ORIGINAL ARTICLE

Investigation of the Pre-Service Science Teachers' Conception of Assessment and Its Connection with Their Approaches to Assessment

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Abstract: This study aimed to examine Turkish pre-service science teachers' conceptions of assessment, and how pre-service science teachers with different approaches to assessment conceptualize assessment. A total of 15 pre-service science teachers participated in the study. To achieve this aim, an adapted version of the Approaches to Classroom Assessment Inventory was first administered to identify participants' assessment approaches across four dimensions: purpose, process, fairness, and assessment theory. Subsequently, semi-structured interviews were conducted to gather in-depth data. The interview data were analyzed using qualitative content analysis, with parent and child codes identified both inductively and deductively. The results indicated that, according to most participants, assessment should focus on the "student" in order to diagnose learning difficulties and misconceptions, monitor progress, and provide feedback. Furthermore, participants emphasized the importance of contemporary assessment methods, such as portfolio assessment, peer assessment, self-assessment, and the use of Vee diagrams. The study concluded that pre-service science teachers' approaches to assessment reflect contemporary views, though their conceptions of assessment were not fully aligned with any single assessment approach.

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***Keywords**: Conception of Assessment, Approaches to Assessment, Assessment Literacy, Pre-Service Science Teachers*

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Introduction

OVER THE YEARS, teachers have used assessment in classrooms to understand what and how students learn, to support and improve their learning, to guide instruction, and to provide feedback to students, parents, and other teachers (Phye, 1996). Through assessment, teachers make inferences about students' learning status in order to make appropriate educational decisions, provide evidence to students, parents, and teachers about students' progress, and demonstrate students' accomplishments (Popham, 2013).

Accordingly, when many different educational systems are examined, it is realized that there is an increased priority and attention on teacher assessment literacy (DeLuca et al., 2016a). Assessment literacy refers to teachers' ability and knowledge to construct, administer, and score assessments; to measure learning through assessment (Popham, 2013); to initiate, advance, accommodate, and use suitable assessment approaches to improve student learning (DeLuca et al., 2016a). Considering this definition, proficiency in assessment practices is essential for teachers to improve the quality of teaching and learning (Volante & Fazio, 2007) because teachers' classroom assessment practices influence student learning. In fact, effective classroom assessment practices allow teachers to draw conclusions about each student's achievement, communicate with students and parents based on these conclusions, and focus on future practices (Brookhart, 1999). On the contrary, ineffective classroom assessment practices cause decreased reliability and validity, leading to misguided and improper educational decisions for future practices (DeLuca & Klinger, 2010). In addition, according to Popham (2013), there are four traditional and three current reasons why teachers should know about classroom assessment. The four traditional reasons that teachers should know about assessment are to (1) decide students' status in instruction, (2) monitor students' progress, (3) assign grades to students, and (4) decide teachers' own efficiency in instruction. Moreover, the three current reasons are (1) assessment results influence and shape public impression of educational efficiency, (2) assessment performances help the evaluation of teachers and their teaching, and (3) assessment instruments are prepared to clarify instructional goals and to guide efficient instructional decisions by teachers. For these reasons, teachers need to carry out assessment practices well because they improve instruction and the learning environment (Coombs et al., 2018) and affect students' motivation and learning (McMillan, 2000; Timperley, 2009). In general, teachers' approaches to assessment affect students' motivation, engagement, and advancement both positively and negatively (DeLuca et al., 2019).

In this study, a four-dimensional assessment literacy framework was used to describe teachers' approaches to classroom assessment. The four di-

Table 1. Assessment Literacy Domains.

Assessment Literacy Dimension	Priority Approach	Description of Priority Approach
Assessment Purpose	Assessment of learning	Teachers use summative assessment which includes tests-based results of the questions based on the syllabus of the lesson to evaluate students' learning at the end of the learning process (Vlachou, 2018), and to make a final decision about the instructional activities (Popham, 2013).
	Assessment for learning	Teachers and students use formative assessment to provide feedback during learning process (Wen et. al., 2006), to make decisions about following steps of instruction, and to enhance instructions and students' learning (Brookhart, 2011).
	Assessment as learning	Students use assessment to monitor and assess their learning process (Earl, 2003). Includes teachers but emphasize the role of the student (DeLuca et. al., 2019).
Assessment Process	Design	Teachers underline the design and development of reliable assessments according to learning goals (DeLuca et. al., 2019).
	Use/scoring	Teachers focus adaptation and use of rubrics (DeLuca et. al., 2019).
	Communication	Teachers give priority communicating with students and parents to interpret assessment results and give aimful feedback (DeLuca et. al., 2019).
Assessment Fairness	Standard	Teachers apply same assessments for all of the students (DeLuca et. al., 2019).
	Equitable	Teachers use accommodation and modification on assessments for identified students (DeLuca et. al., 2019).
	Differentiated	Teachers apply individualized assessments for each student (DeLuca et. al., 2019).
Assessment Theory	Consistent	Teachers try to assure reliability and consistency in assessment results including scoring, design and administration across time intervals and different teachers (DeLuca et. al., 2019).
	Contextual	Teachers try to assure assessment adjust with learning objectives, reflect students' learning correctly, and consider student and context while interpreting the assessment results (DeLuca et. al., 2019).
	Balanced	Teachers try to assure reliability and consistency in measuring what an assessment aims and demands to measure (DeLuca et. al., 2019).

mensions of assessment literacy include (1) assessment purposes (choosing an appropriate assessment form based on instructional goals and learning objectives), (2) assessment processes (constructing, administering, and scoring assessments; interpreting assessment results to assist instructional decision making), (3) assessment fairness (providing fair assessment conditions for all students while considering student diversity), and (4) assessment theory (understanding psychometric properties and the reliability and validity of assessments) to represent the contemporary aspects of teacher assessment literacy (DeLuca et al., 2016a). Each dimension is associated with three priority approaches. To illustrate, assessment fairness is associated with standard, equitable, and differentiated approaches. The complete list of priority approaches with their definitions is presented in **Table 1**.

According to Harrison (2005) and Popham (2013), teachers' approaches to assessment are influenced by several factors, which include assessment experiences and practices, their values, beliefs and knowledge of

assessment, and students' learning needs. Additionally, Tierney (2006) described six other factors: professional development, educational policy, educational research, large-scale assessments, evaluative inquiry, and teachers' beliefs. Analyzing teachers' beliefs helps to clarify the relationship between their beliefs, students' outcomes, and classroom practices (Opre, 2010), because teachers' beliefs affect how they teach and how students achieve (Savasci-Acikalin, 2009). According to Opre (2015), teachers' beliefs are an essential factor in determining instructional practices and students' learning processes.

To address the different terminology regarding beliefs, researchers who study beliefs about assessment have used the term "conception," which is the preferred term and is commonly used in the specialized assessment literature (Opre, 2015). The term "conception" originates from Thompson (1992) and can be defined as "general mental structure, encompassing beliefs, meanings, concepts, propositions, rules, mental images, preferences, and the like" (p. 130).

Accordingly, teachers' conceptions depict various categories of ideas related to their descriptions of how they experience educational concepts (Pratt, 1992). These conceptions represent teachers' views, interactions, and interpretations of the teaching environment (Marton, 1981).

Studies related to teachers' conceptions of assessment are important because teachers' conceptions of learning, teaching, assessment, and curriculum affect the way they teach and how their students learn and achieve learning goals (Thompson, 1992), the quality of teachers' performance and the implementation of methods in educational activities (Opre, 2015), and their perceptions and evaluation of student performance (i.e., assessment) (Brown, 2004). In addition, teachers' conceptions of assessment have an impact on their interpretations and contributions within their teaching context (Skott, 2015). Therefore, studies on teachers' conceptions of assessment significantly contribute to understanding how teachers comprehend assessment, how they conceive assessment, and how their conceptions affect their teaching (Opre, 2015).

According to various researchers, teachers hold four conceptions of assessment. The first conception is that assessment advances the student learning process and the quality of teaching (Black & Wiliam, 1998). In order to identify advancement in learning and teaching, assessment must provide valid and reliable information about students' performance (Brown, 2004). Assessment should also provide teachers with information to improve their teaching and instructional activities (Opre, 2015). The second conception is that assessment can be used to represent teachers', schools', or the education system's use of public resources. Assessment results demonstrate teachers' or schools' performance and communicate the consequences of that performance to others (Firestone et al., 1998). In other words, teachers

and schools are the two main factors that affect students' performance (Opre, 2015). The third conception is that students are independently responsible for their learning through assessment. Assessment results carry important consequences for individual students, such as placement into learning groups or classes, graduation, and admission to higher levels of education based on their grades, performance, and exams (Brown, 2004). The fourth conception is that assessment has no valid role in teaching and learning. Assessment is generally considered to cause negative consequences for students, teachers, and the education system. For instance, assessment may create anxiety in students and lead them to underestimate their abilities (Opre, 2015). Moreover, assessment can distract from the actual purpose of teaching and learning, negatively affecting teachers' autonomy and professionalism (Dixon, 1999).

Additionally, Brown (2004) summarized teachers' four conceptions of assessment: (a) assessment improves teacher instruction and student learning by providing quality information for decision-making; (b) assessment makes students accountable for their learning; (c) teachers or schools are made accountable through assessment; and (d) assessment is irrelevant to the work of teachers and the lives of students (p. 305). According to Brown (2004), these four conceptions of assessment can interact with each other. In other words, teachers can hold multiple conceptions about assessment. To illustrate, teachers who believe assessment is irrelevant may also think that assessment improves instruction and student learning (Brown, 2004). It has also been demonstrated that teachers' conceptions of assessment can be influenced by several factors, such as their years of professional experience, their prior experiences as students, the educational context in which they work, and the socio-economic status of their schools (Brown, 2004). However, these conceptions can also be altered by the educational system, teachers' understanding of content (Vandeyar & Killen, 2007), their perceptions of societal expectations, and their beliefs about their students' abilities (Bright & Joyner, 1998).

In several empirical studies, Brown and his colleagues (Brown, 2004; Brown & Harris, 2009; Brown et al., 2011) used the Teachers' Conceptions of Assessment (COA) instrument to measure teachers' agreement and disagreement with 50 items related to the four conceptions of assessment. The results revealed that the participant teachers agreed with the conceptions that assessment improves teacher instruction and student learning by providing quality information for decision-making, that assessment makes students accountable for their learning, and that teachers or schools are made accountable through assessment. Conversely, they disagreed with the conception that assessment is irrelevant to the work of teachers and the lives of students. DeLuca et al. (2016a) also reported that "teachers conceptualize and value assessment purposes differently," pointing to potential variability in teachers' approaches to assessment (p. 360).

In another study, Hargreaves (2005) explored teachers' conceptions of assessment. Data were collected from 83 teachers. Based on the participants' responses, the author summarized six conceptions of assessment for learning: (1) monitoring students' performance against learning goals; (2) using assessment results to inform the next steps of learning and teaching; (3) providing feedback for improvement; (4) gaining insights into students' learning; (5) enabling students to take control of their own learning and assessment; and (6) using assessment as a learning event.

Another study was conducted by Wang, Kao, and Lin (2010) to describe and analyze pre-service teachers' initial conceptions about the assessment of science learning. Data were collected from 215 pre-service teachers through open-ended written questions and interviews. The results showed that more than half of the participants conceived of assessment as a way to measure students' knowledge related to learning objectives; approximately half believed that knowledge application should be assessed; roughly 10% indicated that the aim of assessment should be fundamental process skills and that students' involvement in learning tasks should be assessed; and less than 5% believed that higher levels of inquiry thinking processes should be assessed.

Based on the above-mentioned literature, this study aimed to investigate pre-service science teachers' conception of assessment through semi-structured interviews to get an in-depth understanding of their conceptions. More specifically, the current study aims to reveal how pre-service science teachers with different approaches to assessment conceptualize assessment.

Thus, the research questions of this study are as follows:

1. *What are the pre-service science teachers' conceptions of assessment?*
2. *How do pre-service science teachers with different approaches to assessment conceptualize assessment?*

Significance of the Study

Capability for understanding the principles of assessment and evaluation is a fundamental skill for advancing teaching and learning (Volante & Fazio, 2007), because teachers' assessment practices improve instruction and the learning environment (Coombs et al., 2018) and affect students' motivation, learning, and achievement (McMillan, 2000; Timperley, 2009). For this reason, teacher education programs should attach importance to improving pre-service teachers' assessment literacy so that they can select and apply suitable assessments effectively (Siegel & Wissehr, 2011). However, most research on assessment literacy has emphasized assessment purposes while ignoring other aspects of assessment literacy (DeLuca et al., 2016a). Thus, in the present study, an adapted version of the Approaches to Classroom Assessment Inventory (ACAI), which focuses on four themes (aspects) of as-

sessment literacy: (1) assessment purpose, (2) assessment process, (3) assessment fairness, and (4) assessment theory (DeLuca et al., 2016b) was used. This instrument is intended to provide a comprehensive understanding of pre-service science teachers' approaches to assessment based on a multidimensional assessment literacy framework. In fact, the majority of studies on teachers' assessment literacy have been conducted using the 1990 standards (i.e., American Federation of Teachers, National Council on Measurement in Education, National Education Association, & Standard for Teacher Competency in Educational Assessment of Students, 1990). Because there are no reliable data on teachers' current approaches to classroom assessment due to a lack of assessment literacy measures (DeLuca et al., 2016a; Gotch & French, 2014), DeLuca et al. (2016b) developed ACAI based on new assessment standards. For these reasons, the Approaches to Classroom Assessment Inventory (ACAI) were selected for the present study. ACAI was translated and adapted into Turkish and used in Türkiye for the first time. Based on the study results, some suggestions can be made for teachers, prospective teachers, teacher educators, and educational policymakers to improve teaching and the learning process in science classes. Furthermore, this study has the potential to contribute to both the national and international literature by portraying pre-service science teachers' approaches to assessment within a four-theme assessment literacy framework that includes contemporary emphases on assessment. Finally, during the literature review, the researcher did not encounter any study examining the link between pre-service teachers' approaches to classroom assessment and their conceptions of assessment. Therefore, the current study is believed to be the first in the related literature to focus on this link.

Method

Study Context

In Türkiye, students must take a national university entrance exam at the end of high school to be able to attend the Elementary Science Education (ESE) program. The general aim of the ESE program is to educate future science teachers for grades 5–8 in elementary schools. In Türkiye, the ESE program was prepared by the Council of Higher Education (CoHE) in 1998, 2006, and 2018. The participants of this study followed the program that was prepared in 2006. It is a four-year program and consists of required courses related to scientific field knowledge, professional teaching knowledge, general knowledge, and elective courses (Arduc et al., 2020). One of the courses focuses on educational assessment.

Samples

The sample consisted of 15 volunteer Turkish PSTs (12 females and 3 males). They ranged in age from 20 to 27. Most of the participants took only one assessment course and only one did not take any courses related to assessment. The highly endorsed approaches by each participant were determined using their responses to the Approaches to Classroom Assessment Inventory as detailed in the instruments sub-section. The instrument was initially administered to a total of 676volunteer PSTs. The last section of the ACAI asked the participants whether they would be volunteers to participate in the semi-structured interviews. A total of 85 participants volunteered to participate in the semi-structured interviews. An e-mail was sent to volunteers to confirm their volunteer participation. Of 85 volunteers, 15 agreed to participate in the study. The semi-structured interviews were conducted with them. Data analysis revealed that 15 participants were sufficient to provide saturation. A summary of the participants' characteristics is provided in Appendix. As seen in the Appendix, the there was a variety concerning participants' gender, number of courses taken, perceived adequacy of the courses, and particular approaches to assessment in each theme. Therefore, with these 15 participants maximum variation was provided to be able to indicate both the variety and the mutual patterns in that diversity. All participants involved in the study gave consent prior to the study. The present study, was approved by the Human Subjects Ethics Committee at Middle East Technical University (496 ODTU 2019).

Instruments

The Approaches to Classroom Assessment Inventory (ACAI)

The ACAI was developed by a research team based on the new Classroom Assessment Standards of the Joint Committee for Standards on Educational Evaluation (Joint Committee on Standards for Educational Evaluation, 2015). The instrument developers identified four themes and each theme is associated with three assessment approaches: (1) assessment purposes (includes assessment of learning (AoL), assessment for learning (AfL) and assessment as learning (AaL) approaches), (2) assessment processes (includes design, use/scoring and communication approaches), (3) assessment fairness (includes standard, equitable and differentiated approaches), and (4) assessment theory (includes consistent, contextual and balanced approaches) to represent the contemporary aspects of teacher assessment literacy (DeLuca et al., 2018). It was adapted to Turkish science education context by the authors by

taking necessary permission from the instrument's developers. Specifically, the adaptation process of the instrument was carried out systematically to ensure its linguistic equivalence, cultural appropriateness, and content validity. In the first stage, the wording of all items was carefully reviewed by a panel of experts consisting of two specialists in psychological counseling and guidance, three Turkish language teachers, two English language teachers, one science education scholar with 18 years of expertise in assessment, and one consultant from the Academic Writing Center. This multidisciplinary evaluation aimed to eliminate linguistic ambiguities, avoid unfamiliar or contextually inappropriate terminology, and secure alignment with the educational and cultural characteristics of the target population. Based on expert recommendations, several items were revised, and the process was repeated until full consensus on clarity and appropriateness was achieved.

To further enhance the face validity of the instrument, two experts in science education and one expert in Turkish language education were also consulted. Based on the experts' feedback, necessary parts were revised and rechecked. They provided insights into the comprehensibility of the items from the perspective of the intended respondents, ensuring that the instrument was appropriate to the context of pre-service science teachers. Moreover, the questions were pilot tested with two pre-service science teachers. Their feedback focused on the questions in terms of comprehensibility, clarity, and wording. According to their suggestions, some words were revised to make the questions more comprehensible.

In addition, the researcher maintained ongoing communication with the developers of the original instrument throughout the adaptation process. The developers reviewed the suggested revisions, granted approval for the modifications, and contributed additional recommendations. Accordingly, several items of the ACAI were revised in line with both expert and developer feedbacks. For example, in Scenario 5, the term "*standardized test*" was replaced with "*high school entrance examination*" to enhance contextual relevance to the local educational system.

There are five scenario-based questions in part two with four items, each of which is designed to analyze and determine the PSTs' approaches to classroom assessment. For each item, there are three actions, and the participants were asked to rate the likelihood of enacting each action on a five-point scale (1= not at all likely; 5= highly likely). In total, there are twelve actions associated with twelve assessment approaches for each scenario. The participants' endorsement of a particular approach is determined by averaging their responses across five scenarios. More specifically, the pre-service science teachers were identified as highly supportive of an approach when their mean scores, obtained by averaging their endorsements across all five scenarios, were 4 or above. This cut-off point was determined considering the strategies recommended by one of the developers of the ACAI: it was

Table 2. Endorsement of Approaches by Each Participant.

	Assessment Purpose			Assessment Process			Assessment Fairness			Assessment Theory		
Participant	AoL	AfL	AaL	Design	Use/scoring	Communication	Standard	Equitable	Differentiated	Consisted	Contextual	Balanced
A		x				x		x				
B							x					
C		x	x	x	x	x	x	x		x	x	x
D	x	x				x		x	x			x
E		x	x	x	x	x		x	x			x
F			x	x				x				
G		x	x	x	x	x	x		x			x
H	x	x	x			x		x				
I	x						x			x		
J	x	x	x	x	x	x		x	x		x	x
K		x								x		
L												
M		x		x				x				
N			x			x		x	x		x	x
O		x	x	x		x		x	x			x

recommended that one strategy can be to calculate central tendency (mean or median) for each approach and to use this value to group participants into high/low groups. Another strategy can be to select a cut-off value. The consulted ACAI developer suggested that the greater the cut-off value for high levels of endorsement, the better it would function in identifying the participants. Accordingly, considering these two suggested strategies together (i.e., considering the mean for each approach and selecting a greater cut-off value for a better identification of high levels of endorsement), a cut-off value of 4 or above was selected in this study. **Table 2** summarizes the highly endorsed approaches by each participant considering the abovementioned cut-off point.

Interviews

The authors formed the questions of the semi-structured interviews considering the research questions of the present study, the Approaches to Classroom Assessment Inventory (ACAI) questions, and the related literature (Wang et al., 2010). Accordingly, the interview questions were grouped under 3 main aspects: focus of assessment, method (mode) of assessment, and perceived deficiencies (in assessment). The semi-structured interviews lasted approximately 13 minutes. **Figure 1** displays the summary of methodology followed in the study.

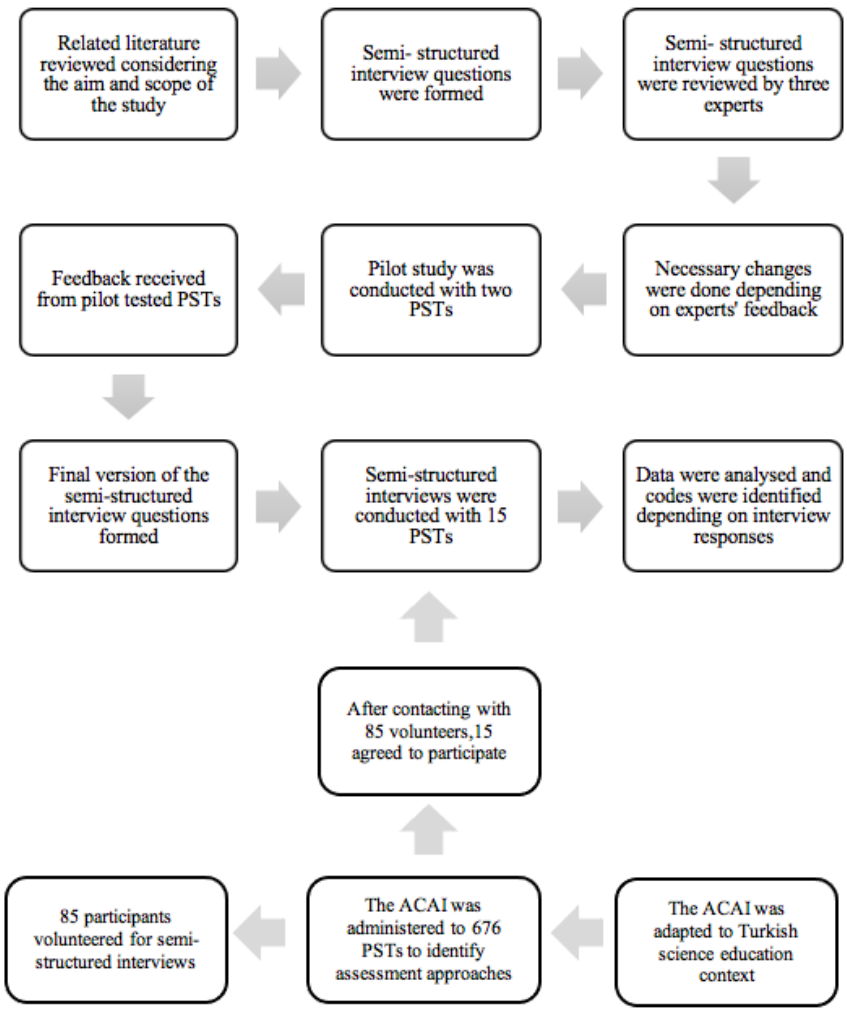

Figure 1. Summary of Methodology.

Data Analysis

Interview responses were examined through qualitative content analysis. In the present study, hybrid coding was used. Hybrid coding involves both inductive and deductive approaches (Saldana, 2013). For the data analysis, three aspects were identified: focus of assessment, method (mode) of assessment, and perceived deficiencies. For each aspect, parent codes and child-codes were identified both inductively (as emergent codes) and deductively (as predetermined codes). More specifically, in the present study, the

interview questions were structured under 3 main aspects: focus of assessment, method (mode) of assessment, and perceived deficiencies (in assessment). During the data analysis, for each aspect, child-codes and parent-codes were identified either inductively or deductively. For example, concerning method (mode) of assessment aspect, based on the study conducted by Wang et al. (2010), some of the child-codes were pre-determined (e.g., paper-pencil test, oral questioning) but others were identified inductively as emergent codes (e.g., self-assessment, Vee diagram). The related parent-codes for this aspect were all identified deductively considering Wang, Kao, and Lin's study. On the other hand, regarding perceived deficiencies aspect, all child-codes and related parent codes were identified inductively.

Before the data analysis, the interview audio recordings were transcribed verbatim. The transcripts were read several times to achieve a thorough comprehension of the participants' responses to interview questions. In line with Lincoln and Guba's (1985) framework, trustworthiness was addressed through four criteria: credibility, dependability, transferability, and confirmability. Credibility, which refers to the alignment between participants' responses and the data obtained (Korstjens & Moser, 2018), was ensured through investigator triangulation. Specifically, an expert in science education with 18 years of experience teaching assessment was consulted during the coding and data analysis process. Any discrepancies that emerged during coding were systematically examined and resolved through in-depth discussion, resulting in complete consensus on the final set of codes. Dependability, or the consistency of findings, was ensured through investigator triangulation (Merriam, 2009), recognizing that exact replication is often difficult in qualitative research due to the dynamic nature of social experiences. Lincoln and Guba (1985) noted that strategies enhancing credibility inherently contribute to dependability. Transferability, the degree to which findings can be applied to other contexts (Korstjens & Moser, 2018), was facilitated by providing detailed descriptions of the pre-service teachers and illustrative excerpts from their interview responses. Finally, confirmability, which pertains to the neutrality of the researcher and the extent to which findings reflect participants' perspectives rather than researcher bias (Stahl & King, 2020), was ensured through investigator triangulation and by maintaining a clear audit trail of the data collection and analysis procedures (Shenton, 2004). These combined measures strengthened the overall trustworthiness of the qualitative findings.

Results

A qualitative content analysis was conducted to determine PSTs conceptions of assessment based on their responses to interview questions. The main questions of the interviews were related to PSTs' conceptions about focus of

Table 3. Codes Identified Based On The Pre-Service Science Teachers' Responses.

Aspect	Parent Code	Child Code
Focus of assessment	Curriculum	Content
		Learning objectives
	Student	Diagnosing learning difficulties
		Diagnosing misconceptions
		Monitoring student learning
		Providing feedback to students
		Grading
	Teacher	Providing feedback to teaching
Method (mode) of assessment	Measurement mode	Paper-pencil test
	Performance mode	Portfolio assessment
		Performance assessment
		Peer assessment
		Self-assessment
		Vee diagram
		Structured grid
		Predict-Observe-Explain
		Open-ended questions
	Informal mode	Oral questioning
		Informal observation
Perceived deficiencies	Teacher education program	Inadequacy of the offered assessment course
		Lack of opportunity for applying theoretical knowledge
		Lack of in-class experience

assessment, method (mode) of assessment and perceived deficiencies in assessment. The parent-codes and child-codes identified as results of data analysis are provided in **Table 3**. In this section, the findings related to the first research question on pre-service science teachers' conceptions of assessment are presented separately under the headings "Pre-service Science Teachers' Conceptions about the 'Focus of Assessment,' 'Method (Mode) of Assessment,' and 'Perceived Deficiencies in Assessment.' Subsequently, the findings related to the second research question are presented.

Pre-service Science Teachers' Conceptions about Focus of Assessment

Pre-service science teachers' responses to the interview questions in relation to focus of assessment revealed three parent codes: curriculum, student and teacher. In general, PSTs emphasized that the focus of the assessment should be student.

First of all, content and learning objectives are found to be the child codes of curriculum parent code (see **Table 3**). More than a half of the PSTs supported this parent code. For example, in the following excerpts the key terms/statements used to identify the codes were written in italics.

"The focus is observing whether students meet learning objectives or not. Assessment should focus lecture content and learning objectives" (PST A)

"That is to say, it should mostly focus content" (PST D)

"… assessing whether students meet the learning objectives or not" (PSTs G, J, O)

"Totally learning objectives" (PST K)

"The main focus is understanding whether students meet the learning objectives or not, so it is so critical tool" (PST N)

Secondly, diagnosing learning difficulties, diagnosing misconceptions, monitoring student learning, providing feedback to students and grading were the emergent child-codes arranged into "student" parent code. According to these findings, while PSTs' views ranged from traditional to contemporary views, contemporary views appeared to be more dominant. Examples given in the following excerpts:

"… it is important to diagnose learning difficulties and specify students' missing points in science lectures" (PSTs A, C, D)

"… because assessing student's learning, in other words assessing student's learning of science is important" (PST B)

"I can say that it is a tool that helps to follow students' learning" (PST C)

"The focus can change but mostly assessment can be used to diagnose misconceptions, grading and understand what student learned at the end of every unit" (PST F)

"We can check and monitor what student learned about the lectures" (PSTs H, I, K)

"The main focus is to see how much students understood. Also, it can be used to diagnose misconceptions and grading them" (PST M)

"Diagnosing misconceptions and monitoring student learning are two main focus, I cannot prioritize one over the other." (PST N)

"In science lectures, the target and the focus are determining misconceptions. Then, we can eliminate the misconceptions. Also, with the help of the assessment, we can specify learning difficulties" (PST O)

Lastly, providing feedback to teaching was the only child-code which was linked to teacher parent-code. Approximately half of the PTSs emphasized this code. Example quotations can be given below:

"… provide feedback about how much I taught to students" (PSTs C, F, M)

"We should focus how much we I taught and able to teach to students, not what students understood" (PST E)

"… helps to understand what I taught to students and what should I done if I did not teach something" (PST H)

"… provide information about what should I do if students fall behind in lecture" (PST K)

"… if there is a problem about our teaching method, we can understand with assessment… teachers can realize their own deficiency in teaching, then they can make up the deficiency" (PST L)

".. I can change my teaching methods if there is a problem, or I can make those methods permanent if I see they work well with students" (PST N)

Overall, although some PSTs emphasized curriculum and grading, the majority of them highlighted diagnosing misconceptions, monitoring student learning, and providing feedback. These findings demonstrate a stronger orientation toward contemporary conceptions of assessment.

Pre-service Science Teachers' Conceptions about Method (mode) of Assessment

Considering pre-service science teachers' responses to the questions related to the most effective method (mode) of assessment, the child codes were integrated into three parent codes namely, measurement mode, performance mode and informal mode. According to the results, most of the PSTs (B, C, D, E, F, G, H, I, J, L, N, O) focused one method of assessment fitting to one parent code. However, some of the PSTs (A, K, M) mentioned about the use of more than one method fitting more than one parent code. In general, PSTs appear to emphasize performance mode and informal mode. There is only one PST expressing paper-pencil tests as the most effective way for assessment.

Firstly, paper-pencil test is only the child-code of measurement mode parent code. Example quotations can be given below:

"At the end of the units, paper-pencil test can be conducted to understand what student learn" (PTS A)

Also, portfolio assessment, performance assessment, peer assessment, self-assessment, open-ended questions, vee diagram, structured grid and predict-observe-explain are the child-codes integrated into performance mode. The followings were sample excerpts:

"Or vee diagram can be useful, we used it in our teacher education program" (PST A)

"I cannot say specific method for science lectures, but self-assessment and peer assessment can be helpful to criticize themselves" (PST C)

"For example, self-assessment forms, or predict-observe-explain method can be efficient methods while assessing and teaching" (PST D)

"In the future, portfolio assessment can be the right technique" (PST E)

"We can involve students by using self-assessment methods, so students assess themselves. Or predict-observe-explain method can be used to observe them" (PST F)

"Open-ended questions can be good choice. Student can put an interpretation on questions" (PST H)

"I think the best method is performance assessment. In science lectures, science teachers should use laboratory assessment and portfolio assessment" (PST G)

"The method can change depending on the subject, but vee diagram or predict-observe-explain method can be used" (PST J)

"Open-ended questions and structured grid can be used but we can choose methods depend on the subject" (PST L)

"… open-ended questions are the best because the responses show students ideas and knowledge" (PST M, N)

"I can use portfolio assessment. It helps students to allow creative and critical thinking. Students should be active, so I can use peer-assessment. To see misconceptions, I can use structured grid" (PST O)

Finally, oral questioning and informal observation are the child codes integrated into informal mode. Quotes from the PSTs are given in the following:

"Or oral questioning can be used to assess students" (PST A)

"I think students should be questioned orally in person and, teachers can observe students' behaviors and abilities." (PST I)

"Oral questioning and observing students are efficient methods. For example, while observing students, we can see how students communicate with others, how they learn and how they apply their knowledge" (PST K)

"Oral questioning during lectures is effective, I will use in my teaching profession" (PST M)

Overall, the PSTs highly endorsing various approaches thought that the most effective mod of assessment was performance assessment. The common endorsed approaches by these PSTs were in assessment purpose theme (AaL and AfL approaches), in assessment process theme (design and communication approaches), and in assessment fairness theme (standard and equitable approaches). The portfolio assessment code was obtained from the PSTs who highly endorsed design and communication approaches in assessment process theme, differentiated approach in assessment fairness

theme, and balanced approach in assessment theory theme. Furthermore, peer-assessment and structured grid modes of assessment were stated by the PSTs who were highly supportive of AfL, AaL, design, communication, equitable and balanced approaches. PSTs who thought that the most effective mod of assessment was self- assessment were highly supportive of equitable approach in assessment fairness theme. There was no common endorsement of a particular assessment approach for the PSTs expressing vee diagram as an effective assessment method.

Pre-service Science Teachers' Perceptions about their Deficiencies in Assessment

Analysis of pre-service science teachers' responses to the questions related to their perceived deficiencies in assessment revealed three child codes: inadequacy of the offered assessment course, lack of the opportunity for applying theoretical knowledge, and lack of in-class experience. These codes were integrated into teacher education program parent-code. Accordingly, the participant PSTs mainly emphasized lack of application and in-class experience as their deficiencies and these deficiencies were related to the assessment course offered by the teacher education program. Followings are the sample excerpts:

"I took assessment course, but it is not an applied course. We could not put what we learned into practice" (PST A)

"I cannot know because I have theoretical knowledge, but I did not practice" (PSTs C, F, I)

"We did not take any assessment course that involves assessment methods for students with exceptionalities. Therefore, I do not know what to do when I meet this challenge" (PST E)

"Because I did not experience assessment in classes with students, I could not know what is waiting for me" (PSTs K, O)

"I did not have any experience, so I can say that I feel insufficient for all subjects" (PSTs J, L)

Overall, more than half of the PSTs stated that they have deficiencies in assessment resulting from their teacher education program. These PSTs were mostly endorsed AfL and AaL approaches within the theme of assessment purpose, design and communication approaches within the theme of assessment process.

On the whole, these findings describe pre-service science teachers' general conceptions of assessment in terms of its focus, methods, and perceived deficiencies, which addresses the first research question.

The second research question examined how PSTs with different approaches to assessment conceptualize assessment. In general, PSTs who expressed the focus of the assessment should be curriculum (content and learning objectives) were highly supportive of AfL approach in assessment purpose theme, communication approach in assessment process theme, equitable and differentiated approaches in assessment fairness theme, and balanced approach in assessment theory theme. Grading child-code were supported by two PSTs who highly endorsed design approach in assessment process theme and equitable approach in assessment fairness theme. Also, diagnosing learning difficulties child-code was supported by the PSTs who highly endorse AfL, communication, equitable and balanced approaches. The PSTs who stated focus of the assessment should be diagnosing misconceptions were highly supportive of AaL, design and equitable approaches. The PSTs who endorsed AoL, AfL, AaL, equitable, communication, consistent approaches expressed the focus of the assessment should monitoring student learning and providing feedback to students. In addition, PSTs who stated the focus of the assessment should be providing feedback to teaching for teacher most commonly endorsed AfL and AaL approaches in assessment purpose theme, design and communication approaches in assessment process theme, and equitable approach in assessment fairness theme. Thus, these results suggest that, in general, pre-service science teachers' conception of assessment concerning the focus of assessment are not distinctively linked to specific approaches to assessment. However, pre-service science teachers' both conceptions of assessment regarding this aspect and their approaches to assessment appear to reflect contemporary views to assessment. Moreover, some findings suggest a link between conception of assessment and approaches to assessment. For example, the PSTs who stated that the focus of the assessment should be grading were found to be highly supportive of design and equitable approach. In other words, the PSTs, emphasizing construction of reliable assessments in line with objectives and utilizing accommodation and modification for the assessment of identified students were found to think that the assessment should focus on grading. On the other hand, the PSTs expressing that the focus should be on monitoring student learning and providing feedback to students appeared to highly endorse all approaches in assessment purpose theme. Thus, these PSTs are highly supportive of the use both summative and formative assessment as well as involvement of students in assessment process. In addition, they prioritize communicating with students and parents, using accommodation and modification for identified students, and assuring consistency of assessment results.

Discussion

The main purpose of the current study was to examine pre-service science teachers' conceptions of assessment. For this purpose, semi-structured interviews were conducted. For the analysis of interview data, three aspects were identified: focus of assessment, method (mode) of assessment, and perceived deficiencies in assessment. For each aspect, parent codes and child-codes were identified both inductively and deductively. Concerning the focus of assessment aspect, the curriculum, student, and teacher were identified as parent-codes based on the responses of the PSTs. Among these parent codes, the one most emphasized by the PSTs was found to be "student".

Regarding the method (mode) of assessment, three methods of assessment namely, measurement, performance and informal were identified deductively considering Wang, Kao, and Lin's study (2010). In general, the current findings regarding the PSTs' conceptions about assessment methods were found to be partially consistent with related literature. For instance, in line with the results of the study conducted by Wang et al. (2010), most of the PSTs in the present study stated that the performance mode of assessment was the best mode to assess students' learning. On the other hand, only one PST identified the measurement mode as the most effective way to assess students' learning, whereas about half of the PSTs preferred this mode in Wang et al.'s (2010) study. In addition, the study conducted by Hargreaves (2005), revealed that most of the teachers held measurement mode of assessment. Another difference from the related literature concerned the informal mode of assessment. More specifically, while about half of the PSTs considered informal mode of assessment as effective in the present study, less PSTs expressed informal mode in the study of Wang et al. (2010). The reason why the current findings regarding measurement and informal modes of assessment differ from the related findings in the literature may be the countries' various educational systems and policies, various cultural priorities, and the cultural and linguistic differences between societies (Brown & Remesal, 2012), and the context of the assessment courses (Bandura, 2001). In fact, the majority of the studies used the assessment literacy framework based on 1990 standards. Although these standards undoubtedly guided assessment researches for years, they do not reflect contemporary views of assessment and measure teachers' approaches to classroom assessment based on current assessment context. They also do not involve current formative assessment conceptions and social issues that teachers can face with while constructing and administering assessment methods (DeLuca et al., 2016b; Brookhart, 2011). For these reasons, Classroom Assessment Standards (JCSEE, 2015) were published, emphasizing teachers' contemporary views of and approaches to assessment. Furthermore, in Türkiye, Ministry of National Education (2017) gave an emphasis on revising teacher competencies according to current needs and views in educational field. For this reason, there can be differences between the results of the recent studies and

the studies conducted before the implementation of Classroom Assessment Standards (JCSEE, 2015) because of the different views of assessment in the past and present. In fact, a recent study conducted in Türkiye resulted in similar findings with the current study (Izci & Caliskan, 2017). More specifically, in the study of Izci and Caliskan (2017), the PSTs were asked to indicate their preference for different assessment methods to use in their teaching profession before and after attending the assessment course. The content of the course involved traditional assessment methods, alternative assessment methods, how to diagnose students' learning difficulties and misconceptions, how to interpret and use assessment results to support students' learning and teaching, how to provide equitable assessment for each student. After attending the course, consistent with current findings, the PSTs tended to use open-ended questions, portfolio assessment, peer assessment, structured grid, and concept maps. On the other hand, the findings in the present study also demonstrated that according to the participant PSTs, the assessment course offered in their teacher education program was not sufficient for their teaching profession, due to the lack of opportunities to apply theoretical knowledge in practice and lack of in-class experience.

Overall, these findings indicate that PSTs mainly conceptualize assessment as a tool for student learning and performance-based practices, while also revealing significant gaps in their preparation due to limited opportunities for practice.

On the other hand, the analysis of the data considering the participant pre-service science teachers' approaches to assessment revealed that the PSTs conceptions of assessment about the focus of assessment were not completely connected to particular assessment approaches in each theme. For example, one of the PSTs (PST L) taking two assessment courses stated that the course provided her with sufficient information about assessment methods and learned making laboratory experiments and preparing lessons plans. Consistent with this background in assessment, this PST was found to conceptualize the assessment as monitoring students' learning and providing feedback to teaching. However, none of the approaches were highly endorsed by the PST. This was an unexpected finding, because according to relevant literature, teachers' conception of assessment influences their instructional decisions and activities (Vandeyar & Killen, 2007), and their contributions into context of the teaching (Skott, 2015). In addition, Vandeyar and Killen (2007) reported that different assessment conceptions lead to different assessment practices. Based on these studies in the relevant literature, it was reasonable to expect that the PST L prioritized approaches reflecting a contemporary view, such as AfL approach. The reason for this unexpected result may be that pre-service science teachers who do not have extensive in-class assessment practices were involved in this study. When they start their career, their conceptions of and approaches to assessment can be more con-

gruent based on their experiences. However, this explanation is speculative and future research can examine the link between teachers' conceptions of and approaches to assessment at different career stages and make a comparison. In addition, consistent with results related to focus of assessment, the findings concerning the PSTs' conceptions of assessment about the effective methods of assessment were not completely connected to particular assessment approach in each theme.

Considering these findings collectively, it can be deduced that PSTs generally tend to endorse contemporary approaches to assessment. However, their conceptions are not yet fully aligned with specific approaches, likely due to their limited classroom experience.

Furthermore, it should be emphasized that in the present study, the data analysis was based entirely on self-report data. In future studies, pre-service and in-service science teachers' approaches and conceptions can be analyzed in detail by observing their classroom assessment practices and their lesson plans in addition to the self-report data. Moreover, the study can be replicated in different countries and educational contexts and the results can be compared.

Implications

The present study highlighted pre-service science teachers' approaches to and conceptions of classroom assessment. According to the results, not all pre-service science teachers prioritized the same approaches and had the same assessment conceptions. Their approaches and conceptions of assessment provide insight into how teachers understand assessment, develop assessment methods, and make instructional decisions in classrooms (DeLuca et al., 2018). Therefore, the current findings can have important implications for teacher education programs. According to the results of the study, the PSTs tend to have contemporary conceptions of and approaches to assessment. However, there was also a PST holding traditional conceptions (e.g., emphasizing grading as a focus of assessment) and prioritizing traditional approaches to assessment (e.g., AoL and standard approach). To encourage such PSTs to have a more contemporary conception of and approaches to assessment, the importance of assessment in the teaching and learning process, rather than grading, should be emphasized in assessment courses. In addition, there can be more than one assessment course emphasizing both traditional and contemporary views. In fact, the PST (PST I) who took only one assessment course stated that the course was not sufficient. He further indicated that he learned how to construct exam questions in this course. Thus, it appeared that the course was delivered based on traditional views. Consistent with his background in assessment, the assessment approaches that he highly endorsed were found to be AoL and standard. In addition, ac-

cording to the PSTs' responses, the inadequacy of the offered assessment courses, the lack of the opportunities to apply theoretical knowledge, and the lack of in-class experience are the problems that PSTs face. For these reasons, it is suggested that the assessment courses offered in teacher education programs should be designed to provide PSTs with opportunities to apply their theoretical knowledge in practice. Moreover, PSTs can be provided with opportunities to gain in-class experiences regarding the implementation of different assessment methods in real classroom settings before starting their professional careers.

Limitations

This study has several limitations that should be taken into account when interpreting the findings. First, the generalizability of the results is limited. Data were collected from third- and fourth-year pre-service science teachers enrolled in 12 universities across Türkiye, and therefore the findings may not be generalizable to broader populations, other countries, or different educational contexts. In future studies, data can be collected from pre-service science teachers from different domains and in-service science teachers. Additionally, the study employed a mixed-methods research design. The quantitative phase employed the adapted version of the Approaches to Classroom Assessment Inventory (ACAI), whereas the qualitative phase involved semi-structured interviews. Both phases relied on self-reported data. In future research, pre-service science teachers' assessment approaches could be examined more comprehensively through direct observation of classroom assessment practices and analysis of their lesson plans.

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Appendix

Pre-service Science Teacher A is a 23 years old senior student on teacher education program. She reported that she took one assessment course. According to her response to the related question, this course helped her to understand what assessment is and how she can meet the objectives in science. She thinks that this course contributed to her, but it is not sufficient. PST A was found to be highly supportive of assessment for learning (AfL) approach (M=4.20) in the theme of assessment purpose and equitable approach (M=4.20) in the theme of assessment fairness.

Pre-service Science Teacher B is a 20 years old junior student taking only one assessment course on teacher education program. She stated that she did not learn too much about assessment in this course. A standard approach (M=4.00) within the theme of assessment fairness was highly endorsed by the PST B.

Pre-service Science Teacher C is a 21 years old, senior student. He took two assessment courses. He indicated that in these courses, assessment methods, how to use these methods, interpretation of methods were taught. According to him, he cannot know whether these courses were sufficient or insufficient without experience. Except from assessment of learning (AoL) approach within assessment purpose theme and differentiated approach within assessment fairness theme, all remain approaches (AfL (M=4.80), assessment as learning (AaL) (M=4.00), design (M=5.00), use/scoring (M=4.00), communication (M=4.40), standard (M=4.00), equitable (M=4.40), consistent (M=4.00), contextual (M=4.20), and balanced (M=4.00)) were endorsed from PST C.

Pre-service Science Teacher D is a 22 years old senior student. She took one assessment course. This course provided her to assess student knowledge and assessment methods. She thinks that this course contributed to her, but it is not sufficient, and she can improve themselves with the help of instructors in her teacher education program and their articles or books. PST D was found to be highly supportive of assessment AoL (M=4.60) and AfL (M=4.20) approaches within the theme of assessment purpose, communication approach (M=4.20) within the theme of assessment process, balanced approach (M=4.60) within the theme of assessment theory, equitable (M=4.00) and differentiated (M=4.40) approaches within the theme of assessment fairness.

Pre-service Science Teacher E is a 22 years old, senior student. She took one assessment course. In this course, she learned sufficient information about traditional assessment methods, and how to use performance assessment and portfolio assessment. PST E was found to prioritize communication (M=4.80) and use/scoring (M=4.20) approaches in assessment process theme, AfL (M=4.40) and AaL (M=4.60) approaches in assessment purpose theme, equitable (M=4.60) and differentiated (M=4.40) approaches in assessment fairness theme, and balanced approach (M=4.20) in assessment theory theme.

Pre-service Science Teacher F is a 22 years old, senior student. She took one assessment course. According to her, the instructor gave an emphasis on preparing exam questions. She thinks this course was not sufficient, and she can improve themselves with experience. PST F was highly supportive of design approach (M=4.80) within the theme of assessment process, AaL approach (M=4.00) within the theme of assessment purpose, and equitable approach (M=4.00) within the theme of assessment fairness.

Pre-service Science Teacher G is a 22 years old, senior student. She reported that

she did not take any assessment courses. PST G was found to highly endorse communication (M=5.00), design (M=4.60), and use/scoring (M=4.00) approaches in assessment process theme, AfL (M=4.60) and AaL (M=4.60) approaches in assessment purpose theme, differentiated (M=4.80) and standard (M=4.00) approaches in assessment fairness theme, and balanced approach (M=4.40) in assessment theory theme.

Pre-service Science Teacher H is a 21 years old, senior student. She took one assessment course. According to her, she learned some current methods of assessment. She stated that this course was not fully sufficient. PST H was found to be highly supportive of equitable approach (M=4.60) in the theme of assessment fairness, and AoL (M=4.40) and AaL (M=4.00) approaches in the theme of assessment purpose

Pre-service Science Teacher I is a 23 years old, senior student. He took one assessment course. He indicated that he learned how to prepare exam questions with the help of this course. According to him just one assessment course is not enough for them. As shown in Table 3.3, PST I was found to highly endorse a standard approach (M=4.20) in the theme of assessment fairness, AoL approach (M=4.00) in assessment purpose theme, and consistent approach (M=4.00) in assessment theory theme.

Pre-service Science Teacher J is a 21 years old, senior student. She took one assessment course. She reported that, in this course, traditional assessment methods, performance assessment, portfolio assessment and structured grid were covered. According to her, this was not sufficient for her teaching profession, and she tries to improve herself by researching and reading related books. Except from standard approach in assessment fairness theme and consistent approach in assessment theory theme, all remain approaches (AoL (M=4.20), AfL (M=4.20), AaL (M=5.00), design (M=4.20), use/scoring (M=4.40), communication (M=4.80), differentiated (M=5.00), equitable (M=4.40), contextual (M=4.80), and balanced (M=4.60)) were endorsed from PST J.

Pre-service Science Teacher K is a 21 years old, senior student. She took one assessment course. She learned assessment methods including laboratory assessment. She thinks the course provide her sufficient information for her teaching profession. PST K highly prioritized consistent approach (M=4.80) within the theme of assessment theory and AfL approach (M=4.00) within the theme of assessment purpose.

Pre-service Science Teacher L is a 21 years old, senior student. She took two assessment courses. According to her, these courses provided her with sufficient information about assessment methods. Also, she learned making experiments, preparing lesson plan and classroom management in this course. Across four assessment themes, none of the approaches were highly endorsed by PST L.

Pre-service Science Teacher M is a 22 years old, junior student. He took one assessment course. In this course, he learned sufficient information about preparing open-ended questions, multiple choice questions, homework, and giving feedback to monitor student learning during or at the end of the learning. PST M was more likely to prioritize design approach (M=4.40) in assessment process theme, AfL approach (M=4.20) in assessment purpose theme, and equitable approach (M=4.00) in assessment fairness theme.

Pre-service Science Teacher N is a 27 years old, senior student. She took two assessment courses. She learned how to write learning objectives, assessment methods, preparing various types of exam questions with advantages and disadvantages. She thinks these courses contributed them enough knowledge about assessment theoreti-

cally, but she needs experience in practice. PST N was highly supportive of communication approach (M=4.60) within the theme of assessment process, contextual (M=4.20) and balanced (M=4.00) approaches within the theme of assessment theory, equitable (M=4.00) and differentiated (M=4.00) approaches within the theme of assessment fairness, and AaL approach (M=4.00) within the theme of assessment purpose.

Pre-service Science Teacher O is a 23 years old, senior student. She took one assessment course. In this course, she thinks that she learned sufficient information such as advantages of assessment methods. Also, assessment can provide feedback to us about teaching process. PST O was found to be highly supportive of AfL (M=4.40) and AaL (M=4.20) approaches within the theme of assessment purpose, differentiated (M=4.40) and equitable (M=4.00) approaches within the theme of assessment fairness, design (M=4.20) and communication (M=4.00) approaches within the theme of assessment process, and balanced approach (M=4.20) within the theme of assessment theory