited resources, weak theory–practice connections, difficulties in assessing inquiry skills, and inconsistent implementation. Addressing these requires curricular reform, stakeholder involvement in professional development (Guskey, 2014), and attention to how preservice teachers experience IBL. As they are shaping their professional identities, their perspectives can guide improvements in training. Given our interest in the aspects of teaching, experimentation, assessment, and differentiation in IBL, we formulated two research questions:

- 1) What knowledge and skills do preservice teachers prioritise for teaching, experimenting, assessing, and differentiating in IBL?
- 2) What support do preservice teachers consider necessary to implement IBL?

Methodology

Participants in this study were 41 bachelor students ($M = 22.9$ years, $SD = 4.1$) at an Estonian university studying inquiry learning. A questionnaire was constructed to determine what knowledge and skills preservice teachers prioritise in teaching, experimenting, assessing, and differentiating in IBL. The questionnaire included both Likert-scale items and open-ended questions. Respondents rated on a five-point scale their agreement with statements about whether teacher education should address advantages, challenges, and examples in four aspects: teaching, experimentation, assessment, and differentiation. As clarification, the teaching aspect was defined as preparing and conducting IBL lessons. Students then responded to open-ended questions about what a teacher should know and be able to do in teaching, experimentation, assessment, and differentiation in IBL lessons. We also aimed to determine what support preservice teachers need to implement IBL. To achieve this, open-ended questions were posed about the desired support in all four aspects: teaching, experimentation, assessment, and differentiation. Descriptive statistics were used to analyse the Likert scale items, while responses to the open-ended questions were analysed independently by two authors through content analysis and then discussed together to reach consensus.

Results and discussion

The results for the Likert-scale items showed that preservice teachers strongly agree that advantages, challenges, and examples of IBL should be presented in teacher education. Agreement ranged from 4.5 to 4.8 on a five-point scale.

Analysis of the qualitative data revealed several categories. Preservice teachers highlighted that preparation for IBL must go beyond collecting materials, requiring a clear grasp of IBL phases, authentic scientific content, and ways to spark curiosity. Lessons should give learners the freedom to explore, while teachers act as mentors who guide when needed and allow productive struggle. Time constraints and resource availability were recurring concerns, underscoring the importance of both pedagogical clarity and logistical foresight.

Experimentation was seen as central yet unpredictable. Respondents stressed hypothesis formulation, safety, and adaptability, noting the value of failure as a learning opportunity. The preservice teachers were encouraged to plan for contingencies, align tasks with available resources, and adapt methods to their class. Assessment emerged as complex, with tensions between traditional grading and IBL's process-oriented nature. Many advocated assessing effort and progress, not just outcomes, and called for fairness, transparency, and varied methods. Feedback should be forward-looking, with self- and peer assessment supporting reflection and ownership. Differentiation was framed as ensuring accessibility without diluting challenge. Teachers should design tiered or flexible tasks, offer targeted support, and consider fairness to avoid stigmatisation. For gifted learners, complexity rather than quantity was emphasised.

The preservice teachers identified strong needs for support in implementing IBL. They sought ready-made materials, practical examples, structured planning tools, and collegial mentoring. This aligns with the conclusions of Strat et al. (2024), who found that a key challenge for preservice teachers is bridging the gap between the theoretical understanding of IBL and its actual classroom implementation. Time pressures, safety in experimentation, and access to equipment were major challenges. Assessment support was desired in the form of shared rubrics, criteria, and models that legitimise open-ended outcomes. For differentiation, assistance from specialists, teaching assistants, and templates for tiered tasks were valued. Above all, the preservice teachers stressed the importance of collaboration networks, clear guidance, and opportunities to connect IBL theory with practice.

This study shows Estonian preservice teachers support combining IBL with direct instruction, echoing de Jong et al. (2023). They emphasise balancing less-guided inquiry approaches with more guided, direct instruction through structure, safety, assessment, differentiation, and resources, while noting constraints such as time and fairness. Their insights highlight the need to equip future teachers with practical tools for effective guided inquiry.

Limitations and recommendations

This study is limited by its small, convenience sample, participants' limited teaching experience, reliance on self-reports, and lack of validated instruments or classroom observations. Findings thus reflect perceived rather than enacted needs. A longitudinal approach spanning bachelor's to master's studies could better capture how preservice teachers' understandings of IBL evolve across practicum and subject-specific pedagogy.

Keywords: inquiry-based learning, teacher education, experimentation, assessment, differentiation