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Enhancing pre-service teachers' self-efficacy to educate critical online readers

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ABSTRACT

With growing concerns about mis- and disinformation online, teachers play an important role in educating critical online readers. To fulfill this responsibility, they must feel confident in teaching online credibility evaluation skills. To address this issue, we conducted two studies in two Finnish universities among Finnish-speaking pre-service teachers. In Study I, we developed a teacher self-efficacy measure for online credibility evaluation, including three dimensions: self-efficacy in discipline-specific online credibility evaluation, self-efficacy in general online credibility evaluation, and self-efficacy in teaching online credibility evaluation. Results indicated that three dimensions were distinct but highly correlated. In Study II, we applied the developed measure to assess the efficacy of a university course grounded in five design principles for enhancing pre-service teachers' self-efficacy in online credibility evaluation. We employed a quasi-experimental pre-post test design with intervention and control groups and conducted a qualitative analysis of pre-service teachers' written reflections to enrich quantitative results. The course enhanced pre-service teachers' self-efficacy, particularly in teaching online credibility evaluation skills, as also evidenced by their reflections on benefits of several course elements. Results suggest that pre-service teachers benefit from opportunities to practice and reflect on their own credibility evaluation skills and, in collaboration with peers, to carefully design and implement classroom instruction for online credibility evaluation.

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Teachers play a pivotal role in educating critical online readers to evaluate the credibility of online information by considering the accuracy of the content, the trustworthiness of the source, and the context where information appears (Barzilai et al., 2020; Forzani et al., 2022). There are several reasons why teachers are important in this process. First, education is considered a cornerstone in decreasing the negative effects of misinformation spreading online (European Commission, Directorate-General for Communication Networks, Content and Technology, 2018; European Commission, Directorate-General for Education, Youth, Sport and Culture, 2022; United Nations Educational & Scientific & Cultural Organization, 2013). Second, online credibility evaluation is demanding, and learning effective online credibility evaluation strategies requires explicit teaching (Abel et al., 2024; Forzani, 2020; Kiili et al., 2025). Third, many students lack sufficient online credibility evaluation skills, showing the need for teacher support (Abed & Barzilai, 2023; Hämäläinen et al., 2020; Marten & Stadtler, 2025).

To meet these requirements, teachers themselves need sufficient online credibility evaluation skills, and pre-service teachers would benefit from support to improve their own skills (Kulju et al., 2024). Teachers also need to feel confident in evaluating the credibility of online information (Andreassen & Bråten, 2013) and teaching online credibility evaluation skills (cf. Bandura, 1997). Notably, teacher

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education should support pre-service teachers in fulfilling these requirements. To contribute to this need, we designed an intervention to support pre-service teachers' self-efficacy in online credibility evaluation (i.e. self-efficacy in evaluating online information and teaching online credibility evaluation). To test the efficacy of the intervention, we first developed and tested a self-efficacy measure for our purposes.

Consequently, this paper includes two studies conducted among Finnish-speaking pre-service teachers. In Study I, we developed a measure for assessing their teacher self-efficacy in online credibility evaluation and examined its structure. In Study II, we designed and implemented an intervention to promote pre-service teachers' self-efficacy in online credibility evaluation and in teaching online credibility evaluation skills to their students.

Teacher self-efficacy

According to Bandura's (1997) social cognitive theory, learning occurs in the interaction between cognitive and social processes embedded in the learning environment. In this interaction, the key cognitive process relates to an individual's self-efficacy, which refers to situation-specific beliefs about one's ability to perform a specific task. Notably, self-efficacy beliefs reflect individuals' perceptions of how well they can succeed with their skills, not their actual skills (Reichenberg & Andreassen, 2019).

Regarding the teaching profession, teacher self-efficacy refers to beliefs about the ability to accomplish the actions and tasks needed for working as a teacher (Bandura, 1997). The situation-specific nature of self-efficacy is manifested in teacher self-efficacy being domain-specific (Skaalvik & Skaalvik, 2007; Tschannen-Moran & Woolfolk Hoy, 2001) and even student-specific (Schwab, 2019; Zee et al., 2016).

Research on teacher self-efficacy has most often concentrated on the central aspects of teachers' daily work, such as classroom management, student engagement, and instructional strategies (Tschannen-Moran & Woolfolk Hoy, 2001). High general teacher self-efficacy is likely to positively impact teachers and their students. Self-efficacious teachers have reported more job satisfaction (Toropova et al., 2021), greater commitment to their work (Zee & Koomen, 2016), and fewer feelings of burnout (Aloe et al., 2014). When students and independent observers have evaluated classroom activities, self-efficacious teachers' instruction has been rated as high quality (Klassen & Tze, 2014), as evidenced by teachers' ability to differentiate instruction (De Neve et al., 2015) and apply innovative teaching practices (Thurlings et al., 2015). Importantly, students of self-efficacious teachers have been more likely to be interested in learning (Fauth et al., 2019) and achieve higher academic outcomes (Kim & Seo, 2018) than students of teachers with lower self-efficacy.

Research on teacher self-efficacy related to specific content or a particular subject has most often been investigated in teaching math (Bjerke & Xenofontos, 2024; Perera & John, 2020) or science (Naidoo & Naidoo, 2023; Velthuis et al., 2014), while some studies have also focused on pre-service teachers' self-efficacy and its development in reading instruction (Ciampa & Gallagher, 2018; Clark, 2020; Leader-Janssen & Rankin-Erickson, 2013). To our knowledge, studies on teacher self-efficacy in online credibility evaluation are nearly nonexistent, except for a study by Andreassen and Bråten (2013). They investigated how in-service teachers' ($N = 263$) source evaluation self-efficacy, measured with four parallel items in the context of special education (in the measure, source referred to the online texts), was associated with their self-reported evaluation criteria when judging the trustworthiness of websites on special needs education. It was found that the better self-efficacy teachers had, the more they emphasized the importance of considering the URL address and author of the website, as well as its content, layout, and publication date. The results indicate that self-efficacy in source evaluation can reflect understanding the role of relevant source features. However, the teachers' actual online credibility evaluation skills were not measured in the study.

Sources of teacher self-efficacy

Bandura (1997) has proposed four sources that can influence a teacher's or any individual's self-efficacy: mastery experiences, vicarious experiences, social and verbal persuasion, and physiological reactions or states.

Mastery experiences refer to previous successful experiences that serve as evidence of one's capabilities (Bandura, 1997). Teacher education can facilitate mastery experiences by organizing teaching practicums or short-term teaching opportunities (Knoblauch & Chase, 2015; Täschner et al., 2025), teaching one's peers (Sheehan & Moore, 2019), and role-playing (Dicke et al., 2015). Mastery experiences are regarded as the most impactful source of self-efficacy, particularly when success occurs in a highly demanding task. However, teaching experiences as such do not directly affect self-efficacy; rather, what matters is how they are reflected upon and interpreted (Tschannen-Moran et al., 1998). When a teaching experience is interpreted as successful, it can enhance teacher self-efficacy, whereas interpreting an experience as a failure may decrease it. Notably, occasional failures do not seem to affect one's self-efficacy beliefs if preceded by several mastery experiences (Schunk & Usher, 2011).

Second, *vicarious experiences* cover situations where individuals observe a model doing something (Bandura, 1997). For example, pre-service teachers can observe in-service teachers' practices (Johnson, 2010) or their peers' lessons in a teaching practicum (Cabaroglu, 2014). Modeling demonstrations can also involve watching classroom videos (Bowlin et al., 2015) or videotaped teaching models (Van der Scheer & Visscher, 2016). Furthermore, pre-service teachers' co-teaching with their peers or in-service teachers can also be useful for their learning and confidence building (Hawkman et al., 2019). According to Bandura (1997), vicarious experiences can affect self-efficacy, especially when the task is novel, and observers perceive the model as similar to themselves.

The third source of self-efficacy, *social and verbal persuasion,* includes situations in which individuals receive support and encouragement for their specific activity (Bandura, 1997). In teacher education, social and verbal persuasion may occur when pre-service teachers receive coaching (Michos et al., 2022) or feedback (Weber et al., 2019) from their peers or supervisors. According to Bandura (1997), the effectiveness of persuasion depends on the perceived expertise of the person providing the feedback and how the feedback is framed. There is evidence that constructive feedback on pre-service teachers' lesson plans (see meta-analysis by Mok et al., 2023) and lessons (Prilop et al., 2019) can positively affect their self-efficacy. Furthermore, persuasion can be a part of discussions and collaboration with peers and supervisors (Thiel et al., 2023). Notably, social and verbal persuasion, along with vicarious experiences, can be crucial for pre-service teachers who do not yet have many mastery experiences (Bandura, 1997).

Finally, individuals' *physiological and emotional reactions or states* (e.g. sweating hands, excitement) to a situation can influence their perception of self-efficacy. When teachers interpret their physiological and emotional reactions positively, they can feel enthusiastic in the classroom instead of nervous (Täschner et al., 2025). Importantly, modeling or mastery experiences can reduce feelings of anxiety (Bandura, 1997; see also Palmer, 2006).

It is noteworthy that pre-service teachers' experiences shape their self-efficacy beliefs not directly but through interpretation and reflection on those experiences (Täschner et al., 2025; Tschannen-Moran et al., 1998). For example, Bauer et al. (2024) found that throughout a long-term practicum, reflection during accompanying university courses, in particular, predicted a positive change in pre-service teachers' self-efficacy. Notably, the ways in which the four sources of self-efficacy affect self-efficacy beliefs seem to include various cognitive, primarily subconscious processes, such as reflecting, evaluating, and weighing information (Bandura, 1997). Thus, explicit, guided moments of reflection can support positive self-efficacy beliefs (Täschner et al., 2025).

In addition to the four sources of self-efficacy introduced above, different forms of *knowledge* can also be regarded as sources of self-efficacy (see Morris et al., 2017). For example, increased content knowledge (knowledge of the taught subject, in our case, knowledge about evaluation strategies) or subject-specific pedagogical knowledge can enhance teacher efficacy (Palmer, 2006). According to Palmer (2006), this 'cognitive mastery'—which refers to understanding something rather than successfully performing something—is a prerequisite for mastery experiences in real-life situations. In contrast, teachers may lack theoretical knowledge about, for example, reading, which is key to efficient classroom practices, and at the same time be overconfident about their abilities to teach reading (Kehoe & McGinty, 2024).

Interventions targeting teacher self-efficacy

As teachers' confidence in their teaching capabilities has many advantages, various interventions have been implemented to strengthen teacher self-efficacy (see meta-analyses by Mok et al., 2023, and Täschner et al., 2025). On average, teachers have reported significantly higher levels of teacher self--efficacy after interventions than before them, with overall effect sizes ranging from small ($g = 0.47$; Täschner et al., 2025) to medium ($g = 0.68$; Mok et al., 2023).

Of the sources of self-efficacy, most interventions have included mastery experiences or social and verbal persuasion along with vicarious experiences, often in combination (Täschner et al., 2025). However, only a few interventions have focused on physiological or emotional reactions or states. A recent meta-analysis (Täschner et al., 2025) found no significant differences in the impact of interventions on teacher self-efficacy based on the sources they incorporated. The results suggest that sources of self-efficacy are highly intertwined and may not affect teacher self-efficacy independently but together.

Täschner et al. (2025) showed that interventions offering mastery experiences were most useful for pre-service teachers ($n = 11$; $g = 0.62$), whereas in-service teachers benefited most from interventions offering vicarious experiences ($n = 7$; $g = 0.83$). However, pre-service teachers seemed to benefit even more from interventions combining vicarious experiences with other sources of self-efficacy ($n = 27$; $g = 0.73$). Overall, the results suggest that mastery and vicarious experiences seem to be the most relevant sources for teacher self-efficacy, whereas social and verbal persuasion play a minor role (Täschner et al., 2025).

Research design and ethical considerations

The current research consists of two interconnected studies. In Study I, we developed a three-dimensional measure to assess teacher self-efficacy in online credibility evaluation and examined whether the three dimensions were distinctive. This measure was developed because no suitable existing instruments were available to evaluate the efficacy of an intervention implemented in Study II (an intervention study). In Study II, we designed a course for Finnish pre-service teachers to promote their self-efficacy in online credibility evaluation and in teaching these skills to their students. The efficacy of the intervention was assessed using the self-efficacy measure developed in Study I.

Study II was an intervention study that employed both quantitative and qualitative approaches. To examine the efficacy of the intervention, we applied a quasi-experimental pre-post test design with a nonequivalent control group (see Section Design and Hypotheses under Study II for more details). For the quantitative analysis, we used the teacher self-efficacy measure developed in Study I to test whether the course enhanced pre-service teachers' self-efficacy in online credibility evaluation. To support the interpretations of the quantitative results in Study II, we conducted a qualitative analysis of reflections that pre-service teachers wrote at the end of the course to identify whether different course elements served as sources of self-efficacy.

In both studies, we followed the research ethics guidelines of the Finnish Advisory Board on Research Integrity (Kohonen et al., 2019) as well as the ethical guidelines of each respective university. Informed consent–including information about the purpose of the research, their rights as participants, and how their data would be used–was obtained from all students. In cases where personal data were collected, students were provided with a privacy notice in accordance with the EU General Data Protection Regulation (GDPR).

Study I: developing a measure of teacher self-efficacy in online credibility evaluation

In Study I, we sought to develop a self-efficacy measure that assesses both teachers' self-efficacy as evaluators of online information and their self-efficacy in teaching online evaluation skills. We then examined the structure of the developed measure among pre-service teachers.

Methods

Participants and context

Participants in this study took part in an obligatory literacy course for pre-service class teachers in two Finnish universities. Of the course participants, 298 pre-service teachers gave informed consent to use their data for research purposes. Most participants (83.6%) were under 25 (*Md* = 21) and female (83.9%), which aligns with the gender distribution in class teacher education in Finland (see Vipunen - Education Statistics Finland, 2022). The majority of the participating pre-service teachers (78.9%) had earned 100 or fewer out of 300 ECTS credits (the European Credit Transfer and Accumulation System; one ECTS credit equals 27 hours of study). They had completed one or no practicum (94.0%), and 62.4% of the participants had less than one month of experience as a teacher.

In Finland, class teachers must complete a master's degree with education as their major. The degree requires a minimum of 300 ECTS credits. Teacher educators can design their teacher training courses to meet the requirements of ECTS by including a sufficient number of lessons and pre-service teachers' individual work and tasks in their courses.

Self-efficacy measure

To assess pre-service teachers' self-efficacy beliefs about their ability to evaluate the credibility of online texts and teach online credibility evaluation skills to their students, we developed the measure for *Teacher Self-Efficacy in Online Credibility Evaluation.* In the development, we drew upon existing measures of teachers' source evaluation self-efficacy (Andreassen & Bråten, 2013) and teacher self-efficacy (Skaalvik & Skaalvik, 2007, 2010).

We included three self-efficacy dimensions in our measure as we believe that confidence in these areas may affect teachers' instructional practices related to online credibility evaluation. First, confidence in the ability to seek credible educational science texts online to inform their classroom practices is essential for teachers' professional development (Andreassen & Bråten, 2013). This is particularly crucial in the domain of digital literacy, as literacy practices are constantly changing (Coiro, 2021; Greene & Crompton, 2025) and, consequently, the most recent information is often published online. We labeled this dimension *self-efficacy in discipline-specific online credibility evaluation.*

Second, teachers need to be confident in their ability to evaluate and justify the credibility of online texts of varying quality and topics, as their students may encounter diverse texts in their schoolwork and beyond. Teachers with low confidence in their own skills may avoid assigning authentic online inquiry tasks to their students. This second dimension was labeled *self-efficacy in general online credibility evaluation.* Third, teachers need to be confident in their ability to support their students, who may differ considerably in their online credibility evaluation skills. This dimension was labeled *self-efficacy in teaching online credibility evaluation.*

Each of the measures' dimensions consisted of four items that pre-service teachers were asked to evaluate with a 7-point scale (Describes me 1 = very poorly/2 = poorly/3 = quite poorly/4 = not poorly or well/5 = quite well/6 = well/7 = very well). The first dimension—*self-efficacy in discipline-specific online credibility evaluation*—measured pre-service teachers' confidence in evaluating the credibility of educational science texts published online. An example item of this dimension is, '*I am confident that I can evaluate the author's expertise of an educational science text published online*'.

The second dimension—*self-efficacy in general online credibility evaluation*—measured pre-service teachers' confidence in evaluating texts other than educational science texts published online. The items of this dimension were parallel to the discipline-specific items; only the context of the evaluation varied (discipline-specific context vs. no specific context). An example item of this dimension is, '*I am confident that I can evaluate whether an online text is published on a credible website*'.

Finally, the third dimension measured pre-service teachers' self-efficacy in teaching online credibility evaluation. Relying on previous teacher self-efficacy measures (e.g. Skaalvik & Skaalvik, 2007, 2010), each of the four items reflected a central aspect of teaching: instruction, motivating students to learn, differentiating teaching, and assessing students' skills (e.g. '*I am confident that I can design online credibility evaluation tasks that support students with differing skills*'). The items, with descriptive statistics, are presented in Appendix A.

Each dimension was contextualized to a specific situation. For example, before responding to the items on self-efficacy in teaching online credibility evaluation, the pre-service teachers were asked to consider how well the statements described them in a situation where they were teaching students how to evaluate the credibility of online texts.

Results

We conducted a confirmatory factorial analysis to confirm the existence of a three-factor structure (*Self-efficacy in discipline-specific online credibility evaluation*, *Self-efficacy in general online credibility evaluation*, and *Self-efficacy in teaching online credibility evaluation*, each saturated by four items) for the self-efficacy measure (see Appendix B).

The model did not achieve satisfactory goodness of fit ($\chi^2 = 223$, $df = 51$, $p < 0.001$; CFI = 0.88, TLI = 0.85; RMSEA = 0.11). An analysis of the modification indices on residual covariances suggested that each item in the dimension *self-efficacy in discipline-specific online credibility evaluation* was correlated with its counterpart in the dimension *self-efficacy in general online credibility evaluation*. This is reasonable if we consider that items have a similar linguistic formulation (e.g. '*I am confident that I can evaluate whether an educational science text has been published on a credible website*' for self-efficacy in discipline-specific online credibility evaluation and '*I am confident that I can evaluate whether a text has been published on a credible website*' for self-efficacy in general online credibility evaluation). Thus, we re-conducted the confirmatory factorial analysis by adding these covariances to the model, with the hypothesis that items in the dimensions *self-efficacy in discipline-specific online credibility evaluation* and *self-efficacy in general online credibility evaluation* are independent, yet related, constructs (see Appendix C).

The model achieved satisfactory goodness of fit ($\chi^2 = 75.9$, $df = 47$, $p = 0.005$; CFI = 0.98, TLI = 0.97, RMSEA = 0.04). The alternative two-factor model, with all items in the dimensions *self-efficacy in discipline-specific online credibility evaluation* and *self-efficacy in general online credibility evaluation* loading on one factor and the *self-efficacy in teaching online credibility evaluation* items loading on another factor, did not have satisfactory goodness of fit ($\chi^2 = 372$, $df = 53$, $p < 0.001$; CFI = 0.78, TLI = 0.73, RMSEA = 0.14). In the three-factor structure, each item significantly loaded on the hypothesized factor (with all the estimates being statistically significant for $p < 0.001$; see Appendix D).

Factorial covariances (see Appendix E) were all statistically significant but not too high, suggesting that the factors measured distinct constructs and had good discriminant validity. The composite reliability scores for the three factors were all above 0.70, indicating acceptable internal consistency for each scale. However, the average variance extracted scores for two factors (self-efficacy in discipline-specific online credibility evaluation and self-efficacy in teaching online credibility evaluation) were slightly below the recommended threshold (AVE > 0.50), suggesting that the latent factors did not explain a large proportion of each item's variance. The AVE score for self-efficacy in general online credibility evaluation factors was above 0.50, suggesting that more variance in the items is explained by the latent factor than by measurement error.

Taken together, these results suggest that the three-factor measure of teachers' self-efficacy has acceptable discriminant validity and reliability, whereas the convergent validity is not as strong as desirable. The last result suggests that more work is needed on the items, such as refining wording or considering the inclusion of stronger indicators. However, having confirmed the factorial structure of the self-efficacy measure, we used it in Study II to assess changes in teachers' self-efficacy as a function of the intervention.

Study II: intervention study

In Study II, we developed an intervention that aimed at enhancing pre-service teachers' self-efficacy in online credibility evaluation and tested its efficacy with the measure developed in Study I.

Methods

Participants

Participants consisted of 127 pre-service class teachers (74.0% female), who all gave informed consent to participate in the study. Most participants (80.3%) were under 28 ($Md = 25$). Participants were in an advanced phase of their studies: most (92.9%) had earned more than 151 ECTS credits, and 70% had completed at least three practicums during their study program. Most participants (76.4%) had five months or less experience as teachers.

Research design and hypotheses

We applied a quasi-experimental pre-post test design with a nonequivalent control group. The intervention group comprised 60 students (73.3% female), and the control group comprised 67 students (74.6% female). Students in the groups had equal amounts of ECTS credits ($U = 1809.50$; $p = 0.279$) and practicums ($U = 1798$; $p = 0.201$) completed, as well as experience as a teacher ($t(125) = -0.26$; $p = 0.795$). The intervention group participated in the course 'Tools for Teaching Critical Online Reading', whereas the control group participated in a different course of advanced studies unrelated to online credibility evaluation. During the first and last lessons of the intervention, students completed the Teacher Self-Efficacy in Online Credibility Evaluation measure. In comparison, the control group students had an equal time between the two measurement points.

We hypothesized that pre-service teachers' self-efficacy would improve across all three measured self-efficacy dimensions. First, we assumed that pre-service teachers would feel more confident in evaluating the credibility of both educational science texts published online (self-efficacy in discipline-specific online credibility evaluation) and diverse types of online texts beyond the educational context (self-efficacy in general online credibility evaluation) after completing the course. This assumption was based on course components that provided knowledge about online credibility evaluation strategies and opportunities to reflect on one's own skills through online credibility evaluation tasks that pre-service teachers completed at the beginning and end of the course (see Tables 1 and 2 for more details).

Table 1. Design principles (DPs)[a] to foster teacher self-efficacy in educating critical online readers, their Implementation in the course, and their potential to serve as sources of self-efficacy.

Design principle	Implementation	Potential sources of self-efficacy
DP1 Facilitate the acquisition of theoretical knowledge on online credibility evaluation and effective instructional practices.	Pre-service teachers watched expert videos, read scientific articles, and joined interactive lectures.	Increased theoretical knowledge
DP2 Foster instructional design by explaining how to use existing practices and materials in the classroom.	The teacher educator explained how online credibility evaluation strategies could be taught and shared research-based learning materials designed for teaching online credibility evaluation.	Vicarious experiences Increased theoretical knowledge
DP3 Facilitate collaborative instructional design and its implementation in the classroom	Pre-service teachers designed and implemented a teaching experiment (75–90 min) in pairs or threes for a teacher-training school classroom.	Mastery experiences Vicarious experiences
	Pre-service teachers shared experiences of the teaching experiment with their peers.	Vicarious experiences Social and verbal persuasion
	Pre-service teachers improved their instructional designs based on their teaching experiences and provided theoretical knowledge. Design ideas were shared with others.	Mastery experiences Vicarious experiences Social and verbal persuasion
DP4 Create spaces for discussion and giving and receiving feedback	The teacher educator encouraged and gave feedback on pre-service teachers' instructional designs, lessons taught, and their improved instructional designs.	Social and verbal persuasion
	Pre-service teachers gave feedback on their peers' instructional designs, lessons taught, and their improved instructional designs.	Social and verbal persuasion
DP5 Provide opportunities for reflection	Pre-service teachers wrote guided, systematic reflections at three key junctures of the course.	Interpreting experiences through reflection
	Pre-service teachers and teacher educators shared discussions throughout the course.	Social and verbal persuasion

Note: [a]Modified from Authors, 2024b.

Table 2. Course modules, their components, Implementation week (W), and applied design principles (DPs).

Modules (M)	M1: Building theoretical knowledge on online credibility evaluation and effective instructional practices	M2: Designing and implementing a teaching experiment	M3: Deepening understanding of teaching online credibility evaluation
Lesson (L) topics	L1: Orientation to the course; completing the self-efficacy measure and an online credibility evaluation task (W1) L2: Students' online credibility evaluation skills (W2)	L3: Designing teaching experiments and sharing ideas with peers (W3) L4: Discussing experiences on implemented teaching experiments (W7)	L5: Assessing students' online credibility evaluation skills and discussing inclusive instructional practices (W8) L6: Infographics presentations (T7); completing the self-efficacy measure and an online credibility evaluation task (W9)
Tasks (T)	T1: Recalling teaching experiences on reading and specifying the interests toward the course (before the course) T2: Reading three pedagogical journal articles on designing instruction for online credibility evaluation and summarizing their main insights (W2)	T3: Watching three 15-minute expert videos; preparing an initial instructional design for the teaching experiment (W3) T4: Finalizing the instructional design (W5) T5. Implementing the 75–90-minute teaching experiment (W6)	T6: Watching three 15-minute expert videos and summarizing their main insights; writing down ideas on developing instructional design further or suggesting alternative solutions (W8) T7: Creating an infographic describing improved instructional design (W9)
Guidance		Personal guidance (30–45 min/design) based on the initial instructional design (W5)	
Reflections (R)	R1: One's own online credibility evaluation skills and teaching them based on the online credibility evaluation task and self-efficacy measure (W1)	R2: One's own online credibility evaluation skills and teaching them based on the teaching experiment and related discussions in the lessons (W7)	R3: Development as an online reader and a teacher based on the whole course, completed online credibility evaluation tasks, and the infographic (W10)
DPs	DP1, DP5	DPs 1–5	DP1, DP4, DP5

Second, we assumed that the course would enhance pre-service teachers' confidence in teaching students to evaluate the credibility of online texts. The course offered several potential sources of self-efficacy, including theoretical knowledge as well as mastery and vicarious experiences (see Tables 1 and 2 for more details), which have been shown to support teacher self-efficacy in other contexts (Mok et al., 2023; Täschner et al., 2025).

Design principles informing the course design and its implementation

We designed a 5-ECTS credits course, 'Tools for Teaching Critical Online Reading', which was informed by five design principles to enhance teacher self-efficacy in educating critical online readers (Kiili & Kulju, 2024). Table 1 shows the design principles, their implementation in the course, and their relation to sources of self-efficacy.

The course consisted of three modules that were implemented over 10 weeks. The first author taught the course twice, and the second author taught it three times at the other university, with only slight differences in schedules. Both were experienced teacher educators and reading researchers and were also involved in designing the course. To ensure similar implementation of each course, we developed a course on an online learning platform (Moodle) and used exactly the same course design, tasks, and materials. Even though two of these courses were executed remotely, the content of all courses was similar, and all participating pre-service teachers carried out their teaching experiments face-to-face in teacher-training school classrooms.

The modules, their components, and the applied design principles in each module are presented in Table 2. All modules were designed around a teaching experiment that students designed and implemented in a fifth-grade classroom. Module 1 (Weeks 1–2) offered pre-service teachers content knowledge and subject-specific pedagogical knowledge that they could apply in designing their teaching experiments. Module 2 (Weeks 3–7) focused on designing, implementing, and reflecting on the teaching experiment. Finally, in Module 3 (Weeks 8–10), pre-service teachers were provided with additional knowledge on motivation, individual differences in online credibility evaluation, and on pedagogical support

for students with varying reading skills to deepen their understanding of teaching online credibility evaluation. In this module, pre-service teachers improved their instructional design based on their experiences in the classroom and provided theoretical knowledge. Pre-service teachers created and presented an infographic to illustrate the improved design.

At the beginning of Module 1 and the end of Module 3, students also completed an online credibility evaluation task. They read and evaluated four online texts (two more and two less credible) on educational topics (learning styles in Module 1 and gender differences in mathematics in Module 3) from different perspectives (see Kulju et al., 2024 for more details about the task). The task allowed pre-service teachers to consider their online credibility evaluation skills in reflections written during the course.

Pre-service teachers wrote three individual reflections: one at the beginning of the course (Module 1), one after the teaching experiment (Module 2), and one at the end of the course (Module 3). Each reflection focused on their thoughts and feelings about online credibility evaluation and teaching it (cf. Husu et al., 2008). To ensure meaningful reflection, each reflection was guided by different questions and prompts (Allas et al., 2020; Cengiz, 2020). The first reflection was supported by the online credibility evaluation task, the self-efficacy measure, and the first lesson of the course, including joint discussions. The main input for the second reflection was the implemented teaching experiment and subsequent shared discussions. The third reflection asked pre-service teachers to reflect on the entire course, considering the completion of the second online credibility evaluation task, the presented infographics on improved instructional designs, and possible changes in their online credibility evaluation skills and pedagogical competence.

Qualitative analysis of pre-service teachers' final reflections

Qualitative analysis was conducted on pre-service teachers' reflections ($N = 57$) written after the final lesson of the course. Of the 60 intervention group students, one student did not complete the course, one did not submit the final reflection, and one did not consent to the use of their reflections for research purposes.

We limited the data to phrases ($N = 226$) that mentioned a course element, such as the teaching experiment or discussions. Thus, a unit of analysis was a single meaningful phrase that included a reference to a course element. For example, 'I feel that planning the teaching experiment also played a significant role in developing my own skills' (PT15) was treated as one unit.

Then, we conducted a theory-driven content analysis (Hsieh & Shannon, 2005) to identify sources of self-efficacy (Bandura, 1997; Morris et al., 2017) in these phrases. A coding framework (a codebook) was developed to guide the analysis (Schreier, 2012). The main codes were derived from the theory and research about the sources of self-efficacy (e.g. Bandura, 1997; Morris et al., 2017), and the subcodes were developed through engagement with the data to capture the variation within the main categories. For instance, pre-service teachers gained mastery experiences through completing the credibility evaluation task or engaging in activities related to the teaching experiment.

The second author familiarized herself with the data and conducted initial coding. At this point, we engaged in researcher triangulation involving three authors' observations of the data, aiming at increasing the consistency of coding (Carter et al., 2014; Wilson, 2014). This process included refinement of coding categories, resolving borderline cases, and establishing exclusion criteria. For instance, after a thorough discussion, we agreed that expressions simply saying that a specific course component was useful, educational, or constructive were too vague to be considered sources of self-efficacy.

Overall, we identified phrases ($n = 117$) that included at least one expression interpreted as a source of self-efficacy. Notably, some phrases contained expressions that we coded into more than one category. Altogether, we identified 130 expressions indicating a source of self-efficacy.

After several months of completing the qualitative analysis, we examined inter-coder reliability by having the first author code 20% of the phrases ($n = 23$) that included an expression of self-efficacy. This coding was compared with the second author's subcodes, resulting in a Cohen's kappa of .82. The full codebook, including the main codes, subcodes, exclusion criteria, and data examples, is provided in Table 3.

Table 3. Codebook with definitions and illustrative examples.

Source of self-efficacy	subcode	Exclusion criteria	Example
Mastery experiences Expression indicating an experience of success in planning, implementing, or improving the instructional design or in completing the online credibility evaluation task.	• Experience of success in an evaluation task • Experience of success in a teaching experiment • Experience of success in an improved instructional design • Explicit expression of increased self-efficacy due to a teaching experiment • Perceived improvement in own reading skills through a teaching experiment	Statements about a course component being useful, educational, or constructive. Comments about a course component unrelated to self-efficacy (e.g. evaluation strategies)	In our opinion*, our teaching experiment was successful. In particular, we succeeded in selecting online texts and teaching methods for the lesson. (PT56)
Vicarious experiences Expression appreciating peers' instructional ideas or teaching experiences, or instructional examples in developing teaching practices.	• Perceived benefits from peers' teaching experiment • Perceived benefits from peers' improved instructional design • Perceived benefits from instructional examples	Expressions lacking clear appreciation (e.g. examples gave food for thought).	When looking at others' infographics [improved instructional designs], it was great to see many different ways to approach teaching critical online reading. (PT8)
Knowledge Expression indicating an increase in theoretical content knowledge or subject-specific pedagogical knowledge	• Expression of increased content knowledge • Expression of increased subject-specific pedagogical knowledge	Expressions not clearly indicating increased theoretical content knowledge or subject-specific pedagogical knowledge (e.g. theory has been educational).	I learned many terms and important topics related to online reading, or at least they were reinforced during the course. I feel much more confident and positive about teaching the topic in the future. (PT30)
Social or verbal persuasion Expression appreciating discussions or feedback in supporting the development of teaching competencies	• Perceived benefits from discussions	Expressions not clearly indicating appreciation (e.g. discussions were constructive or educational).	It was only discussions and exchanges of ideas after the teaching experiments and the improved versions of them that strengthened my perceptions of my own competence in teaching critical reading. (PT47)
Physiological or emotional states Expression indicating emotional or physiological experiences while planning, implementing, or improving the instructional design.	• Expression indicating positive feelings • Expression indicating negative feelings • Expression indicating both positive and negative feelings		When planning the teaching experiment, I sometimes felt very uncertain, as some things were new to me and difficult to understand. Thinking that I should be able to teach these things to students was daunting. (PT12)

Note: *By using the expression 'in our opinion', the student refers to a work done in pairs and a joint evaluation of its success.

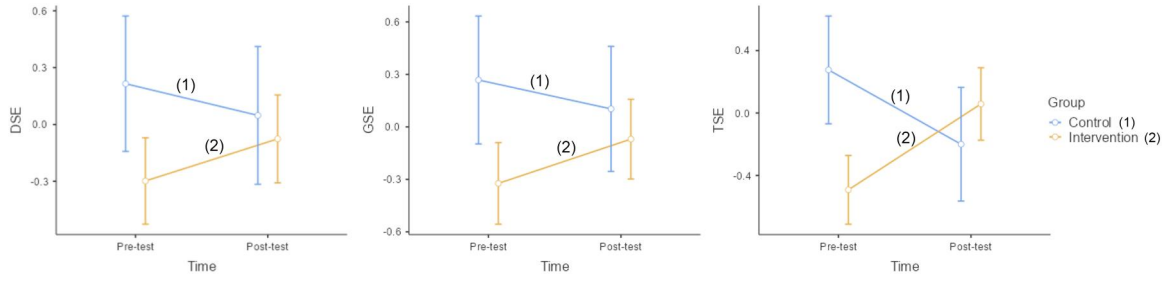

Figure 1. Graphical representation of changes in Self-Efficacy Scores from pre-test to post-test across the intervention and control groups (DSE = Self-Efficacy in Discipline-Specific Online Credibility Evaluation; GSE = Self-Efficacy in General Online Credibility Evaluation; TSE = Self-Efficacy in Teaching Online Credibility Evaluation).

Results

Intervention effects on teacher self-efficacy (quantitative results)

To investigate whether the course enhanced pre-service teachers' self-efficacy in online credibility evaluation from pre-test to post-test, we calculated factorial scores for each self-efficacy dimension and then

conducted a series of repeated-measures ANOVAs. The factors were normally distributed (skewness and kurtosis scores were between −1 and +1).

In the pre-test, the control group rated their self-efficacy higher in all self-efficacy dimensions than the intervention group (see Figure 1 and Appendix F for descriptive statistics): self-efficacy in discipline-specific online credibility evaluation ($t = 3.50$, df = 119, $p < 0.001$, $d = 0.64$), self-efficacy in general online credibility evaluation ($t = 3.80$, df = 119, $p < 0.001$, $d = 0.69$), and self-efficacy in teaching online credibility evaluation ($t = 6.65$, df = 119, $p < 0.001$, $d = 1.21$). While this result is not ideal from a statistical perspective, it may indicate that pre-service teachers with high self-efficacy were unlikely to enroll in a voluntary course on the topic that they felt they were mastering.

As shown in Figure 1, the course did not significantly improve pre-service teachers' self-efficacy in discipline-specific online credibility evaluation [Time * Group interaction, $F = 3.22$, $p = 0.08$, $\eta^2_p = 0.04$]. Notably, this association was slightly above the conventional threshold of $p = .05$. However, the course significantly improved pre-service teachers' self-efficacy in general online credibility evaluation [Time * Group interaction, $F = 4.77$, $p = 0.03$, $\eta^2_p = 0.06$]. The most considerable effect was observed in pre-service teachers' self-efficacy in teaching online credibility evaluation [Time * Group interaction, $F = 31.36$, $p < 0.001$, $\eta^2_p = 0.28$].

Overall, the course helped pre-service teachers feel more confident in all self-efficacy dimensions, although not significantly in self-efficacy regarding discipline-specific online credibility evaluation, and with a large effect size for self-efficacy in teaching online credibility evaluation.

Sources of self-efficacy identified in pre-service teachers' reflections (qualitative results)

Pre-service teachers' final reflections included expressions representing five different types of sources of self-efficacy, including mastery experiences, vicarious experiences, knowledge, social or verbal persuasion, and physiological and emotional states.

Mastery experiences ($n = 62$) formed the largest category of self-efficacy sources. They served either as a source of self-efficacy for one's own credibility evaluation skills or for teaching abilities. Completing the online credibility evaluation task at the beginning and end of the course offered them an opportunity to reflect on changes in their performance as noted by one pre-service teacher (PT20): 'In the final task [online credibility evaluation task], I felt more confident. I knew what to pay attention to, and the task felt easier and smoother to do'. Altogether, in 40 expressions, pre-service teachers reported feeling more confident in completing the second online credibility task or felt that their critical online reading skills had improved.

Importantly, the teaching experiment offered pre-service teachers mastery experiences ($n = 22$) related to planning or implementing the teaching experiment. While some pre-service teachers stated that the teaching experiment was successful, others explicitly expressed that it increased their confidence in teaching credibility evaluation. For example, 'The course gave me confidence in teaching critical online reading skills. The teaching experiment, where we got to try out teaching the topic and planning lessons in practice, definitely played a big part in this' (PT10).

Vicarious experiences ($n = 29$), related to peers' teaching experiences or teaching materials, were also quite often acknowledged. Fourteen expressions indicated that peers' pedagogical ideas, task ideas, or teaching experiences served as an inspiration for pre-service teachers' future teaching. One pre-service teacher (PT15) commented, 'I learned a surprising number of ways to teach, for example, from other pre-service teachers and their teaching experiments'. In addition, peers' infographics describing improved instructional designs were mentioned in some reflections. It is important to note that although pre-service teachers did not observe their peers' teaching experiments in the classroom, it was the shared experiences, reflections, and discussions that provided vicarious experiences. Notably, we identified a similar number of expressions ($n = 15$) in pre-service teachers' reflections that indicated that materials such as examples of research-based task types nurtured new instructional ideas for teaching online credibility evaluation.

Different types of knowledge can serve as a source of self-efficacy, and we identified 24 expressions that described how pre-service teachers' *content knowledge or subject-specific pedagogical knowledge* increased during the course. Pre-service teachers pointed out that they learned terminology about critical online reading, as illustrated by one pre-service teacher (PT14): 'The biggest change is probably that the course gave me a lot of concepts and knowledge related to evaluation of credibility of online texts'

(PT14). The acquired scientific knowledge also supported their pedagogical thinking in terms of teaching online credibility evaluation skills. Theoretical knowledge was supported, for example, by teaching experiments, shared discussions, and readings.

Social or verbal persuasion ($n = 2$) was hardly mentioned in such a way that they were interpreted as a source of self-efficacy. The two identified expressions described how shared discussions supported pre-service teachers' confidence in teaching online credibility evaluation skills. Notably, none of the pre-service teachers specifically mentioned teacher educators' feedback in their reflections at the end of the course. This may be because their feedback was intertwined with discussions about experiences in implementing teaching experiments during class hours.

Pre-service teachers experienced *positive or negative emotions* ($n = 13$) when planning and implementing the teaching experiment or improving their instructional designs. Four expressions indicated that the teaching experiment aroused positive feelings. For example, 'After a very successful teaching experiment, I felt a sense of success, joy, and satisfaction' (PT1). Such positive emotions were linked to mastery experiences. On the other hand, five expressions described feelings of uncertainty or insufficiency in planning or implementing the designed experiment. Furthermore, four expressions described how pre-service teachers' emotions transitioned from uncertainty to excitement during the course.

Discussion

As teachers are responsible for educating critical online readers, it is crucial that teacher education prepares teachers who are confident in fulfilling this responsibility. The present research, consisting of two studies, contributed to this goal in three ways. First, we designed and tested the efficacy of a course (5 ECTS credits) for pre-service teachers that employed five theoretically grounded design principles to support teachers' self-efficacy in teaching online credibility evaluation. Grounding the course on design principles provides flexibility for teacher educators to apply the findings of this study in their practices.

Second, given that we could not identify any existing self-efficacy measure that would have allowed us to assess the targeted efficacy of the course, we developed a measure to assess teacher self-efficacy in online credibility evaluation and tested its three-dimensional structure. This measure can be used not only to assess the efficacy of instructional practices but also as a reflection tool for pre-service teachers.

Third, in addition to examining the efficacy of the applied design principles with the self-efficacy measure, we also employed a qualitative approach to gain insights into their usefulness. We examined pre-service teachers' reflections at the end of the course to explore whether the course components offered sources of self-efficacy that could potentially enhance pre-service teachers' self-efficacy in online credibility evaluation. Next, we discuss the main findings and limitations of the study, after which we turn to the instructional implications.

Multidimensional structure of teacher self-efficacy in online credibility evaluation

In Study I, we tested the three-dimensional structure of the developed measure for teacher self-efficacy in online credibility evaluation. The confirmatory factor analysis verified the structure of the measure, consisting of the following interrelated dimensions: self-efficacy in discipline-specific online credibility evaluation (i.e. credibility evaluation of educational science texts published online), self-efficacy in general online credibility evaluation (i.e. credibility evaluation of online texts on various topics), and self-efficacy in teaching online credibility evaluation. The results suggest that self-efficacy related to online credibility evaluation may vary across situations, which aligns with the theoretical assumption of situation specificity of self-efficacy beliefs (Bandura, 1997). Notably, the analysis also indicated that the dimensions of self-efficacy in discipline-specific and general online credibility evaluation overlapped considerably. One reason for this overlap is that the items used parallel wording, which may have concealed the distinctiveness of these two dimensions.

Implemented design principles enhanced teacher self-efficacy of online credibility evaluation

The implemented design principles in the voluntary teacher training course enhanced pre-service teachers' self-efficacy in all three online credibility evaluation dimensions, although only marginally for self-efficacy in discipline-specific online credibility evaluation (Study II). Remarkably, self-efficacy in teaching online credibility evaluation improved, with a large effect size ($\eta^2_p = 0.28$). It should be noted that the effect size for this self-efficacy dimension was considerably larger compared to the average effect sizes of previous teacher self-efficacy interventions (cf. effect sizes ranging from small $g = 0.47$; Täschner et al., 2025 to medium $g = 0.68$; Mok et al., 2023). This is also a favorable result, as high self-efficacy in teaching online credibility can encourage pre-service teachers to emphasize and develop online credibility evaluation instruction as future schoolteachers.

Pre-service teachers' written reflections at the end of the course suggested that especially mastery and vicarious experiences related to the teaching experiment, as well as acquired theoretical knowledge, served as sources of self-efficacy, likely explaining most of the improvement in self-efficacy in teaching online credibility evaluation skills. This aligns with the results of Täschner et al. (2025) review, which found that embedding a combination of potential sources of self-efficacy into interventions seems to be the most effective way to enhance teacher self-efficacy. Although written reflections were not mentioned as a source of self-efficacy, they provided pre-service teachers with opportunities to interpret their experiences (Tschannen-Moran et al., 1998). Furthermore, interventions that include moments of reflection have been more effective in enhancing teacher self-efficacy than interventions without them (Täschner et al., 2025).

Our results suggest that the teaching experiments do not need to be long (in this study, only 75–90 minutes) to provide mastery experiences for pre-service teachers (see also Bauer et al., 2024). However, it is important to note that the collaborative instructional design was facilitated: after careful planning, the pairs received guidance and constructive feedback on their designs before implementing them in the classroom. Additionally, as advanced pre-service teachers, they already had experience in classroom management, allowing them to concentrate on teaching online credibility evaluation skills.

Our findings also indicate that vicarious experiences do not necessarily require observing others' teaching in a classroom or through video recordings (cf. Täschner et al., 2025). Simply listening to and relating to peers' teaching experiences seems sufficient to support pre-service teachers' self-efficacy in teaching. Additionally, the research-based online credibility evaluation materials (e.g. task examples for elementary grades) served as models for pre-service teachers' instructional designs.

Furthermore, the timely provision of theoretical knowledge served as a source of self-efficacy. In their reflections, pre-service teachers referred to the knowledge provided at different phases of the course, suggesting that sequencing theoretical knowledge at critical points in the instructional design process worked as intended. First, we provided content knowledge about credibility evaluation strategies, followed by subject-specific pedagogical knowledge about effective instructional practices. More comprehensive knowledge (e.g. differentiating, motivating) was provided after the teaching experiments to stimulate improvements in instructional designs. It may be that the acquisition of theoretical knowledge and supporting instructional design may have helped to reduce possible negative feelings (cf. Palmer, 2006), as suggested by some reflections that described how pre-service teachers' negative feelings and uncertainty turned into positive feelings. It is noteworthy that, although creating spaces for discussions and giving and receiving feedback was an integral design principle of the course, their role as a source of self-efficacy did not very clearly emerge from pre-service teachers' reflections. The low frequency may be due to social and verbal persuasion being embedded within vicarious experiences.

The course also managed to enhance pre-service teachers' self-efficacy in evaluating general and educational science texts online, though not to the same extent as their self-efficacy in teaching online credibility evaluation. Notably, only self-efficacy in general online credibility evaluation was statistically significantly improved. These results were not surprising, as the design principles emphasized teaching online credibility evaluation more than developing pre-service teachers' own evaluation skills. It is also worth noting that pre-service teachers were already quite confident in their online credibility evaluation skills before the course. Consequently, there was less room for improvement compared to their self-efficacy in teaching online credibility evaluation, which started at a lower level.

However, completing the online credibility evaluation tasks on educational topics at the beginning and end of the course allowed pre-service teachers to reflect on how their own skills had improved after acquiring knowledge about evaluation strategies and how to apply them with students. Indeed, pre-service teachers reported mastery experiences related to their evaluation skills after completing both credibility evaluation tasks. As not all pre-service teachers are proficient in evaluation skills (Kulju et al., 2024; List et al., 2022), addressing their own online credibility evaluation skills as part of the intervention seemed well justified and was also a unique feature in our design (cf. Mok et al., 2023; Täschner et al., 2025).

Limitations and future research

Despite the promising results, the present studies have several limitations that should be taken into account in future studies. First, the two dimensions of teacher self-efficacy in the online credibility evaluation measure (self-efficacy in discipline-specific online credibility evaluation and self-efficacy in general online credibility evaluation) shared a considerable amount of variation. The wording of the items differed only in their context (evaluating discipline-specific vs. general online texts), and pre-service teachers may have had difficulty differentiating between these contexts. Future research should develop a self-efficacy measure that better specifies discipline-specific evaluation practices. For example, instead of asking pre-service teachers to evaluate their confidence with the item *'whether an educational science text has been published on a credible website',* as in this study, they could be asked to consider their confidence with the item *'whether the publication venue of an educational science text can ensure the quality of the content'*.

Second, the number of students in the intervention study was limited. Furthermore, for practical reasons, we reached less than half of the control group students for the post-test. However, the unequal number of students in the intervention and control groups was taken into account in the statistical analyses. Third, pre-service teachers in the control group reported higher self-efficacy in all three dimensions in the pre-test than pre-service teachers in the intervention group, even though the groups did not differ in their backgrounds. It is possible that pre-service teachers who chose to participate in the course felt less confident in online credibility evaluation than those who opted for the parallel course in their advanced studies. However, the intervention appeared effective in closing the gap in self-efficacy beliefs between the groups. Future research could examine not only pre-service teachers' self-efficacy but also their actual credibility evaluation skills and pedagogical knowledge. Such research may reveal potential gaps between perceived and actual competence and knowledge, as well as how these gaps may influence pre-service teachers' intention to participate in courses focusing on pedagogies for online credibility evaluation.

Fourth, we restricted the analysis of sources of self-efficacy to reflections at the end of the course. Future research could examine the sources of self-efficacy throughout the course. Additionally, the set of reflection tasks was designed as authentic course tasks; therefore, instructions for the final reflection task may have directed students' attention to specific components of the course.

Conclusion

The role played by teachers in educating critical online readers is crucial. However, they are challenged by constant changes in online environments, with the advent of large language models being a recent example (e.g. Bråten et al., 2026; Latini et al., 2026). These changes require new evaluation skills, strategies, and practices, and confident teachers can best adapt to these changes (Thurlings et al., 2015). Therefore, teacher education needs to support pre-service teachers in becoming confident in evaluating online information and teaching their students the necessary evaluation skills needed for a digitalized society. This study showed that implementing design principles that intentionally and seamlessly integrate the most important sources of self-efficacy into course design can improve teacher self-efficacy in online credibility evaluation. Our results suggest that courses should provide pre-service teachers with opportunities to practice and reflect on their own credibility evaluation skills and, in collaboration with peers, carefully design

instruction for online credibility evaluation and implement it in classrooms. Theoretical knowledge and timely support from teacher educators and peers can ensure successful experiences.

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Data availability statement

Quantitative data is available on request from the authors.

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