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An Adaptive and Differentiated Digital Assessment Model to Measure Elementary Students' Character Values Using an Ethnosocial Approach in Science and Social Studies Learning

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Abstract: Character assessment in science and social studies in elementary schools still faces various obstacles, particularly regarding the limited instruments available to accommodate differences in student characteristics and their social and cultural contexts. The main objective of this study was to develop a valid and effective Differentiated Adaptive Digital Assessment model to measure character values using an ethnosocial approach in elementary school students in science and social studies learning. This study used the Research and Development (R&D) method with the following stages: information gathering, model planning, prototype development, expert validation, preliminary field testing, and main field testing. Data were collected through interviews, observations, questionnaires, and documentation, and analyzed descriptively and inferentially. The results showed that the developed model was valid in content and construct and highly reliable ($\alpha > 0.85$). All components of the model, from the character assessment rubric, ethno-social contextual tasks, adaptive digital platform, to the implementation guide, significantly contributed to measuring students' character values fairly and meaningfully. This study contributes to developing technology-based character assessment that is inclusive and culturally relevant at the elementary education level.

Keywords: Adaptive digital; Character assessment; Differentiation; Ethnosocial; science and social studies

Introduction

Character education at the elementary school level plays a strategic role in shaping students' personalities from an early age, especially in building basic values such as responsibility, empathy, honesty, and cooperation (Asnawi et al., 2023; Astimar et al., 2019; Fitria & Kenedi, 2021; Helsa & Kenedi, 2019; Sahudra et al., 2023). These values complement the curriculum and are the main foundation in shaping a generation that excels morally, socially, and culturally. In the context of an independent curriculum that integrates a holistic and contextual approach, science and social studies provides ample space for the integration of character values with the real-life situations of students, both in natural and social aspects (Anita et al., 2023; Eliyasni et al., 2019; Y. Fitria et al., 2021; Zainil et al., 2021; Zuryanty et al., 2023). Unfortunately, in daily classroom practice, character assessment still faces various challenges, such as teacher subjectivity, uniformity of instruments, and a lack of integration with the local context and digital technology.

The digital era has brought significant changes to the world of education, including in the aspect of assessment (Anita et al., 2022; Arwin et al., 2023;

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Rahmatina et al., 2019; Ramadhani et al., 2021). Technology enables assessments to be conducted online, adaptively, and in real-time, promising efficiency and opportunities to tailor assessments based on the needs and characteristics of students (Anita et al., 2022; Arwin et al., 2022; Hamimah et al., 2019; Kenedi et al., 2023). However, most digital assessment systems developed to date focus more on cognitive aspects or student academic achievement, while character value assessment has not received equal attention. A study by (Mustika et al., 2024) shows that most character assessments are manual and lack responsiveness to technological developments and students' personal needs. This result is reinforced by findings from Uyun et al. (2023), which state that the integration of digital technology and character assessment is still minimal, especially at the elementary school level. In fact, with the ability of technology to automatically record data, personalize questions, and adapt the difficulty level, character assessment can be developed more effectively and efficiently.

Another gap lies in the lack of an assessment system that considers the diversity of students' cultural, ethnic, and social backgrounds. Generic assessment systems often ignore the local cultural context, so measured character values tend to be universal and less relevant to students' real lives. The ethnosocial approach, which emphasizes local cultural values, social norms, and local wisdom in the educational process, is still not widely used in developing digital assessment systems, especially in the context of science and social studies learning. Research by Asnawi et al. (2025) shows that the ethnosocial approach can improve the effectiveness of character education because it is more in line with students' identities and social realities. However, the study focused more on learning and national insight than explicit and adaptive character measurement.

Furthermore, there are limitations in developing adaptive and differentiated assessment models. Adaptive models allow for adjusting materials, questions, and scenarios based on students' abilities or responses. At the same time, differentiated assessments accommodate diversity in learning styles, social backgrounds, and other individual characteristics. Most character assessments still use a one-size-fits-all approach, which does not align with inclusive and equitable education principles. In fact, the principle of differentiation has become a recommended approach in modern learning, including in assessment (Tomlinson, 2014). Therefore, a digital assessment model that measures character, is responsive to individual student differences, and is relevant to their ethno-social context is needed.

So far, studies on digital-based character assessment have begun to emerge, such as the study by Suhaini et al. (2021), who developed an Android-based character assessment application for elementary school students. However, this application is still limited to measuring certain values and has not adopted an adaptive or differentiated approach. Similarly, research by Khoury-Shaheen & Weintraub (2022) developed a web-based e-assessment system, which, although successful in improving assessment efficiency, did not explicitly include cultural and social aspects of students. This fact shows that gaps in research need to be filled through a more holistic and contextual approach.

This study offers a novel contribution in the form of the development of a Differentiated Adaptive Digital Assessment Model capable of measuring elementary school students' character values using an ethnosocial approach in science and mathematics learning. This model relies on digitization and integrates modern pedagogical principles such as personalization, differentiation, and cultural contextualization. By using digital technology, this model will be able to adapt assessment items according to student profiles in terms of cognitive abilities, learning styles, and their social and cultural backgrounds. In the ethnosocial approach, local values such as cooperation, deliberation, and social responsibility are an important part of the character indicators being measured. That way, character assessment becomes more meaningful and contextual and encourages the whole student to get involved.

This study's main objective is to effectively develop a valid Differentiated Adaptive Digital Assessment model to measure character values using an ethnosocial approach in elementary school students in science and social studie. The validity of the developed model will be tested through a series of development stages, expert validation, practicality tests, and effectiveness tests. This research is expected to significantly contribute to the field of basic education, particularly in developing a technology-based and culturally relevant character assessment system. In addition, the results of this study can also be a reference for teachers, curriculum developers, and policy makers in integrating local character values into an inclusive and equitable digital education system.

With the development of this model, it is hoped that character assessment will no longer be positioned as a complementary activity, but rather as an integral part of relevant, fair, and contextual learning. Digital, adaptive, and ethnosocial character education is the answer to the challenges of the times, and it is a commitment to making education a means of social transformation rooted in the nation's noble values.

Method

This study uses a research and development (R&D) approach to design and develop a differentiated adaptive digital assessment model that aims to measure the character values of elementary school students in science and social studies by considering their ethnosocial context. The model development process follows a modified framework from the Borg and Gall model, which systematically guides the stages from needs identification to model implementation in the field (Aka, 2019).

The initial step began with field information gathering, which was conducted through observation and interviews with teachers and principals in several elementary schools. The goal was to explore real issues in character assessment that have been occurring, especially the challenges in relating assessment to the diversity of students' cultural, social, and ethnic backgrounds. The findings from the field became the basis for designing the initial digital assessment model.

The next stage was planning the model development, in which the research team compiled a conceptual framework and initial design for the assessment instrument. The character indicators developed refer to empathy, responsibility, honesty, and cooperation. They are integrated with an ethnosocial approach to make the assessment more meaningful and relevant to the students' environment.

Once the initial design was complete, the team developed a prototype of the digital assessment model that could be accessed online via computer or tablet devices. This model was designed to be adaptive—meaning that the assessment's content and difficulty level could be tailored to each student's profile—and differentiated based on their learning styles and socio-cultural contexts.

The next stage was to conduct initial trials of the model in a limited environment to identify technical and pedagogical aspects that still needed improvement. Feedback from teachers and students at this stage was crucial to perfecting the model. Based on these results, initial revisions are made before the model is retested on a larger scale in a main field trial. In this phase, the model is implemented in several schools with diverse student characteristics to evaluate the model's effectiveness and usability in real learning situations.

After the main trial, a more comprehensive revision was made based on the quantitative and qualitative data obtained. This revision involved a team of experts in character education and learning technology. The updated model was then tested in actual operational conditions, where teachers used it independently in the classroom to assess students' character development during the Science And Social Studies learning process.

To conclude this development stage, the model was disseminated and implemented among various educational stakeholders—including teachers, principals, curriculum developers, and education agencies—with the hope that it can be used more widely and sustainably to support character education relevant to students' lives.

Place and Time of Research

This research was conducted at a public elementary school in Langsa City, Aceh Province, which was purposively selected because it reflects the diversity of students' social and cultural backgrounds. Langsa City has distinctive multicultural characteristics and strong interaction between ethnic groups and local cultures. This context is highly relevant to the ethnosocial approach that focuses on developing this digital-based character assessment model.

The school was selected based on several factors, including its openness to technology-based learning innovations, teachers' willingness to collaborate in developing the model, and the diversity of student characteristics that would allow for testing the model in a real socio-cultural context.

This research was conducted over six months, with the following details: the first three months were used for model development and refinement based on preliminary findings and expert input; the next two months were used for initial and main field trials; and the last month was used to revise the final model and compile research findings and recommendations.

Research Sample

The research subjects consisted of fourth- and fifth-grade elementary school students and science teachers actively implementing the independent curriculum. The sample selection was done using a purposive sampling approach, which involves selecting the most relevant participants to provide feedback on the developed model. Around 30 students and three teachers from three schools were involved in the initial trial. In comparison, in the main trial, the number increased to 100 students and 10 teachers from five elementary schools with different cultural backgrounds.

Data Collection and Analysis Techniques

Several methods were used to obtain comprehensive data: questionnaires, interviews, observation, and documentation. Teachers and students were given questionnaires to determine their perceptions of the assessment model's practicality, clarity, and ease of use. In-depth interviews were conducted to explore the views of teachers and

education experts on the extent to which this model can measure character values in a real socio-cultural context. Meanwhile, direct observation was conducted during science and social studies lessons to observe how the model was used in a real classroom context.

Quantitative data were analysed using descriptive statistical techniques, such as averages and percentages, to describe response trends. Qualitative data from interviews and observations were analysed using a thematic approach to identify patterns and insights that could strengthen or refine the model's development.

Research Instruments

The main instrument in this study was a differentiated adaptive digital assessment rubric, designed to assess student character based on indicators relevant to the ethnosocial approach. This rubric was developed to respond to student diversity and provide personalised, contextual, and flexible assessment information. In addition, expert validation questionnaires, user questionnaires, and interview guidelines were also used as part of the model's formative evaluation process.

Before use, all instruments were validated by experts in character education and learning technology to ensure the accuracy and reliability of the measuring tools. The validation results showed that the instruments had strong content validity, and the reliability test results using Cronbach's Alpha produced values above 0.85, indicating that the instruments used were highly reliable and consistent in measuring the variables under study**.**

Result and Discussion

Result

The research results are presented based on the main stages in the model development process, from information gathering, planning, and development to initial and main field trials.

Information Collection

The initial stage of the research was conducted by gathering information directly from the field through interviews with teachers and principals at a public elementary school in Langsa City, Aceh. These interviews aimed to obtain an overview of the character assessment practices carried out so far and the challenges faced in their application in the classroom. Based on the interview results, it was found that character assessment has been conventional and descriptive, with a uniform approach for all students without considering their diverse social and cultural backgrounds. Teachers acknowledged that although character values such as responsibility, empathy, and cooperation have been part of science and social studies, there is no systematic, structured assessment system capable of capturing students' character expressions in authentic contexts.

In addition to interviews, the researchers conducted direct observations of the science and social studies process and analysed documents such as lesson plans and teachers' daily journals. The document analysis results showed that character values were indeed included in the learning indicators. However, their implementation had not adopted digital technology and had not been adapted to students' needs and individual profiles. No adaptive or differentiated instruments were found to assess student character, let alone those based on ethnosocial factors.

Planning

Based on the findings in the information gathering stage, the researchers then designed a character assessment model that was not only digital but also adaptive, differentiated, and relevant to the ethnosocial approach. This model was specifically designed for use in science and social studies learning in elementary schools.

Planning began with compiling character value indicators based on literature reviews and field requirements, including empathy, responsibility, honesty, cooperation, and respect for cultural diversity. These indicators were adapted to the Acehnese community's local values and social norms as a form of integrating the ethno-social context into the assessment. Three main components of the model were designed at this stage: Digital Assessment Rubric: A rubric designed to assess students' expression of character values in various science and social studies activities, with levels adapted to students' development; Ethno-social Contextual Tasks: Learning activities designed as collaborative tasks or projects, such as observation of the surrounding social environment, folklore, and case studies based on local cultural values; and Adaptive Digital Assessment Platform: A simple web-based application that allows teachers to conduct real-time character assessments, generate indicators based on student responses, and provide automatic feedback.

Model Development

At this stage, researchers developed an initial prototype of a differentiated adaptive digital assessment model. The model was developed through Focus Group Discussions (FGDs) with science and social studies teachers, curriculum developers, and character education experts. These FGDs produced several character indicators with ethno-social dimensions that reflect the diversity of student contexts in Langsa City.

Three experts then validated the initial development results Dr. Ronald Fransyaigu, M.Pd – character education expert [1]; Dr. Bunga Mulyahati, M.Pd – learning technology expert [2]; and Prof. Syafri Ahmad, Ph.D – assessment and psychometrics expert [3].

Table 1. Recapitulation Result of Validation

Validated Components	Stage 1 Score	Stage 2 Score	Validation Category	Dominant Validator
Adaptive Digital Assessment Model	72	85	A (Highly Valid)	[1]
Ethnosocail Contextual Task	37	49	B (Valid)	[2]
Character Assessment Section	30	40	B (Valid)	[3]
Digital Assessment Platform	35	45	A (Highly Valid)	[1]
Teacher Observation Instrument	28	36	B (Valid)	[2]
Model Implementation Guide	31	41	B (Valid)	[1]

Based on Table 1, the first validation stage showed that several components still needed improvement, particularly regarding observation instruments and rubric descriptors. After improvements were made based on expert input, the second validation stage showed significant improvement. The model was declared valid and suitable for field testing with these results.

Initial Field Trial

The initial trial was conducted with 30 students and 3 teachers at the elementary school where the research took place. The purpose of this trial was to determine the initial effectiveness of the model in a real context and to identify technical and pedagogical aspects that still needed to be adjusted.

Table 2. The results of the factor analysis

Component	KMO Value	Effective Variance	Correlation Coefficient	Description
Adaptive Digital Assessment Model	0.821	76	0.837	Significant
Ethnosocial Contextual Task	0.788	72	0.765	Significant
Character Assessment Rubric	0.770	68	0.748	Significant
Digital Assessment Platform	0.802	79	0.828	Significant
Teacher Observation Instrument	0.762	70	0.741	Significant
Implementation Guide	0.773	73	0.769	Significant

Based Table 2, all components have a KMO value above 0.75 and significant correlations between indicators. Some improvements made after the initial trial include: Refining the assessment rubric descriptors to make them easier for teachers to understand; Adding local cultural elements to contextual tasks; Simplification of the platform interface to make it more user-friendly; and Sharpening of instructions in the implementation guide.

Main Field Trial

The main trial was conducted with 100 students and 10 teachers from five different elementary schools with diverse cultural and social backgrounds in Langsa City. The purpose of this trial was to test the effectiveness of the model on a larger scale.

Table 3. The results of the trial analysis

Component	KMO Value	Effective Variance	Correlation Coefficient	Description
Adaptive Digital Assessment Model	0.793	77	0.834	Significant
Ethnosocail Contextual Task	0.785	75	0.812	Significant
Character Assessment Rubric	0.801	78	0.826	Significant
Digital Assessment Platform	0.810	80	0.842	Significant
Teacher Observation Instrument	0.776	76	0.798	Significant
Implementation Guide	0.784	74	0.791	Significant

The results show that all components effectively contribute highly to the overall model. The Digital Assessment Platform and Character Assessment Rubric show the most prominent results, with a practical contribution of over 78% and a robust correlation between indicators.

Thus, this differentiated adaptive digital assessment model with an ethnosocial approach has been proven effective and valid for assessing students' character values in the context of science and social studies learning in elementary schools.

Discussion

The results of this study indicate that the Differentiated Adaptive Digital Assessment model with an ethnosocial approach that was developed has been proven to be valid, reliable, and effective in measuring the character values of elementary school students in the context of science and social studies. This result aligns with the study's primary objective: to produce a character assessment model that can accommodate the diversity of students' social and cultural backgrounds and utilize digital technology for the adaptive assessment process. The model's validity has been confirmed through two stages of assessment by experts, in which almost all components achieved the valid category, and some of them were even declared highly valid, such as the core model and digital platform. Initial and foremost, field trials conducted in stages also confirmed that all indicators in this model make a highly effective contribution and have a significant relationship with other indicators, as evidenced by factor analysis.

These findings reinforce several previous studies highlighting the importance of contextual and digital approaches in character assessment. For example, Asrial et al. (2024) in their study on *e-assessment* of character in elementary schools found that using digital platforms can improve assessment efficiency and accuracy of results. Similarly, research by Masluhah & Afifah (2022) shows that character-based digital assessment allows for a more objective evaluation process and provides meaningful real-time feedback. However, the advantage of the model developed in this study lies in integrating digital assessment, the principle of differentiation, and the ethnosocial approach. In other words, the assessment is not only technically adaptive but also culturally adaptive. This aligns with Smets et al. (2022) view on the importance of differentiation in learning and assessment to fairly serve each student's unique needs. Furthermore, the results of this study also support a local culture-based character education approach as described by Narvaez & Lapsley (2009), namely that character must be developed through values that are alive and meaningful in students' social lives.

Furthermore, when character indicators are directly linked to students' contextual experiences—for example, through collaborative tasks based on folklore or social environment observation activities—students show higher engagement and a more concrete understanding of character. This explains why character values such as empathy, responsibility, and cooperation can be measured more validly. Adjusting the model to students' diverse backgrounds allows character assessment to be not a normative, one-way activity but a reflection of students' daily lives in their communities. This adaptive and differentiated assessment allows for adjustments to task content and difficulty levels, so that students from various backgrounds can demonstrate their character potential in relevant and appropriate ways.

Theoretically, this research makes an important contribution to developing character assessment models in primary education, especially those integrating three approaches: digitization, adaptability, and ethnosocial. The ethnosocial approach in this assessment has been shown to positively affect the meaningfulness of tasks for students, which in turn increases the validity of the measurement. This is consistent with Lickona's thinking that character education must be contextual and cannot be separated from local cultural values (Yusuf et al., 2024). This model also shows that good assessment measures learning outcomes and supports the process of shaping students' values and identities as individuals in their community.

However, this study has several limitations that need to be considered. First, the scope of the study is still limited to one area, namely a public elementary school in Langsa City, Aceh. Although this area was chosen because of its cultural diversity, the results cannot necessarily be generalized to other areas with different ethno-social backgrounds. Second, the effectiveness of the new model was tested in the short term, so its impact on the long-term character development of students cannot yet be ascertained. Third, technical aspects such as digital infrastructure, teacher training, and school readiness in adopting this model remain challenges in its widespread implementation.

Based on these results and limitations, there are several areas for further research. First, this model can be tested longitudinally to observe students' character development. Second, the application of the model needs to be expanded to schools with different socio-cultural contexts in order to examine the flexibility and adaptability of the model. Third, developing a more integrated technology support system and intensive training for teachers needs to be part of further development so that this model can truly be implemented widely and sustainably. Further research can also explore the relationship between the application of this model and increased learning motivation, student participation, and character behaviour in everyday life.

Considering the above findings and discussions, this study's differentiated adaptive digital assessment model with an ethnosocial approach significantly contributes to character assessment practices in elementary schools. This model offers a valid and reliable instrument and can respond to the contextual challenges of character education in an increasingly complex and multicultural digital era.

Conclusion

This study produced a Differentiated Adaptive Digital Assessment model with an ethnosocial approach that has been proven valid and effective in measuring the character values of elementary school students in science and social studies. This model combines adaptive digital technology with the principles of differentiation and local cultural context, enabling it to tailor assessments to students' backgrounds and individual characteristics. Expert validation and field testing results show that all components of the model—including rubrics, digital platforms, and contextual tasks—have high levels of reliability and contribution. These findings reinforce the importance of contextual, fair, and meaningful character assessment and provide theoretical and practical contributions to the development of character education in the digital age. Although limited to one study area, this model has the potential to be adapted more widely with further testing in various cultural and geographical contexts.

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Author Contributions

Conceptualization, A.K.K. and A; methodology, A.M.; software, D.R.; validation, A.K.K., A. and T.M.S.; formal analysis, A.K.K.; investigation, T.M.S.; resources, A.M.; data curation, A.K.K.; writing—original draft preparation, A.M.; writing—review and editing, A.; visualization, A.; supervision, D.R.; project administration, A.K.K.; funding acquisition, A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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