Self-efficacy of Estonian and Finnish teachers in relation to paradigm shift in science education: integration of socio-scientific topics

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Summary

Introduction

Science education is undergoing a major paradigm shift from content-centred instruction toward integrated approaches that connect science learning with socio-scientific issues (SSI) and real-world challenges. This transition requires teachers to develop new competencies and self-efficacy in teaching complex, interdisciplinary topics such as sustainable development, health and medicine, and digital technology (Owens & Sadler, 2024; Zeidler et al., 2019). Previous studies have highlighted that science teachers often have low self-efficacy when teaching controversial or value-laden topics such as climate change and sustainable development (Herranen & Aksela, 2024), biotechnology, or health and medicine (Boedeker et al., 2023; Haberbosch et al., 2025) related topics. Digitalisation has transformed how science is taught and learned, requiring teachers to integrate technology meaningfully into their practice (Laius & Orgusaar, 2025; Pedaste et al., 2015). Addressing this challenge is particularly important in Estonia and Finland, where there remains a risk that digital tools are employed merely as supplementary extensions of traditional instruction rather than as catalysts for deeper learning and conceptual understanding (Valtonen et al., 2015). Therefore, further research is needed to explore science teachers' readiness to address and integrate global societal challenges – such as digital technology, sustainable development, transversal skills, and health and medicine – into their teaching practices.

This study explores pre-service and in-service science teachers' perceived self-efficacy across four competence domains – transversal skills, health and medicine, sustainable development, and digital technology – in Estonia and Finland.

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Research Questions

1. To what extent do Estonian and Finnish science teachers differ in their perceived self-efficacy in teaching transversal skills, health and medicine, sustainable development, and digital technology?
2. How do pre- and in-service teachers differ in their perceived self-efficacy across these domains?

Method

Sample

The study involved 137 science teachers from Estonia (n = 68) and Finland (n = 69), including 63 pre- and 74 in-service teachers. Participants represented various educational backgrounds (biology, chemistry, physics, mathematics, geography), school levels teaching (primary, lower secondary, upper secondary), and by teaching experience (no teaching experience, 0–5 years, 5–10 years, 10–15 years, or more than 15 years).

Instrument

A self-reported questionnaire was developed to assess teachers' perceived self-efficacy across four thematic domains: transversal skills (8 items), health and medicine (12 items), sustainable development (12 items), and digital technology (9 items). All statements within each domain were rated on a six-point Likert-type scale, where 1 indicated very low self-efficacy, and 6 indicated very high self-efficacy in one's own abilities. Altogether 41 items were included in the questionnaire, such as "I can manage your time for achieving personal goals", "I feel confident in guiding students to analyse sustainability-related problems", or "I can integrate digital tools effectively in my teaching."

Data Collection and Analysis

Data were collected through the Erasmus+ Teacher Academy project acaSTEMy (Trans-national STEM teacher education focusing on transversal competence and sustainability education) simultaneously in both countries during May – June 2024 using electronic questionnaires. For data collection, the study invitation was distributed to master's students in science education in Estonia and Finland and shared via information lists for in-service science teachers in both countries. Analyses were conducted using Exploratory Factor Analysis (EFA) to confirm the instrument's structure, and Mann-Whitney U tests were used to compare groups (Estonian vs. Finnish teachers; pre- vs. in-service teachers).

Reliability was high across all subscales (Cronbach's $\alpha > 0.74$). Data analysis was performed using Microsoft Excel and JASP.

Results and discussion

Factor analysis revealed two sub-factors in each domain, such as problem-solving and self-regulation skills under transversal skills; practical applications of health and medicine; biological functioning of the body under health and medicine; sustainable consumption and quality of life; sustainable energy production and use under sustainable development; knowledge in applying digital technologies, and self-efficacy in using digital technologies under the digital technology domain. Internal consistency across all factors was satisfactory (Cronbach's $\alpha = 0.74–0.88$), and item-total correlations indicated stable subscale structures. Across all participants, self-efficacy was highest in transversal skills ($M = 4.28–4.78$) and lowest in health and medicine ($M = 2.99–3.49$). These findings suggest that teachers in both countries feel confident in their ability to develop and apply transferable skills; however, science teachers still experience uncertainty when teaching interdisciplinary or ethically complex topics. This echoes previous research indicating that teachers often feel less prepared for issues that transcend disciplinary boundaries (Borg et al., 2014; Laurie et al., 2016).

Results showed that Estonian teachers rated their self-efficacy significantly higher than Finnish teachers in several domains, particularly in health and medicine, sustainable consumption, and quality of life. Estonian teachers' higher self-efficacy in these areas may reflect their stronger subject-based training, while Finnish teacher education's focus on learner-centred pedagogy may lead to less emphasis on detailed subject content (Mikkilä-Erdmann et al., 2019). Lower ratings towards health and medicine and sustainable development domains highlight the need to strengthen teachers' preparation in areas where scientific and social issues intersect, requiring broad knowledge and the ability to connect multiple perspectives (Zeidler et al., 2019).

Comparisons between pre- and in-service teachers showed that experienced teachers scored significantly higher in self-efficacy in several domains – transversal skills, practical applications of health and medicine, and sustainable energy production and use. These differences may be attributed to the fact that in-service teachers have several years of teaching experience, which in turn enhances their self-efficacy in integrating complex topics into classroom practice. Likewise, Herranen & Aksela (2024) emphasised that teachers' self-efficacy in addressing socio-scientific issues (SSI) tends to increase with practical experience, thereby strengthening their confidence in integrating

complex topics into classroom instruction. However, both groups showed high levels of self-efficacy and no significant differences in their use of digital technologies, suggesting that digital competence has become a shared and essential component of professional readiness across experience levels in the post-pandemic context. However, significant differences emerged between Estonian and Finnish teachers in their self-efficacy regarding the use of digital technology, with Estonian teachers reporting notably higher confidence in integrating digital tools into teaching and learning. This can be explained by Estonia's systematic national investments in developing teachers' digital competence and providing consistent support for technology integration, whereas Finland's more decentralised approach relies largely on local initiatives and individual teachers' efforts.

Conclusions

This study reveals several differences in the self-efficacy of Estonian and Finnish science teachers in addressing global challenges through science education. Teachers feel most confident in fostering transversal skills and digital technology, but less in health and medicine, as well as sustainable development topics that require both scientific and ethical reasoning. Supporting teachers' professional growth through collaborative learning, context-based training, and integrative pedagogies is essential for advancing interdisciplinary science education. Digital technologies should be seen not as add-ons but as catalysts for reflective and inquiry-based teaching.

Keywords: Digital technology, socio-scientific issues, teacher self-efficacy, transversal skills

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