frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 19 May 2025
DOI 10.3389/feduc.2025.1555073

OPEN ACCESS

EDITED BY
Brandy Walker,
University of Georgia, United States

REVIEWED BY
Susan Ramlo,
University of Akron, United States
Tonia Dousay,
University of Alaska Anchorage, United States

*CORRESPONDENCE
Ines Kling
✉ kling@ibw.uni-heidelberg.de

RECEIVED 03 January 2025
ACCEPTED 28 April 2025
PUBLISHED 19 May 2025

CITATION
Kling I and Buhl M (2025) Applying Q methodology in higher teacher education for pre-service teachers' (self-)reflection, learning and professional development. *Front. Educ.* 10:1555073. doi: 10.3389/feduc.2025.1555073

Applying Q methodology in higher teacher education for pre-service teachers' (self-)reflection, learning and professional development

Ines Kling* and Monika Buhl

Institute of Educational Sciences, Heidelberg University, Heidelberg, Germany

Reflection is as a key element in the professional development of pre-service teachers and one of the most important goals of teacher education. However, traditional reflection methods often lack the structure and effectiveness needed to foster meaningful and deep reflection. This paper highlights the need for innovative reflective approaches by investigating whether and how Q methodology can be applied to prompt pre-service teachers' (self-)reflection in a university classroom setting. The reflection design developed combines Q-sorting with different (self-)reflective stimuli, like reviewing analysis of these sorts—based on Q-method results—and is applied in a graduate course at a university in southern Germany. The pre-service teachers engage in several occasions for self-reflection through exploration, while simultaneously receiving feedback from peers and the researcher. The paper takes the reader through the four phases of the reflection design and its findings, enabling them to envision using Q in higher teacher education for pre-service teachers' (self-)reflection, learning and professional development. The findings show that Q is invaluable for application in a university setting with pre-service teachers: Not only are they participants, but they also use Q-sorting and its results to learn about their own teacher beliefs and attitudes, which manifest themselves through reflection and reinforces the student' professional development. The paper also underlines the value of Q in facilitating the teachers' continuous professionalization and engagement with topics relevant to teaching, as well as encouraging self-reflection in the teacher role.

KEYWORDS

Q methodology, pre-service teachers, (self-)reflection, professional development, higher teacher education

1 Introduction

Professional development of pre-service teachers begins with their experiences as learners in school and previous life experiences before they enter university. Studies (Hudson et al., 2010; Chang-Kredl and Kingsley, 2014) have shown that the beliefs gained within these contexts form their concepts of the teaching profession and their understanding of what good teaching and what an effective teacher (Ivanova and Skara-Mincāne, 2016; Körkkö et al., 2016). These beliefs, as well as both the beliefs developed

in teacher education at university and in practical phases in school, contribute to the professional development of pre-service teachers (McKenzie et al., 2005; Levin and He, 2008; Körkkö et al., 2016). They are considered action-guiding and are formed individually not just through experiences but also through social processes like confrontations, through irritation as well as through discourse and reflection (Taibi, 2013). The aspect of reflecting on one's own learning and teaching experiences is considered to be particularly effective and a prerequisite for the formation, conscious examination, development and change of one's own often implicit beliefs (Park and Ertmer, 2007; Swan, 2007; Taibi, 2013; Reusser and Pauli, 2014; Sööt and Viskus, 2015; Fives and Buehl, 2017; Lunn Brownlee et al., 2017). Besides, reflection is also "crucial for learning new educational theories and concepts as well as developing teaching practice based on them" (Ketonen and Nieminen, 2023, p. 1). Reflection can thus be seen as a key element in the professional development of pre-service teachers, for it is also a skill that can be trained (Zeichner and Liston, 1987; Körkkö et al., 2016). Professional development, in turn, is considered one of the most important goals of teacher education (Depaepe and König, 2018). Therefore, professional development in teacher education is one of the main reasons why reflection is internationally considered a goal for teacher education programs (Dewey, 1933; van Manen, 1977; Schön, 1983, 1987; Zeichner and Liston, 1996; Abou Baker El-Dib, 2007; Collin and Karsenti, 2011; Körkkö et al., 2016; Korthagen, 2017).

Given the research gap on reflection in university teacher education as means of fostering the professional development of pre-service teachers, this paper aims to investigate whether and how Q methodology (henceforth Q) can be applied in a university classroom setting to prompt pre-service teachers' (self-)reflection. It sheds light on reflection in teacher education, the limitations of traditional reflection methods, and the effectiveness of the Q sort as a structured tool to foster deep reflection in pre-service teachers. The theoretical background and literature review, the reflection design incorporating Q methodology, as well as its findings demonstrate the general need for innovative (self-)reflective approaches such as Q in teacher education, following a teaching-led research approach with integrated research-led teaching elements. The following section discusses theoretical foundations and a literature review on (the role) of reflection in teacher education.

2 Theoretical foundations and literature review

2.1 Reflection in teacher education

While most discussions on professional development contain some reference to the central role that reflection plays in teachers' learning lifes (Day, 1993), there exist varying definitions of the term reflection (Clarà, 2015; see, e.g., Aeppli and Lötscher, 2016; Steinmann, 2022). Besides the common ground that reflection is a special form of thought (McNamara, 1990; Sparks-Langer and Colto, 1991), there is rather a lack of clarity regarding the definition of reflection. This is surprising considering the vast majority of approaches (van Manen, 1977; Calderhead, 1989; Valli, 1990; Korthagen and Kessels, 2001; Zeichner, 2010) that are based on the same theoretical sources, mainly Dewey (1910, 1933) and Schön (1983, 1987), which are very well defined. According to Dewey "[r]eflection commences when one inquiries into his or her own experiences and relevant knowledge to find meaning in his or her own beliefs" (1933). Schön emphasized the relationship between reflection and experience even further, distinguishing between "reflection-in-action" and "reflection-on-action". While Schön's "reflection-in-action" (1983, 1987) involves simultaneous reflecting and doing (during teaching), reflection-on-action happens retrospectively after teaching. Many theorists have expanded concepts of reflection upon Dewey's and Schön's thoughts and put forward different theoretical frameworks and various action- or theory-bound approaches to reflection (van Manen, 1977; Calderhead, 1989; Valli, 1990; Mezirow, 1991; McLaughlin, 1999; Korthagen and Kessels, 2001; Zeichner, 2010; Korthagen, 2017; Ketonen and Nieminen, 2023). Action-bound theorizations about reflection and teacher learning, which relate to the exploration of experiences in an active and purposeful way, are most common in the context of teacher education. Like Schön's (1983) guiding principle of the "reflective practitioner", they focus on practical phases or pre-service teacher education (Clarke, 1995; Ivanova and Skara-Mincāne, 2016; Svojanovsky, 2017; Artmann et al., 2018; Jennek et al., 2022; Ketonen and Nieminen, 2023). Undoubtedly, teaching practice is a crucial and controversial element in teacher education. Many pre-service teachers are confronted with the classroom realities and responsibilities of a teacher for the first time. It provides authentic observation and teaching experience and gives them opportunities to practically implement their theoretical knowledge from initial teacher training in real-life situations (Patry, 2014; Ivanova and Skara-Mincāne, 2016). A change of perspective from the student to the teacher role is encouraged.

2.2 Role of reflection in teacher education

In the last decades, teacher education has been in a transitional state "from a training model that emphasizes the acquisition of skills and mastering of competencies to a practice-based model that emphasizes participation, engagement, and reflection" (Hoffman et al., 2015, p. 100). Given the international tendency to extend practical phases in teacher education, the term "practical turn" has been established in academic discourse (Mattsson et al., 2011; Fraefel, 2016; Fischer, 2021). Nevertheless, opposing views exist on this expansion due to the lack of evidence on their effectiveness and on the role of reflection in the professional development of pre-service teachers (cf. Hascher, 2011; Helsper et al., 2001; Patry, 2014; Terhart, 2013; Weyland, 2014). Svojanovsky (2017), for example, points out that teaching experience gained in practical phases does not necessarily transform into "insightful and valuable learning" (ibid., p. 338). Similarly, Leonhard and Rihm (2011) argue that the willingness to reflect cannot be taken for granted but needs contexts, in which reflection can be experienced as subjectively meaningful and helpful. Taibi (2013) and Patry (2014) also emphasize the importance of incorporating academic

theories and knowledge from initial teacher training into pre-service teachers' reflections to foster professional development. Thus, theory-bound approaches to reflection emphasize its context- as well as its content-specificness (Lee, 2005; Korthagen, 2017). Besides, professional development also highly depends on self-reflection, including the understanding of the internal factors that shape both one's own motives and behaviors as well as preferred thought patterns in pedagogical interactions and conflicts. Moreover, scholars (Schön, 1983; Valli, 1992; Zeichner and Liston, 1996; Palmer, 1998; Gay, 2000; Danielewicz, 2001; Ladson-Billings, 2001) emphasize that (student) teachers knowing themselves, understanding their teaching-contexts and challenging their knowledge and assumptions is as important as mastering techniques for effective teaching. Therefore, in teacher education, both "the disruption and rebuilding of one's beliefs about education" (Ketonen and Nieminen, 2023, p. 2) through reflection that reconstructs knowledge and conceptions from initial teacher training (theory-bound approach) as well as the systematic reflection of teaching practice experiences (action-bound approach) is required in order to develop an integral reflective stance (Altet et al., 2013; Ketonen and Nieminen, 2023).

3 Q methodology

Q comprises methodology, method and data collection technique all at the same time. It aims to determine the extent of participants' diverging and converging beliefs, opinions, points of view, or feelings on a given topic. Q can uncover even marginalized opinions that might be ignored or even missed by traditional survey methods (Brown, 2006; Ramlo et al., 2008; Brewer-Deluce et al., 2019; Yang and Xu, 2021). It is used to systematically uncover and study subjectivity within a group of people in order to gain insight into their motivations and behavior by integrating both qualitative and quantitative procedures in data generation, analysis and interpretation (Brown, 1993; Stenner and Stainton Rogers, 2004). The mixed-methods approach aims to uncover differences and similarities in subjective constructs identified through individual rating: Participants rank-order a set of statements (Q sample) on a continuum within a forced distribution grid (Q sort). Data are then reduced to groups of respondents with shared viewpoints through the intercorrelation of the individuals' overall self-referential response behavior. The correlation is followed by a factor analysis and the decision on the number of factors to extract and how to rotate these factors (cf. Brouwer, 1999; Brown, 1993; Ramlo, 2021; Smith, 2001; Stephenson, 1935; Watts and Stenner, 2005). Finally, the factors are (holistically) interpreted *a posteriori* in terms of types of persons instead of searching *a priori* for patterns among participants (cf. Brown, 1976). The whole procedure relies on the qualitative data collected by the researcher, such as the post-sorting surveys in our case. This unique approach to research behavior from the internal perspective of the participants is distinct to R methodology's examination of behavior from the external perspective of a researcher. R measures with researcher-defined meanings and groups variables based on shared characteristics, whereas Q analyzes an individual's entire Q sort (all statements in relation to each other), focusing on the object of research and therefore on substantive generalizability (about the population) and not on the statistical generalizability (to the population) (Brown, 1980, 1993, 1996; Rieber, 2020).

Q has been applied in various disciplines such as economics (e.g., Barry and Proops, 1999), public healthcare (e.g., van Exel et al., 2015) and marketing (e.g., Mokrý and Dufek, 2014). In educational research, it is still considered underrepresented although it has received increasing attention in the recent years (Barnes et al., 2015; Conrad et al., 2019; Hopkins, 2010; Irie et al., 2018; Lundberg et al., 2020; Pruslow and Owl, 2012; Ramlo, 2012; Rieber, 2020; Rodl et al., 2020). Q's study of subjectivity is a vital research approach for educational topics, since it adheres to the fact that "human actions depend on what humans think they are doing" (Eisenhart and DeHaan, 2005, p. 5). Here, subjectivity is not meant to be in "opposition to presumed scientific objectivity" (Lundberg et al., 2020, p. 2) but rather in accordance with individual self-referential ideas (Stephenson, 1953).

In the study at hand, Q methodology provides the research method, accompanied by reflective writing at the end of the sorting activity. Card sorting in general "aims to illuminate how participants understand and organize concepts" (Conrad et al., 2019, p. 525) and is used to explore participants' subjective beliefs, attitudes, values and perceptions. It prompts participants "to prioritize among competing values, and provides participants with an opportunity for reflection and learning" (ibid., p. 526). Researchers have studied a range of different card sorting activities in terms of their use as research method and its value in educational settings (e.g., Boyle and Jackson, 2009; Conrad et al., 2019; Fincher and Tenenberg, 2005; Hopkins, 2010; Lundberg et al., 2020; Wolf, 2022). For the researcher, the main difficulty that comes with card sorting activities is to analyze its data (cf. Fincher and Tenenberg, 2005). Q-method provides a way to address this difficulty while maintaining all the advantages of card sorting activities (Woods, 2011; Pruslow and Owl, 2012; Ramlo, 2012; Barnes et al., 2015).

3.1 Research method for reflection

In this paper, the understanding of reflection is based on Mezirow's (1991) theory-bound conceptualization of reflection originating in his transformative learning theory. The intention is not to ignore the value of action-bound reflection but to focus on the more fitting approach for the study's university classroom setting. According to Mezirow, reflection is a tool for questioning one's own reasoning. It aims at emancipation and a change in perspective while focusing on the social dimension of transformative learning. Interacting with others is important "to identify alternative perspectives", to analyze one's own interpretation of a situation from different perspectives, "to identify one's dilemma as a shared and negotiable experience [.] and to provide models for functioning within the new perspective" (Mezirow and Associates, 1990). The university classroom context offers pre-service teachers a pressure-free environment in which they can think about and reflect on their own beliefs and their origins in order to realize the influence they have on their own thinking and (idealized) behavior as a teacher (Mezirow, 1991; Pruslow and Owl, 2012; Körkkö et al., 2016; Ketonen and Nieminen, 2023). The examination of their own experiences is not neglected but rather used as a frame of reference for reflection.

To promote (self-)reflection intentionally, numerous strategies such as peer coaching, feedback conversation with teachers, video recordings, reflective journal writing/podcasting, portfolios and card sorting have been described in the literature (e.g., Hatton and Smith, 1995; Ketonen and Nieminen, 2023; Pruslow and Owl, 2012; Richert, 1990; Sööt and Viskus, 2015; Svojanovsky, 2017; Zeichner and Liston, 1987). A comparison of traditional reflection methods with innovative card sorting activities, such as Q-sorting, reveals notable limitations in traditional methods. Reflective journal writing and portfolios depend heavily on the individual's ability to critically analyze and organize thoughts and also rely on subjective interpretation. These methods lack the structured and comparative framework inherent in Q (Watts and Stenner, 2012). Furthermore, peer coaching, feedback conversations, and select card sorting activities require explicit guidance to be effective in fostering deeper critical analysis and meaningful reflection (Zeichner and Liston, 1987; Richert, 1990). Reliance on external facilitation can introduce social or interpersonal biases, such as influence due to power dynamics or conformity. In contrast, Q offers a self-contained framework that can guide participants through reflection with minimal external input, thereby minimizing biases by structuring reflection as an individual and standardized process (Svojanovsky, 2017). Strategies such as feedback conversations and peer coaching are dialogue-driven and individualized, and therefore typically generate qualitative insights that are difficult to recognize and compare across individuals systematically (Zeichner and Liston, 1987; Richert, 1990). Q, in turn, allows for direct comparison of beliefs, values, attitudes, and perceptions by quantifying subjective viewpoints (Stephenson, 1953; Brown, 1980). Some methods like video and portfolio creation comprise time-intensive activities such as recording, reviewing, and analyzing, which may result in surface-level engagement without fostering deeper critical thinking (Hatton and Smith, 1995; Sööt and Viskus, 2015). Q-sorting is also more time-intensive than, for example, Likert-scale surveys, which are typically completed by respondents in a hurry and without much reflection, simply marking each item with a score (Serfass and Sherman, 2013). Yet, Q-sorting "is usually found to be engaging for participants and thus can generate more authentic results" (Yang and Xu, 2021, p. 119). The technique overcomes many traditional limitations by combining qualitative reflection with quantitative rigor, whereby it has the potential to facilitate a structured approach to classroom discussion and (self-)reflection (Fincher and Tenenberg, 2005; Boyle and Jackson, 2009; Owens and Duncan, 2009; Duncan and Owens, 2011; de Leeuw et al., 2019).

3.2 Q in higher education research and teacher education

Two educational research domains in which Q studies are conducted are higher education research and teacher education: In higher education research (Ramlo, 2012), study foci include beginner student expectations (Balloo, 2018), students' approaches to studying (Godor, 2016), successful learning environments in the light of rapid digitalization (due to COVID-19) (Lundberg and Stigmar, 2023), identification of models of consensus views among students (Ramlo, 2008) and evaluation (Brewer-Deluce et al., 2019; Collins and Angelova, 2015; de Leeuw et al., 2019; Jurczyk and Ramlo, 2004; Ramlo, 2015b, 2015a, 2017; Ramlo et al., 2008; Yang and Xu, 2021). Ramlo (2012) points out that a Q sort can be a versatile tool for multiple purposes in higher education when the viewpoints of students are important. Looking into the domain of teacher education, there is a small number of studies using Q methodology to explore the points of view of pre-service teachers: Berry et al. (2012) assess prospective student teachers' concerns regarding the student-teaching experience. Yang and Montgomery (2013) research attitudes of pre-service teachers (and teacher educators) toward student diversity. Demir (2016) analyzes pre-service teachers' attitudes and opinions regarding the teaching profession, and Irie et al. (2018) investigate pre-service EFL teachers' mindsets about teaching competences, to name but a few (for a systematic review see Lundberg et al., 2020). Kling and Lintner (2022) also reveal existing patterns of student teachers' attitudes on selected topics of school practice—focusing on Q as a research methodology. This study also shows that Q can stimulate reflective processes in a university classroom setting and should therefore be increasingly used in higher teacher education as it can contribute to the professional development of pre-service teachers. Relating to the point of stimulating reflection processes, there is only a small number of research papers (Mulder et al., 2019; Sayeski and Higgins, 2013) that explore the use of a Q sort "as an educational tool to prompt participants to reflect" (de Leeuw et al., 2019, p. 2). In the domain of teacher education, Pruslow and Owl (2012) and Rimm-Kaufman et al. (2006) can be mentioned. However, none of their research approaches focus on the application of Q to prompt reflection in a university classroom setting as means of fostering the professional development of pre-service teachers.

3.3 Research question(s)

This paper aims to close this gap and investigates the questions whether and how Q can be applied in a university classroom setting to prompt (self-)reflection of pre-service teachers. Hereby, the pre-service teachers are not only participants, but use Q-sorting and its results to learn about their own teacher beliefs and attitudes, which manifest themselves through reflection and reinforces the student' professional development. This, in turn, sensibilizes them to possible (challenging) school topics and situations in later school life.

4 Reflection design

4.1 Research setting

The research setting was a graduate course at a university in southern Germany. The participants were n = 37 pre-service teachers in their final mandatory module of educational sciences in the Master of Education program. It is important to note that the federalistic educational system in Germany results in differences not only in school education but also in teacher education at colleges and universities. In the state of Baden-Württemberg, pre-service teachers who aim to become teachers for secondary level II study at a university. They first complete a (polyvalent) Bachelor's

degree, followed by the Master of Education. Both phases of higher teacher education include practical phases at school. They then complete one and a half years of pre-service teacher training. The focus at university is clearly on academic education as opposed to professional training at colleges, which made the students ideal participants in this paper's research design. For it is extremely important to establish a link to school practice not just in practical phases in school but also in the academic studies at university. This will provide a scientific reference for the professional field, addressing the criticism that practical phases often rather lack the very same (Hesse and Lütgert, 2020).

4.2 Research object and statement development

The contents of the module on "Professionalization in the Teaching Profession" formed the research objective for the Q sort. The concourse was developed in a hybrid way. It includes research articles on professional development and professionalization in teacher education (e.g., Baumert and Kunter, 2006; Helmke, 2017; Rothland, 2013; Zierer, 2015), reflective essays from pre-service teachers on their beliefs about teaching and their understanding of professionalism, as well as the researcher's own experience teaching the graduate course. The contents were summarized into seven topics (categories), which were then conceptualized and operationalized as a structured sample in 23 statements as displayed in Table 1. Several experts in the field of teacher education reviewed the concourse and student teachers in their master's studies tested the Q sort in order to identify potentially confusing instructions and statements. After minor adjustments to the wording of some statements, the study was conducted online during the summer semester using Q-Perspectives® Online Software (Walker and Lin, 2017).

TABLE 1 Categories and Q sample of 23 statements in English translation.

Topics	Nr.	Statements
Lesson planning/design	1	. . .that there is a pleasant learning atmosphere in my class.
	2	. . .to prepare each topic individually for my students.
	3	. . .to get through my school material so that individual support sometimes must take a back seat.
Diagnostics and counseling of students	4	. . .to have extensive psychological-diagnostic knowledge.
	5	. . .to be able to counsel students at risk (misbehavior, violence, drugs, etc.).
Error culture and performance evaluation	6	. . .that my students achieve the learning goals and requirements I have set.
	7	. . .to convey to my students that mistakes are part of the learning process.
	8	. . .to compare the performance of the individual with that of the class, irrespective of individual development.
Professional cooperation and communication	9	. . .to work in professional teams.
	10	. . .to resolve conflicts in my classes without collegial help, as I know the classes best.
	11	. . .that students perceive me as a contact person not only in class.
Taking responsibility for students and self-protection	12	. . .to enable students to experience themselves as self-effective.
	13	. . .to show responsibility for my students outside of the classroom context.
	14	. . .not to tell my students anything personal so as not to make myself vulnerable.
Teaching (of) values	15	. . .to exemplify and actively convey democratic values to students.
	16	. . .to put my personal views to one side and not to influence students' opinions.
	17	. . .to encourage self-determined judgment and a willingness to take responsibility among students.
Key perspectives education plan Baden-Württemberg (education for sustainable development, education for tolerance and acceptance of diversity, prevention and health promotion, media education)	18	. . .to enable students to contribute to sustainable development through their commitment and actions.
	19	. . .to show students boundaries not only in the classroom context.
	20	. . .to encourage students to stand up for tolerance and acceptance of diversity.
	21	. . .to teach students how to use media in a meaningful, reflective and responsible way.
	22	. . .that I implement digital learning in all my subjects.
	23	. . .to always be informed about current media developments and to use them in the classroom.

4.3 Reflection design

The reflection design (Figure 1) comprises four successive phases of self-reflection: (1) Pre-Flection-Q-Sort: topic-specific Q sort at the beginning of the semester, (2) Stimulus I: exchange of perspectives on the evaluation of the statements (P-Set), (3) Stimulus II: factor characterization & self-assessment, (4) Post-Flection-Q-Sort: topic-specific Q sort at the end of the semester & consultation sessions. The objective of the design is to integrate a Q sort as a dynamic means that allows reflection of pre-service teachers in an already existing seminar structure. The terms "Pre" and "Post" for the Q sorts refer to the temporal aspect within the design at the beginning and at the end of the semester, comprising a total of 4 months. However, it should be explicitly mentioned that the research focus is not to show through comparison that patterns of beliefs and attitudes are changeable or particularly stable. Also, the design is not intended to create alignment among the participants. Instead, the focus is on how Q can be applied in initial teacher training at university to provide pre-service teachers with formats for self-reflection, learning and professional development through both seminar content and methodological understanding. The design follows a teaching-led research approach, which in turn integrates research-led teaching elements. The researcher takes on the role of action researcher which makes her both, the lecturer and part of the research process. Teaching which is based on research as well as the generation of knowledge through research, corresponds to highly demanded general expectations in higher education contexts (Compagnucci and Spigarelli, 2020; Lundberg, 2022). It also addresses the German Quality Initiative for Teacher Education and its discussion of the (in-) significance of a science-based teacher education in that it ensures a strengthening of the research

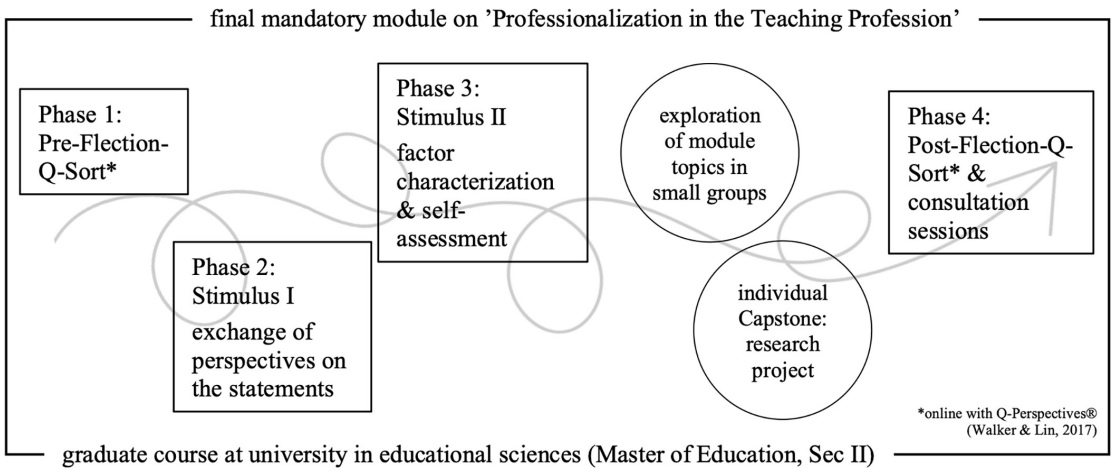

FIGURE 1
Reflection design. ☐ Phases of reflection design; o curricular aspects within the reflection design.

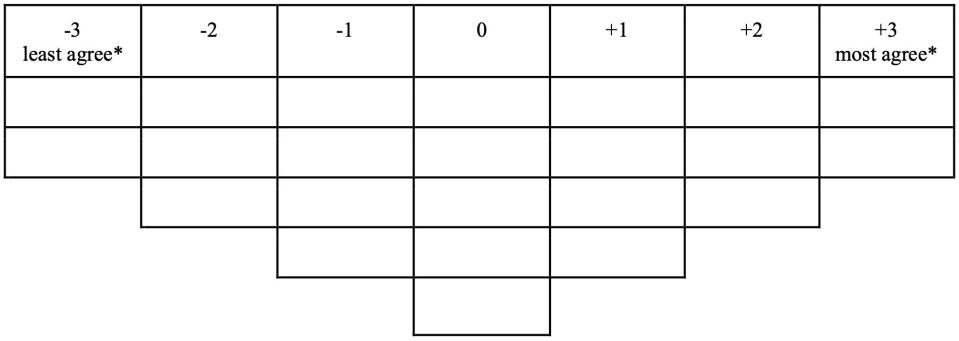

FIGURE 2
Distribution grid. *agreement refers to the importance of each statement (the term "agree" was predefined by the online tool).

reference in the process of pre-service teacher professionalization (Berkemeyer, 2023). The reflection design introduces students to, as well as actively involves them in, a research method. This supports them in both their own learning and professionalization process and also to help them conduct their own research with Q methodology, for example as part of their Master's thesis.

4.3.1 Phase 1: Pre-Flection-Q-Sort

In phase 1, 37 pre-service teachers (P-set) completed the Pre-Flection-Q-Sort. The participants were 60% female, 78% between 23-26 years old, and 95% in semester 9 + . None of them had prior experience with Q. The pre-service teachers rated the statements in relation to each other and sorted them into a bipolar, (pseudo-) normal distribution grid from −3 (least agree) to + 3 (most agree) (Figure 2). Hereby, it was explained to the students that the agreement refers to the importance of each statement. The term "agree" was predefined by the online tool and, as such, could not be altered. The sorting itself was based on the question: "You are a future teacher. How important are the individual statements to you?" Afterward, participants answered open questions in a post-sorting survey to reflect on their motives and reasons for choosing the statements at the extreme ends of the continuum. Participants also answered open questions to reflect on the sorting activity itself. These qualitative responses are used to (help) answer the research questions and to demonstrate the potential of the four phases in terms of reflection, learning and professional development.

4.3.2 Phase 2: stimulus I

During phase 2, the pre-service teachers engaged in an exchange of perspectives with their peers and the lecturer regarding the overall statement rating and their individual sortings. The focus was on those statements which were consistently rated high (e.g., 1, 9) or low (e.g., 8, 13) and on the bipolar ratings (e.g., 10, 21). To facilitate this, the students were presented with an overview of the overall rating of the statements—as a snapshot of unanalyzed data—in the outer scale ranges (−3 and + 3; see Table 2), called a group snapshot (Walker and Lin, 2017; Walker et al., 2018). The objective of this stimulus is to exchange and reinforce opinions and not to immediately rethink, let alone be right or wrong.

4.3.3 Phase 3: stimulus II

Phase 3 involves another stimulus from the lecturer. In this phase, the analytical results of the factor analysis and factor extraction of the Pre-Flection-Q-Sort were presented to the pre-service teachers in detail, both graphically (see Figure 3 as an example) and verbally. The pre-service teachers then worked in

-3	-2	-1	0	+1	+2	+3
8 …to compare the performance of the individual with that of the class, irrespective of individual development.	* 19 ...to show students boundaries not only in the classroom context.	o 7 …to convey to my students that mistakes are part of the learning process.	4 ...to have extensive psychological-diagnostic knowledge.	** > 22 …that I implement digital learning in all my subjects.	9 …to work in professional teams.	o 1 ...that there is a pleasant learning atmosphere in my class.
** < 13 …to show responsibility for my students outside of the classroom context.	o 2 ...to prepare each topic individually for my students.	* 23 …to always be informed about current media developments and to use them in the classroom.	* > 12 ...to enable students to experience themselves as self-effective.	18 ...to enable students to contribute to sustainable development through their commitment and actions.	o 5 …to be able to counsel students at risk (misbehavior, violence, drugs, etc.).	** > 20 …to encourage students to stand up for tolerance and acceptance of diversity.
	3 ...to get through my school material so that individual support sometimes must take a back seat.	** < 17 …to encourage self-determined judgment and a willingness to take responsibility among students.	** 6 ...that my students achieve the learning goals and requirements I have set.	16 …to put my personal views to one side and not to influence students' opinions.	** > 14 …not to tell my students anything personal so as not to make myself vulnerable.	
		11 …that students perceive me as a contact person not only in class.	** 15 …to exemplify and actively convey democratic values to students.	21 …to teach students how to use media in a meaningful, reflective and responsible way.		
			o 10 ...to resolve conflicts in my classes without collegial help, as I know the classes best.			

FIGURE 3
Example for results in graphic form and composite Q sort for factor 1. o consensus statement for all factors; *distinguishing statement at $p < 0.05$ (distinguishing factor 1 from the other factor); **distinguishing statement at $p < 0.01$ (distinguishing factor 1 from the other factor); < z-score for the statement is lower than in all other factors; > z-score for the statement is higher than in all other factors.

small groups to evaluate and categorize similarities and differences in all the factors, without knowing about their own affiliation with any of the factors. They implemented factor characterizations by identifying and profiling teacher types for each factor, which were then presented and discussed in class. Hereby, there was no intention to profile valid teacher types but to identify and characterize similarities within the students. In the end, all students agreed on one final characterization for each factor. Finally, in a take-home task, the students assessed and assigned themselves to one of the factors. They were provided with their own Pre-Flection-Q-Sort in graphic form and could access additional information about their statistical factor affiliation, such as the extent to which they contributed to the corresponding factor. This data-based stimulus is designed to prepare the students for both exploring the module topics reflected in the Q sample and the main component of the module. The exploration of the module topics includes the choice of three topics, which the pre-service teachers then worked on in small groups. The main component of the module comprises the development and preparation of a small research project based on one specific topic of their own choice with a practical or empirical focus as part of the students' individual Capstones. Capstone is the title of the final module in the master's

TABLE 2 Group snapshot presenting an overview of the statements rated in the extreme ends of the continuum (−3 and + 3).

1 ★★★★★★★★★★★ ★★★★★★★	7	13 ★☆☆☆☆☆☆☆☆☆☆ ☆☆☆☆☆☆☆☆☆☆☆	19 ★☆☆☆
2 ☆☆☆☆☆☆	8 ☆☆☆☆☆☆☆☆☆☆☆☆ ☆☆☆☆☆	14 ★★★★★	20 ★★★★★★☆
3 ☆☆☆☆☆☆☆☆☆☆	9 ★★★★★★★★★★	15 ★☆☆	21 ★★☆☆
4 ★★★★★★	10 ★★☆☆	16 ★★★★★★	22 ★★★★★☆
5 ★★★★★★	11 ★☆☆☆☆	17 ★★★★★★	23 ☆
6 ★☆☆	12 ★	18 ★☆	

★ Number of statements ranked at + 3 by the participants; ☆ Number of statements ranked at −3 by the participants.

degree program. It stands for "a stone at the top of a wall or building" (Cambridge University Press, n.d.) and aims to bring together and deepen the profession-specific skills acquired during the degree program.

4.3.4 Phase 4: Post-Flection-Q-Sort and consultation sessions

In the final phase 4 at the end of the semester, n = 15 pre-service teachers (60% female) participated in the Post-Flection-Q-Sort. Participation was optional since it fell in the semester break. However, it is deliberately designed to take place after the module examination. The students presented their Capstone results to a broad audience of prospective teachers at an on-site education conference—an important part in their transformative learning process. Those who found it helpful for this process and their professional development decided to participate in the Post-Flection-Q-Sort. The students reflected on their motives and reasons for statement rating as in phase 1. They further reflected on their pre- and post-sorting and on the now familiar tool itself by answering open questions. In the case of a positive self-report on change, the students stated what they attribute the change to. They also evaluated how Q-sorting helped them to develop professionally in open questions. The objective of the pre-post-comparison is for the pre-service teachers to reflect on whether they perceive a change in their own statement rating and perspective, and not to analyze emerging Pre- and Post-Flection-Factors. Therefore, the Q sorts were only intra-individually statistically compared. In addition to the self-report, the students were provided with the statistical comparison and their pre-post distinguishing and consensus statements. All this information was used for individual consultation sessions between the students and the researcher on a voluntary level. The aim of these sessions is to attract students who are interested in the method (ology) as well as students whose Q sorts give them so much food for thought that there is an objective need for consultation or discussion.

5 Findings

This section presents our findings on the application of Q for pre-service teachers' (self-)reflection, learning and professional development within a university graduate course in educational sciences. Again, the structure follows the reflection design for better comprehensibility. The main objective is to take the reader through all four phases in order to enable them to envision using Q in a university classroom setting. To help understand Q in full detail and to determine whether it could be a useful tool in their work, a number of articles outline the main procedures for conducting a Q study: Donner, 2001; Herrington and Coogan, 2011; Lundberg, 2022; Müller and Kals, 2004; Rieber, 2020; Stainton Rogers, 1995; van Exel and Graaf, 2005; Watts and Stenner, 2005; Yang and Xu, 2021. Also Kling and Lintner (2022) provide an in-detail description of a Q study's procedural steps (concourse development and Q sample construction, data collection, data analysis, and factor interpretation), which correspond to the same steps taken for the development, implementation and analysis of the Pre- and Post-Flection-Q-Sort. For this reason, no detailed description is provided in this paper. Nevertheless, due to the research-based nature of Q, two specific aspects of the procedure that constitute an essential part within the reflection design are additionally presented in this section's "data-detours": Data analysis and results of the Pre-Flection-Q-Sort and the statistical comparison of intra-individual change. Both "data-detours" contribute to a better methodological understanding of Q in the present paper and are primarily intended for readers who are more closely interested in the analytical and technical aspects of the method. In line with the reasoning for the reflection design's teaching-led research approach, which in turn integrates research-led teaching elements, the rationale for integrating "data-detours" in this paper is twofold. One is that research-based teacher education is of great importance to teacher education programs (Compagnucci and Spigarelli, 2020; Lundberg, 2022; Berkemeyer, 2023). Second, readers who are university faculty in teacher education almost always represent two roles: That of the teacher educator and that of the researcher in relation to, or with relevance for, teacher education. Nonetheless, the focus is on the application of Q and not on the Q-method results, which is why the data-detours represent additional information and not a necessity for this paper.

5.1 Phase 1: Pre-Flection-Q-Sort

In phase 1, both the implementation of the Pre-Flection-Q-Sort and the answering of the open questions provide occasions for the pre-service teachers' (self-)reflection. This stimulates thoughts about and understanding of their own perspectives and beliefs on the importance of the different statements. For the researcher, knowing why the students place certain statements at the extreme ends of the continuum gives insight into their teacher beliefs systems. Further, the students' frames of reference are expanded

or narrowed by explicitly addressing their demands and needs through research-informed teaching: Module content, which is reflected in the Q sample, is adapted or specifically selected in the seminar in order to respond to the students' beliefs.

The answers to the open questions on the Q-sorting and the statements showed a high level of reflection among the pre-service teachers. The participants' responses were translated into English and included in the text in *italics*. They reflected that there are *some aspects of being a teacher that I hadn't thought about before*. Also, the tool enabled them to *reflect more closely and deeply on many aspects that are important in the teaching profession—what values do I actually represent?* Some pre-service teachers also showed reflection concerning the multiple facets of the teaching profession which are represented in the statements. One student stated that *it will be difficult to meet all the requirements in the job at the same time*. Another reflected on *which aspects of professionalism are important to me personally and which of these I definitely want to implement*. Here, one student directly referred to the Q sort's distribution grid and stated that it *clearly demonstrated visually where my priorities lie*. The need to prioritize, what makes Q so special compared to traditional testing in R, *prompts reflection on one's own beliefs*: *For each single statement, I was able to listen to myself and uncover my attitude to the respective statement. Sometimes I heard "yes, that's very important", while with other statements I immediately felt a sense of resistance. For almost all the statements, I thought about a reason in my head as to why I put which statement in which place.*

5.2 Phase 2: stimuli I

The exchange of perspectives on the group snapshot, the overall statement sorting in both the + 3 and −3 ranges, occasions (self-)reflection in phase 2. The students found that especially statements 1 (that there is a pleasant learning atmosphere in my class) and 13 (not to tell my students anything personal, so as not to make myself vulnerable) display strong approval or rejection. For statement 1, the students almost unanimously stated that it is a basic condition for successful teaching and learning. For statement 13, the reasons for the choice of statement vary considerably: Many students argued that one needs to reveal oneself to the students, to show oneself as a private person, so that they open up to the teacher. Others mentioned that they had thought about the term "anything" in the statement and do not want to be completely transparent, but want to be approachable in order to build a good teacher-student relationship. After the exchange of perspectives on the group snapshot, the statements are linked to the different module topics in the seminar. This step helps the pre-service teachers connect their own perspectives to the seminar content and prepares them to choose their three module topics, informed by their own Q sort, for in-depth exploration in Phase 3.

5.3 Phase 3: stimulus II

For phase 3, the *results of the Pre-Flection-Q-Sort analysis* were presented to the pre-service teachers in the seminar, thoroughly walking them through the whole analytical process. Afterward they made themselves familiar with the composite Q sorts for each factor. Figure 3 displays the composite Q sort for Factor 1 as an example. The composite Q sort is a hypothetical Q sort which represents 100% of the perspectives of the factor (cf. McKeown and Thomas, 2013). Self-reflection in this phase occasions in the identification of teacher types for each extracted factor. Asking the participants to interpret the factors is a common participatory approach in Q (Pruslow and Owl, 2012). This phase not only provides pre-service teachers with insight into Q as a research method and the factor extraction process, but also prompts them to consider the various belief structures and opinions represented by the factors. The students demonstrated great interest and enthusiasm in working on the characterization of the underlying teacher types for each factor. They focused on both the highest and lowest rankings in each of the three composite Q sorts as well as on the distinguishing statements for each factor. The statements on the extreme ends of the distribution continuum help to characterize each of the factors as a teacher type. Since it is not the aim of this paper to interpret the factors in full detail, the pre-service teachers' characterizations are only presented briefly:

- Factor 1—Professionalism with a focus on student personal growth and development
- Factor 2—Designing student-centered learning settings
- Factor 3—Responsible individualism with a focus on subject-related learning objectives

To conclude phase 3, students are asked to assess themselves according to their factor affiliation in a take-home reflection task. This step stimulates the examination of their individual Q sorts with reference to the affiliated factor. It allows for data-informed choices on different module topics and on the research project for the students' individual Capstones. Of the 37 pre-service teachers, 87% stated that they made their choices based on their own Q data, with nearly 90% of them selecting module topics based on statements from the MOST AGREE range. One pre-service teachers stated that *I realized once again how important it is to me that school education contributes to a fairer and more peaceful world. Accordingly, I selected this module topic for my individual Capstone.* Another student commented on the integration of the reflection phases with the seminar content, stating, *engaging with the Q sort made me think and reflect. In particular, the subsequent engagement with the individual Capstone allowed my confidence in my own beliefs and attitude to grow.* The remaining 13% did not provide any information on their task selection process. Due to its optional nature, the students were asked to provide reasons for performing the take-home reflection task. A number of students indicated that they found the exercise interesting, in particular, knowing (about) the factor they belonged to. Others wanted to know whether their self-assessment was correct or they were interested in the method statistically. Some students wanted to ascertain whether they thought like most of their fellow students, while one student stated that he found it interesting to see that *everyone has a pronounced tendency toward a certain teacher personality and to know about my own.*

TABLE 3 Factor loadings with defining sorts.

Q sort and participant Nr.	Factor 1	Sig.	Factor 2	Sig.	Factor 3	Sig.
8	0.9508	*	−0.0277		−0.1197	
37	0.8551	*	0.2033		−0.04	
23	0.8425	*	0.089		−0.0777	
29	0.8414	*	0.2108		−0.2106	
15	0.841	*	0.1937		−0.0854	
35	0.8329	*	0.1489		0.0899	
22	0.8287	*	0.3934		−0.1178	
12	0.817	*	0.2488		0.0424	
25	0.8082	*	0.3019		−0.1586	
32	0.8041	*	0.2526		0.0482	
1	0.803	*	0.16		−0.0357	
31	0.8022	*	0.2983		−0.0814	
24	0.793	*	0.2975		−0.2859	
27	0.7601	*	−0.0702		0.1054	
2	0.7548	*	0.1703		0.0994	
17	0.7525	*	0.1208		0.1787	
33	0.7513	*	0.1603		−0.0926	
7	0.7441	*	0.2355		−0.119	
13	0.7406	*	−0.1341		−0.307	
19	0.7054	*	−0.1968		0.2765	
11	0.6787	*	−0.0079		−0.2125	
28	0.6719	*	0.1201		0.0392	
6	0.6389	*	−0.129		−0.3881	
3	0.6051	*	0.1321		−0.3647	
18	0.5995	*	0.2084		−0.479	
26	0.5728	*	0.4613		−0.0567	
21	0.5407	*	0.2147		0.1716	
36	−0.0823		0.7788	*	0.0525	
30	0.4473		0.6614	*	−0.2512	
20	0.4444		0.6101	*	−0.2884	
9	0.3946		0.6025	*	0.0565	
5	0.3542		0.5518	*	−0.5095	
4	0.0596		0.5504	*	−0.2085	
10	−0.1548		0.3965		0.1615	
34	0.0855		0.4297		0.6585	*
16	0.4455		−0.0268		0.6583	*
14	0.3668		0.0879		−0.3868	
% expl. variance	44		11		7	

Varimax and judgmental rotation applied; the factor onto which each Q sort is loaded ($p < 0.01$ and a majority of common variance was required) is indicated by *.

5.3.1 Data-detour I: analysis of the Pre-Flection-Q-Sort

$n = 37$ Pre-Flection-Q-Sorts were analyzed. Inter-correlations among the Q sorts were computed using the Q methodology software Ken-Q 2.0.1 (Banasick, 2023). The sorts were then subjected to principal components analysis (PCA). Among the different statistical criteria best used to determine the number of factors in a Q method study (cf. Brown, 1980; Herrington and Coogan, 2011; Watts and Stenner, 2012), the researcher decided to depend the factor extraction on eigenvalues, the number of sorts

that load onto the factors (significant loading and Humphrey's Rule), the elimination of confounded cases and distinguishing statements: Eigenvalues, also known as the Kaiser-Guttman criterion (Guttman, 1954; Kaiser, 1960), were above 2.00 and explained 60% of the variance in the data. Further, factors with two or more significant loadings were accepted. Humphrey's rule also applied (Brown, 1980). With 23 statements and a standard error of $1/\sqrt{(23)} = 0.2085$, factor loadings with $2.58\ (0.2085) = \pm 0.538$ for $p < 0.01$ were significant (ibid., p. 222). Varimax rotation was used to simplify the data structure. To maximize the inclusion of pre-service teachers, adjustments were made through judgmental rotation, at the same time integrating the researcher's subjective impressions of the data (Brown, 1993). Specifically, Factor 3 was considered relevant both as a meaningful perspective for the pre-service teachers' interpretation and reflection and as a counterpart to the other two factors. Given its relevance as a distinct teacher type, it was necessary for at least two participants to load significantly onto this factor. Through these secondary rotations, the number of students associated with one of the three factors increased from 33 to 35 out of 37, as presented in Table 3. Participant Q sorts Nr. 10 and Nr. 14 did not load significantly onto any of the three factors and were thus excluded from the final analysis. However, they participated in all reflection phases and received a separate explanation from the lecturer regarding their lack of factor affiliation in phase 3. Factor 3 was inverted. The distinguishing statements of the three factors, which are presented in Table 4, showed meaningful patterns among the pre-service teachers.

5.4 Phase 4: Post-Flection-Q-Sort and consultation sessions

The occasion for self-reflection in phase 4 differs from phase 1 in that the students had *already carried out the Q sort once before*, were *more familiar with the process* and already *knew the content of the statements*. Consequently, they were in a position to conduct a more informed and reflective sorting. Therefore, they were no longer "pre-flecting" but operationalizing their perspectives based on new experiences. The pre-service teachers noted that the sorting process was considerably more straightforward for them the second time. They felt *more secure and confident because the Q-sorting and the distinctive features of the method were already known*. Also, the *topics of the statements were addressed and discussed in the seminar* and the students had *time to reflect on many content-related aspects in the meantime*. At the end of the final phase, all participants in the Pre- and Post-Flection-Q-Sorts were provided with both their Q sorts by the researcher for individual comparison via personalized codes. In order to verify the pre-service teachers' self-reported changes statistically, the researcher conducted a statistical comparison for each of the 15 students to *determine intra-individual change* (cf. Walker, 2013).

Ten out of 15 pre-service teachers took the opportunity to attend individual consultation sessions with the researcher. Some students wanted to discuss different topics for their Master's thesis based on their individual Q sorts, others wanted to talk about the applicability of the methodology. Those students did not show and

TABLE 4 Distinguishing statements of all 3 factors.

Distinguishing statements for factor 1				Distinguishing statements for factor 2				Distinguishing statements for factor 3			
statement Nr.	Q sort value	sig.		Statement Nr.	Q sort value	sig.		statement Nr.	Q sort value	sig.	
20	3	**	>	16	3	**	>	6	2	**	>
14	2	**	>	11	2	**	>	15	2	**	>
22	1	**	>	19	1	**	>	3	1	**	>
12	0	*	>	21	0	*	<	13	1	**	>
6	0	**		8	0	**	>	23	0	**	>
15	0	**		15	−1	**	<	20	0	*	
23	−1	*		13	−1	**		9	−1	**	<
17	−1	**	<	6	−2	**	<	18	−2	**	<
19	−2	*		23	−2	*	<	19	−3	*	<
13	−3	**	<	20	−3	*	<				

*$p < 0.05$, **$p < 0.01$; z-score of the statement is higher than in all other factors; < z-score of the statement is lower than in all other factors.

TABLE 5 Intra-individual comparison between Pre- and Post-Flection-Q-Sorts.

	Loadings Pre-Flection-Q	Loadings Post-Flection-Q	Correlation between sorts	Statistical change	Self-report of change
	Factor 1	Factor 2	r = .	r < 0.8	
P34 Pre	0.9961X	0.0886	0.18	Yes	Yes
P34 Post	0.0886	0.9961X			
% expl. variance	50	50			
P10 Pre	0.9946X	0.1035	0.21	Yes	Yes
P10 Post	0.1035	0.9946X			
% expl. variance	50	50			
P14 Pre	0.9681X	0.2507	0.49	Yes	Yes
P14 Post	0.2507	0.9681X			
% expl. variance	50	50			
P3 Pre	0.9202X	0.3916	0.72	Yes	No
P3 Post	0.3916	0.9202X			
% expl. variance	50	50			
P37 Pre	0.9068X	0.4217	0.76	Yes	Yes
P37 Post	0.4217	0.9068X			
% expl. variance	50	50			
P32 Pre	0.8966X	0.4429	0.79	Yes	Yes
P32 Post	0.4429	0.8966X			
% expl. variance	50	50			

also not articulate any considerable change in their Pre- and Post-Flection-Q-Sorts. Three pre-service teachers (P34, P10, and P14) expressed the desire to discuss the professional role of a teacher in greater depth. One student questioned the foundation of their previous teacher identity, given the large discrepancy observed in the intra-individual comparison of the two Q sorts. Other students expressed the need to talk about reflection for their own professional development, particularly in the context of pre-service teacher training. They sought advice on the integration of various forms of reflection into this practical phase and the most effective methods for doing so. Another student expressed gratitude for the semester. They had always been aware of their future role as a teacher and the values they wished to represent. Participating in both Q sorts made this awareness more tangible. This would encourage them to enter the traineeship with confidence and self-assurance.

5.4.1 Data-detour II: statistical comparison of intra-individual change

Each participant's Pre- and Post-Flection-Q-Sort served as the two entries into Ken-Q. Typically, a person's reliability coefficients with themselves range from 0.80 upwards (Frank, 1956; Steller and Meurer, 1974; Brown, 1980). Therefore, if the correlation coefficient between a student's Pre- and Post-Flection-Q-Sort is less than 0.80, change can be said to have occurred. Table 5 shows the correlation between the sorts for each student, as well as the distinguishing statements indicating which statements are statistically significant at $p < 0.01$. Six of the fifteen pre-service teachers showed statistically significant correlations of $r < 0.80$, indicating a statistically significant change in their perspectives from Pre- to Post-Flection-Q-Sort. Of these six students, five also reported a change themselves.

6 Discussion and conclusion

The present study seeks to answer the questions of whether and how Q can be applied in a university classroom setting to prompt pre-service teachers' (self-)reflection, contributing to their professional development in the field of educational sciences. Our findings correspond to results from previous studies (Jaschke, 2018; Kling and Lintner, 2022; Lim-Ratnam et al., 2022) that Q indeed prompts pre-service teachers' self-reflective processes. The reflection design's specificity lies in supplementing the application of Q-sorting with data-based occasions for (self-)reflection, like reviewing analysis of these sorts—based on Q-method results—through different stimuli. Throughout one semester, learning through reflection manifests itself in and reinforces pre-service teachers' professional development.

Overall, the results suggest that Q methodology offers an innovative and practical approach to fostering (self-)reflection and professional (further) development. Its structured and interactive nature makes it not only a motivating alternative to traditional reflection methods but also a valuable addition to existing didactic approaches in teacher education with a research-oriented focus. Therefore, Q should be used in both pre-service training

and professional development to sustainably strengthen teachers' reflective competencies.

6.1 Using Q for reflection

Using the Pre- and Post-Flection-Q-Sorts, the methodological orientation avoids a one-sided assessment of the statements through relational evaluation (*especially the part in which you have to weigh up which of the statements is more important for you triggers reflection on your own attitude*). Besides, the pre-service teachers can reconsider and change their sorting at any time, allowing them to reflect while sorting: *I realized a few things while sorting that made me reconsider and evaluate some statements differently*. They state that they experience the sorting process as exciting and motivating although it is rather time-consuming. Such procedures characterize the Q sort as a dynamic medium and as a reflection tool, and are not intended in standardized questionnaire studies. Besides, the mixed-methods approach provides the participants with both card sorting and reflective writing (open questions) as strategies to reflect on themselves, their beliefs and attitudes, and their future role(s) as teachers. Q-sorting also allows a more in-depth exploration of the research subject. The statements establish a connection to school practice and sensibilize the pre-service teachers for possible (challenging) school situations in the future: *As a teacher, I will not be able to pay attention to everything that is somehow important to me later on. Instead, I will have to limit my focus and energy to a few aspects. The Q sort has been able to show me which aspects these are.*

Relying on their own practical experiences and on their academic knowledge as frames of reference, Q increases the prerequisite for reflective processes: the willingness to reflect (*I was able to learn more about myself and better understand why I act or react in a certain way in some situations*).

6.2 Stimuli for (self-)reflection, learning and professional development

The combination of Q with (self-)reflection through different stimuli in the university classroom provides the pre-service teachers with several occasions for self-reflection through exploration, while simultaneously receiving feedback from peers and the researcher. Q is inherently self-referential, and thus does not necessarily require external feedback. However, interactions with fellow pre-service teachers during the stimulus phases, which are either based on or incorporate Q, are very valuable. They can lead to the identification, recognition of and also irritation through shared or alternative perspectives and diverse points of view *(the opinions of the others gave me a different perspective on my own attitudes and beliefs)*. This serves the social dimension of Mezirow's (1991) transformative learning theory. In the process, reflexivity and identity are reconciled and one's own teacher beliefs and attitudes are developed and consolidated. According to Marcia (1980), exploration plays a pronounced role in the moratorium, during which pre-service teachers form their professional identity. The stimulation of such active exploration is facilitated by (self-)reflection processes: *By completing the seminar, I have a clearer picture of what is behind the individual concepts and components that needed to be categorized in the Q sort. This has helped me to gain a greater sense of security with some previously unknown aspects. Other components suddenly seem less relevant or realistic from a practical perspective.*

6.3 Meeting the criticism of recent decades

In integrating both the sorting activity and the results of the analysis in the reflection design, the criticism of recent decades is addressed: Q often—also with regard to its practical application—gets reduced or equated to Q-sorting and either ignores or neglects Q's methodological underpinnings. In the recent development toward web-based tools, this criticism is often connected to their fast instruction and analysis of results (Rieber, 2018, 2020). Web-based tools (e.g., Walker and Lin, 2017; Walker et al., 2018) provide the opportunity to conduct Q-sorting online, collect data electronically, and even share results with participants immediately after they complete the Q sort. Web-based data collection also enables thoughtful analysis—not just for research purposes but also for the application of Q as a research-based tool in teacher education within a university classroom setting. Considering the time resources available, web-based Q tools are ideal for such settings.

6.4 Helpful recommendations

Based on experience, some recommendations for the application of a reflection design in the university classroom shall be made: Developing an appropriate design and Q sample requires time-intensive preparation and implementation. Also, clear and precise instructions are important to ensure that Q sorts are conducted correctly. They help prevent misunderstandings, such as misinterpreting the scaling as non-continuous or selectively assigning statements to the grid while omitting others. In addition, the voluntary nature of participation in the design's reflection stimuli needs to be considered. Furthermore, the amount of guidance provided by the researcher/lecturer plays an important role: Should (self-)reflective processes by the students be carried out independently or under supervision? Finally, the methods for recording the "results" of the self-reflection stimuli must be defined.

6.5 The role of educational sciences in the professional development of (future) teachers

Teachers have to be professional. This involves being critical and reflective. Providing the necessary conditions for professional reflection (Kunina-Habenicht et al., 2012), educational sciences play an important role as a subject-independent domain in initial teacher training and pre-service teachers' professional pedagogical development (cf. Schlömerkemper, 2004; Seidel, 2017). In his

specification of the independent significance of educational science study components in the university phase, Kramer (2020) argues that they have to enable students to engage with school and teaching practice without the pressure to act. Nevertheless, in comparison to their other study elements—subjects, subject didactics and school practice—pre-service teachers attribute the least importance to educational sciences (cf. Fischer, 2021). However, it is not only among students that educational sciences do not receive enough attention. In empirical research, too, this domain is still considered to be an underdeveloped area of higher teacher education (cf. Kunter et al., 2017). This paper is intended to encourage other researchers and lecturers to explore the field of educational sciences and corresponding questions with Q, for example: What attitudes do (prospective) teachers have about dealing with certain situations (e.g., conflict or shy students) in the classroom? What are students' mindsets regarding female students in STEM?

6.6 The reflection design's purpose

Although it may initially seem so, the reflection design does not represent a classic pre-post-study design with focus on the results of the Pre- and Post-Flection-Q-Sorts. The objective is not to present a change in the pre-service teachers' beliefs and attitudes through data analysis or to provide them with predetermined reflection and learning outcomes, as would be the case in an intervention study. Instead, the design's purpose is to prompt reflection, learning and professional development of pre-service teachers with and through Q methodology. The students experience and reflect the methodology and statement content, gain insights into their own teacher beliefs and attitudes, and reflect on their (transformational) learning experiences. It is, of course, possible for them to alter their original perspective as part of this process. The stimuli are designed to guide and encourage the students to reflect on their own beliefs and attitudes, thereby facilitating professional development through reflection and learning. They are not intended as interventions with the objective of group thinking or radical change.

The reflection design considers the role of the pre-service teachers as not only participants in Q, but also as students who use the results to actively work on their own professionalization as future teachers. The findings show that Q is invaluable for application in a university setting with pre-service teachers. At the same time, its value for in-service and continuing professional teacher training or for self-guided application in schools is implied. Wherever the continuous professionalization of teachers and the examination of topics relevant to teaching are to be facilitated and self-reflection in the teacher role is to be prompted, the application of Q should be considered.

6.7 Implications for future research

One strength of Q methodology is its suitability for small numbers of participants, as applied in the present article (n = 37 Pre-Flection, n = 15 Post-Flection). Since the P-set in Q does not represent a population and generalizability is not the primary objective (Brown, 1993), working with specifically selected target groups is appropriate. Nevertheless, the findings offer valuable insights with relevance for broader teacher education settings. The patterns and themes observed can contribute to the design and implementation of reflective practices in teacher education programs. Further research could explore whether similar or different perspectives and patterns emerge in larger and more diverse samples, including pre-service teachers from different universities and educational contexts such as professional development programs or pre-service training.

The present study focuses on graduate students, who are likely to have more experience with self-reflection and may feel more comfortable engaging in structured introspection compared to undergraduate pre-service teachers. This raises the question of how age and prior experience with reflective practice might have influenced the participants' engagement with Q-sorting and its results. Undergraduate students, who may have had less experience with structured reflection, might require additional scaffolding or support. Future research should explore these potential differences by comparing how undergraduate and graduate pre-service teachers use Q for reflection. Such investigations could provide valuable insights into how to tailor the implementation of Q methodology to different levels of prior experience.

With regard to the (self-)professionalization of pre-service teachers, longitudinal studies could provide deeper insights, particularly through pre-post intervention designs within a semester or across different phases of teacher training—from university education to pre-service training and career entry. Such studies would allow for the identification of intra-individual changes and provide concrete insights into pre-service teachers' self-professionalization processes. Additionally, a longer survey period spanning multiple semesters or an accompanying study throughout teacher education would be beneficial in assessing the sustainable effect of reflective stimuli on (self-)professionalization of student teachers. This approach would enable a systematic examination of specific reflection processes contributing to self-professionalization, their mechanisms, and their concrete manifestations. Furthermore, longitudinal analysis could investigate differences between the ideal and real self and thus changes in the self-concept of prospective teachers over time.

Finally, in a next step, the interpretation of the identified teacher types and their implications for teaching practice will be deepened. It will be particularly interesting and relevant to examine how these types align with existing models of professional development and teacher identity formation (e.g., Korthagen, 2017; Zeichner and Liston, 1996). Expanding analysis in this direction will provide a more comprehensive understanding of how teacher identity forms and is shaped by reflective practice.

Data availability statement

The original contributions presented in this study are included in this article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical approval was not required for the studies involving humans because the research was conducted in a university classroom—an established educational setting—and involves normal educational practices and poses no more than minimal risk to participants. Furthermore, data were collected anonymously, and only with written informed consent by the participants (students). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

IK: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing. MB: Conceptualization, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

References

Abou Baker El-Dib, M. (2007). Levels of reflection in action research. An overview and an assessment tool. *Teach. Teach. Educ.* 23, 24–35. doi: 10.1016/j.tate.2006.04.002

Aeppli, J., and Lötscher, H. (2016). EDAMA - ein Rahmenmodell für Reflexion. *BzL - Beiträge Lehrerinnen Lehrerbild.* 34, 78–97. doi: 10.36950/bzl.34.1.2016.9540

Altet, M., Desjardins, J., Paquay, L., Etienne, R., and Perrenoud, P. (2013). *Former des enseignants réflexifs: Obstacles et résistances*. Bruxelles: De Boeck.

Artmann, M., Berendonck, M., Herzmann, P., and Liegmann, A. (2018). *Professionalisierung in Praxisphasen der Lehrerbildung: Qualitative Forschung aus Bildungswissenschaft und Fachdidaktik*. Bad Heilbrunn: Verlag Julius Klinkhardt.

Balloo, K. (2018). In-depth profiles of the expectations of undergraduate students commencing university: A Q methodological analysis. *Stud. High. Educ.* 43, 2251–2262. doi: 10.1080/03075079.2017.1320373

Banasick, S. (2023). *Ken-Q Analysis (version 2.0.1) [Computer software]*. doi: 10.5281/zenodo.8310377

Barnes, C., Angle, J., and Montgomery, D. (2015). Teachers describe epistemologies of science instruction through Q methodology. *Sch. Sci. Math.* 115, 141–150. doi: 10.1111/ssm.12111

Barry, J., and Proops, J. (1999). Seeking sustainability discourses with Q methodology. *Ecol. Econ.* 28, 337–345. doi: 10.1016/S0921-8009(98)00053-6

Baumert, J., and Kunter, M. (2006). Stichwort: Professionelle Kompetenz von Lehrkräften. *Zeitschrift Erziehungswissenschaft* 9, 469–520. doi: 10.1007/s11618-006-0165-2

Berkemeyer, N. (2023). Institutionalisierung der Lehrkräftebildung – warum so zaghaft? Ein Diskussionsbeitrag zum "Eckpunktepapier Institutionalisierung Lehrerbildung" aus dem Kontext der Qualitätsoffensive Lehrerbildung. *DDS – Die Deutsche Schule* 2, 162–171. doi: 10.31244/dds.2023.02.11

Berry, R. A. W., Shields, B. A., Krickovich, S. R., and Sadler, J. T. (2012). Prospective student teachers' concerns regarding the student-teaching experience. *Operant Sub.* 35, 159–175.

Boyle, M., and Jackson, P. (2009). *Using card sorts. Physical Sciences Centre-Briefing Paper 1*. Available online at: https://hydra.hull.ac.uk/assets/hull:4519/content (accessed May 21, 2024).

Brewer-Deluce, D., Sharma, B., Akhtar-Danesh, N., Jackson, T., and Wainman, B. (2019). Beyond average information: How Q-methodology enhances course evaluations in anatomy. *Anat. Sci. Educ.* 13, 137–148. doi: 10.1002/ase.1885

Brouwer, M. (1999). Q is accounting for tastes. *J. Adv. Res.* 39, 35–39.

Brown, S. R. (1976). "Die Q-Technik: Verstehen meßbar gemacht," in *Wahlforschung: Sonden im politischen Markt*, eds C. Böhret, G. D. Brewer, R. D. Brunner, H. Ehrenberg, K. Liepelt, E. Spiegel, et al. (Wiesbaden: VS Verlag für Sozialwissenschaften), 221–226. doi: 10.1007/978-3-322-88750-4_20

Brown, S. R. (1980). *Political subjectivity: Applications of Q methodology in political science*. New Haven, CT: Yale University Press, doi: 10.22488/okstate.80.100561

Brown, S. R. (1993). A primer on Q methodology. *Oper. Sub.* 16, 91–138. doi: 10.22488/okstate.93.100504

Brown, S. R. (1996). Q methodology and qualitative research. *Qual. Health Res.* 6, 561–567. doi: 10.1177/104973239600600408

Brown, S. R. (2006). A match made in heaven: A marginalized methodology for studying the marginalized. *Qual. Quant.* 40, 361–382. doi: 10.1007/s11135-005-8828-2

Calderhead, J. (1989). Reflective teaching and teacher education. *Teach. Teach. Educ.* 5, 43–51. doi: 10.1016/0742-051X(89)90018-8

Cambridge University Press (n.d.). *Capstone. Cambridge Advanced Learner's Dictionary & Thesaurus*. Available online at: https://dictionary.cambridge.org/dictionary/english/capstone (accessed May 23, 2024).

Chang-Kredl, S., and Kingsley, S. (2014). Identity expectations in early childhood teacher education: Pre-service teachers' memories of prior experiences and reasons for entry into the profession. *Teach. Teach. Educ.* 43, 27–36. doi: 10.1016/j.tate.2014.05.005

Clarà, M. (2015). What is reflection? Looking for clarity in an ambiguous notion. *J. Teach. Educ.* 66, 261–271. doi: 10.1177/0022487114552028

Clarke, A. (1995). Professional development in practicum settings: Reflective practice under scrutiny. *Teach. Teach. Educ.* 11, 243–261. doi: 10.1016/0742-051X(94)00028-5

Collin, S., and Karsenti, T. (2011). The collective dimension of reflective practice: The how and why. *Ref. Pract.* 12, 569–581. doi: 10.1080/14623943.2011.590346

Collins, L., and Angelova, M. E. (2015). What helps TESOL methods students learn: Using Q methodology to investigate students' views of a graduate TESOL methods class. *Int. J. Teach. Learn. High. Educ.* 27, 247–260.

Compagnucci, L., and Spigarelli, F. (2020). The third mission of the university: A systematic literature review on potentials and constraints. *Technol. Forecast. Soc. Change* 161:120284. doi: 10.1016/j.techfore.2020.120284

Conrad, L., Demasson, A., Gorichanaz, T., and Vanscoy, A. (2019). Exploring card sort methods: Interaction and implementation for research, education, and practice. *Proc. Assoc. Inform. Sci. Technol.* 56, 525–528. doi: 10.1002/pra2.81

Danielewicz, J. (2001). *Teaching selves: Identity, pedagogy, and teacher education*. New York, NY: State University of New York Press.

Day, C. (1993). Reflection: A necessary but not sufficient condition for professional development. *Br. Educ. Res. J.* 19, 83–93. doi: 10.1080/0141192930190107

de Leeuw, R. R., de Boer, A. A., Beckmann, E. J., van Exel, J., and Minnaert, A. (2019). Young children's perspectives on resolving social exclusion within inclusive classrooms. *Int. J. Educ. Res.* 98, 324–335. doi: 10.1016/j.ijer.2019.09.009

Demir, S. (2016). An analysis of pre-service teachers' attitudes and opinions regarding the teaching profession via Q-methodology. *Eur. J. Contemp. Educ.* 17, 295–310. doi: 10.13187/ejced.2016.17.295

Depaepe, F., and König, J. (2018). General pedagogical knowledge, self-efficacy and instructional practice: Disentangling their relationship in pre-service teacher education. *Teach. Teach. Educ.* 69, 177–190. doi: 10.1016/j.tate.2017.10.003

Dewey, J. (1910). *How we think*. Boston, MA: D.C. Health and Company, doi: 10.1037/10903-000

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the education process*. Boston, MA: D.C. Health and Company.

Donner, J. C. (2001). Using Q-sorts in participatory processes: An introduction to the methodology. *Soc. Dev. Papers* 36, 24–49.

Duncan, N., and Owens, L. (2011). Bullying, social power and heteronormativity: Girls' constructions of popularity. *Child Soc.* 25, 306–316. doi: 10.1111/j.1099-0860.2011.00378.x

Eisenhart, M., and DeHaan, R. L. (2005). Doctoral preparation of scientifically based education researchers. *Educ. Res.* 34, 3–13. doi: 10.3102/0013189X034004003

Fincher, S., and Tenenberg, J. (2005). Making sense of card sorting data. *Exp. Syst.* 22, 89–93. doi: 10.1111/j.1468-0394.2005.00299.x

Fischer, T. (2021). *Professionalisierung von Lehramtsstudierenden im Spannungsverhältnis von Wissenschaftsorientierung und Berufsfeldbezug*. Dissertation, Flensburg: Europa-Universität Flensburg.

Fives, H., and Buehl, M. (2017). "The functions of teachers' beliefs: Personal epistemology on the pinning block," in *Teachers' personal epistemologies: Evolving models for informing practice*, eds G. Schraw, J. Lunn Brownlee, L. Olafson, and M. Vander Veldt Brye (Charlotte, NC: Information Age Press), 25–54.

Fraefel, U. (2016). "Vorwort zur Publikationsreihe: Professionalisierung im Schulfeld: Von einem diskursiven Feld innerhalb der Lehrerinnen- und Lehrerbildung zu einem eigenständigen Forschungsbereich," in *Professionalisierungsprozesse angehender Lehrpersonen in den berufspraktischen Studien*, eds J. Košinár, S. Leineweber, and E. Schmid (Münster: Waxmann), 7–12.

Frank, G. H. (1956). Note on the reliability of Q-sort data. *Psychol. Rep.* 2:182. doi: 10.2466/pr0.1956.2.3.182

Gay, G. (2000). *Culturally responsive teaching: Theory, research, and practice*. New York, NY: Teachers College Press.

Godor, B. P. (2016). Moving beyond the deep and surface dichotomy: Using Q methodology to explore students' approaches to studying. *Teach. High. Educ.* 21, 207–218. doi: 10.1080/13562517.2015.1136275

Guttman, L. (1954). An outline of some new methodology for social research. *Public Opin. Q.* 18, 395–404. doi: 10.1086/266532

Hascher, T. (2011). "Forschung zur Wirksamkeit der Lehrerbildung," in *Handbuch zur Forschung zum Lehrerberuf*, eds E. Terhart, H. Bennewitz, and M. Rothland (Münster: Waxmann), 573–591.

Hatton, N., and Smith, D. (1995). Reflection in teacher education: Towards definition and implementation. *Teach. Teach. Educ.* 11, 33–49. doi: 10.1016/0742-051X(94)00012-U

Helmke, A. (2017). *Unterrichtsqualität und Lehrerprofessionalität. Diagnose, Evaluation und Verbesserung der Unterrichts.* Available online at: https://www.psychauthors.de/psychauthors/index.php?wahl=forschung&amp (accessed May 23, 2024).

Helsper, W., Böhme, J., Kramer, R.-T., and Lingkost, A. (2001). *Schulkultur und Schulmythos: Gymnasium zwischen elitärer Bildung und höherer Volksschule im Transformationsprozeß*. Budrich: Budrich Verlag.

Herrington, N., and Coogan, J. (2011). Q methodology: An overview. *Res. Teach. Educ.* 1, 24–28. doi: 10.15123/uel.8604v

Hesse, F., and Lütgert, W. (2020). *Auf die Lernbegleitung kommt es an! Konzepte und Befunde zu Praxisphasen in der Lehrerbildung*. Bad Heilbrunn: Verlag Julius Klinkhardt.

Hoffman, J. V., Wetzel, M. M., Maloch, B., Greeter, E., Taylor, L., DeJulio, S., et al. (2015). What can we learn from studying the coaching interactions between cooperating teachers and preservice teachers? A literature review. *Teach. Teach. Educ.* 52, 99–112. doi: 10.1016/j.tate.2015.09.004

Hopkins, E. (2010). Classroom conditions for effective learning: Hearing the voice of key stage 3 pupils. *Imp. Sch.* 13, 39–53. doi: 10.1177/1365480209357297

Hudson, P., Usak, M., Fančovičová, J., Erdogan, M., and Prokop, P. (2010). Preservice teachers' memories of their secondary science education experiences. *J. Sci. Educ. Technol.* 19, 546–552. doi: 10.1007/s10956-010-9221-z

Irie, K., Ryan, S., and Mercer, S. (2018). Using Q methodology to investigate pre-service EFL teachers' mindsets about teaching competences. *Stud. Sec. Lang. Learn. Teach.* 8, 575–598. doi: 10.14746/ssllt.2018.8.3.3

Ivanova, I., and Skara-Mincāne, R. (2016). Development of professional identity during teacher's practice. *Proc. Soc. Behav. Sci.* 232, 529–536. doi: 10.1016/j.sbspro.2016.10.073

Jaschke, T. (2018). Mathematikunterrichtsbezogene Überzeugungen mithilfe der Q-Methode typisieren. *Bildungsforschung* 1, 1–15. doi: 10.25656/01:16571

Jennek, J., Rother, S., Tosch, F., Wendland, M., Kludt, S., Krauskopf, K., et al. (2022). "Professionalisierung in Praxisphasen: Ergebnisse der Lehrerbildungsforschung an der Universität Potsdam," in *Potsdamer Beiträge zur Lehrkräftebildung und Bildungsforschung*, ed. J. Jennek (Potsdam: Universitätsverlag Potsdam), doi: 10.25932/publishup-50096

Jurczyk, J., and Ramlo, S. E. (2004). "A new approach to performing course evaluations: Using Q methodology to better understand student attitudes," in *Proceedings of the International Q Methodology Conference*, (Athens, GA).

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educ. Psychol. Meas.* 20, 141–151. doi: 10.1177/001316446002000116

Ketonen, L., and Nieminen, J. H. (2023). Supporting student teachers' reflection through assessment: The case of reflective podcasts. *Teach. Teach. Educ.* 124:104039. doi: 10.1016/j.tate.2023.104039

Kling, I., and Lintner, A. (2022). Praxisbezogene Einstellungen von Lehramtsstudierenden – eine Q-Studie. *Zeitschrift Emp. Pädagogik* 36, 80–98.

Körkkö, M., Kyrö-Ämmälä, O., and Turunen, T. (2016). Professional development through reflection in teacher education. *Teach. Teach. Educ.* 55, 198–206. doi: 10.1016/j.tate.2016.01.014

Korthagen, F. (2017). Inconvenient truths about teacher learning: Towards professional development 3.0. *Teach. Teach.* 23, 387–405. doi: 10.1080/13540602.2016.1211523

Korthagen, F., and Kessels, J. (2001). *Linking practice and theory: The pedagogy of realistic teacher education*. Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Kramer, R.-T. (2020). "Zum Problem der Professionalisierung im Lehramtsstudium und zum Potenzial der Hochschullernwerkstatt," in *Hochschullernwerkstätten – Elemente von Hochschulentwicklung? Ein Rückblick auf 15 Jahre Hochschullernwerkstatt in Halle und andernorts*, eds K. Kramer, D. Rumpf, M. Schöps, and S. Winter (Bad Heilbrunn: Klinkhardt), 275–288.

Kunina-Habenicht, O., Lohse-Bossenz, H., Kunter, M., Dicke, T., Förster, D., Gößling, J., et al. (2012). Welche bildungswissenschaftlichen Inhalte sind wichtig in der Lehrerbildung? Ergebnisse einer Delphi-Studie. *Zeitschrift Erziehungswissenschaft* 15, 649–682. doi: 10.1007/s11618-012-0324-6

Kunter, M., Kunina-Habenicht, O., Baumert, J., Dicke, T., Holzberger, D., Lohse-Bossenz, H., et al. (2017). "Bildungswissenschaftliches Wissen und professionelle Kompetenz in der Lehramtsausbildung," in *Entwicklung von Professionalität pädagogischen Personals: Interdisziplinäre Betrachtungen, Befunde und Perspektiven*, eds C. Gräsel and K. Trempler (Wiesbaden: Springer Fachmedien Wiesbaden), 37–54. doi: 10.1007/978-3-658-07274-2_3

Ladson-Billings, G. (2001). *Crossing over to canaan: The journey of new teachers in diverse classrooms*. San Francisco, CA: Jossey-Bass.

Lee, H.-J. (2005). Understanding and assessing preservice teachers' reflective thinking. *Teach. Teach. Educ.* 21, 699–715. doi: 10.1016/j.tate.2005.05.007

Leonhard, T., and Rihm, T. (2011). Erhöhung der Reflexionskompetenz durch Begleitveranstaltungen zum Schulpraktikum? Konzeption und Ergebnisse eines Pilotprojekts mit Lehramtsstudierenden. *Lehrerbildung Prüfstand* 4, 240–270. doi: 10.25656/01:14722

Levin, B., and He, Y. (2008). Investigating the content and sources of teacher candidates' Personal Practical Theories (PPTs). *J. Teach. Educ.* 59, 55–68. doi: 10.1177/0022487107310749

Lim-Ratnam, C., Tay, L., Tan, J. Y., Ong, M., and Aiyoob, T. (2022). Applying Q methodology to understand priorities in profiles of teacher reflections. *Teach. Teach. Educ.* 109:103535. doi: 10.1016/j.tate.2021.103535

Lundberg, A. (2022). Academics' perspectives on good teaching practice in Switzerland's higher education landscape. *Int. J. Educ. Res. Open* 3:100202. doi: 10.1016/j.ijedro.2022.100202

Lundberg, A., and Stigmar, M. (2023). University teachers' shifting views of successful learning environments in the future. *Scand. J. Educ. Res.* 67, 964–979. doi: 10.1080/00313831.2022.2115127

Lundberg, A., de Leeuw, R., and Aliani, R. (2020). Using Q methodology: Sorting out subjectivity in educational research. *Educ. Res. Rev.* 31:100361. doi: 10.1016/j.edurev.2020.100361

Lunn Brownlee, J., Ferguson, L. E., and Ryan, M. (2017). Changing teachers' epistemic cognition: A new conceptual framework for epistemic reflexivity. *Educ. Psychol.* 52, 242–252. doi: 10.1080/00461520.2017.1333430

Mattsson, M., Eilertsen, T. V., and Rorrison, D. (2011). *A practicum turn in teacher education*. Rotterdam: Sense Publishers, doi: 10.1007/978-94-6091-711-0

McKenzie, P., Santiago, P., and Oecd. (2005). *Teachers matter: Attracting, developing and retaining effective teachers*. Paris: OECD, doi: 10.1787/9789264018044-en

McKeown, B., and Thomas, D. B. (2013). *Q methodology*. SAGE Publications, Inc. doi: 10.4135/9781483384412

McLaughlin, T. H. (1999). Beyond the reflective teacher. *Educ. Philos. Theory* 31, 9–25. doi: 10.1111/j.1469-5812.1999.tb00371.x

McNamara, D. (1990). Research on teachers' thinking: Its contribution to educating student teachers to think critically. *J. Educ. Teach.* 16, 147–160. doi: 10.1080/0260747900160203

Mezirow, J. (1991). *Transformative dimensions of adult learning*, 1st Edn. San Francisco, CA: Jossey-Bass.

Mezirow, J., and Associates (1990). *Fostering critical reflection in adulthood: A guide to transformative and emancipatory learning*, 1st Edn. San Francisco, CA: Jossey-Bass.

Mokrý, S., and Dufek, O. (2014). Q method and its use for segmentation in tourism. *Proc. Econ. Finance* 12, 445–452. doi: 10.1016/S2212-5671(14)00366-9

Mulder, H., Ter Braak, E., Chen, H. C., and Ten Cate, O. (2019). Addressing the hidden curriculum in the clinical workplace: A practical tool for trainees and faculty. *Med. Teach.* 41, 36–43. doi: 10.1080/0142159x.2018.1436760

Müller, F. H., and Kals, E. (2004). Die Q-Methode. Ein innovatives Verfahren zur Erhebung subjektiver Einstellungen und Meinungen. [Q-technique and Q-methodology – innovative methods for examining attitudes and opinions]. *Forum Qual. Sozialforschung/Forum: Qual. Soc. Res.* 5:17. doi: 10.17169/fqs-5.2.600

Owens, L., and Duncan, N. (2009). They might not like you but everyones knows you: Popularity among teenage girls. *J. Stud. Wellbeing* 3, 14–39. doi: 10.21913/JSW.v3i1.408

Palmer, P. (1998). *The courage to teach: Exploring the inner landscape of a teacher's life*. San Francisco, CA: Jossey-Bass.

Park, S. H., and Ertmer, P. (2007). Impact of problem-based learning (PBL) on teachers' beliefs regarding technology use. *J. Res. Technol. Educ.* 40, 247–267. doi: 10.1080/15391523.2007.10782507

Patry, J.-L. (2014). "Theoretische Grundlagen des Theorie-Praxis-Problems in der Lehrer-/innenbildung," in *Schulpraktika in der Lehrerbildung*, eds K.-H. Arnold, A. Gröschner, and T. Hascher (Münster: Waxmann), 29–44.

Pruslow, J., and Owl, R. (2012). Demonstrating the application of Q methodology for fieldwork reporting in experiential education. *J. Exp. Educ.* 35, 375–392. doi: 10.1177/105382591203500207

Ramlo, S. E. (2008). "Determining the various perspectives and consensus within a classroom using Q methodology," in *Proceedings of the Physics Education Research Conference*, (Edmonton, AB), 179–182. doi: 10.1063/1.3021248

Ramlo, S. E. (2012). Determining faculty and student views: Applications of Q methodology in higher education. *J. Res. Educ.* 22, 86–107.

Ramlo, S. E. (2015a). Q methodology as a tool for program assessment. *Mid-Western Educ. Res.* 27, 207–223. Available online at: https://www.mwera.org/MWER/volumes/v27/issue3/v27n3-Ramlo-FEATURE-ARTICLE.pdf

Ramlo, S. E. (2015b). Student views about a flipped physics course: A tool for program evaluation and improvement. *Res. Sch.* 22, 44–59.

Ramlo, S. E. (2017). Improving student evaluation of teaching: Determining multiple perspectives within a course for future math educators. *J. Res. Educ.* 27, 49–78.

Ramlo, S. E. (2021). "Q methodology as mixed analysis," in *The routledge reviewer's guide to mixed methods analysis*, eds A. J. Onwuegbuzie and R. B. Johnson (England: Routledge), 199–208. doi: 10.4324/9780203729434-18

Ramlo, S. E., McConnell, D., Duan, Z.-H., and Moore, F. B. (2008). Evaluating an Inquiry-Based Bioinformatics Course Using Q Methodology. *J. Sci. Educ. Technol.* 17, 219–225. doi: 10.1007/s10956-008-9090-x

Reusser, K., and Pauli, C. (2014). "Berufsbezogene Überzeugungen von Lehrerinnen und Lehrern," in *Handbuch der Forschung zum Lehrerberuf*, eds E. Terhart, H. Bennewitz, and M. Rothland (Münster: Waxmann), 642–661.

Richert, A. E. (1990). Teaching teachers to reflect: A consideration of programme structure. *J. Curriculum Stud.* 22, 509–527. doi: 10.1080/0022027900220601

Rieber, L. P. (2018). "Subjectivity in the classroom: A design case study of a Q sort tool," in *Paper Presented at the annual meeting of the American Educational Research Association*, (New York, NY).

Rieber, L. P. (2020). Q methodology in learning, design, and technology: An introduction. *Educ. Technol. Res. Dev.* 68, 2529–2549. doi: 10.1007/s11423-020-09777-2

Rimm-Kaufman, S. E., Storm, M. D., Sawyer, B. E., Pianta, R. C., and LaParo, K. M. (2006). The Teacher Belief Q-Sort: A measure of teachers' priorities in relation to disciplinary practices, teaching practices, and beliefs about children. *J. Sch. Psychol.* 44, 141–165. doi: 10.1016/j.jsp.2006.01.003

Rodl, J., Cruz, R., and Knollman, G. (2020). Applying Q methodology to teacher evaluation research. *Stud. Educ. Eval.* 65:100844. doi: 10.1016/j.stueduc.2020.100844

Rothland, M. (2013). "Belastung und Beanspruchung im Lehrerberuf und die Modellierung professioneller Kompetenz von Lehrerinnen und Lehrern," in *Belastung und Beanspruchung im Lehrerberuf*, ed. M. Rothland (Wiesbaden: Springer VS), 7–20. doi: 10.1007/978-3-531-18990-1_1

Sayeski, K., and Higgins, K. (2013). Redesigning special education teacher preparation programs with a focus on outcomes. *Teach. Educ. Spec. Educ.* 37, 91–105. doi: 10.1177/0888406413513274

Schlömerkemper, J. (2004). Eckpunkte zum Kernstudium der Lehrerbildung. Der Beitrag der Bildungswissenschaften zur Professionalisierung von Lehrerinnen und Lehrern.. *Erziehungswissenschaft* 15, 25–36. doi: 10.25656/01:1051

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. London: Temple Smith.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions*, 1st Edn. San Francisco, CA: Jossey-Bass.

Seidel, A. (2017). "(Weiter-)Entwicklung der Lehrerbildung im Land Brandenburg. Der Beitrag der Bildungswissenschaften in der Potsdamer Sekundarstufenlehrerausbildung," in *Studium nach Bologna. Befunde und Positionen (Potsdamer Beiträge zur Hochschulforschung)*, eds S. Schubarth, S. Mauermeister, and A. Seidel (Potsdam: Universitätsverlag Potsdam), 137–159.

Serfass, D. G., and Sherman, R. A. (2013). A methodological note on ordered Q-sort ratings. *J. Res. Pers.* 47, 853–858. doi: 10.1016/j.jrp.2013.08.013

Smith, N. W. (2001). *Current systems in psychology: History, theory, research, and applications*. London: Wadsworth.

Sööt, A., and Viskus, E. (2015). Reflection on teaching: A way to learn from practice. *Proc. Soc. Behav. Sci.* 191, 1941–1946. doi: 10.1016/j.sbspro.2015.04.591

Sparks-Langer, G. M., and Colto, A. B. (1991). Synthesis of research an teachers' reflective thinking. *Educ. Leadersh.* 48, 37–44.

Stainton Rogers, R. (1995). "Q methodology," in *Rethinking methods in psychology*, eds J. A. Smith, R. Harré, and L. van Langenhove (London: AGE Publications, Inc.), 178–192.

Steinmann, S. (2022). *Shared und mutual beliefs in der lehrerinnen- und lehrerbildung. untersuchung über die beliefs von lehrerausbildenden bezüglich des lehrens, lernens und der rolle der lehrperson*. Münster: Waxmann.

Steller, M., and Meurer, K. (1974). Zur Reliabilität eines Q-Sorts zur Veränderungsmessung. *Psychol. Beiträge* 16, 618–624.

Stenner, P., and Stainton Rogers, R. (2004). "Q methodology and qualiquantology: The example of discriminating between emotions," in *Mixing methods in psychology: The integration of qualitative and quantitative methods in theory and practice*, eds Z. Todd, B. Nerlich, S. McKeown, and D. D. Clarke (New York, NY: Psychology Press), 101–120.

Stephenson, W. (1935). Correlating persons instead of tests. *J. Pers.* 4, 17–24. doi: 10.1111/j.1467-6494.1935.tb02022.x

Stephenson, W. (1953). *The study of behavior. Q-technique and its methodology*. Chicago, IL: University of Chicago Press.

Svojanovsky, P. (2017). Supporting student teachers' reflection as a paradigm shift process. *Teach. Teach. Educ.* 66, 338–348. doi: 10.1016/j.tate.2017.05.001

Swan, M. (2007). The impact of task-based professional development on teachers' practices and beliefs: A design research study. *J. Mathemat. Teach. Educ.* 10, 217–237. doi: 10.1007/s10857-007-9038-8

Taibi, M. (2013). *Berufsbezogene Überzeugungen angehender Lehrpersonen. Eine qualitative Studie zur Rekonstruktion der Entwicklungsprozesse im Zeitraum der universitären Ausbildung*. Dissertation, Germany: Universität zu Köln.

Terhart, E. (2013). "Vorwort," in *Die Reform der Praxisphasen in der ersten Phase der Lehrerbildung: Eine qualitative Dokumentenanalyse*, eds E. Offenburg and J. Walke (Bonn: Stifterverband für die Deutsche Wissenschaft).

Valli, L. (1990). "Moral approaches to reflective practice," in *Encouraging reflective practice in education*, eds R. Cliff, W. R. Houston, and M. Pugach (New York, NY: Teachers College Press), 39–56.

Valli, L. (1992). *Reflective teacher education: Cases and critiques*. Albany, NY: State University of New York.

van Exel, J., and Graaf, G. (2005). *Q methodology: A sneak preview*. Available online at: https://www.researchgate.net/publication/228574836_Q_Methodology_A_Sneak_Preview (accessed May 14, 2024).

van Exel, J., Baker, R., Mason, H., Donaldson, C., and Brouwer, W. (2015). Public views on principles for health care priority setting: Findings of a European cross-country study using Q methodology. *Soc. Sci. Med.* 126, 128–137. doi: 10.1016/j.socscimed.2014.12.023

van Manen, M. (1977). Linking ways of knowing with ways of being practical. *Curriculum Inq.* 6, 205–228. doi: 10.2307/1179579

Walker, B. B. (2013). *Identifying participants' perspective changes in mediation training using Q methodology*. Athens, GA: University of Georgia.

Walker, B. B., and Lin, Y. (2017). *Q-Perspectives® online*. Available online at: https://www.qperspectives.com/ (accessed April 28, 2024).

Walker, B. B., Lin, Y., and McCline, R. M. (2018). Q methodology and Q-Perspectives® Online: Innovative research methodology and instructional technology. *TechTrends* 62, 450–461. doi: 10.1007/s11528-018-0314-5

Watts, S., and Stenner, P. (2005). Doing Q methodology: Theory, method and interpretation. *Qual. Res. Psychol.* 2, 67–91. doi: 10.1191/1478088705qp022oa

Watts, S., and Stenner, P. (2012). *Doing Q methodological research: Theory, method & interpretation*. Thousand Oaks, CA: SAGE Publications, Inc, doi: 10.4135/9781446251911

Weyland, U. (2014). Schulische Praxisphasen im Studium: Professionalisierende oder deprofessionalisierende Wirkung? *bwp@ Berufs- und Wirtschaftspädagogik – online Profil* 3, 1–24. Available online at: https://www.bwpat.de/profil3/weyland_profil3.pdf (accessed May 21, 2024).

Wolf, A. (2022). "Perspectives on Q sorting," in *Cultivating Q methodology: Essays honoring Steven R. Brown*, eds J. C. Rhoads, D. B. Thomas, and S. E. Ramlo (Hudson, OH: International Society for the Scientific Study of Subjectivitiy), 242–268.

Woods, C. (2011). Using Q methodology to explore leadership: The role of the school business manager. *Int. J. Leadersh. Educ.* 14, 317–335. doi: 10.1080/13603124.2010.507877

Yang, X., and Xu, M. (2021). "The use of Q methodology to evaluate instruction in higher education," in *A practitioner's guide to instructional design in higher education*, eds S. Conklin, R. M. Oyarzun, R. M. Reese, and J. E. Stefaniak (EdTech Books), doi: 10.59668/164.4270

Yang, Y., and Montgomery, D. (2013). Gaps or bridges in multicultural teacher education: A Q study of attitudes toward student diversity. *Teach. Teach. Educ.* 30, 27–37. doi: 10.1016/j.tate.2012.10.003

Zeichner, K. (2010). Rethinking the connections between campus courses and field experiences in college and university-based teacher education. *J. Teach. Educ.* 61, 89–99. doi: 10.1177/0022487109347671

Zeichner, K., and Liston, D. P. (1987). Teaching student teachers to reflect. *Harv. Educ. Rev.* 57, 23–48. doi: 10.17763/haer.57.1.j18v7162275t1w3w

Zeichner, K., and Liston, D. P. (1996). *Reflective teaching: An introduction*. Mahwah, N.J.: L. Erlbaum Associates.

Zierer, K. (2015). Pädagogische Expertise. *Vierteljahrsschrift Wissenschaftliche Pädagogik* 91, 121–132. doi: 10.30965/25890581-091-01-90000008