

The Role of Accessible Instructional Materials and Teachers' Digital Literacy in Promoting Learning Participation among Students with Special Needs in Indonesia

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ABSTRAK

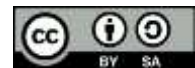
Penelitian ini mengkaji peran materi pembelajaran yang aksesibel dan literasi digital guru dalam meningkatkan partisipasi belajar siswa berkebutuhan khusus di Indonesia. Desain penelitian kuantitatif eksplanatori digunakan dengan melibatkan 135 guru dan pendidik yang memiliki pengalaman langsung mengajar siswa berkebutuhan khusus di lingkungan pendidikan inklusif maupun pendidikan luar biasa. Data dikumpulkan menggunakan kuesioner terstruktur dengan skala Likert lima poin dan dianalisis menggunakan SPSS versi 25. Analisis yang dilakukan meliputi statistik deskriptif, uji validitas dan reliabilitas, uji asumsi klasik, korelasi Pearson, dan regresi linear berganda. Hasil penelitian menunjukkan bahwa materi pembelajaran yang aksesibel memiliki pengaruh positif dan signifikan terhadap partisipasi belajar. Literasi digital guru juga menunjukkan pengaruh positif dan signifikan serta muncul sebagai prediktor yang lebih kuat. Secara simultan, kedua variabel tersebut secara signifikan menjelaskan partisipasi belajar, dengan nilai $F(2,132) = 83,051$, $p < 0,001$, dan $R^2 = 0,557$. Dengan demikian, 55,7% variasi dalam partisipasi belajar dijelaskan oleh aksesibilitas materi pembelajaran dan literasi digital guru. Temuan ini menegaskan bahwa pendidikan inklusif tidak hanya memerlukan sumber belajar yang aksesibel, tetapi juga guru yang memiliki kompetensi digital untuk beradaptasi, mengintegrasikan, dan memanfaatkan teknologi sesuai dengan beragam kebutuhan peserta didik. Penguatan kedua dimensi tersebut dapat berkontribusi pada terciptanya lingkungan belajar yang lebih inklusif dan partisipatif bagi siswa berkebutuhan khusus di Indonesia.

ABSTRACT

This study examines the role of accessible instructional materials and teachers' digital literacy in enhancing the learning participation of students with special needs in Indonesia. A quantitative explanatory research design was employed involving 135 teachers and educators who had direct experience teaching students with special needs in inclusive and special education settings. Data were collected using a structured questionnaire measured on a five-point Likert scale and analyzed using SPSS version 25. The analysis included descriptive statistics, validity and reliability testing, classical assumption testing, Pearson correlation, and multiple linear regression. The results showed

that accessible instructional materials had a positive and significant effect on learning participation. Teachers' digital literacy also demonstrated a positive and significant effect and emerged as the stronger predictor. Simultaneously, both variables significantly explained learning participation, with $F(2,132) = 83.051$, $p < 0.001$, and $R^2 = 0.557$. Thus, 55.7% of the variation in learning participation was explained by instructional-material accessibility and teachers' digital literacy. The findings emphasize that inclusive education requires not only accessible learning resources but also teachers who possess the digital competencies necessary to adapt, integrate, and utilize technology according to diverse learner needs. Strengthening both dimensions can contribute to more equitable and participatory learning environments for students with special needs in Indonesia.

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1. INTRODUCTION

Inclusive education has become a central priority in global efforts to ensure equitable access to meaningful and high-quality education for all learners. Contemporary perspectives on inclusion extend beyond the physical placement of students with different abilities in the same educational setting and emphasize the removal of barriers that constrain access, participation, interaction, and achievement. For students with special needs, such barriers may arise from instructional practices, communication methods, learning resources, technology, physical environments, and teachers' limited capacity to adapt instruction to individual characteristics (Irwani, 2025; Sari et al., 2022). This challenge is particularly relevant in Indonesia, where the expansion of inclusive education has not yet eliminated disparities between children with and without disabilities. UNICEF (2023) reported that although the number of inclusive schools in Indonesia increased by approximately 29% between 2020 and 2021, around 36% of children with disabilities were still not attending school, compared with approximately 8% of children without disabilities. These disparities suggest that expanding educational access alone is insufficient; inclusive education must also enable students with special needs to participate actively in instructional activities, interact with teachers and peers, engage with learning tasks, and demonstrate their understanding through appropriate forms of expression.

Indonesia has sought to strengthen this dimension of inclusion through Regulation of the Minister of Education, Culture, Research, and Technology No. 48 of 2023 concerning Reasonable Accommodation for Students with Disabilities. The regulation requires educational institutions to provide appropriate accommodation through infrastructure, educational personnel, curriculum, instructional support, flexible learning processes, materials, assessment, and completion arrangements based on students' assessed needs. Such provisions indicate a policy transition from inclusion understood primarily as physical access toward an approach centered on accessibility and meaningful participation (Sukbunpant et al., 2013; Walker & Musti-Rao, 2016). However, translating these regulatory commitments into classroom practice remains challenging, particularly when

instructional resources are inaccessible or teachers lack the competencies required to adapt technology-supported learning. Instructional materials represent one of the most immediate points of interaction between learners and the curriculum because they mediate information, instructions, activities, and assessments. Materials dominated by text may disadvantage learners with visual, cognitive, or reading difficulties; videos without captions can restrict access for students with hearing impairments; and scanned documents, complex visual layouts, or inaccessible digital interfaces may prevent students from independently engaging with learning content. Evidence from Indonesia has similarly indicated that inaccessible information continues to constitute an educational barrier for students with disabilities despite institutional commitments to inclusion (Kantavong & Kiettikunwong, 2020; Muchsin et al., 2022).

The importance of instructional accessibility is conceptually consistent with Universal Design for Learning (UDL), which emphasizes designing learning environments from the outset to accommodate learner variability through multiple means of engagement, representation, and action and expression. Rather than treating accessibility as a corrective intervention introduced only after students encounter difficulties, UDL positions it as an integral element of instructional design. The CAST UDL Guidelines emphasize that curricular materials should respond to different interaction requirements and remain compatible with accessibility features and assistive technologies (CAST, 2024). Accordingly, accessible instructional materials may incorporate alternative text formats, audio support, captions, readable layouts, adjustable visual presentation, multimodal explanations, clear instructions, and compatibility with assistive devices. These characteristics can reduce unnecessary barriers between students and instructional content, increase opportunities for independent engagement, and provide different pathways through which students with special needs can understand information, complete learning activities, communicate responses, and demonstrate learning. From this perspective, accessibility is not simply a technical property of learning materials but an instructional condition that may directly influence students' opportunities to participate meaningfully in the learning process.

Nevertheless, the availability of accessible materials does not automatically produce inclusive learning outcomes because their educational value depends substantially on how teachers select, modify, and implement them. Teachers' digital literacy therefore constitutes another critical condition for technology-supported inclusive education. Digital literacy extends beyond basic operational skills in using computers, smartphones, presentation applications, or online platforms and encompasses the ability to identify appropriate resources, evaluate digital information, create and adapt content, communicate in digital environments, and integrate technology according to pedagogical objectives and learner characteristics. (Munisa et al., 2024; Sofkova Hashemi & Cederlund, 2016) demonstrated that teacher digital competence involves planning technology-supported instruction, using digital technologies pedagogically, facilitating technology-mediated student activities, and supporting learners' digital capabilities. These competencies are especially important in inclusive and special education, where heterogeneous learner profiles require teachers to adapt documents, multimedia, assistive technologies, digital interfaces, and instructional modalities to specific needs. However, (Lin et al., 2023) found that professional development specifically addressing digital competence among special education teachers remains limited, with many programs emphasizing general technological skills rather than accessibility, assistive technology, and pedagogical adaptation. Recent evidence similarly suggests that effective digitally

mediated inclusive instruction requires teachers to vary learning modalities, scaffold technology use, structure content, and individualize learning according to learner needs (Lin et al., 2023).

Accessible instructional materials and teachers' digital literacy can therefore be viewed as complementary rather than independent conditions of meaningful learning participation. Accessible materials provide the resources through which students engage with learning, whereas teachers' digital literacy determines how these resources are selected, designed, adapted, and pedagogically utilized. Technology itself does not guarantee inclusion; its contribution depends on teachers' ability to transform digital resources into learning experiences that respond to student diversity. Conversely, digitally competent teachers may still encounter difficulties when appropriate accessibility features, instructional resources, or institutional support are unavailable. When learning materials are available through multiple accessible formats and teachers possess the competence to adapt digital tools to individual requirements, students with special needs may face fewer barriers to understanding content, completing activities, communicating, interacting, and expressing their learning. Despite this potential complementarity, previous research has frequently examined instructional accessibility and teacher digital competence separately. Studies on accessibility commonly focus on infrastructure, assistive technologies, or particular instructional media, whereas research on digital literacy often examines teachers in general education contexts. Indonesian studies have also tended to be qualitative, developmental, institution-specific, or focused on particular disability groups, leaving limited quantitative evidence regarding the simultaneous relationship of accessible instructional materials and teachers' digital literacy with students' actual participation in learning.

Addressing this gap is important because enrollment or physical presence in an inclusive classroom does not necessarily constitute meaningful educational participation. Students with special needs may be present in school yet remain marginally engaged when they cannot access instructional materials, participate in technology-mediated activities, communicate responses, or complete tasks designed without consideration of learner variability. Meaningful inclusion instead requires opportunities to engage with instructional content, interact with teachers and peers, complete learning activities, ask and answer questions, and express knowledge using modalities appropriate to individual capabilities. Against this background, the present study examines the role of accessible instructional materials and teachers' digital literacy in enhancing the learning participation of students with special needs in Indonesia. Specifically, it investigates the individual contribution of accessible instructional materials and teachers' digital literacy to learning participation and examines their collective explanatory role. The study contributes theoretically by integrating resource accessibility and teacher digital capacity within a single explanatory framework of learning participation, thereby positioning inclusion as an outcome of interaction between accessible learning environments and teachers' pedagogical capacity. Practically, the findings are expected to inform schools, teachers, educational administrators, and policymakers regarding the simultaneous need to improve instructional accessibility and strengthen teachers' digital competencies related to adaptation, assistive technology, accessibility, and differentiated instruction, thereby supporting the transition from formal inclusion toward more active, independent, and equitable participation among students with special needs.

2. LITERATURE REVIEW

2.1 *Theoretical Foundation*

The relationship between instructional accessibility, teachers' digital literacy, and the learning participation of students with special needs can be explained through Universal Design for Learning (UDL), DigCompEdu, and student engagement theory. UDL emphasizes reducing learning barriers through multiple means of engagement, representation, and action and expression, enabling students with diverse needs to access and respond to learning materials more effectively (CAST, 2024). DigCompEdu complements this perspective by highlighting teachers' ability to select, adapt, create, and integrate digital resources to support accessibility and participation (Kelly et al., 2022; Palei, 2024). In inclusive education, these competencies are particularly important for adapting content, assistive technologies, and instructional strategies to students' needs (Kelly et al., 2022; Palei, 2024). Learning participation reflects behavioral, emotional, and cognitive engagement, including active involvement, interaction, persistence, and opportunities to express understanding (Daud, 2022; Et al., 2021). Together, these perspectives suggest that accessible materials reduce learning barriers, while teachers' digital literacy supports their effective implementation, thereby strengthening meaningful student participation.

2.2 Accessible Instructional Materials

Accessible instructional materials are learning resources designed to be perceived, understood, navigated, and used by learners with diverse abilities without unnecessary barriers. From a Universal Design for Learning (UDL) perspective, accessibility includes flexible representation and interaction through multimodal content, captions, readable layouts, adaptable formats, and compatibility with assistive technologies (CAST, 2024). Studies show that accessible technologies can improve engagement and participation among students with disabilities, although their effectiveness may be limited by inadequate teacher training and support (Kelly et al., 2022; Palei, 2024). Evidence from Indonesia also indicates that inaccessible PDFs, image-based content, and uncaptured audiovisual materials remain barriers for students with special needs (Bukit, 2023; Kantavong & Kiettikunwong, 2020; Pradana et al., 2020). Accordingly, accessible instructional materials can be characterized by readability, multimodal presentation, ease of navigation, flexibility, assistive-technology compatibility, and adaptability to individual learner needs.

2.3 Teachers' Digital Literacy

Teachers' digital literacy refers to the knowledge, skills, judgment, and pedagogical capacity required to use digital technologies effectively and inclusively in teaching. Guided by DigCompEdu, this competence extends beyond technical operation to include selecting and evaluating digital resources, creating and adapting instructional content, integrating technology into learning, facilitating interaction, and empowering learners according to their needs. In inclusive education, digital literacy is particularly important because teachers must be able to identify accessibility barriers, use assistive technologies, modify learning materials, and provide flexible forms of communication and assessment. Previous studies indicate that limited teacher training and insufficient understanding of accessibility remain major challenges in implementing inclusive digital learning (Farisia & Syafi'i, 2024; Sofkova Hashemi & Cederlund, 2016). Accordingly, teachers' digital literacy can be reflected in their ability to evaluate digital

resources, adapt instructional content, integrate technology pedagogically, use accessibility features, respond to learner needs, and solve digital learning problems.

2.4 Hypothesis Development

Learning participation refers to students' active involvement in learning activities, including completing tasks, interacting with teachers and peers, sustaining attention, and expressing understanding. For students with special needs, participation extends beyond physical presence in the classroom because inaccessible resources or instructional practices may restrict meaningful engagement. Drawing on the multidimensional engagement framework of (Farisia & Syafi'i, 2024; Sofkova Hashemi & Cederlund, 2016), participation can be behavioral, cognitive, interactive, and affective. Accessible instructional materials can strengthen participation by reducing barriers to accessing, understanding, and responding to learning content. Consistent with UDL, multimodal resources, captions, screen-reader-compatible documents, flexible formats, and accessible navigation provide alternative pathways for students with different abilities to engage with instruction. Previous studies indicate that accessible and assistive technologies can improve academic engagement and educational participation, although their effectiveness depends on appropriate design and implementation (Farisia & Syafi'i, 2024; Sofkova Hashemi & Cederlund, 2016).

Teachers' digital literacy also plays an important role in determining how effectively technology supports inclusive participation. From the DigCompEdu perspective, digitally competent teachers are better able to select accessible technologies, adapt instructional materials, differentiate learning activities, facilitate digital interaction, and address accessibility problems. Evidence shows that inadequate teacher competence and limited training can hinder the effective use of assistive and inclusive technologies, particularly in special education (Obinyan, 2021; Ramli & Arsad, 2023; Sofkova Hashemi & Cederlund, 2016). Accessible materials and teachers' digital literacy should therefore be viewed as complementary conditions: accessible resources reduce environmental barriers, while digitally competent teachers ensure that these resources are appropriately integrated into instruction. Learning participation is thus expected to increase when students have access to inclusive learning resources and receive pedagogical support from teachers capable of using digital technologies responsively and effectively.

Based on this theoretical and empirical reasoning, the following hypothesis is proposed:

H1: Accessible instructional materials have a positive and significant effect on the learning participation of students with special needs.

H2: Teachers' digital literacy has a positive and significant effect on the learning participation of students with special needs.

H3: Accessible instructional materials and teachers' digital literacy simultaneously have a positive and significant effect on the learning participation of students with special needs.

3. RESEARCH METHODS

This study employed a quantitative explanatory design to examine the effects of Accessible Instructional Materials (X_1) and Teachers' Digital Literacy (X_2) on the Learning Participation of students with special needs (Y) in Indonesia. The population consisted of teachers and educators who worked directly with students with special needs in inclusive or special education settings. Using purposive sampling, 135 respondents were selected based on their direct teaching experience, use of conventional or digital instructional materials, and involvement in technology-supported learning. Teachers were chosen as the unit of analysis because they are directly involved in selecting, adapting, and delivering instructional resources and observing students' participation during learning activities.

Primary data were collected using a structured questionnaire measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Accessible Instructional Materials were measured through indicators including accessibility of formats, readability, multimodal presentation, navigation, flexibility, compatibility with assistive technologies, and adaptability to individual needs. Teachers' Digital Literacy covered the ability to access and evaluate digital resources, create or modify instructional content, integrate technology into teaching, use accessibility features, adapt technologies to learner needs, and solve digital learning problems. Learning Participation was measured through students' involvement in classroom activities, task completion, interaction with teachers and peers, responsiveness, persistence, use of learning resources, and expression of understanding. Before further analysis, the instrument was evaluated for validity using item-total correlations and for reliability using Cronbach's Alpha, with a coefficient of ≥ 0.70 indicating acceptable internal consistency.

Data were analyzed using IBM SPSS Statistics version 25. The analysis included descriptive statistics, validity and reliability testing, classical assumption tests, Pearson correlation, and multiple linear regression. Normality, multicollinearity, and heteroscedasticity tests were conducted to ensure the suitability of the regression model. The partial effects of Accessible Instructional Materials and Teachers' Digital Literacy on Learning Participation were examined using t-tests, while their simultaneous effect was evaluated using the F-test. Statistical significance was determined at $p < 0.05$, and the coefficient of determination (R^2 and adjusted R^2) was used to assess the proportion of variance in Learning Participation explained by the two independent variables.

4. RESULT AND DISCUSSION

4.1 Respondent Characteristics

A total of 135 valid responses were included in the statistical analysis. All respondents were teachers or educators with direct experience in teaching students with special needs in inclusive or special education settings. The demographic profile of the respondents is presented in Table 1.

Table 1. Characteristics of Respondents

Characteristic	Category	Frequency	Percentage (%)
Gender	Male	48	35.6
	Female	87	64.4
Educational Setting	Inclusive School	82	60.7
	Special Education School	53	39.3
Teaching Experience	< 5 years	33	24.4
	5–10 years	54	40.0

	> 10 years	48	35.6
Digital/Inclusive Education Training	Yes	96	71.1
	No	39	28.9

A total of 135 respondents participated in the study, comprising 48 male teachers (35.6%) and 87 female teachers (64.4%). Most respondents worked in inclusive schools (60.7%), while 39.3% were from special education schools. In terms of teaching experience, 24.4% had less than five years of experience, 40.0% had between five and ten years, and 35.6% had more than ten years of experience. Furthermore, 71.1% of respondents had participated in digital or inclusive education training, whereas 28.9% had not. Overall, the respondent profile indicates that the sample was dominated by female educators, teachers from inclusive schools, educators with at least five years of teaching experience, and those who had received relevant digital or inclusive education training.

4.2 Validity and Reliability of the Measurement Instrument

Before hypothesis testing, validity and reliability analyses were conducted to evaluate the quality of the measurement instrument. Based on 135 respondents, all questionnaire items showed corrected item-total correlation coefficients above the minimum critical value of approximately 0.169 at the 5% significance level, indicating that all items were valid. Internal consistency was subsequently assessed using Cronbach's Alpha, with the reliability results for each construct presented in Table 2.

Table 2. Validity and Reliability Test Results

Variable	Items	Corrected Item-Total Correlation Range	Cronbach's Alpha	Interpretation
Accessible Instructional Materials (AIM)	7	0.562–0.786	0.882	Valid and Reliable
Teachers' Digital Literacy (TDL)	8	0.575–0.812	0.901	Valid and Reliable
Learning Participation (LP)	8	0.548–0.794	0.889	Valid and Reliable

The validity and reliability results confirm that all three constructs met acceptable measurement criteria. Accessible Instructional Materials (AIM) consisted of seven items with corrected item-total correlations ranging from 0.562 to 0.786 and a Cronbach's Alpha of 0.882. Teachers' Digital Literacy (TDL) comprised eight items with correlation values between 0.575 and 0.812 and an Alpha coefficient of 0.901, while Learning Participation (LP) included eight items with correlations ranging from 0.548 to 0.794 and a Cronbach's Alpha of 0.889. Since all item correlations exceeded the critical value and all Alpha coefficients were above 0.70, the three constructs were considered valid and reliable for further analysis.

4.3 Descriptive Statistics

Descriptive statistics were used to provide an overview of respondents' assessments of Accessible Instructional Materials, Teachers' Digital Literacy, and Learning Participation. Since all variables were measured on a five-point Likert scale, higher scores represented more favorable conditions.

Table 3. Descriptive Statistics of Research Variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Accessible Instructional Materials (AIM)	135	2.57	5.00	4.02	0.53
Teachers' Digital Literacy (TDL)	135	2.50	5.00	3.91	0.57
Learning Participation (LP)	135	2.63	5.00	4.05	0.50

The descriptive statistics show that all three variables were rated relatively high by the 135 respondents. Accessible Instructional Materials (AIM) had a mean of 4.02 with a standard deviation of 0.53, ranging from 2.57 to 5.00. Teachers' Digital Literacy (TDL) recorded a mean of 3.91 and a standard deviation of 0.57, with scores ranging from 2.50 to 5.00. Learning Participation (LP) showed the highest mean at 4.05 with a standard deviation of 0.50 and scores ranging from 2.63 to 5.00.

4.4 Classical Assumption Tests

Prior to multiple linear regression analysis, the assumptions of normality, multicollinearity, heteroscedasticity, and independence of residuals were evaluated. The results are summarized in Table 4.

Table 4. Classical Assumption Test Results

Assumption	Indicator	Result	Criterion	Conclusion
Normality of Residuals	Kolmogorov-Smirnov Sig.	0.200	> 0.05	Normal
Multicollinearity – AIM	Tolerance	0.750	> 0.10	No multicollinearity
	VIF	1.333	< 10.00	No multicollinearity
Multicollinearity – TDL	Tolerance	0.750	> 0.10	No multicollinearity
	VIF	1.333	< 10.00	No multicollinearity
Heteroscedasticity – AIM	Glejser Sig.	0.284	> 0.05	No heteroscedasticity
Heteroscedasticity – TDL	Glejser Sig.	0.417	> 0.05	No heteroscedasticity
Residual Independence	Durbin-Watson	1.934	Approximately 2	Acceptable

The classical assumption tests confirmed that the regression model met the required statistical assumptions. The Kolmogorov–Smirnov significance value of 0.200 indicated normally distributed residuals. Both Accessible Instructional Materials (AIM) and Teachers' Digital Literacy (TDL) showed tolerance values of 0.750 and VIF values of 1.333, indicating no multicollinearity. The Glejser test also showed no heteroscedasticity, with significance values of 0.284 for AIM and 0.417 for TDL. In addition, the Durbin–Watson value of 1.934 indicated acceptable residual independence.

4.5 Multiple Linear Regression Analysis

Multiple linear regression was performed to determine the extent to which Accessible Instructional Materials and Teachers' Digital Literacy explained Learning Participation.

4.5.1 Model Summary

The regression model produced an R value of 0.746, indicating a strong relationship between Accessible Instructional Materials (AIM), Teachers' Digital Literacy (TDL), and Learning Participation (LP). The R^2 value of 0.557 shows that AIM and TDL jointly explained 55.7% of the variance in Learning Participation, while the adjusted R^2 of 0.550 indicates that 55.0% remained explained after adjustment for the number of predictors. The remaining 44.3% of variance was

attributable to other factors not included in the model. The standard error of the estimate was 0.335, and the Durbin–Watson value of 1.934 indicated acceptable residual independence

4.5.2 Simultaneous Significance Test

The overall significance of the regression model was evaluated using the ANOVA F-test.

Table 5. ANOVA Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	18.666	2	9.333	83.051	<0.001
Residual	14.834	132	0.112		
Total	33.500	134			

The ANOVA results showed that the regression model was statistically significant, with $F = 83.051$ and $p < 0.001$. The regression sum of squares was 18.666 with 2 degrees of freedom, while the residual sum of squares was 14.834 with 132 degrees of freedom. These findings indicate that Accessible Instructional Materials (AIM) and Teachers' Digital Literacy (TDL) jointly had a significant effect on Learning Participation (LP), confirming that the overall regression model was appropriate for explaining variations in students' learning participation.

4.5.3 Partial Regression Coefficients

The individual contribution of each independent variable was evaluated through regression coefficients and t-tests.

Table 6. Multiple Linear Regression Coefficients

Predictor	B	Std. Error	Standardized Beta	t	Sig.	Tolerance	VIF
Constant	0.963	0.244	—	3.943	<0.001	—	—
Accessible Instructional Materials	0.358	0.063	0.380	5.682	<0.001	0.750	1.333
Teachers' Digital Literacy	0.421	0.059	0.480	7.177	<0.001	0.750	1.333

The regression results showed that Accessible Instructional Materials had a positive and significant effect on Learning Participation ($B = 0.358$, $\beta = 0.380$, $t = 5.682$, $p < 0.001$), indicating that greater instructional accessibility was associated with higher student participation; therefore, H1 was supported. Teachers' Digital Literacy also had a positive and significant effect ($B = 0.421$, $\beta = 0.480$, $t = 7.177$, $p < 0.001$), supporting H2. The standardized coefficients further showed that Teachers' Digital Literacy ($\beta = 0.480$) made a larger unique contribution to Learning Participation than Accessible Instructional Materials ($\beta = 0.380$), suggesting that teachers' capacity to select, adapt, and integrate digital resources played a particularly important role in supporting student participation.

Discussion

The findings demonstrate that accessible instructional materials contribute to improving the learning participation of students with special needs. Materials that are readable, flexible, multimodal, easy to navigate, and compatible with assistive technologies can reduce barriers that prevent students from accessing information and participating independently. This finding is

consistent with Universal Design for Learning (UDL), which emphasizes multiple means of representation, engagement, and action and expression to accommodate learner variability (CAST, 2024). It also aligns with previous studies showing that accessible and assistive technologies can support educational participation among students with disabilities (Bukit, 2023; Kantavong & Kiettikunwong, 2020; Pradana et al., 2020). Accessibility should therefore be regarded as an integral component of instructional design rather than an additional accommodation provided only after difficulties arise.

The findings also highlight the important role of teachers' digital literacy in supporting meaningful participation. Digital competence enables teachers to select appropriate technologies, modify instructional materials, provide alternative formats, use accessibility features, personalize learning activities, and respond to technological difficulties experienced by students. This interpretation is consistent with DigCompEdu, which positions digital competence as a combination of technological and pedagogical capacities aimed at improving accessibility, differentiation, and learner engagement. Previous research similarly indicates that special education teachers require competencies extending beyond general technology use to include assistive technologies, accessibility, and adaptive pedagogy (Azwar et al., 2021; Jauhari et al., 2020). Digital literacy therefore functions as an enabling professional capacity through which technology can be transformed into inclusive learning experiences.

Accessible instructional materials and teachers' digital literacy should consequently be understood as complementary dimensions of inclusive education. Accessible resources provide pathways for students to obtain and interact with instructional information, while teachers determine how these resources are selected, adapted, and integrated into learning activities. This relationship connects the principles of UDL with DigCompEdu by emphasizing both inclusive learning design and teacher competence. Providing digital devices or platforms alone may have limited benefits when instructional content remains inaccessible, just as accessible resources may not achieve their intended purpose when teachers lack the competence to use them appropriately. Effective inclusion therefore requires alignment between accessible resources and responsive instructional practices.

More broadly, the findings reinforce the view that meaningful participation is shaped by interactions between learners, instructional resources, technology, and teacher practices rather than by technology alone. Teachers continuously make decisions about how information is presented, what support students require, which technologies are appropriate, and how students can demonstrate their learning. At the same time, accessible materials reduce environmental barriers that could otherwise restrict participation regardless of students' capabilities. Schools should therefore strengthen both the accessibility of instructional resources and teachers' digital competence through appropriate professional development, institutional support, and inclusive instructional design. Such an integrated approach can create learning environments in which students with special needs have greater opportunities to engage, interact, complete learning activities, and express their understanding.

5. CONCLUSION

This study concludes that accessible instructional materials and teachers' digital literacy are important factors in strengthening the learning participation of students with special needs in Indonesia. Accessible, flexible, multimodal, and assistive-technology-compatible learning resources

can reduce barriers to participation, while digitally competent teachers are better able to select, adapt, and integrate technology according to diverse learner needs. These findings indicate that inclusive education should not focus solely on providing digital technologies, but should combine accessible instructional design with continuous development of teachers' competencies in accessibility, assistive technology, differentiated instruction, and inclusive digital pedagogy. Educational institutions and policymakers should therefore strengthen both resource accessibility and teacher capacity to support more meaningful participation. However, the study is limited by its cross-sectional design, purposive sampling, and reliance on teacher perceptions; future research should involve broader samples, student perspectives, longitudinal designs, and additional factors such as institutional support, classroom climate, parental involvement, and availability of assistive technologies.

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