Analyzing Pre-Service Teachers' Needs and Perceptions: Integrating Technology-Enhanced AfL, AaL, and AoL within Differentiated Instruction in Indonesian EFL Contexts

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Abstract

This study analyzed EFL pre-service teachers' target and learning needs for developing an instructional model of technology-based AfL, AaL, and AoL. in the context of differentiated instruction. The approach employed in this research involves a Mixed Method, utilizing questionnaires to collect quantitative data and interviews to collect qualitative data as primary data collection instruments. Interviews with nine EFL lecturers and questionnaires distributed to 200 Indonesian EFL pre-service teachers explored their lacks, necessities, wants, roles, settings, and learning activities related to technology-based AfL, AaL, and AoL. The findings revealed that EFL pre-service teachers have diverse needs for technology-driven AfL, AaL, and AoL in differentiated English education. The lack demonstrated that they invest considerable time in preparing instructional materials and assessments, often struggling to select the appropriate technology for effectively implementing AfL, AoL, and AaL. Challenges arise in providing feedback during AfL because there are few strategies to accommodate students with diverse learning styles. The study recommends future research to develop an instructional model of technology-based AfL, AaL, and AoL for EFL pre-service teachers, providing standard guidelines to maximize the EFL teaching-learning process and assessment within the differentiated instruction framework.

Keywords

AfL 1, AaL 2, AoL 3, Differentiated Instruction 4, Technology 5

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Introduction

Effective teaching strategies accommodating diverse learner needs have become increasingly paramount in education. The integration of technology has not only revolutionized educational paradigms but has also opened avenues for personalized and differentiated instruction. Students nowadays, who have grown up as digital natives in the digital age, require skills that extend beyond conventional academic knowledge. The World Economic Forum (2016) highlights sixteen critical skills required for the 21st century, including literacy, numeracy, ICT literacy, critical thinking, collaboration, and adaptability. Among these, ICT literacy plays a pivotal role in education by emphasizing the incorporation of various tools, technologies, and strategies to support learning across formal, informal, and lifelong educational settings.

However, advancements in educational technologies continually evolve, hastening shifts in learning, teaching, and assessment methods and increasing the expectations placed on teachers' and students' capacities(Mualim et al., 2025; Mena-Guacas et al., 2025). Hence, do teachers in Indonesia understand their own needs for advancing educational technology within the differentiated instruction paradigm? Teachers are challenged to understand students' diverse personalities, which influences their instructional strategies and assessment practices (Ertmer, 2015) This complexity prompts teachers to grapple with questions such as whether they should create different lesson plans each day, how to manage a classroom with diverse activities effectively, and how to conduct assessments within the context of varied lesson plans (Baecher et al., 2012).

Assessment literacy is of significant importance to teachers, with Assessment for Learning (AfL), Assessment as Learning (AaL), and Assessment of Learning (AoL) as interconnected components that shape the learning process (van der Vleuten et al., 2017). Historically, teachers have often prioritized AoL. However, the integration of AfL and AaL profoundly impacts the effectiveness of AoL (Yan, 2021). Teachers' integration into the implementation of AaL and AfL aims to elicit timely and precise feedback, providing valuable information to optimize AoL outcomes (Wu et al., 2021; Panadero et al., 2018). The characteristics of AfL about assessment and learning (Yan & Boud, 2022) assist teachers in incorporating diagnostic assessment within differentiated instruction.

Moreover, according to Crooks (2011), Earl & Katz (2006), and Earl (2014) AaL entails students taking an active role in self-assessment and independent learning to enhance the learning process. From this perspective, students are viewed as proactive evaluators who cultivate metacognitive and self-regulatory learning abilities (Lam, 2016). Some scholars argue that AaL should be classified as a subset of AfL (Clark, 2012; Earl 2014; Lam, 2018) Despite ongoing discussions about teachers' comprehension of AfL and AaL, given their similarities, prior research underscores the need to further investigate AaL within the framework of EFL teaching in Indonesia while balancing AfL and AoL (Yan & Boud, 2022). Traditionally, teachers have primarily addressed AoL through technology, and successful implementation has necessitated consideration of both AaL and AfL. The integration of AfL and AaL significantly influences the AoL process. However, EFL teachers often struggle to combine AaL and AfL within technology-enhanced differentiated instruction (DI).

Within Differentiated Instruction, they function as an integrated feedback loop rather than isolated events. First, AfL (e.g., diagnostic quizzes or digital exit tickets) identifies students' readiness, interests, and learning profiles, exactly the data teachers need to differentiate

content, process, or product. Second, this AfL data directly enables AaL: students use self-assessment tools (e.g., digital checklists or reflection journals) to monitor their own progress and choose which tiered tasks to attempt, thereby differentiating for themselves. Third, AoL (e.g., differentiated summative assessments) becomes not a one-size-fits-all test but a flexible culmination where each student demonstrates mastery of the same core competencies through varied products (e.g., video, infographic, or essay) appropriate to their readiness level. Crucially, in a technology-enhanced Indonesian EFL context, digital platforms can streamline this cycle: automated AfL analytics inform teacher differentiation, AaL scaffolds such as goal trackers foster learner autonomy, and AoL portfolios capture diverse evidence of achievement. Without this explicit interplay, teachers risk treating DI as a separate classroom management strategy rather than an assessment-driven pedagogical framework.

Furthermore, despite growing recognition of the importance of integrating technology, assessment, and differentiation, there is a lack of research systematically examining how EFL pre-service teachers understand and implement the alignment among technology-based AfL, AaL, AoL, and differentiated instruction. Existing studies have not sufficiently addressed the gap between conceptual knowledge and practical implementation, the decision-making process in selecting appropriate technologies for assessment, and the absence of structured guidance or models to support this integration. As a result, the field lacks a clear conceptual and empirical foundation for designing effective instructional models that integrate these elements in EFL teacher education.

Based on this gap, this study aims to investigate the needs and perceptions of Indonesian EFL pre-service teachers regarding the integration of technology-based AfL, AaL, and AoL within a differentiated instruction framework. Specifically, the study addresses the following research questions:(1) What are the needs of Indonesian EFL pre-service teachers for implementing technology-based AfL, AaL, and AoL within the context of differentiated instruction? (2) How do Indonesian EFL pre-service teachers perceive the alignment of technology-based AfL, AaL, and AoL with differentiated instruction?

The novelty of this research lies in its integrative perspective, examining the intersection of assessment frameworks (AfL, AaL, AoL), differentiated instruction, and technology within pre-service teacher education, an area that remains underexplored in current literature.

Method

Research Design

The study employed needs analysis to explore EFL pre-service teachers' needs (target and learning needs) and perception of technology-based AfL, AaL, and AoL within a differentiated instruction framework. Semi-structured interviews were conducted to gather insights into EFL teachers' needs for integrating technology-based AfL, AaL, and AoL. Content analysis with coding was employed, following the Grounded Theory framework proposed by Glaser & Strauss (2017) and Saldaña (2021). The questionnaires were analyzed using descriptive analysis in Microsoft Excel. Three experts from educational technology and English language assessment assessed the content reliability and validity of interview and questionnaire questions, spending weeks evaluating each question's applicability, precision, and language suitability. The study employed the formula developed by Aiken (1987) to validate the

instruments' content, which were deemed good using the Aiken Value method. The reliability test of the instrument using the Alpha Cronbach criteria.

Table 1. Reliability Criteria of Alpha Cronbach

Range	Category
<0.80	Excellent
0.7 – 0.8	Good
0.6 – 0.7	Acceptable
0.5 – 0.6	Poor
< 0.5	Unacceptable

Participants and Research Setting

The data for this study were acquired from 200 EFL pre-service teachers and 9 EFL lecturers from Indonesia who volunteered to participate. Pre-service teachers were candidates for EFL teachers who had studied the major of English language assessment and practiced micro-teaching in the teaching practice class and a real school. EFL lecturers were teaching English language assessment and microteaching classes.

Instruments

The researcher distributed the questionnaire via Google Forms and analyzed it in Microsoft Excel to investigate the current situation, target needs (lacks, necessities, and wants), and learning needs (roles, settings, and learning activities) that EFL pre-service teachers and lecturers were experiencing.

Table 2. Need Analysis Questions

No		Question	Response			
			5	4	3	2
			SA	A	D	SD
1	A1	My understanding of instructional models for teaching is high.				
2	A2	My understanding of assessment *for, as,* and *of* learning in English language teaching of Merdeka curriculum is high.				
3	A3	I am capable of utilizing strategies that integrate content, technologies, teaching methodologies, AfL, AaL, and AoL that I have acquired through my coursework in the classroom setting.				
4	A4	I am capable of selecting the appropriate technologies that enrich the content of a lesson, support the learning process, and align with AfL, AaL and AoL.				
5	B1	It is essential to incorporate technology in AfL, AaL and AoL conducted within the English classroom learning process.				
6	B2	It is necessary to incorporate technology in technology-based assessment *for* learning (AfL).				
7	B3	Using technology in AfL activities helps teachers meet specific goals and pinpoint the learning needs of students or groups.				
8	B4	Incorporating technology into AfL activities enables teachers to develop differentiated teaching strategies, materials, assessments to support each student's progress in learning.				
9	B5	Using technology in AfL activities provide immediate feedback and guidance.				
10	B6	It is necessary to incorporate technology in instructional model of technology-based assessment *as* learning (AaL)?				

11	B7	AaL activities integrating with technology guides the students to have the skills of self-assessment.
12	B8	Incorporating technology into AaL activities helps students set and track their goals.
13	B9	Using technology in AaL activities help students to set clear criteria of excellence and offers frequent and challenging practice opportunities.
14	B10	Using technology in AaL activities help students to cultivate their ability to assess their own performance confidently and competently.
15	B11	Incorporating technology into AaL activities motivates students to monitor and question their thoughts and helping them feel comfortable with not knowing all the answers while learning.
16	B12	Using technology in AaL activities watches over how students think about their own thinking (metacognitive processes) and their learning.
17	B13	Using technology in AaL activities offers detailed feedback.
18	B14	It is necessary to incorporate technology in instructional model of technology-based assessment *of* learning (AoL)?
19	B15	Teachers have the responsibility of reporting student learning accurately and fairly.
20	B16	Teachers provide transparent approaches to evaluation.
21	B17	Teachers provide descriptions of the assessment process.
22	C1	I comprehend the principle of assessment *for* learning (AfL), assessment *as* learning (AaL), and assessment *of* learning (AoL).
23	C2	I understand how to leverage technology in the teaching and learning processes to apply AfL, AaL, and AoL.
24	D1	I want directly and comprehensively measure important skills and instructional results by using technology based English AfL, AaL, AoL.
25	D2	The technology based English Afl, AaL, and AoL should be appropriate for my students' ages, developmental, academic, cognitive, language, social, behavioural, and technological skill levels.
26	D3	I want to easily implement AfL, AaL, and Aol with technology.
27	D4	I want to comprehend how to plan, deliver, evaluate, and revise my program by comprehending the instructional model of AfL, AaL and AoL through technology.
28	E1	Lecturers teach the instructional of technology-based English AfL, AaL, and AoL.
29	E2	Lecturers teach how to provide the standard immediate feedback to students to guide their learning for identifying students' strengths and weaknesses to tailor instruction.
30	E3	Lecturers monitors the progress to ensure we are on track to meet learning objectives.
31	E4	Lecturers teach how to encourage and promote student self-reflection, metacognition and self-monitoring their own learning and progress.
32	E5	Lecturers teach how to provide opportunities for every student to ask questions and express opinions.
33	E6	Lecturers teach how to provide opportunities for peer feedback and collaboration.
34	E7	Lecturers teach how to provide evidence of students' learning outcome.
35	E8	Lecturers teach how to assess students at the end of each session about their English mastery of content and skills.
36	F1	I feel ready and comfortable for completing the tasks about English learning assessment using technology individually by lecturer directed.

37	F2	I feel ready and comfortable for completing the tasks about English learning assessment using technology in pairs/ small group/bigger groups by lecturer directed.
38	G1	The learning activities about technology-based learning assessment should be fun, well organized, and interactively.
39	G2	The materials of technology-based learning assessment should accommodate theoretically and practically.
40	G3	Kind of technology-based learning assessment should be introduced in the teaching learning process.

Additionally, conducting interviews by asking fifteen questions about the present situation analysis, target needs (lacks, necessities, and wants), and learning needs (roles, setting, and learning activities) in integrating technology-based AfL, AaL, and AoL to 10 EFL pre-service teachers were approached for 30-60-minute interviews documented through audio recording and subsequent transcription, during non-instructional time.

1. Do you understand the learning assessments taught in your language assessment class, like AfL, AaL, and AoL?
2. Do you need help understanding the principles of AfL, AaL, and AoL?
3. Do you comprehend how to integrate technology into AfL, AaL, and AoL?
4. Do you understand how to utilize strategies to integrate content, technologies, teaching methodologies, and assessments (AfL, AaL, and AoL)?
5. Do you understand how to select the appropriate technologies that enrich the content of a lesson, support the learning process, and align with AfL, AaL, and AoL?
6. Do you need help leveraging technology in the teaching and learning processes to apply AfL, AaL, and AoL?
7. What challenges do you encounter while practicing technology-based English AfL, AaL, and AoL?
8. Do you think it is necessary to understand the principles of AfL, AaL, and AoL? Why?
9. Do you think it is necessary to understand how to differentiate the learning activities between AfL, AaL, and AoL? Why?
10. Is implementing technology-based English AfL, AaL, and AoL necessary for your future students? Why?
11. As an English teacher, do you know why you want to learn learning assessment?
12. What do you want to learn during the technology-based English AfL learning process. AaL, and AoL?
13. Do you enjoy practicing conducting diagnostic assessments and immediate feedback by integrating technology in the pre-activities interactively during the learning process? Why?
14. Do you enjoy practicing conducting self-assessments and monitoring the metacognitive processes with technology during the learning process?
15. Do you like practicing how to report student learning accurately and fairly by incorporating technology during the learning process? Why?

Furthermore, the researchers conducted semi-structured interviews with 9 EFL lecturers who taught English language assessment and microteaching classes, asking 16 questions.

1. Do your students comprehend the learning assessments like AfL, AaL, and AoL taught in your language testing class? What challenges did your students encounter?
2. Do your students comprehend how to integrate technology into AfL, AaL, and AoL? What challenges did your students encounter?

3. Do your students understand how to utilize strategies that integrate content, technologies, teaching methodologies, and assessments (assessment for learning, assessment as learning, and assessment of learning)?
4. Do your students understand how to select the appropriate technologies that enrich the content of a lesson, support the learning process, and align with AfL, AaL, and AoL?
5. What challenges did your students encounter when implementing technology-based English AfL, AaL, and AoL?
6. Do your students need to understand the principles of AfL, AaL, and AoL? Why?
7. Do your students need to understand how to differentiate the learning activities between AfL, AaL, and AoL? Why?
8. Do your students need to understand how to implement technology-based English AfL, AaL, and AoL? Why?
9. Do your students know what they want to join the language assessment class?
10. Do your students understand what technology can be integrated into English learning assessment? How can technology support them in accommodating teaching and learning activities, particularly regarding AfL, AaL, and AoL, while considering individual student differences?
11. Do your students understand what kind of technology can be integrated into providing the standard immediate feedback to their future students to guide them in identifying their future students' strengths and weaknesses to tailor instruction as the process of AfL?
12. Do your students understand what kind of technology can be integrated into encouraging and promoting their future student self-reflection, metacognition, and self-monitoring as the process of AaL?
13. Do your students understand what kind of technology can be integrated into assessing their future students at the end of each session about English mastery of content and skills as the process of AoL?
14. What kind of classroom arrangements do your students like in learning assessment activities? Why do they like it?
15. Do your students enjoy practicing the learning activities related to technology-based learning assessment?
16. Do your students enjoy understanding the materials of technology-based English AfL, AaL, and AoL in the language testing class?

Data Collection Procedure

The data-gathering strategy for this study involved conducting semi-structured interviews with representatives of 10 EFL pre-service teachers among 200 EFL pre-service teachers in Indonesia. During non-instructional time, a 30-to 60-minute session was extensively documented through audio recording and subsequent transcription. Saldaña (2021) used content analysis and Glaser's Grounded Theory framework (1967) to analyze transcribed materials, identifying patterns and themes. The recorded interview data were analyzed using an iterative inductive approach through content analysis, which involved systematically revisiting the data to identify consistent patterns and recurring themes. The questionnaire was distributed through Google Forms.

Data Analysis

The findings were subjected to qualitative and quantitative analysis in accordance with the research design. Specifically, content analysis was employed on the interview data, and the transcribed data were systematically coded using an iterative inductive methodology involving repeated revisits for refinement. Techniques outlined by Saldaña (2021) and Ahmadi & Sheykholmoluki (2023) were followed for coding and quantification. Recorded interview data was codified using an iterative inductive content analysis of transcribed materials, identifying patterns and themes and systematically revisiting common and recurring themes within the dataset. Respondents clarified their needs regarding various aspects of technology-based AfL, Aal, and AoL within differentiated instruction. Microsoft Excel analyzed the questionnaires using descriptive analysis.

Results

This section presents the study's findings based on the research questions. The first is to analyze the needs of Indonesian EFL pre-service teachers for implementing technology-based AfL, AaL, and AoL within the context of differentiated instruction. The second is to analyze how Indonesian EFL pre-service teachers perceive the alignment of technology-based AfL, AaL, and AoL with differentiated instruction.

The Needs of Indonesian EFL Pre-Service Teachers in Conducting Technology-based AfL, AaL, and AoL within the Framework of Differentiated Instruction

A questionnaire containing 40 questions was distributed to 200 EFL pre-service teachers to investigate their needs for conducting technology-based AfL, AaL, and AoL, divided into present situation analysis, necessities, lacks, wants, roles, settings, and learning activities.

Table 3. EFL Pre-service teachers' age

Information	Frequency	Percentage
Pre-Service Teachers' age:		
20 years old	89	44,5%
21 years old	97	48.5%
22 years old	14	7%

EFL pre-service teachers' personal background (age) ranged from 20 (44.5%) to 22 (17%) years old. They had enrolled in and completed the English Language Assessment and Microteaching classes. Data on EFL pre-service teachers' demographics show that they are candidates for English teaching positions and must be ready to teach digital natives who need remarkable teachers who can adapt to the digital era. Besides being future EFL teachers, they were born between 2004 and 2005, making them Generation Z digital natives who will be teaching students from the Alpha generation. Most of them should be ready to teach and assess their students in the future when they are integrated with technology.

Necessities

Most EFL pre-service teachers (74%) believe that the necessity of an instructional model for technology-based AfL, AaL, and AoL facilitates their incorporation of technology-based assessment within the framework of differentiated instruction in the classroom. The findings on pre-service teachers were consistent with the interviews' conclusion, which confirmed that

EFL lecturers, especially English language assessment lecturers, strive to improve their EFL pre-service teachers to effectively implement the appropriate instructional model to accommodate technology-based AfL, AaL, and AoL within the framework of differentiated instruction.

> "AfL is a part of the assessment that accommodates diagnostic assessment; it is the first step that helps teachers to implement differentiated instruction". (L6, Interview questions 1, 6, 10)
> "The result of Afl using diagnostic assessment helps teachers to understand the students' characteristics, abilities, and needs." (L3, Interview questions 1 and 10)

The responses related to Westbroek et al. (2020), AfL, and differentiated instruction both focus on learning processes and learning needs and positively affect student learning.

> "Pre-service teachers understand that technology is not only a tool for the teaching-learning process, but also a way to make innovative contents, interactive classroom, accessible materials, flexible teaching-learning, and assessment." (L7-L9, Interview questions 2 and 10)
> "I love using technology in the process of teaching and assessment in my class; it makes my class alive, students are excited, and it encourages them to participate" (PST 5)

Lacks

The multitude of technologies continually being developed and made available to enhance teaching, learning, and assessment impacted teachers who did not possess sufficient technological proficiency would encounter challenges in determining the most suitable technology for AfL, AaL, and AoL, 81% of EFL pre-service teachers said that they are not capable of selecting the appropriate technology.

> "Mostly EFL pre-service teachers know kinds of technologies, yet they do not know what technology fits, is meaningful, and is accessible to integrate into the teaching-learning process, including assessment." (L1 and L5, Interview questions 2, 4, 5)
> "The teaching-learning process using Afl, AaL, and Aol in the differentiated instruction framework took much effort and time. To meet these demands, EFL pre-service teachers must be well-planned, well-arranged, fast, adaptable, creative, innovative, and lifelong learners. Pre-service teachers not only joined English language assessment and micro-teaching classes, but they also independently take part in several workshops related to these topics."(L2, Interview questions 5, 8, 10, 15, 16)
> "I have learned the fundamentals of AfL, AaL, and AoL. However, I had difficulties implementing it; the other hand, selecting the technologies is another knowledge that must be learned too." (PST 15)
> "Time management should be one of my priorities as well in order to create the effectiveness of classroom assessment"(PST 43)
> "AoL is the easiest way to conduct an assessment after materials did. However, I got challenges when integrating AfL and AaL"(PTS 127)

Therefore, EFL pre-service teachers must be proficient in technology literacy, the principles of AfL, AaL, and AoL, and differentiated instruction principles to effectively guide them in selecting technologies that effectively facilitate AfL, AaL, and AoL within the framework of differentiated instruction.

Wants

Among EFL pre-service teachers, 78% said they want to quickly implement AfL, AaL, and AoL with technology and arrange differentiated instruction to support each student's learning progress, the questionnaire responses aligned with the interview responses from EFL pre-service teachers and lecturers.

> "I have learned the fundamentals of AfL, AoL, and AaL easily, and I have been implementing them in micro-teaching classes and school". (PST 87)

Roles

For pre-service teachers, 71% said they have learned how to implement AfL, AaL, and AoL with technology and to arrange differentiated instruction to support each student's learning progress.

Settings and Learning Activities

67% and 56% of EFL pre-service teachers said they felt ready and comfortable teaching their students by implementing technology-based AfL, AaL, and AoL as their instructional model in their teaching-learning process and assessment. However, some of them were not ready because they needed to have the standard guidance for implementing technology-based AfL, AaL, and AoL effectively and appropriately.

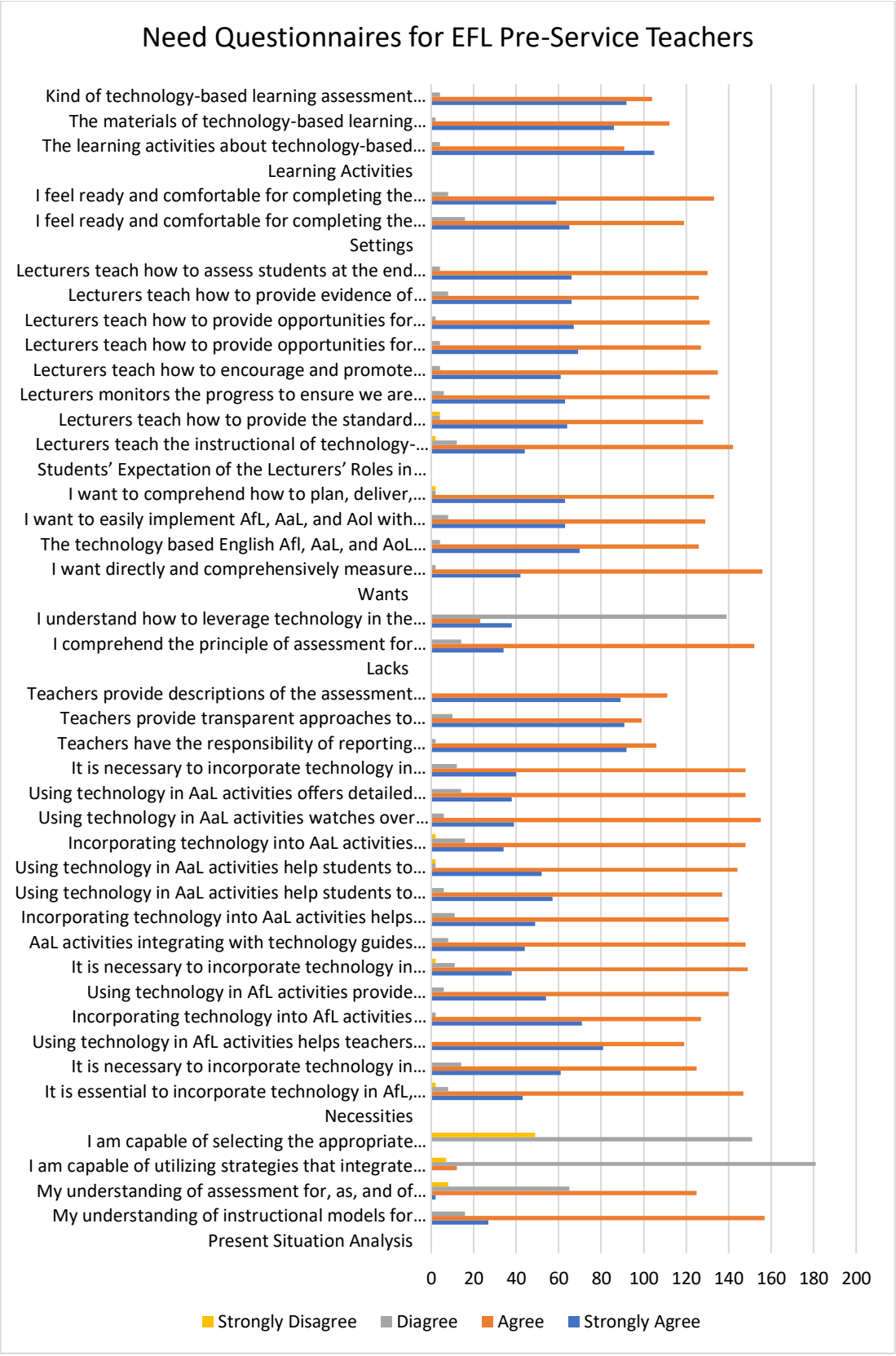

Figure 1. Results of Need Questionnaires of EFL Pre-Service Teachers

Even though EFL pre-service teachers are part of the digital natives, in which technology is part of the landscape, they should understand the novelty of technology, which may be distracting and overwhelming. They should be more patient with guided instruction that

provides them with the steps for implementing technology-based AfL, AaL, and AoL. Therefore, EFL pre-service teachers must be adequately proficient in technology literacy, appropriately integrated with the principles of AfL, AaL, and AoL, to effectively guide them in selecting technology that facilitates AfL, AaL, and AoL in the English language teaching-learning process.

Despite the lack, 78% of pre-service teachers said they want to easily implement AfL, AaL, and AoL with technology, especially the AfL process, which would allow them to arrange differentiated instruction to support each student's learning progress. There are 66.5% of EFL pre-service teachers want to comprehend how to plan, deliver, evaluate, and revise their lesson by comprehending the instructional model of AfL, AaL and AoL through technology, even though it takes time and effort, and 67% of EFL pre-service teachers said that they felt ready and comfortable for teaching their students by implementing technology-based AfL, AaL, and AoL as their instructional model in their teaching-learning process and assessment; however, some of them were not ready because of they did not have the standard guidance for implementing technology-based AfL, AaL, and AoL effectively and appropriately.

In conclusion, the need analysis reveals a discrepancy between EFL pre-service teachers' understanding of the principles of AfL, AaL, and AoL and their understanding of how to leverage technology-based AfL, AaL, and AoL. The analysis indicates that to enhance EFL pre-service teachers' comprehension and performance in leveraging technology-based assessment, lecturers must consider the difficulties they encounter in learning about technology-based AfL, AaL, and AoL, as well as the strategies they will require. It's clear from the questionnaire's response that EFL pre-service teachers brought up a few points, they expect to learn how to provide the standard immediate feedback to their students to guide their learning for identifying students' strengths and weaknesses to tailor instruction, how to monitors the progress to ensure they are on track to meet learning objectives, how to encourage and promote student self-reflection, metacognition and self-monitoring their own learning and progress, how to provide opportunities for every student to ask questions and express opinions, how to provide opportunities for peer feedback and collaboration, how to provide evidence of students' learning outcome, and how to assess students at the end of each session about their English mastery of content and skills.

Hence, it is imperative to include a model in the framework of technology-based AfL, AaL, and AoL instruction, as this model prioritizes providing diagnostic assessment and feedback to learners and teachers, thereby facilitating ongoing progress in the learning process. Furthermore, it helps EFL pre-service teachers minimize overwhelm and time constraints when implementing technology-based AfL, AaL, and AoL, which have not been fully integrated into the current learning process. Hence, this model is necessary in light of EFL pre-service teachers' concern to implement technology-based AfL, AaL, and AoL that create more dynamic and interactive learning environments, enabling their students to engage more deeply with the material. Additionally, it supports formative practices where assessment becomes an integral part of the learning process, helping students reflect on their progress and make real-time adjustments. Lastly, it provides a reliable and efficient means for evaluating students' overall achievements, offering a comprehensive view of their learning progress.

The majority of pre-service teachers 78% said that they want to directly and comprehensively measure English skills and instructional results by using technology-based English AfL, AaL, and AoL to facilitate differentiated instruction, 74% said that it is essential to incorporate technology in AfL, AaL and AoL conducted within the English classroom learning process, 81% said they encounter challenges in determining the adequate technology for AfL, AaL, and AoL, and 78% said that they want to quickly implement AfL, AaL, and AoL with technology effectively in amount of time.

> "As an educator, I got sometimes overwhelmed with the process of implementing AfL for implementing differentiated instruction using technology; it seemed to happen as well to EFL pre-service teachers when they have to arrange the activities of AfL and AoL, and also they should develop differentiated assessments, which takes time and effort." (L4, Interview questions 2, 10)
>
> "Some technologies like LMS, Google Classroom, Near, Pallet, and Wakelet facilitate me as a lecturer to arrange a diagnostic assessment to understand the students' needs, characteristics, and abilities, including AI like Mentimeter, Quizizz." (L8, Interview questions 1, 15, and 16)
>
> "I was enjoying joining the class of technology that integrated with the teaching-learning process and assessment."(PST 13)

These responses indicated that technology should align with any instructional model in teaching and learning, including assessment, despite the need for further learning and the time and effort required to achieve proficiency.

Discussion

EFL pre-service teachers' dedication to integrating core educational fundamentals like AfL, AaL, and AoL into differentiated instruction, alongside essential principles of technology utilization, highlights their perpetual learning ethos. Their commitment is evident in their active pursuit of professional development through education courses, literature reviews, and participation in assessment-related events. Endorsing technology-based AfL, AaL, and AoL to enhance comprehension underscores their assessment literacy and proactive stance on professional growth (Hooper, 2022; Kahmann et al., 2022). Additionally, their comprehensive grasp of these concepts is shaped by factors like self-efficacy, influenced by personal experiences and knowledge (Peebles & Mendaglio, 2014; Tafazoli, 2022; Wang et al., 2004) Despite curriculum changes, Indonesian EFL pre-service teachers display resilience and adaptability, driven by a steadfast commitment to meeting students' evolving needs and overcoming challenges with enthusiasm and efficacy.

The study illuminated the hurdles EFL pre-service teachers face when integrating technology-based AfL, AaL, and AoL within the framework of differentiated instruction. These obstacles encompass a mismatch between curriculum and technology, a limited grasp of differentiated instruction, and feelings of overwhelm and time constraints (Maknun et al., 2024; Margana et al., 2026). To surmount these challenges, teachers must tailor content, processes, and products, employing diverse methodologies to address varying student needs while aligning with learning goals. Strategies advocated by academics such as Lim & Park (2022) and

Tomlinson (2017) provide holistic assistance for the progress of both entire classes and individual students. Furthermore, it is essential to enhance technology proficiency among EFL pre-service teachers by providing consistent digital literacy training sessions and workshops. Collaborating with technology firms to offer on-campus support services, address device and connectivity issues, and implement initiatives to ensure affordable access to essential technology and internet connectivity are crucial measures for empowering both teachers and students to utilize technology effectively (Lim & Park, 2022; Tomlinson, 2017).

Conclusion

Incorporating technology-based AfL, AaL, and AoL within the differentiated instruction framework presents advantages for teachers and students. Students can develop a range of skills simultaneously, encompassing educational, interpersonal, professional, practical, and technological competencies. Teachers can employ these approaches to monitor students' learning progress and make informed instructional choices. Gradual integration of these methods helps narrow the digital divide, cultivate digital literacy among students, understand students' needs, characteristics, and abilities, protect their work, and keep teachers abreast of new technologies and assessment methodologies. Additionally, teachers should thoroughly evaluate different technologies to identify the most effective, fair, and appropriate options for teaching, learning, and assessment. Teachers must gauge how well technology-based assessment practices align with their educational objectives and curriculum content. Furthermore, teachers must assess the resources, time, and preparation necessary for successful implementation.

Students' contributions are valuable for recognizing effective practices and proposing enhancements for technology-based assessment. This cooperative method ensures that technology-based assessment supports effective teaching and learning. Incorporating technology-based AfL, AaL, and AoL into differentiated instruction facilitates EFL pre-service teachers to grasp and accommodate the diverse needs of their students. It underscores the significance of a flexible teaching approach within an inclusive environment, with assessment guiding instruction and adaptable classroom management.

The study encountered limitations, including a small sample size, brief observation periods, limited participant diversity, and a need for greater input from policymakers. Subsequent research endeavors should thoroughly examine policymakers' perspectives. Nevertheless, the findings yield valuable insights and implications for further investigation. Establishing standard guidelines for implementing technology-based AfL, AaL, and AoL in differentiated instruction is imperative. Moreover, it is highly recommended that an instructional model for technology-based AfL, AaL, and AoL be developed to accommodate student variation. It addresses their needs within the framework of differentiated instruction.

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