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Reflective thinking among Finnish pre-service teachers and its relation to metacognitive awareness

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ABSTRACT

Reflection has been identified as a crucial goal, both as a process and as an outcome, in pre-service teacher education. However, a notable gap exists in the systematic measurement of pre-service teachers' reflective thinking. This study examined pre-service teachers' reflective thinking and its relationship with metacognitive awareness, as well as the prerequisites for its measurement. The participants ($N = 247$) were pre-service teachers from a Finnish university, primarily from early childhood education and primary school programmes, with a smaller number from subject-specific teacher education programmes in craft and home economics. The results demonstrated the validity and reliability of the Reflective Thinking Questionnaire, sufficiently consistent measurement across two larger groups of pre-service teachers, and a strong correlation between reflective thinking and metacognitive awareness. The findings can support teacher educators in better understanding the characteristics of reflection.

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Reflective thinking;
metacognitive awareness;
teacher education; pre-service teacher

Introduction

Reflection and metacognition have been identified as key capabilities for teachers, both in their everyday practical work in schools and in their continuous learning and development in the teaching profession. The capability to monitor, reflect on and consider one's own and others' thoughts, behaviours and development forms the basis for learning (Desautel 2009; Saariaho et al. 2019). This is particularly relevant in the context of academic and research-based teacher education, which places a strong emphasis on developing pre-service teachers' higher-order thinking – reflection and metacognition (Körkkö 2021; Matsumoto-Royo, Ramírez-Montoya, and Glasserman-Morales 2022; Metsäpelto et al. 2022).

Reflection has been identified as a crucial goal in teacher education (Beauchamp 2015; El-Dib 2007). Recent research continues to affirm the value of reflection, while also underscoring the persistent challenges involved in fostering its

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development among pre-service teachers (Gläser-Zikuda et al. 2024; Liu, Yuan, and Wang 2025), as well as more broadly recognising the need to identify pre-service teachers who may benefit from additional guidance during their professional development (Heinz 2024). Despite this widely acknowledged importance, there is a notable gap in the systematic measurement of pre-service teachers' reflective thinking (RT) to assess the effectiveness of academic programmes, particularly through quantitative methods. While various scales have been developed to study reflection (e.g. Akbari, Behzadpoor, and Dadvand 2010; Kember et al. 2000; L. Y. Tay et al. 2023), most of the existing research has used qualitative methods, small sample sizes, and has studied reflection through written assignments, portfolios, interviews and videos (Engelbertink et al. 2021; Körkkö 2021; Toom, Husu, and Patrikainen 2015).

To demonstrate the effectiveness of teacher education in achieving its central goal, comparable data are needed on the development of RT among pre-service teachers during their studies. We incorporate metacognition as a complementary concept to enhance the quantitative examination of reflection as an individual and internal cognitive process, as these higher-order thinking constructs share theoretical similarities (Hiver et al. 2021; Risko, Roskos, and Vukelich 2005; Tarricone 2011). Metacognition is increasingly emphasised in pre-service teacher education for its positive impact on learning outcomes, teaching practices, and professional development (Bedel 2012; Ho and Lau 2025; Matsumoto-Royo, Ramírez-Montoya, and Glasserman-Morales 2022; Vosniadou et al. 2021). Specifically, we focus on metacognitive awareness (MA), which involves the awareness and regulation of one's cognitive processes (Schraw and Dennison 1994). MA has been widely examined using quantitative methods (e.g. Magno 2010; Mäkipää, Kallio, and Hotulainen 2021; Tuononen et al. 2023; Young and Fry 2008), offering a well-established framework for capturing cognitive processes. Its integration as a valid criterion for RT not only aligns with theoretical perspectives but also enhances the methodological rigour necessary for advancing the quantitative examination of RT.

Connections between reflection and metacognition have been studied in various contexts (Alian 2019; Desautel 2009; Ersözlü and Arslan 2009; Whittaker and van Garderen 2009). However, studies examining their interconnection specifically within the context of pre-service teacher education remain scarce. Some research has addressed this topic among pre-service teachers (Adadan and Oner 2018; Alt and Raichel 2020), but with mixed views on which construct forms the foundation and which serves as a prerequisite for the other. By studying these concepts together, we provide a more comprehensive quantitative analysis and deepen understanding of the characteristics of RT. Moreover, examining both RT and MA can enhance teacher education by fostering pre-service teachers' awareness of these constructs and, accordingly, their reflective and cognitive regulation skills.

The present study examines RT and its relationship with MA among pre-service teachers, while also addressing the prerequisites for measurement. The study adopts a twofold approach. First, from both theoretical and empirical perspectives, RT is operationalised and framed in relation to MA, and this relationship is empirically investigated. Second, from a methodological perspective, an in-depth examination of the measurement prerequisites is conducted. To this end, the study seeks to develop effective means

of exploring the relationship between RT and MA, as well as to lay the foundation for comparing teacher education programmes.

Reflective thinking and metacognitive awareness

Reflective thinking in teachers' work and teacher education

Reflection, as initially defined by Dewey, refers to an individual's 'active, persistent, and careful consideration of any belief or supposed form of knowledge', in which beliefs and prior knowledge are based on supporting reasons and held tendencies (Dewey 1933, 6). Building on Dewey's definition, Mezirow's (1991, 2009) transformative learning theory characterises RT as an individual and internal cognitive process. This framework also provides the conceptual groundwork for distinguishing RT from non-RT, the latter referring to habitual and routine thought processes without reflection (Lundgren and Poell 2016; Mezirow 1991).

In the context of research-based teacher education, there is a specific aim to educate reflective and pedagogically thinking teachers (Kansanen 2014; Toom et al. 2010) who are aware of their professional thoughts, practices, and the considerations underlying them (Vesterinen, Toom, and Krokfors 2014). Reflection plays a crucial role in teachers' work, as it allows them to connect their past experiences to educational and pedagogical practices, theoretical knowledge, and conceptions of teaching (Korthagen and Vasalos 2005). In other words, RT serves as a foundation for teacher learning and pedagogical development, enabling the integration of educational theory and teaching practice (Calderhead 1989; Husu, Toom, and Patrikainen 2008; Ketonen, Körkkö, and Pöysä 2023; Korthagen 2001).

Teacher education aims to foster RT capabilities in pre-service teachers. Previous studies indicate a positive relationship between pre-service teachers' RT and their learning and professional development (Korthagen 2001; Lee 2005). RT enables pre-service teachers to view their teaching from different perspectives and to understand how their actions relate to educational theories (Toom et al. 2010; Toom, Husu, and Patrikainen 2015). Moreover, critical reflection, characterised by questioning one's assumptions, enables pre-service teachers to examine phenomena and concepts beyond their prior understanding (Mezirow 1991). This process enhances self-evaluation and self-awareness, thereby deepening pre-service teachers' understanding of the teaching profession (Clara 2015; Moon 2013).

Despite its recognised importance, recent studies highlight ongoing challenges. Pre-service teachers often struggle to engage in RT in a deep or sustained manner, even when they recognise its importance (Liu, Yuan, and Wang 2025), and overall levels of RT tend to remain low (Gläser-Zikuda et al. 2024). This underlines the need for teacher education programmes to more intentionally support the development of RT (Collin, Karsenti, and Komis 2013; Körkkö 2021). To that end, many programmes incorporate tools such as portfolios. However, recent systematic review suggest that robust evidence of their broader impact is still lacking (Feder and Cramer 2025). Meta-analytical findings indicate that the use of diverse activities, sustained practice and peer interaction enhance the development of RT (Guo 2022). In addition, adopting a self-guided approach that

considers individual learning needs may support this development – especially during practicum periods (Tiainen, Lutovac, and Korkeamäki 2024).

Many pre-service teachers recognise the importance of reflection in professional practice (Mulryan-Kyne 2021). However, previous studies (Allas, Leijen, and Toom 2020) demonstrate that pre-service teachers preparing to become early childhood education, primary school, and subject teachers perceive reflection similarly, but focus on different topics. This variation may be due to different professional emphases in their respective degree programmes (Allas, Leijen, and Toom 2020). As a consequence, these observed differences highlight the need to gain insights into pre-service teachers' initial capabilities in order to foster the growth of RT during their studies.

Distinguishing non-RT from RT, which involves differentiating routine thinking without cognitive commitment from more complex levels of thinking (El-Dib 2007; Moon 2013), provides the basis for defining the qualities of RT. Several frameworks (e.g. Jay and Johnson 2002; F. Korthagen and Vasalos 2005; Valli 1997; Ward and McCotter 2004) have been developed to evaluate the qualities of reflection in which pre-service teachers and teachers engage. However, many of these frameworks, designed for qualitative research, do not necessarily differentiate non-RT from RT and are therefore not applicable to the present study. Mezirow's transformative learning theory offers a framework for distinguishing non-RT from RT and for exploring the qualities of reflection (Lundgren and Poell 2016). Alongside non-RT, Mezirow (1991) identifies three RT qualities: content, process, and premise reflection. Content reflection involves evaluating what is known, focusing on understanding aspects of the content of RT. Process reflection involves actively assessing one's actions and the influence of past experiences. Premise reflection, or critical reflection, is characterised by challenging and transforming previous beliefs and thinking patterns.

In the present study, we anchor our approach in Mezirow's theory (Mezirow 1991, 2009) and build on recent empirical studies by Lundgren and Poell (2016) as well as Zhang and Dempsey (2019), which provide a sufficient foundation for this research through their analytical approach to the qualities of RT. We approach reflection from a metacognitive perspective, emphasising that changes in meaning perspectives occur in pre-service teachers' thinking and that their perception of these changes may be explored. The empirical research design centres on pre-service teachers' perceptions of their RT and the perceived qualities of RT. For clarity, these perceptions are referred to simply as 'RT' throughout the present study.

Metacognitive awareness

Metacognition refers to an individual's thinking about their own cognitive processes (Flavell 1979), encompassing active engagement in controlling and monitoring these processes (Harrison and Vallin 2018; Tobias and Everson 2009). It offers a potential framework for explaining and studying learning from a perspective that highlights individual cognitive processes, and the monitoring and control of cognition (Dinsmore, Alexander, and Loughlin 2008). Metacognition can be seen as a crucial ability since it allows students to become independent thinkers who can regulate their own thinking processes (Balcikanli 2011). The term metacognitive awareness (MA) refers to an individual's conception of their own thinking processes and strategies (Schraw and Dennison 1994).

The present study relies on a three-component model of MA, in which self-evaluation is emphasised as one of the primary components, alongside knowledge of cognition and regulation of cognition (Kallio, Virta, and Kallio 2018). Knowledge of cognition refers to what we know about our cognition and is further divided into three kinds of knowledge: declarative (i.e. knowing what the contents of learning are), procedural (i.e. knowing how to process and use learning strategies), and conditional (i.e. knowing why and when to learn) (Schraw, Crippen, and Hartley 2006). Regulation of cognition refers to the active control and management of cognitive processes during learning activities, including planning, monitoring, and adjusting strategies (Schraw and Dennison 1994). These core components are closely intertwined (e.g. Brown 1987; Flavell 1979) and can act inter-dependently, often crossing the boundaries between them (Kallio 2020; see also Efklides 2006).

In the three-component model of MA, self-evaluation refers to the retrospective assessment of how learning outcomes align with intended goals and how the learning process unfolded (von Wright 1992). Although traditional models categorise self-evaluation as a subcomponent of the regulation of cognition (Schraw and Dennison 1994), more recent work suggests that self-evaluation functions as a distinct process, drawing on both knowledge and regulation without being fully reducible to either (Kallio, Virta, and Kallio 2018). Unlike planning or monitoring, which occur during the learning process, self-evaluation typically takes place afterwards. As such, it serves a functionally distinct role within MA, consolidating prior metacognitive activity into outcome-based judgements (Kallio 2020). This model of MA also closely parallels the structure of RT, enabling a meaningful comparative analysis of the two constructs.

Previous studies highlight the importance of fostering MA in teacher education programmes, as it enhances pre-service teachers' own learning and prepares them to teach MA effectively to their future students (e.g. Bedel 2012; Kallio et al. 2021; Matsumoto-Royo, Ramírez-Montoya, and Glasserman-Morales 2022; Vosniadou et al. 2021). Vosniadou and colleagues (2021) found that MA positively influences the academic performance of pre-service teachers, consistent with previous findings regarding college students (Young and Fry 2008). Moreover, empirical evidence suggests that MA develops during teacher education (Cakici 2018; Matsumoto-Royo, Ramírez-Montoya, and Glasserman-Morales 2022), and that in-service teachers with a master's degree provide greater support for their students' MA than those with a bachelor's degree (Kallio et al. 2021).

How are reflective thinking and metacognitive awareness intertwined?

Both metacognition and reflection are broadly regarded as forms of higher-order thinking in which individuals intentionally direct their attention to their own thought processes (Ritchhart and Perkins 2005; Silver 2013). Although reflection and metacognition are integral and integrated components of learning and problem-solving processes (McAlpine et al. 1999), research on their conceptual and empirical alignment is limited, stemming from distinct research traditions and theoretical perspectives (Risko, Roskos, and Vukelich 2005; Tarricone 2011).

The relationship between MA and RT has been studied at a general level in various contexts (Alian 2019; Desautel 2009; Ersözlü and Arslan 2009; Whittaker and van Garderen 2009). However, these studies focus on different aspects of the constructs, define

reflection in dissimilar ways, and propose varying directions for their relationship, leading to an inconclusive understanding of how MA and RT are related. Some studies suggest that improving learners' RT enhances their MA (Alian 2019; Alt and Raichel 2020; Desautel 2009; Ersözlü and Arslan 2009), while others propose the opposite, namely that increasing learners' MA leads to better RT (Adadan and Oner 2018; Whittaker and van Garderen 2009). These contrasting findings reflect broader theoretical claims about the reciprocal nature of the relationship: while RT can support the development of MA, a substantial degree of MA is also necessary to sustain more advanced levels of RT (Harvey, Coulson, and McMaugh 2016).

Although empirical research on the alignment of specific components of RT and MA is limited, theoretical perspectives suggest potential overlaps between the two. For instance, knowledge of cognition – defined as awareness of one's learning processes, strategies, and conditions for effective task performance (Magno 2010; Schraw, Crippen, and Hartley 2006) – resembles content reflection in RT, which involves considering what one thinks, feels, or does in response to a particular situation (Mezirow 1991). RT can serve as a mechanism for constructing metacognitive knowledge by making implicit cognitive processes explicit (Desautel 2009; Harvey, Coulson, and McMaugh 2016). Similarly, regulation of cognition, which involves planning, monitoring, and adjusting cognitive strategies (Balcikanli 2011; Schraw and Dennison 1994), aligns with process reflection, which entails examining how one engages in perceiving, thinking, or acting (Mezirow 1991). Regulation provides the foundation for process reflection, while reflection, in turn, informs and refines subsequent regulatory actions. Research has suggested that RT and regulation of cognition are particularly interconnected (Adadan and Oner 2018; Alt and Raichel 2020).

The relationship between self-evaluation and critical reflection is more nuanced but still important. Self-evaluation, understood here as a meta-level judgement process that informs and assesses both cognitive knowledge and strategy use (Kallio, Virta, and Kallio 2018), has parallels with critical reflection in RT, which seeks to examine underlying assumptions and meaning perspectives (Mezirow 1991). Although they are not interchangeable, self-evaluation could potentially facilitate the distancing necessary for learners to engage in critical questioning and to assess not only their performance, but also the broader purposes and outcomes of learning.

The present study adopts a general-level approach, focusing on individuals' perceptions of their thinking and veering away from the time-sensitive aspects of metacognitive or reflective processes during learning tasks. By acknowledging theoretical intersections (Risko, Roskos, and Vukelich 2005; Tarricone 2011), the study positions MA as a complementary concept that enhances the quantitative examination of RT, aligning with the integrative perspective proposed by Hiver and colleagues (2021). While MA has been extensively examined quantitatively in various educational settings (Magno 2010; Mäkipää, Kallio, and Hotulainen 2021; Tuononen et al. 2023; Young and Fry 2008), including those involving teachers (Kallio et al. 2021; Kallio, Virta, and Kallio 2018; Thienngam, Promlek, and Thongsaard 2020) and pre-service teachers (Bedel 2012; Matsumoto-Royo, Ramírez-Montoya, and Glasserman-Morales 2022; Vosniadou et al. 2021), quantitative studies focusing on RT remain limited. Furthermore, only a few previous studies (Kallio et al. 2021; Kallio, Virta, and Kallio 2018) have employed the three-component

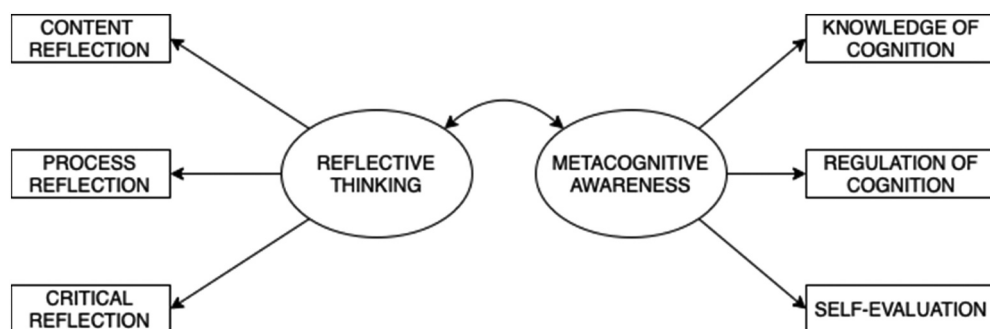


Figure 1. Hypothesised model of the components and relations between pre-service teachers' perceived reflective thinking and metacognitive awareness.

model of MA used in the present study. The unique role of self-evaluation as a key tool for evaluating both knowledge and regulation of MA (Kallio et al. 2021), combined with the suggestion that reflection serves as a crucial link between knowledge and control of learning processes (Ertmer and Newby 1996), presents a promising direction for research.

Aim of the study

The present study aims to develop effective means of exploring the relationship between RT and MA, and to facilitate comparison between teacher education programmes. Prior to testing the association between MA and RT, an in-depth examination of the measurement prerequisites is provided. Based on previous research on the RT and MA of pre-service teachers, the following hypotheses were tested:

H1: Pre-service teachers' RT consists of interconnected components (content reflection, process reflection and critical reflection) that are positively related to each other and distinct from non-RT, specifically habitual action, which is expected to show weak correlations with RT qualities (Lethbridge et al. 2013; Zhang and Dempsey 2019).

H2: The factorial invariance of the Reflective Thinking Questionnaire holds across pre-service early childhood education and primary school teachers, indicating that, regardless of the degree programme within teacher education, pre-service teachers have a similar perception of reflection (Allas, Leijen, and Toom 2020).

H3: RT and MA are positively correlated (Risko, Roskos, and Vukelich 2005; Tarricone 2011) (see Figure 1), suggesting a significant relationship between pre-service teachers' RT and their MA.

Materials and methods

Research context: Finnish teacher education

In Finland, teacher education is provided at the university level and is highly academic. The curriculum is research-based, with an emphasis on research, inquiry, and the analysis of teaching and learning. This approach is based on the idea of the teacher as a researcher of their own work, focusing in depth on students' behaviour, work and thinking (Toom et al. 2010). The teacher education programme consists of a three-year bachelor's degree followed by a two-year master's degree, which includes studies in disciplines, pedagogy, communication, and research, along with teaching practice periods.

Early childhood education teachers require a bachelor's degree to qualify, while primary and secondary school teachers require a master's degree in education. Secondary school teachers complete their degrees in their respective disciplines through different university departments. To qualify as teachers, they also undertake teachers' pedagogical studies (60 ECTS) at the faculty of education. Unlike other subjects, craft and home economics teacher education takes place entirely within the faculty of education, although they follow their own study tracks.

In all three degree programmes, reflection is consistently incorporated into the curricula as part of the learning objectives, course content, and learning activities. It is explicitly stated as a learning objective in four courses for subject and early childhood education pre-service teachers, and in three courses for primary school pre-service teachers, with two courses common to all programmes. The remaining courses are tailored to each major: subject-specific courses for subject pre-service teachers and subject didactics courses for early childhood education and primary school pre-service teachers.

Participants and data collection

A total of 247 first-year students enrolled in teacher education programmes at the University of Helsinki took part in the study in spring 2018. Data were collected using a paper-and-pencil survey administered by the researchers, who visited regular teacher education courses as external observers. Voluntary participation, informed consent, and anonymity were all ensured during the research process. Approval by the university's ethical board was not required, in accordance with Finland's institutional review board criteria (Finnish National Board of Research Integrity 2019). Participants were provided with detailed information about the study, emphasising its voluntary nature. The questionnaire, which took approximately 15 minutes to complete, was administered at the beginning of lessons and completed anonymously and individually.

All first-year pre-service teachers were invited to complete the questionnaire. The total response rate was 76.2%. Participants included early childhood education pre-service teachers ($n = 103$), primary school pre-service teachers ($n = 106$), and subject pre-service teachers from craft and home economics teacher education programmes ($n = 38$). Gender distribution (female $n = 214$, 87.3%, male $n = 31$, 12.6%) was consistent with the overall gender distribution among pre-service teachers. Ages ranged from 19 to 54 years ($M = 26.02$, $SD = 7.05$): almost half (44%) of the participants were aged 19–22, and 78% were under 30.

Measures

An adapted version of the *Reflective Thinking Questionnaire* (RTQ) by Kember et al. (2000), based on Mezirow's theory, was used to measure individuals' perceptions of their involvement in non-reflective and reflective thought processes, focusing on perceived qualities of RT. The RTQ was chosen because it effectively distinguishes non-reflective thinking from reflective thinking. Kember and colleagues (2000) simplified Mezirow's original framework by integrating content and process reflection into a broader category of reflection and using *understanding* as a measure of what Mezirow originally termed *thoughtful action*. Zhang and Dempsey (2019) argued for reverting to Mezirow's original categorisation, suggesting that *understanding* closely aligns with content reflection and requires further exploration in that context. They also proposed that reflection, as defined in Kember and colleagues' (2000) questionnaire, aligns with process reflection. This alignment with Mezirow's original model is adopted and explored in the present study. The RTQ has previously been used with pre-service teachers (Hao 2016; Kalk et al. 2014). Building on the work of Zhang and Dempsey (2019) and Lethbridge et al. (2013), this study treats RT as a higher-order construct with three subscales.

The RTQ consists of 16 items, measuring both non-RT and RT, categorised into *habitual action* (4 items), *content reflection* (4 items), *process reflection* (4 items), and *critical reflection* (4 items) (Zhang and Dempsey 2019). This categorisation aligns with Mezirow's (1991) framework, in which one component is related to non-RT and three components relate to RT. Non-RT is represented by habitual action, characterised by routine thinking and an emphasis on memorisation. The three components of RT are content reflection, process reflection, and critical reflection. In previous research, the RTQ has proved to be a reliable and valid instrument (Hao 2016; Kalk et al. 2014; Zhang and Dempsey 2019).

Content reflection involves directing one's thinking towards gaining a substantive understanding of the material being learned. In process reflection, the focus is on actively evaluating one's own actions, while also considering how past experiences influence current actions. Critical reflection entails challenging previous beliefs and thinking patterns. In contrast to the original RTQ, this study adjusted the Likert scale to a zero-to-positive format (1 = I don't agree, 2 = I slightly agree, 3 = I somewhat agree, 4 = I strongly agree, 5 = I completely agree). This was done to ensure that the response options were interpreted more consistently by eliminating the ambiguity often associated with bipolar (negative – positive) scales (L. Tay and Jebb 2018).

For this research, the original English version of the RTQ was translated into Finnish through a three-step process. First, two native Finnish-speaking researchers each produced their own version of every questionnaire item, which were then combined. A focus group discussion was also conducted. Finally, an experienced translator translated the Finnish version back into English to ensure conceptual consistency. Testing involved a pilot group ($n = 12$) of pre-service teachers who provided feedback, sharing their questions or comments either verbally or in writing. Since the original questionnaire items were targeted at a specific course, minor adjustments were made to some items in line with previous studies (Hao 2016). For example, the original item 'This course has challenged some of my firmly held ideas' was adjusted to 'My studies have challenged some of my firmly held ideas'.

The Metacognitive Awareness Inventory (MAI) by Schraw and Dennison (1994) was used to assess metacognitive knowledge, metacognitive regulation, and self-evaluation. The MAI was chosen because it is grounded in applied theory, allowing for the inclusion of the three components used in this study (Kallio, Virta, and Kallio 2018). The MAI originally consisted of 52 items and was developed to measure MA in adolescents and adults. In the present study, a condensed 18-item version (1 = I completely disagree, 5 = I completely agree) was used, as it has been validated using the translation and back-translation procedure (see Hambleton and Patsula 1998) and has been employed in the Finnish context with both in-service and pre-service teachers (Kallio et al. 2017, 2018; Tuononen et al. 2023). This condensed MAI-18 captures three main components: knowledge of cognition (nine items, e.g. 'I am aware of what strategies I use when I study'), regulation of cognition (six items, e.g. 'I set specific goals before I begin a task'), and self-evaluation (three items, e.g. 'I ask myself how well I accomplished my goals once I'm finished') (Kallio, Virta, and Kallio 2018).

Since 2019, the MAI-18 has been included in the HowULearn questionnaire (Parpala and Lindblom-Ylänne 2012), a survey comprising various research instruments measuring students' conceptions of their learning, as implemented through the UniHow system at a major research-oriented university in Finland (see University of Helsinki 2025). Accordingly, the MAI-18 has been successfully employed in large-scale, systematic inquiry within teacher education and in broader, multidisciplinary higher education contexts (Tuononen et al. 2023).

In the present study, we also considered measures specifically developed to study teachers' MA. One such measure was the Metacognitive Awareness Inventory for Teachers (Balcikanli 2011), which has been validated in Finnish and adapted to the Finnish teaching environment and culture (Kallio et al. 2017). Another option considered was the Teacher Metacognition Inventory (Jiang, Ma, and Gao 2016). However, as the participants in the present study were pre-service teachers and data collection did not occur during teaching practice, the teacher-specific items, which focused heavily on teaching situations, would not have been appropriate. These instruments were therefore deemed unsuitable, and the MAI-18 was selected as the most valid and relevant instrument for capturing MA in the present study.

Statistical analyses

Prior to the main analyses, the data were screened for outliers, missing values, and normality. Four largely incomplete questionnaires were deleted. There were only a few missing values (13) in the data (0.023% of all values), which were found to be random based on Little's MCAR test ($p > .05$).

The data were analysed in three steps according to the hypotheses: 1) model estimation/CFA; 2) measurement invariance/MGCFA; and 3) interrelations between constructs/SEM.

Step 1: Model estimation and model fit evaluation

Confirmatory factor analysis (CFA) was performed to measure and test the factor structure of the RTQ. All items with loadings below 0.32 were removed (Costello and Osborne 2005).

CFAs were performed in a multigroup format to ensure an acceptable fit prior to testing measurement invariance.

The goodness of fit of the estimated standardised model was evaluated using the χ^2 test, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), and the Standardised Root Mean Residual (SRMR). A non-significant χ^2 value, CFI and TLI values near 0.95, an RMSEA value below 0.06, and an SRMR value below 0.08 indicated a good fit with the data (Muthén and Muthén 1998–2017).

For invariance testing, Satorra-Bentler scaled χ^2 difference tests were performed to compare the fit of nested models (Satorra 2000). Differences in goodness-of-fit indices were also evaluated (Cheung and Rensvold 2002). Invariance is rejected if the χ^2 difference test p -value is less than 0.01. According to Chen (2007), if the p -value is less than 0.01, RMSEA should increase by at least 0.01, or CFI should decrease by at least 0.001. In addition, when testing factor loadings and intercepts, there should be a minimum increase of 0.025 in SRMR. Modification indices were used to identify inconsistencies in the measurement structures.

Step 2: Measurement invariance

A multigroup CFA (MGCFA) was used to determine whether the RTQ functions similarly in early childhood education and primary school pre-service teacher data by examining the factorial invariance of the measurement (Putnick and Bornstein 2016). Measurement invariance ensures that the measures forming a measurement model have the same meaning and are applied in the same way by different groups of respondents (Hair et al. 2019). The examination of invariance was limited to early childhood education and primary school pre-service teachers, excluding subject pre-service teachers ($n = 38$) due to sample size restrictions.

The three-step invariance testing process included evaluating configural invariance to assess the similarity of the general factor structure across the two pre-service teacher groups. Next, metric invariance examined whether factor loadings could be set as equal between groups. The final step, scalar invariance, involved constraining item intercepts to be equal while retaining the constraints from the previous step. Invariance testing may result in partial invariance when full measurement invariance is not supported. In such instances, it is recommended that more than half of the items in a latent factor should be invariant in order for the factor to be considered partially invariant, allowing the analysis to continue (Putnick and Bornstein 2016).

Step 3: SEM

To empirically investigate the theoretically proposed relationship, we established a hypothetical structural model incorporating the components of RT and MA. This model was then assessed using structural equation modeling (SEM). The subscale associated with habitual action, indicative of non-RT, was deliberately excluded from this model (see Figure 1). SEM was chosen as it can be used to estimate both the measurement models and the structural relations between latent variables simultaneously (Muthén and Muthén 1998–2017). The problem associated with different factor scoring methods can be avoided when the measurement model for the multiple-item scale is directly embedded into a larger model and all aspects of the model

are estimated simultaneously (Devlieger, Mayer, and Rosseel 2016). However, using a simultaneous approach in SEM can cause estimation difficulties when the sample size is small or when dealing with large models with many indicators (McNeish and Wolf 2020). Taking these complexities into account, we decided to include the measurement model only for the RTQ and to treat the subscales of the MAI-18 as manifest variables to limit the number of indicators. This approach allowed us to explore a second-order model to unravel the relationship between RT and MA.

Results

Pre-service teachers' perceptions of reflective thinking qualities: model estimation and descriptive statistics

To investigate whether the components of RT form a coherent entity in the context of teacher education (H1), we conducted a CFA to begin with. Model fit was first examined among all pre-service teachers in the sample. The CFA initially indicated a poor fit for the expected four-factor model (CFI = 0.90; TLI = 0.88). One item (RTQ32) was removed because it loaded on all factors, and another item (RTQ21) was removed due to its insufficient loading. Following these modifications, the model fit was acceptable χ^2 (71; $n = 247$) = 104.61, $p = 0.006$; CFI = 0.95, TLI = 0.94, RMSEA = 0.04 (90% C.I. = 0.02–0.06), SRMR = 0.058. The final CFA encompassed 14 items, and the means and standard deviations of the four factors are presented in the [Appendix](#). The final CFA model was then tested separately for early childhood education and primary school pre-service teachers to ensure an acceptable model fit. The subject pre-service teacher group was excluded from this comparison due to its small sample size.

As shown in [Table 1](#), while the model fit was acceptable for both groups, some minor variations emerged. The model fit was less acceptable for early childhood education pre-service teachers (CFI = 0.94, TLI = 0.92) compared to primary school pre-service teachers (CFI = 0.98, TLI = 0.97). The reason for this difference was explored further in the next step of the analysis. Overall, the analysis confirmed that the four-factor model and the 14 items of the RTQ were supported in both groups.

Internal consistency was estimated using Cronbach's (1951) reliability coefficients, where an alpha value exceeding .60 is considered acceptable (Hair et al. 2019). Internal consistency for all scales was found to be moderate to good, with alpha values ranging from $\alpha = .63$ to .77 (Habitual action $\alpha = .63$, Content reflection $\alpha = .63$, Process reflection $\alpha = .77$ and Critical

Table 1. Summary of goodness-of-fit statistics for CFAs and measurement invariance tests of the RTQ.

Model	χ^2	df	p	SC	RMSEA	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
CFA	104.61	71	.006	1.032	.044	.954	.941	.058	–	–	–
CFA PS	77.29	71	.284	1.003	.029	.980	.974	.065	–	–	–
CFA ECE	85.81	71	.111	0.991	.045	.943	.926	.076	–	–	–
M1	163.05	142	.109	0.997	.038	.963	.953	.071	–	–	–
M2	186.49	152	.029	1.003	.047	.939	.927	.086	22.50	10	.012
M2 ^a	175.45	151	.085	1.006	.039	.957	.948	.080	12.14	9	.205
M3 ^b	191.70	160	.044	1.005	.044	.944	.937	.085	16.34	9	.060

Note. M1 = configural invariance, M2 = metric invariance, M3 = scalar invariance. ^aFactor loading for item RTQ25 was freely estimated, PS > ESE. ^bItem RTQ25 intercept (PS > ESE, Diff = .22, SE = .08, $p < .001$). PS = Primary school pre-service teacher, ECE = Early childhood education pre-service teacher.

Table 2. Means, standard deviations, and correlations between all factors.

Variable	1	2	3	4	5	6	7
Reflective thinking							
1. Habitual action	–						
2. Content	–.32**	–					
3. Process	–.05	.47**	–				
4. Critical	.10	.23**	.40**	–			
Metacognitive awareness							
5. Knowledge of cognition	.13*	.25**	.29**	.14*	–		
6. Regulation of cognition	–.00	.47**	.61**	.33**	.42**	–	
7. Self-evaluation	–.09	.39**	.64**	.26**	.34**	.66**	–
M	2.73	3.73	2.95	3.09	3.58	3.24	2.83
SD	.70	.63	.82	.71	.45	.57	.75
α	.63	.63	.77	.69	.75	.68	.81

**Correlation is significant at the 0.01 level. *Correlation is significant at the 0.05 level.

reflection $\alpha = .69$). Pearson correlations between the sum scales of the four factors are presented in Table 2. The results indicated that the subscales correlated as expected. Habitual action differed from the other subscales and demonstrated a negative, statistically significant correlation ($r = -.32$) with content reflection. Correlations of content reflection with process reflection ($r = .47$), content reflection with critical reflection ($r = .23$), and process reflection with critical reflection ($r = .40$) were all statistically significant. These results indicate that critical reflection differs, as expected, from the other reflection subscales.

The outcome of the CFA supported the original theoretical structure of the RTQ in the context of teacher education, even though there were minor differences in model fit between primary school pre-service teachers and early childhood education pre-service teachers. Moreover, acceptable alpha scores indicated that the RTQ is internally consistent, and the observed correlations between factors were in line with expectations. These findings supported the hypothesis (H1), demonstrating that pre-service teachers' perceived RT comprises three interconnected components, which were distinct from habitual action.

Establishing measurement invariance for the RTQ

In the second part of our data analysis, we applied MGCFA to two different groups of pre-service teachers to investigate measurement invariance across early childhood education pre-service teachers and primary school pre-service teachers. As in the previous analysis, the subject pre-service teacher group was excluded due to its small sample size. Changes in the chi-square test, RMSEA, CFI, TLI, and SRMR were examined among models with increasingly restrictive equality constraints. The first step in the multi-group invariance (configural) analysis (see Table 1) supported accepting the factorial structure as equivalent among groups. The fit of the configural model was similar to that of the baseline model, with adequate RMSEA and CFI values (see Table 1). Next, by constraining all loadings to be equal across groups, we tested item-level metric invariance to evaluate whether the relationship between each item and its underlying construct should be considered equal in both groups. Table 1 shows that metric invariance held partially (when comparing M1 and M2). After releasing the equality constraints on item RTQ25, belonging to the process reflection factor, the M2^a model fitted the data well.

Subsequent examination of the equality of intercepts revealed that partial scalar invariance could be established. Specifically, intercepts could be set equal between groups (when comparing M2^a vs. M3), except for item RTQ25. In this item, pre-service teachers were asked to rate whether they *enjoyed* the process of thinking, a potentially ambiguous item compared with other items within the process reflection factor, which mainly centred on practical actions.

In summary, the differences observed in the CFA were scrutinised using multigroup invariance analysis, which revealed that the difference was specifically related to the process reflection factor, and more precisely to item RTQ25. The results of these analyses supported partial metric and scalar invariance in the RTQ's ability to capture pre-service teachers' perceived RT, thereby supporting our hypothesis (H2). Consequently, the RTQ is suitable for comparing mean levels of perceived RT between early childhood education and primary school pre-service teachers. However, caution should be exercised when interpreting the mean comparison in relation to the process reflection factor.

Interrelation between pre-service teachers' reflective thinking and metacognitive awareness

This study analysed the relationships between RT and MA. The descriptive statistics (means and standard deviations) and correlations for the first-order latent factors of MA and RT are presented in Table 2.

Moderate correlations among the components within RT ($r^{(\text{min-max})} = .23-.47$) and within MA ($r^{(\text{min-max})} = .43-.66$) factor structures support the conclusion that the partly distinct but related RT and MA components can be accounted for by second-order factor constructs. In terms of MA, the correlation analysis revealed that habitual action demonstrated a low correlation ($r = .13$) with knowledge of cognition, and no significant correlations with regulation of cognition or self-evaluation. This finding underscores the distinction between habitual action and RT, reinforcing the decision to exclude this scale from the hypothesised SEM model.

The structural model was evaluated to examine the interrelation between RT and MA. Since the overall number of observed variables would have been too high to include in the SEM model, the scores on the subscales of the MAI-18 were used as indicators of MA. Contrary to the hypothesised model, the measurement model for the RTQ was retained in the SEM analyses. This decision aligns with the focus of the present study, namely pre-service teachers' RT. Figure 2 presents the results of the SEM, indicating a good model fit to the data: $\chi^2(61, N = 247) = 77.86, p = 0.072$; RMSEA = 0.03, (90% C.I. = 0.00–0.05); CFI/TLI = 0.98/0.97; SRMR = 0.05.

The results indicated that pre-service teachers' RT and MA are interrelated. The tested model confirmed that all components of MA correlated positively with RT. The statistically significant factor loadings in the model (see Figure 2) provided further support for hypothesis H1. In line with H1, RT comprises three components: Content reflection (3 items, $\alpha = .63$), Process reflection (3 items, $\alpha = .77$), and Critical reflection (4 items, $\alpha = .69$). Additionally, MA comprises three components: Knowledge of cognition (9 items, $\alpha = .75$), Regulation of cognition (6 items, $\alpha = .68$), and Self-evaluation (3 items, $\alpha = .81$). The model (Figure 2) supported H3, indicating a strong correlation ($r = .90$) between perceived RT and perceived MA.

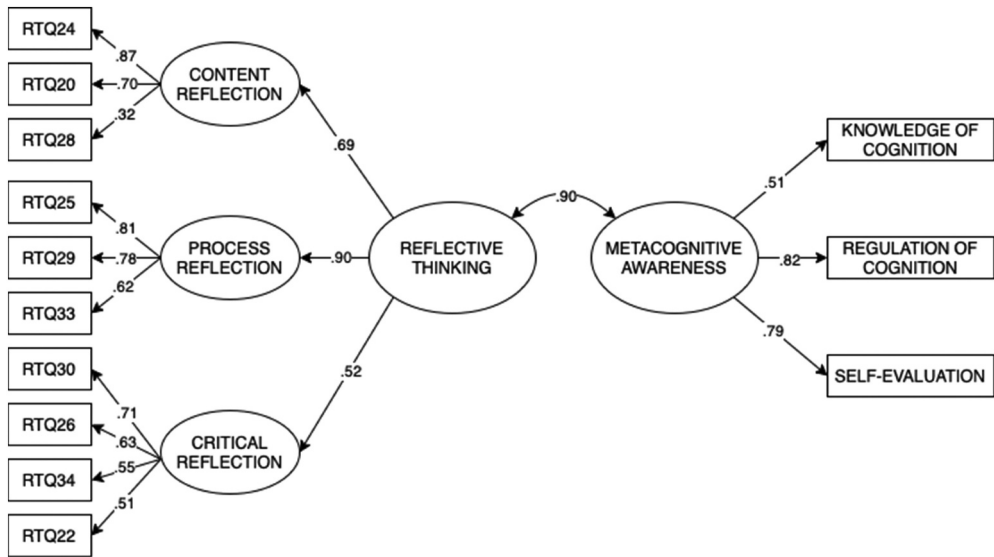


Figure 2. Components and interrelation between pre-service teachers' perceived reflective thinking and metacognitive awareness. Standardised model: χ^2 (61, $N = 247$) = 77.86, $p = 0.072$; RMSEA = 0.03 (90% C.I. = 0.00–0.05); CFI/TLI = 0.98/0.97; SRMR = 0.05.

Discussion

Methodological reflections

In terms of strengths, the study achieved a high response rate, involving over 70% of first-year pre-service teachers at a specific time point. It relied on well-established instruments validated in previous research, specifically those examining RT qualities (Kember et al. 2000) and MA components (Kallio, Virta, and Kallio 2018; Schraw and Dennison 1994). This approach provided valuable insights into the validity and applicability of these instruments. In addition, the study expanded its scope by investigating the applicability of the RTQ through an examination of invariance between two distinct groups of pre-service teachers: those in early childhood education and those in primary school degree programmes. While this analysis strengthens the methodological rigour of the study, one limitation is that the third group – students in subject-specific teacher education programmes in craft and home economics – was excluded from the analysis due to its small sample size.

Concerning limitations, the close association between metacognition and reflection with cognition poses challenges in accessibility and observation (L. Y. Tay et al. 2023). Tobias and Everson (2009) note that the method of observation influences the definition of metacognition. The present study employed a self-report inventory, treating the constructs as being composed of measurable components. While self-report questionnaires have been shown to be a reliable method for assessing the components of MA (Schraw and Dennison 1994), it is crucial to establish the objectives of such measurements. The present study employed questionnaires to examine individuals' perceptions of their own thought processes, emphasising a focus on individuals' own perceptions rather than on time-sensitive processes. However, operationalising a multifaceted mental process as a measurable construct inherently limits its complexity.

Moreover, this study focused on the metacognitive aspects of RT, excluding social and contextual elements beyond its scope. We acknowledge the possibility of social desirability bias in our sample, whereby participants might hesitate to report deficiencies in RT given the central role of reflection in teacher education. Furthermore, as this study forms part of a longitudinal research project, participants were in the early stages of their studies, so the influence of their specific teacher education programmes may not yet have been fully apparent. In addition, it remains unclear to what extent the admissions process and criteria shape initial differences among students, potentially leading to variation in their RT.

Results in the light of previous literature

With respect to the first hypothesis, the data support the assumption that pre-service teachers' perceived RT encompasses three interconnected components: content reflection, process reflection, and critical reflection. These components are interrelated and demonstrate positive relationships with one another. Furthermore, our study highlights that RT is distinct from non-RT, namely in the form of habitual action, while process, content and critical reflection are interconnected. The initial poor fit of the first CFA might be attributed to translation issues, which were subsequently resolved by removing two items, resulting in a well-fitting four-factor model.

Our results support the original RTQ's ability to differentiate between RT and non-RT (Kember et al. 2000; Lethbridge et al. 2013). However, our study aimed to explore the factor model proposed by Zhang and Dempsey (2019), which categorises RT into process, content and critical reflection, aligning with Mezirow's initial theory. Our findings confirm this factor model, supporting the structure proposed by Zhang and Dempsey (2019) and underscoring its applicability in our study context. Our research findings also corroborate previous research demonstrating the utility of the RTQ in various educational contexts (Kember et al. 2000; Lethbridge et al. 2013). Specifically, in the realm of teacher education, our findings align with the work of Kalk and colleagues (2014), who validated the RTQ within the Estonian teacher education context using a two-factor model encompassing the reflection and critical reflection components. In extending these earlier findings, the present study establishes the presence of a model featuring three interconnected components of RT within the context of teacher education.

Moving on to the second hypothesis, the model fit for the data on early childhood education pre-service teachers was slightly less acceptable than that for primary school pre-service teachers. However, invariance analysis indicated that this difference was attributable to one factor and one item. The RTQ achieved partial metric and scalar invariance across pre-service teacher groups after releasing constraints on one item from the process reflection subscale. It is possible that item RTQ25, which states 'I like to think over what I have been doing and consider alternative ways of doing it', deviates from the other two items in the sense that it centres more on a preference for doing something compared to actual involvement in activities, as in the other two items. While partial scalar invariance was achieved, allowing for mean comparisons, further development of the process reflection subscale within the RTQ is necessary to better capture the essence of process reflection.

In summary, the results of the partial metric and scalar invariance suggest that the four factors of the RTQ were comparable in capturing individual variation in perceived RT. This enables comparisons of the latent construct of perceived RT across early childhood education and primary school pre-service teachers. Moreover, the partial scalar invariance result suggests that factor means can be compared in future studies, albeit with some caution regarding the process reflection component. This, in turn, will allow future examination of the relationships between background factors and their effects on perceived RT across early childhood education and primary school pre-service teachers.

Regarding the third hypothesis, the results of our SEM model indicated a high level of interconnection between RT and MA, consistent with Tarricone's (2011) perspective. The strong correlation ($r = .90$) observed in our model suggests that individuals who score high in MA also tend to score high in RT. This empirical observation reinforces the strong theoretical connection between MA and RT. This finding contributes to our understanding of the relationship between RT and MA among pre-service teachers. However, when considering the overlap between RT and MA, it is critical to differentiate between the similarity of the phenomena and the similarity of the operationalised measures. Mere overlap in measurements does not necessarily equate to an accurate representation of the underlying phenomena. Thus, to study this further from a methodological viewpoint, the nomological validity of these measures could be explored.

Our findings indicate stronger connections between RT and the regulation of the cognition component within MA, consistent with previous studies (Adadan and Oner 2018; Alt and Raichel 2020). In our research, we used a modified version of the MAI introduced by Kallio, Virta, and Kallio (2018), which classifies MA into three distinct components. The strongest associations were observed between process reflection and both the regulation of cognition and the self-evaluation components. This supports the three-component model of MA and encourages further exploration of these relationships in the context of teacher education. The extent to which the individual components of these constructs are interrelated remains a topic for future research.

Conclusions and implications

This study highlights several key findings. Firstly, the RTQ demonstrates its validity and reliability in assessing pre-service teachers' RT qualities. Secondly, the measurement of RT qualities using the RTQ remains sufficiently consistent across both early childhood education and primary school pre-service teachers. Thirdly, a strong correlation was observed between RT and MA. The findings provide a solid basis for conducting longitudinal research to examine the development of RT throughout teacher education programmes, including the effects of practical training periods on observed changes in RT.

To use the RTQ effectively in evaluating teacher education, future research should aim to align it more closely with teacher education in general, and with the Finnish teacher education context in particular. Longitudinal studies could provide further insights into the development of RT among pre-service teachers as they progress through their training, potentially informing curriculum design and educational practice, and ultimately enhancing the quality of teacher education. Individual differences could be explored by examining the reflective thinking profiles of pre-service teachers using a person-oriented

approach, supported by more balanced representation from various teacher education programmes. Building on the present findings, RT can be examined across teacher education programmes, supporting the collection of comparable data. This approach would not only facilitate the evaluation and development of teacher education programmes but also enhance their capacity to support the growth of RT among pre-service teachers.

This study provides valuable insights into pre-service teachers' RT and its association with MA. Future studies should investigate the connections between components of RT and MA in greater detail, potentially contributing to an even more precise understanding of how these components interact. The findings emphasise the significance of these skills in teacher education, highlighting the need for continued improvement in measurement tools and pedagogical approaches. The study also points to the need for further exploration of the multifaceted relationship between RT, MA, and effective teaching practices. It forms the basis for a broader research programme aimed at examining certain aspects of higher-order thinking to assess the effectiveness of teacher education in enhancing RT among pre-service teachers.

The importance of examining higher-order thinking and perceptions of RT among pre-service teachers cannot be overstated. Understanding learning characteristics, along with metacognitive and reflective capacities, will empower teacher education programmes to effectively foster their growth. The results of this study can support teacher educators in understanding the characteristics of reflection and in developing pedagogies that enable conscious elaboration of these characteristics with pre-service teachers in various teacher education contexts, both in theoretical courses and in teaching practice. This, in turn, will provide a basis for pre-service teachers not only to become experts in their own learning and thinking processes, but also to serve as role models for RT in their future students.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT (o4-mini) to improve the clarity and readability of the text. Following its use, the authors reviewed and edited the content as necessary, taking full responsibility for the final version of the publication.

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Appendix. Factor loadings, factor means, standard deviations, and Cronbach's alphas based on the final CFA

Items	CFA factor loadings			
	F1	F2	F3	F4
<i>Habitual action</i> ($\alpha = .63$)				
RTQ19 When I am working on some activities, I can do them without thinking about what I am doing.	.637			
RTQ31 If I follow what the lecturer says, I do not have to think too much on this course.	.614			
RTQ27 To pass the courses, it is enough that I memorise the most important contents.	.529			
RTQ23 In my studies, I do things so many times that I started doing them without thinking.	.423			
<i>Content reflection</i> ($\alpha = .63$)				
RTQ24 To pass the courses you need to understand the content.		.817		
RTQ20 It is required in my studies to understand concepts taught by the lecturer		.733		
RTQ28, I need to understand the material taught by teacher in order to perform practical tasks		.328		
<i>Process reflection</i> ($\alpha = .77$)				
RTQ25, I like to think over what I have been doing and consider alternative ways of doing it.			.811	
RTQ29 I often reflect on my actions to see whether I could have improved on what I did.			.790	
RTQ33 I often re-appraise my experience so I can learn from it and improve for my next performance.			.600	
<i>Critical reflection</i> ($\alpha = .69$)				
RTQ30 As a result of my studies, I have changed my normal way of doing things.				.684
RTQ26 My studies have challenged some of my firmly held ideas.				.648
RTQ34 During my studies, I discovered faults in what I had previously believed to be right.				.571
RTQ22 As a result of my studies, I have changed the way I look at myself.				.496
Mean	2.73	3.73	2.95	3.09
SD	0.70	0.63	0.82	0.71

Note. For better readability, factor loadings less than .32 are not listed.