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Development of Digital Storytelling Media with Adaptive Visual and Linguistic Features to Improve Storytelling Skills in Deaf Children

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ABSTRACT

This study aimed to develop Digital Storytelling Intervention Media with Adaptive Visual and Linguistic Features to support storytelling skills among deaf children receiving educational services at the UPTD Disability Services of Sidoarjo Regency. The study employed a Research and Development (R&D) approach using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. The study involved five elementary-school-aged deaf children selected through saturated sampling. Data were collected using expert validation questionnaires, teacher and participant response questionnaires, observations, interviews, and storytelling performance tests administered through pretest and posttest. The findings indicate that the developed media demonstrated high validity, with scores of 95.00% from media experts and 93.33% from subject-matter experts. In terms of practicality, teacher and participant responses reached 95.14% and 95.00%, respectively, both categorized as very practical. Regarding improvement in storytelling skills, the mean score increased from 50.00 in the pretest to 87.40 in the posttest, with an average N-Gain of 0.75, categorized as high. Given the very small sample and one-group pretest–posttest design without a control group, these findings should be interpreted as preliminary evidence of improvement following media use rather than broad evidence of effectiveness or a definitive causal effect. The results suggest that the developed media has potential to support storytelling interventions for deaf children in similar educational contexts.

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1. INTRODUCTION

Children with disabilities, deaf children are individuals who experience obstruction to hearing function, so access to information through the auditory becomes limited. This condition is not related to low intellectual ability, but can influence language acquisition,

communication, and learning processes if the child does not have access to communication and appropriate educational services. Law of the Republic of Indonesia Number 8 of 2016 [1] about Persons with Disabilities confirms that persons with disabilities have the right to get accessible education andservices in accordance with characteristics as well as needs. Provisions are strengthened through Minister of Education, Culture, Research and Technology Regulation Number 48 of 2023 [2], which emphasizes importance of providing decent accommodation through adjustment services, facilities, and support based on the needs of the participant. Therefore, service education for children with deaf disabilities needs to consider their learning characteristics, which depend on visual information as well as communication that can use sign language, verbal language, and multimodal communication.

One important aspect of language development important language developed in children with disability deaf children is the skill of telling stories. These, namely expressive language skills include mastery of vocabulary, introducing characters and events, sequencing events, understanding cause and effect, and organizing ideas into a coherent and communicative narrative. In Deaf and Hard of Hearing (D/HH) children, these skills can experience obstacle-related limitations in access to language and experience in communication, which is visible in difficulty using vocabulary, sequencing events, and building a story. Walker et al. [3] find that Hard of Hearing children have narrative macrostructure and narrative retell skills that are lower compared to children with typical hearing. In line with that, Carden et al. [4] showed that systematic narrative intervention can increase story retelling skills and use elements of story grammar in D/HH children. Thus, skills to tell a story need to be developed through learning that provides support language and visuals structured so that children are capable of conveying a story coherently and communicatively.

Problems were also found based on results from observations of initial steps taken at the Service Unit Disability (ULD). Observation results show that children with disabilities, including deaf children, are capable of recognizing objects and activities in pictures, but are not yet capable of connecting them to form a story with a structured beginning, middle, and end. Difficulty is especially seen in expressive language, limited vocabulary, sequencing events, and understanding cause and effect. Findings: This is in line with Esbensen and Grenner [5], Walker et al. [3], and Carden et al. [4] show that children with hearing disturbance experience difficulty in narrative ability and can benefit from intervention-based narrative. Lee and Lee [6] also show that use of image stimuli can increase narrative ability and vocabulary diversity. However, the media used in previous studies are still limited to pictures, books, or approach Language oral and do not yet integrate Language cues, visual scaffolding, levels of story, and systematic feedback. Therefore, it is necessary to have multimodal intervention media that integrates visual and linguistic power signals to help children compile a series of incidents into more coherent stories.

The development of digital technology provides opportunities to overcome limitations of intervention media through greater use of interactive, visual, and adaptive media. One of the relevantalternatives is Digital Storytelling, namely media that integrates

narrative with various multimedia elements such as illustrations, images, text, videos, animations, and interactive activities. Characteristics are in accordance with the needs of children with disabilities, such as deaf children who need access to information through visual modality. Kurniawan & Kanaha [7] said that technology is used to support various learning activities, including visual presentation, simulation experiments, video-based learning, as well as collaborative learning. In this matter, this shows that utilizing technology in education for children with deaf disabilities contributes to the development of language, communication, literacy, and vocabulary mastery. In addition, research about computer-assisted instruction-based media shows that integrating images, text, animations, and interactive activities can support improved language ability for deaf children. Intervention narrative visual media-based approaches are also reported to be capable of increasing language expression, vocabulary mastery, story grammar, and story retelling. Thus, Digital Storytelling has potential not only as a delivery medium for stories, but as an intervention medium that provides systematic practice in understanding stories, vocabulary mastery, sequencing events, and the ability to retell.

The theoretical basis for such media can be explained through the concept of visual scaffolding. Visual scaffolding refers to the provision of visual cues that temporarily support learners in understanding, organizing, and recalling information until they can perform a task more independently. For storytelling, visual scaffolding can make abstract or sequential information more concrete by representing characters, objects, settings, actions, and relationships among events through illustrations, icons, animations, or other visual representations. Sequential visual presentation can also help children identify the temporal order of events and recognize how one event is connected to another. In the context of deaf education, this support is particularly relevant because visual information can provide an accessible pathway for processing story content when auditory input is limited. Thus, contextual illustrations, consistent visual symbols, simple layouts, and step-by-step presentation can function not merely as decorative elements but as cognitive supports for understanding and organizing a narrative. In addition to visual scaffolding, linguistic scaffolding is important in developing storytelling ability. Linguistic scaffolding provides temporary language support that enables learners to understand and produce increasingly complex expressions. In storytelling activities, such support can take the form of thematic vocabulary, simple and progressively structured sentences, repeated key words, narrative models, language cues, and opportunities to practice retelling. Linguistic scaffolding helps children connect visual representations with appropriate words and sentence structures, thereby reducing the linguistic demands of constructing a story independently. For deaf children, this process is particularly valuable because limitations in language exposure may affect vocabulary knowledge and the ability to formulate coherent narratives. The combination of vocabulary support and narrative structure can therefore help children move from identifying individual objects or events toward expressing relationships among them in a meaningful sequence.

Thus, research previously conducted in Indonesia still shows gaps that need to be filled and resolved. Windarsih and Nurunnisa [8] show that digital storytelling can support development ability Language child through presentation story digitally for show that

photo story approach can serve experience Study child deaf through visual and narrative media. However, research has not yet developed Digital Storytelling as an intervention medium to increase skills of telling a story in children with the disability of deafness. Media that integrates illustration, contextual visual scaffolding, presentation of the story step by step, vocabulary and sentences simple, language model signals, settings complexity story, and bait come back in One the product is still limited.

Previous studies on digital storytelling for deaf children have generally focused on the use of visual media to support comprehension and communication. However, limited attention has been given to the development of storytelling media that simultaneously adapts visual presentation and linguistic features to the specific communication needs of deaf learners. This gap is particularly evident in the limited availability of digital storytelling media designed to support not only story comprehension but also the ability of deaf children to organize events, use appropriate vocabulary, and retell stories coherently. Therefore, this study addresses the gap by developing Digital Storytelling Intervention Media with Adaptive Visual and Linguistic Features using the ADDIE development model. The novelty of this study lies in the integration of adaptive visual elements and simplified linguistic features within a digital storytelling medium specifically designed for deaf children, combined with interactive activities that facilitate story sequencing and retelling. Unlike conventional digital storytelling media that primarily present stories visually, the developed media is designed to align the presentation of narrative content with the linguistic and visual characteristics of deaf learners. The study further contributes preliminary empirical evidence regarding the validity, practicality, and potential improvement of storytelling performance through a limited developmental trial. Thus, the research contributes both a context-specific digital learning innovation and an initial framework for developing more inclusive and adaptive storytelling media for deaf children.

Based on the empirical problems, theoretical considerations, and identified research gap, this study develops Digital Storytelling Intervention Media with Adaptive Visual and Linguistic Features to support storytelling skills among deaf children receiving educational services at the UPTD Disability Services of Sidoarjo Regency. The visual adaptive features include contextual illustrations, simple layouts, clear typography, consistent icons, simple navigation, sequential story presentation, and visual scaffolding. The linguistic adaptive features include thematic and gradually introduced vocabulary, simple sentences, systematic narrative presentation, text aligned with illustrations, sign-language video support, repetition of key vocabulary, and structured storytelling exercises. The integration of these features is intended to provide scaffolding that supports children's understanding of story content, identification of story elements, sequencing of events, vocabulary development, organization of information, and coherent story retelling. Accordingly, the objective of this study is to develop and examine the feasibility of Digital Storytelling Intervention Media with Adaptive Visual and Linguistic Features for supporting storytelling skills among deaf children. Specifically, this study addresses the following research questions: (1) To what extent is the developed Digital Storytelling media valid based on expert evaluation? (2) To what extent is the developed Digital Storytelling media

practical based on teacher and participant responses? (3) What improvement in storytelling skills is observed among the participating deaf children following the use of the developed media?.

2. METHOD

2.1. Type and Design of Research

This study uses the Research and Development (R&D) method Sugiyono [9], with the aim of generating and testing the feasibility of Digital Storytelling Intervention Media with Adaptive Visual and Linguistic Features to increase skills tell a story child disability deaf children in telling stories. The development model used is ADDIE, developed by Branch [10], which consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The selection of the ADDIE model is based on the characteristics of research that is not only development - oriented products, but also includes analysis needs, design, development, validation, implementation, and evaluation. This model enables the development process to be done systematically, and through repair based on results evaluation at each research stage. This produces a product in the form of interactive digital media that combines story, visual illustrations, simple text, language video signals, exercises to understand stories, activities, short events, introductory vocabulary, as well as story retelling activities. The products were developed specifically to support visual learning and meet the communication needs of children with disabilities, including deaf children. The study was designed as a limited developmental trial to examine the validity, practicality, and preliminary improvement in storytelling skills following the use of the developed Digital Storytelling Intervention Media with Adaptive Visual and Linguistic Features. The implementation used a one-group pretest–posttest design without a control group. Therefore, the pretest–posttest findings are interpreted as preliminary evidence of change following media use rather than as strong evidence of effectiveness or a definitive causal effect.

2.2 Research Setting and Participants

The study was conducted at the UPTD Disability Services of Sidoarjo Regency. The entire research process, including preparation, needs analysis, media development, expert validation, product revision, implementation, data collection, data analysis, and final evaluation, was completed within a period of less than two months. The participants were five elementary-school-aged deaf children receiving educational intervention services at the UPTD Disability Services of Sidoarjo Regency. Saturated sampling was used because the number of children who met the study criteria was limited. The inclusion criteria were: (1) having hearing loss that affected language and communication development; (2) being able to participate in visual-based intervention activities; (3) understanding simple instructions through sign language, speech, or a combination of communication modes; (4) having basic expressive communication skills; and (5) being able to engage in two-way communication using at least two vocabulary items and retell simple information. Children who did not yet possess basic expressive communication skills or who were unable to participate in structured intervention activities were excluded. Because the study involved

only five participants selected from a single service setting, the findings are interpreted as preliminary evidence from a limited developmental trial and should not be generalized to the wider population of deaf children.

2.3 Expert Validators

The developed media was evaluated by two expert validators, consisting of one media expert and one subject-matter expert. The number of validators is reflected in the validation instruments, in which each assessment aspect had a maximum score of 20 points across the six assessed aspects. The media expert evaluated the technical and visual quality of the product, including visual display, layout, navigation, interactivity, visual adaptive features, and linguistic adaptive features. The subject-matter expert evaluated the suitability of the story content, story structure, language, vocabulary, compatibility with participant characteristics, and storytelling activities. The manuscript identifies the validators according to their validation roles but does not provide individual names, academic qualifications, institutional affiliations, or years of professional experience. Therefore, these details are not reported here to avoid introducing information that was not documented in the original study.

2.4 Development Procedure

The development procedure followed the ADDIE model.

a. Analysis: The analysis stage identified the needs of deaf children, their characteristics, initial storytelling abilities, communication needs, intervention materials, and available facilities and infrastructure. Particular attention was given to difficulties in understanding story content, recognizing characters and events, sequencing events, using appropriate vocabulary, and retelling stories coherently.
b. Design: The design stage translated the needs identified during the analysis into the structure and features of the digital storytelling media. Activities included determining intervention objectives, selecting story materials, preparing storyboards, designing the interface, selecting contextual illustrations, preparing simple text, designing sign-language videos, and developing interactive activities. The adaptive visual features consisted of contextual illustrations, a simple layout, recognizable icons, simple navigation, and visual scaffolding.
c. Development: At the development stage, the design was transformed into a Digital Storytelling Intervention Media product. The product integrated digital narrative, visual illustrations, simple text, sign-language videos, and interactive activities. The media was designed around five storytelling dimensions: understanding story content, identifying story elements, sequencing events, using appropriate vocabulary or communication forms, and retelling the story coherently. The prototype was subsequently submitted for media and subject-matter validation. Expert feedback was used as the basis for revising the product before its limited implementation.
d. Implementation: The implementation stage involved a limited trial of the developed media with the five deaf children at the UPTD Disability Services of Sidoarjo Regency. The implementation began with an orientation to the media so that participants could

understand how to operate it and follow the activities provided. A storytelling pretest was then administered to identify the participants' initial storytelling performance, followed by the intervention using the developed digital storytelling media and a posttest to examine changes in storytelling performance.

e. Evaluation: Evaluation was conducted through formative and summative activities. Formative evaluation occurred during product development and revision based on expert assessments, whereas summative evaluation considered the final validity, practicality, and preliminary improvement in storytelling performance following implementation.

2.5 Research Instruments

The instruments consisted of expert validation questionnaires, teacher and participant response questionnaires, observation sheets, interview guidelines, and storytelling performance tests administered as pretest and posttest. The instruments were used to assess three distinct aspects: validity of the developed media, practicality of the media, and improvement in storytelling performance.

2.6 Storytelling Performance Rubric

The storytelling performance test assessed five indicators: (1) understanding the story content; (2) identifying story elements; (3) sequencing events logically; (4) using appropriate vocabulary or communication forms; and (5) retelling the story coherently. These indicators were derived from the storytelling competencies targeted by the developed media and were used as the basis for the performance assessment. The rubric was aligned with the intervention objectives and the five storytelling dimensions addressed in the developed media. The subject-matter validation process also examined the suitability of the storytelling activities with the targeted storytelling indicators. The original manuscript does not provide a separate statistical procedure for validating the storytelling rubric, such as a separate content-validity index, pilot testing of the rubric, or formal inter-rater reliability coefficient. Therefore, no additional validity or reliability coefficient is reported here. The manuscript also does not specify that storytelling performances were independently scored by more than one evaluator. Consequently, an inter-rater reliability coefficient was not calculated or reported. The storytelling scores are therefore treated as performance assessment results obtained using the study rubric rather than as independently cross-validated ratings.

2.7 Pretest and Posttest Procedure

Storytelling performance was assessed before and after implementation of the Digital Storytelling Intervention Media. The pretest was conducted to establish participants' initial storytelling performance, while the posttest was conducted after the intervention to identify changes in performance. The original manuscript reports the use of pretest and posttest performance tests but does not explicitly state whether the same story or equivalent stories were used at both measurement points. Therefore, the comparison between pretest and posttest is interpreted descriptively as a change in storytelling performance following the limited implementation. Any potential influence of story

familiarity or repeated exposure should be considered when interpreting the improvement scores.

2.8 Data Collection

Data collection consisted of several complementary procedures. First, expert validation questionnaires were administered to the media expert and subject-matter expert after the product had been developed. Second, teacher and participant response questionnaires were collected after the media was used to assess practicality. Third, observations and interviews were used to obtain information regarding participants' interaction with the media and the implementation process. Finally, storytelling performance tests were administered before and after the intervention to obtain pretest and posttest scores.

2.9 Ethical Considerations

The manuscript does not document a formal institutional ethical approval number or identify a specific ethics committee that reviewed the study. It also does not explicitly report procedures for obtaining written parental or guardian consent or child assent. Accordingly, no specific ethical approval number, parental consent statement, or child-assent procedure is reported in this article because the participants were children, future implementation of this research should explicitly document institutional ethical approval or research permission, informed consent from parents or legal guardians, and assent from participating children where developmentally appropriate.

2.10. Data Analysis Techniques

Data analysis was performed on three main aspects, namely validity, practicality, and effectiveness of the media.

a. Analysis Validity

Validation data were analyzed by media experts and material experts using a four-point Likert scale, namely Score 4 = very good, score 3 = good, score 2 = sufficient, and score 1 = less. Percentage validity was calculated based on comparison between the number of scores obtained and the maximum score, then multiplied by 100%.

Criteria validity used is :

Table 1. Criteria Validity

Percentage	Criteria
85.01–100%	Very valid
70.01–85.00%	Valid
50.01–70.00%	Quite valid
≤ 50.00%	Invalid

Media is declared suitable for use if it obtains a valid or very valid category.

b. Practicality Analysis

Practicality data were obtained through teacher and student response questionnaires after using the media. Data were analyzed using a Likert scale and converted into percentages.

Table 2. Practicality Analysis Table

Percentage	Criteria
85.01–100%	Very practical
70.01–85.00%	Practical
50.01–70.00%	Quite practical
≤ 50.00%	Not practical

Media is declared practical if it gets a practical or very practical category.

c. Effectiveness Analysis

The initial effectiveness of the media was analyzed based on changes in storytelling skill scores between the pretest and posttest. Data were obtained through a story retelling performance test. Next, the increase in scores was analyzed using Normalized Gain (N-Gain) to determine the level of improvement in storytelling skills after using the media.

Interpretation of N-Gain using the criteria:

Table 3. N-Gain Interpretation Analysis

N-Gain Value	Category
$g > 0.70$	Tall
$0.30 \leq g \leq 0.70$	Currently
$g < 0.30$	Low

A high N-Gain value indicates significant improvement in storytelling skills, while a medium value indicates moderate improvement. A low value indicates that the improvement is still low and the product requires further refinement.

8. Product Success Criteria

The final product is declared to meet the development criteria if it meets three aspects, namely: (1) valid, based on the assessment of media experts and material experts; (2) practical, based on the responses of teachers and students; and (3) shows an increase in storytelling skills, based on a comparison of pretest and posttest results and N-Gain analysis. Thus, the final results of the study are not only in the form of a Digital Storytelling product, but also empirical information regarding the suitability of the media to be used as an intervention medium for storytelling skills for children with hearing sensory disabilities in the context of services at the UPTD Disability Services for Sidoarjo Regency.

3. RESULTS AND DISCUSSION

3.1 Results

Study aim: to produce digital storytelling intervention media with Visual and linguistic adaptive features to increase storytelling skills for deaf children with disabilities. Media development is carried out using the ADDIE model consisting of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. Each stage is implemented systematically, starting from identifying needs, media design, development and validation of the product, implementation to educate participants, until product evaluation.

The study was implemented at the Service UPTD Disability Regency Sidoarjo, with subject study in the form of child disability deaf children level Elementary Schools that receive service intervention. Selection of subjects used saturated sampling because the number of participants who meet the study characteristics is relatively limited.

Research results are based on three main aspects, namely media validity, media practicality, and improvement skills to tell a story for participants to educate. Third aspect was used to determine eligibility of the developed products.

3.1.1. Media Development Results

3.1.1.1. Analysis Phase Results

The analysis stage is carried out to identify the needs of participants, the characteristics of children with deafness, storytelling skills, communication needs, as well as media conditions that have been used in service intervention. Analysis results show that the participants' storytelling skills still need strengthening, especially in understanding story content, recognizing story elements, sorting events, using appropriate vocabulary, and telling the story content back in a consistent way. This condition becomes the basis for the need to develop intervention media that provides visual and linguistic support in a more structured way. Results analysis also shows that the media used previously were still dominated by static images and text. The media does not yet optimally provide language model cues, gradual visual aids, setting-level complexity stories, and systematic feedback. Findings become the basis for determining the characteristics of the media developed.

3.1.1.2. Design Phase Results

Based on results analysis needs, the design stage produces Digital Storytelling Intervention Media Design with Adaptive Visual and Linguistic Features. Media design includes compilation of objective intervention, selection of theme story, composition channel story, making storyboards, designing appearance interface, layout illustration, simple text, language video signals, exercises understanding stories, activities sort events, introduction vocabulary, and story retelling activities. Visual adaptive features are designed through use of contextual illustrations, clear images, icons, simple layout, easy navigation, and gradual visual aids. In addition, adaptive linguistic features cover thematic vocabulary, simple sentence structures, coherent story structure, language model signals, as well as arrangement-level complexity material.

3.1.1.3. Development Phase Results

development stage produces Digital Storytelling Intervention Media prototype based on the design that has been made. The product blends digital narrative with visual illustrations, text, language, video signals, and interactive activities. The media is designed to support five aspects of storytelling skills, namely understanding the story, identifying elements of the story, sequencing events, using vocabulary or forming appropriate communication, and the ability to tell the story content sequentially. Fifth aspect is also used as the basis for the compilation test show work. The product is furthermore given to the validator for evaluation of media and material aspects. Validation is used as a basis to determine the product's eligibility before it is used in stage implementation.

3.1.2. Media Validation Results

Media validation is carried out by media experts to evaluate product quality from the aspects of appearance, function, navigation, interactivity, and implementation feature visual and linguistic adaptive instruments on a scale of 1–4.

Table 4. Media Expert Validation Results

No.	Rated aspect	Score Obtained	Maximum Score	Percentage	Category
1	Visual display	19	20	95.00%	Very valid
2	Layout	19	20	95.00%	Very valid
3	Navigation	18	20	90.00%	Very valid
4	Interactivity	19	20	95.00%	Very valid
5	Visual adaptive features	19	20	95.00%	Very valid
6	Linguistic adaptive features	20	20	100.00%	Very valid
	Total	114	120	95.00%	Very valid

Based on results, validation media experts obtained percentage of [95.00]% with category valid. Based on criteria used in research, the percentage of 85.01–100% is categorized as very valid, while 70.01–85.00% is categorized as valid. The media is considered worthy if it gets the valid or very valid category.

The validator provides a number of inputs to products, especially related to [display / navigation / text size / illustration / video language gestures / interactivity]. Input is used as base for revising the product before stage implementation.

3.1.3. Material Validation Results

Validation of the material was done to assess suitability to fill the media with objective interventions and characteristic skills to tell a story for children with disabilities, deaf children. Aspects assessed cover material suitability, story content, language, vocabulary, story structure, and activity suitability, with indicator skill of telling a story.

Table 5. Results of Validation by Material Experts

No.	Rated aspect	Score Obtained	Maximum Score	Percentage	Category
1	Suitability of story content	19	20	95.00%	Very valid
2	Story structure	19	20	95.00%	Very valid
3	Language compatibility	18	20	90.00%	Very valid
4	Vocabulary	19	20	95.00%	Very valid
5	Suitability to student characteristics	19	20	95.00%	Very valid
6	Suitability of storytelling activities	18	20	90.00%	Very valid
	Total	112	120	93.33%	Very valid

Validation results for expert material show percentage of [93.33]% with valid category. The results show that the material contained in Digital Storytelling Intervention Media has fulfilled the eligibility criteria for use in the intervention.

3.1.4. Revision Results Product

The product was developed based on suggestions and input from media experts and material experts. The revision aimed to perfect the product before it was used to educate participants.

Table 6. Media Revisions Based on Validator Input

No.	Component	Validator Input	Revisions Made
1	Appearance	Use more views simple and consistent.	Simplify element decorative and standardizing appearance interface between pages.
2	Illustration	Make it clear illustration so that the object main easy recognized.	Enlarge object main, improve firmness image, and reduce elements that are not required.
3	Text	Summary sentences and adjust them size text with need participant educate.	Change text become sentence simple, enlarge size letters, and adjust distance interline.
4	Sign language video	Language videos signal need placed more clear and easy played repeat.	To clarify video button, placing it near with text story, and add function playback repeat.
5	Navigation	Navigation icons need made more consistent and easier to understand.	Standardize button icons previous, next, back, and home as well as add supporting labels.
6	Interactive activities	Give bait more back clear on activities interactive.	Add sign true /false and message short after participant educate finish activity.
7	Story material	Order story need made more gradually from simple going to complex.	Arranging the story become a number of stage with vocabulary key, sequence images, and support Language signal.

After revision, media is used in stage implementation to obtain practicality and improvement data on storytelling skills.

3.1.5. Practicality Test Results

Practicality test was conducted after participants were educated using the Digital Storytelling Intervention Media. Practicality data were obtained through questionnaires from teachers, and participant responses were collected.

Table 7. Results of Teacher Responses to Media

No.	Aspect	Score Obtained	Maximum Score	Percentage	Category
1	Ease of use	23	24	95.83%	Very practical
2	Media display	23	24	95.83%	Very practical
3	Material suitability	23	24	95.83%	Very practical
4	Adaptive features	22	24	91.67%	Very practical
5	Interactivity	23	24	95.83%	Very practical
6	Compliance with intervention	23	24	95.83%	Very practical
	Total	137	144	95.14%	Very practical

Based on the results of the questionnaire responses, the obtained percentage practicality is [95.14]%, so the media is included in the very practical category

Table 8. Response Results Learners

No.	Aspect	Score Obtained	Maximum Score	Percentage	Category
1	Interest in media	19	20	95.00%	Very practical
2	Ease of understanding the story	19	20	95.00%	Very practical
3	Ease of using media	19	20	95.00%	Very practical
4	Interest in illustration	20	20	100.00%	Very practical
5	Ease of understanding language/signs	19	20	95.00%	Very practical
6	Interest in participating in activities	18	20	90.00%	Very practical
	Total	114	120	95.00%	Very practical

Based on the responses, the participants' education level is [95.00]%. The results show that educated participants give positive responses to media use. Criteria for practicality in use are 85.01–100% for very practical category, 70.01–85.00% for the practical category, 50.01–70.00% for category Enough practical, and ≤50.00% for category No practical.

3.1.6. Skills Test Results Tell a story

Skill test tells a story and shows work in the form of story retelling. Participants are asked to tell the content story using language, gestures, speech, or combination of them.

The test was done twice, namely before media use (pretest) and after intervention (posttest). Assessment covers understanding the content of the story, identifying elements of the story, sequencing events, use vocabulary/form communication, and ability to tell the story in a coherent way.

Table 9. Results of Pretest and Posttest Skills Tell a Story

No.	Learners	Pretest	Posttest	Difference
1	P1	45	82	37
2	P2	50	88	38
3	P3	48	85	37
4	P4	52	90	38
5	P5	55	92	37
	Average	50.00	87.40	37.40

Based on Table 9, the average score for storytelling during the pretest was [50.00], while the average posttest score was [87.40]. Thus, there was an average increase of [37.40] points after participants were educated using Digital Storytelling Intervention Media. Improvement was seen in some aspects of storytelling skills, especially in terms of ability to understand the story, sort events, use appropriate vocabulary, and tell the story content coherently.

3.1.7. N-Gain Analysis Results

N-Gain analysis is used to determine the level of improvement in storytelling skills based on pretest and posttest scores.

Table 10. N-Gain Analysis Results

No.	Learners	Pretest	Posttest	N-Gain	Category
1	P1	45	82	0.67	Currently
2	P2	50	88	0.76	Tall
3	P3	48	85	0.71	Tall
4	P4	52	90	0.79	Tall
5	P5	55	92	0.82	Tall
	Average	50.00	87.40	0.75	Tall

Analysis results show the average value of N-Gain is [0.75], which falls into the high category. Based on criteria used, N-Gain >0.70 is included in the high category, 0.30–0.70 inclusive is moderate, and <0.30 is included in the low category. The results show that the use of Digital Storytelling Intervention Media provides improvement in storytelling skills for participants educated in the trials conducted. However, because study used a pretest–posttest design without a control group, N-Gain results in study are interpreted as proof of improved skills after use of media, not as proof of causality, which definitively shows that improvement was caused only by the media.

3.1.8. Summary of Development Results

Table 11. Recapitulation Results

No.	Assessment Aspects	Results	Criteria	Decision
1	Media expert validation	95.00%	Very valid	Worthy
2	Subject matter expert validation	93.33%	Very valid	Worthy
3	Teacher's response	95.14%	Very practical	Practical
4	Student responses	95.00%	Very practical	Practical
5	N-Gain storytelling skills	0.75	Tall	Increase

Overall, the results show that Digital Storytelling Intervention Media with Visual and Linguistic Adaptive Features fulfil established criteria. From the aspect of validity, media obtained very valid assessment. From the aspect of practicality, the media obtained a very practical response. In addition, the pretest and posttest results show significant improvement in the skills of participants educated to tell stories. Thus, the product

developed can be used as an intervention medium to support storytelling skills for deaf children with hearing disabilities.

3.2 Discussion

3.2.1 Development of Digital Storytelling Intervention Media

The findings suggest that the developed Digital Storytelling Intervention Media has potential as a supportive instructional resource for storytelling development among the five deaf children who participated in this limited developmental trial. The main contribution of the media is not simply the use of digital technology, but the integration of visual, linguistic, narrative, and interactive supports within a single storytelling environment. The initial analysis identified difficulties in understanding story content, sequencing events, using vocabulary, and retelling stories coherently. The developed media was therefore designed to address these difficulties through contextual illustrations, simple text, gradual story presentation, vocabulary support, sign-language videos, and interactive storytelling activities.

Findings: This is in line with study by Marrodan et al. [11] shows that narrative intervention with modeling and visual support can increase story retelling ability in deaf and hard-of-hearing children. In addition, Ingber and Eden [12] find that using a series of pictures for a short incident can increase children's storytelling skills with hearing, as well as show that intervention-based technology and visual support can help deaf and hard-of-hearing children organize and deliver stories. Findings strengthen the idea that integrating visual and linguistic adaptations in Digital Storytelling Intervention Media can help children with disabilities, including deaf children, understand the story, develop vocabulary, sort events, and tell the story in a more coherent way.

The improvement observed after implementation can be understood through the interaction of these features rather than through the digital format alone. Digital storytelling provides repeated and structured access to the same narrative information while allowing visual and linguistic cues to be presented together. This is particularly relevant to the participants in this study because the preliminary analysis indicated that they could recognize objects and activities in pictures but had greater difficulty connecting those elements into a beginning, middle, and end. Thus, the media was designed to support not only recognition of individual visual information but also the organization of that information into a meaningful narrative.

3.2.2 Visual Scaffolding

Visual scaffolding appears to be one of the central mechanisms through which the media may support storytelling development. The developed media uses contextual illustrations, clear visual representations, simple layouts, recognizable icons, gradual visual cues, and sequential presentation. These features can reduce the amount of information that participants need to process simultaneously and make important story elements more visually salient. The revision process also strengthened this function by enlarging important objects, reducing unnecessary visual elements, simplifying the interface, and improving consistency across pages.

The validity of the media also strengthens results from previous studies about use of digital media for educating participants with disabilities, deaf children. Hidayati and Wagino [13] show that digital media can support development of academic and language skills for educating deaf children. However, previous research has focused more on reading ability or language in a general way. Therefore, the media that was developed in this study contributes to the expanded utilization of digital media from learning language in a general way to more interventions specific to skills like storytelling. For storytelling, visual scaffolding is particularly relevant because a narrative requires learners to maintain relationships among characters, objects, actions, and events. When these elements are represented visually and presented in an organized sequence, participants may have a more concrete basis for identifying what happened and how one event relates to another. In this study, the visual component therefore functioned not merely as decoration but as an organizational aid for narrative comprehension and recall. Among the features developed in this study, contextual illustrations and sequential visual presentation are likely to have made an important contribution because the participants' initial difficulties were strongly related to connecting separate visual elements into a coherent story. However, the present design does not allow the independent effect of visual scaffolding to be isolated from the other features.

3.2.3 Practicality of Media in Implementation Intervention

The practicality of the media can be seen from teacher and participant responses during the implementation process. Practical media is not just easy-to-use media used technically, but also media that can be used in the intervention process without giving overload to teachers and participants. In this research, teachers and participants were given chance to use media through stages of orientation, implementation/intervention, and filling out the questionnaire response. If the questionnaire shows the category practical or very practical, the findings show that developed features can be implemented in activity intervention. Simple navigation, contextual usage illustration, gradual presentation of the story, and support language signals potentially reduce obstacles for children in understanding instructions and story content. Thus, practicality not only shows convenient use of media, but also shows suitability between design product and the real intervention process.

Findings support the direction of the study by Nikolaraizi et al. [14], which shows that visual and language resources in multimedia can support story understanding for deaf learners. Birinci and Sarıçoban [15] also found that combining visual and language materials signals is more effective in supporting learning. Thus, the results of the practicality study strengthen the idea that integrating visual, linguistic, and interactive elements can produce more accessible and appropriate digital media for deaf learners.

3.2.4 Improvements in Skills Storytelling of Children with Disabilities Deaf children

Improvement skills tell a story analyzed through comparison of pretest and posttest scores as well as N-Gain value. The pretest was used to describe ability of beginning participants, while the posttest was given after participants received intervention using Digital Storytelling media. Assessment was done through story retelling activities with five indicators, namely understanding the story content, identifying story elements, logically sorting incidents, using vocabulary or forming appropriate communication, and retelling the story content in a coherent way.

If results show that posttest scores are higher than pretest scores, then there is improvement in the skills to tell a story after participants are educated using media. Improvement can be understood through mechanism of presenting stories that provide visual and linguistic support simultaneously. Children not only accept stories in form of text, but also get visual representation, vocabulary, narrative structure, as well as support for helpful communication that connects every part of the story. These conditions can make the process of understanding information easier before child relays it back. Improvements in aspects of events can also be associated with Digital Storytelling structure that sequentially presents story. Presenting incidents in a systematic way helps participants recognize connection between one incident and the next. Next, the use of vocabulary stages and simple sentences provides linguistic scaffolding for children to build more expressions in accordance with the story. Thus, the media not only functions as source of information, but also as a tool to help organize the child's thought process when doing story retelling.

The results support this finding, in line with Işıkoğlu and Güzen [16], who show that Digital Storytelling can increase language ability and skills in narrative children. Raymond and Spencer [16] also found that narrative intervention with visual support, story grammar, modeling, and teaching vocabulary can increase narrative retelling ability in children with hearing. In addition, Carden et al. [4] show that intervention-based narrative can increase use of story grammar elements and completeness of stories in retelling activities. Thus, Digital Storytelling not only functions as delivery medium for stories, but also as helpful scaffolding to help participants understand, sort, and express the returned story in a more coherent way.

3.2.5 The Role of Integration of Visual and Linguistic Adaptive Features

Findings important study This lies in integrating visual and linguistic adaptation in support skills to tell a story child deaf. Visual adaptation through pictures helps children understand objects and the flow of the story, whereas linguistic adaptation through vocabulary and language signals helps children understand as well as disclose information. This is in line with Khotimah and Tama [18], who found that image media can increase vocabulary mastery in deaf children, as well as study by Fifi Elvia Ect [19] regarding storytelling, which shows that activity tell a story can support improved language ability in deaf children. Based on these findings, visual and linguistic support can function as helpful scaffolding for children to understand, organize, and express stories. However, research in Indonesia since 2022 still focuses more on the use of visual media, vocabulary

development, or storytelling in general separately, so there is still room for developing digital media that integrates visual adaptation, adaptation linguistics, and deep storytelling in one intervention with storytelling skills as the main focus.

Findings: This, at a time, answers existing research gaps formulated in the proposal. Research previously regarding digital media, digital storytelling, and intervention linguistics still develops in a way that is relatively separate. Proposals do not yet explicitly identify many media and integrate feature visual and adaptive linguistics in one product intervention with skills to tell a story as the main external focus. Thus, the main contribution of this study is not just to produce digital media, but to produce media that combines narrative approach, digital technology, visual adaptation, and adaptive linguistics in one intervention.

3.2.6 Relationship of Research Results with Previous Studies

Overall, the results of this study strengthen previous studies in Indonesia, which show that storytelling, visual media, and digital media can support development of language and communication in children with hearing impairments. Intikasari, Tumardi, and Wahyuno [20] find that picture-word chip media can increase the ability to write simple sentences among deaf students, while digital media, based on potential apps and videos, supports literacy and skills for deaf. Research by Arianto et al. [21] shows that the use of interactive video that combines visual elements, text, questions, and links can increase students' digital literacy with hearing, with the N-Gain value being 0.7231. Furthermore, research by Melissa Herzig and Thomas E. Allen [22] shows that application books with digital stories that integrate American Sign Language (ASL) and written English can increase involvement of child deaf in activity literacy as well as give support to development of language and narrative skills. Additionally, Ahmad, Sharif, and Talin [23], through their study Creative Digital Storytelling with Teacher–Student and AI Collaboration, show that digital storytelling can be used as approach to develop literacy, reading, and creativity in deaf children through the process of creating stories related to their identity and experience. Fourth, the study shows that the elements of narrative, visual, linguistic, and digital have potential to support learning for children with hearing obstacles. Although research previously tends to study elements separately, such as use of interactive video, visual multimedia, bilingual storybook applications, or digital storytelling. The findings extend the studies cited in the manuscript by bringing several previously separated approaches into one intervention framework. Earlier studies have examined visual media, storytelling, vocabulary development, interactive video, digital applications, and sign-language-supported storybooks. For example, Arianto et al. (2024) reported positive results from interactive video combining visual elements, text, questions, and links, while Herzig and Allen (2022) examined digital storybooks integrating American Sign Language and written English. These studies demonstrate the potential value of combining digital, visual, linguistic, and narrative resources for deaf learners. The present development differs in its specific focus on storytelling intervention and its integration of adaptive visual and linguistic features. The media was designed around storytelling processes rather than merely delivering language-learning content. Its activities explicitly address story

comprehension, story elements, event sequencing, vocabulary, and story retelling. The findings should nevertheless be interpreted cautiously. The observed improvement is compatible with the proposed mechanisms and with previous research, but the study design does not establish that the media itself caused the improvement. A one-group pretest–posttest design is vulnerable to history, maturation, and testing effects. The manuscript itself recognizes that the increase in scores should therefore be interpreted as an indication of improvement following media use rather than definitive causal evidence.

Thus, the results of this study give support to assumptions that the Digital Storytelling media is adapted with visual characteristics and needs language; participant education can become alternative in intervention skills for telling stories. However, the interpretation of the results needs to be placed in accordance with design research used. This study used a one-group pretest-posttest design, namely, measurement done on one group before and after the intervention without an existing control group. The design allows researchers to know change in participants' education based on differences between pretest and posttest scores, but has limitations in drawing causal conclusions. Knapp [24] explains that one-group pretest-posttest design has various threats to internal validity, such as history, maturation, and testing effects, so that improvement scores from pretest to posttest cannot be fully confirmed as being caused only by the intervention given. Something similar was proposed by Bierer and Colbert [25], that change scores on the one-group pretest-posttest design are not enough to prove a causal connection because there is still the possibility that other factors influence change results. Therefore, the increase in scores tells a story in this study. This is more appropriately understood as indication of improved skills after use of media, not as proof that it completely causally isolates media influence from other factors. Furthermore, the use of N-Gain in this study is used to describe the level of improvement in skills and tell a story based on change score between pretest and posttest.

3.2.7 Implications Theoretical and Practical

Theoretically, this study supports the view that storytelling intervention for deaf children can benefit from the integration of narrative structure, visual representation, and linguistic support. Digital storytelling is positioned not merely as a medium for presenting stories but as a structured environment in which learners receive temporary support for understanding, organizing, and expressing narrative information. The findings also suggest that scaffolding should be aligned with the specific stages of storytelling. Visual support can assist comprehension and recognition; sequencing can support organization of events; vocabulary and simple sentence models can support linguistic expression; and sign-language models can provide accessible communication support. This integrated perspective provides a useful basis for future development of storytelling interventions. Practically, the media may serve as an alternative resource for teachers, therapists, and educational companions working with deaf children in similar service contexts. It can be used to support story comprehension, vocabulary practice, event sequencing, and retelling activities. The practicality findings reported in the study indicate that teachers and participants perceived the media as usable and accessible in the implementation setting,

particularly because of its simple navigation, contextual illustrations, gradual story presentation, and language support. However, these practical implications should be understood as context-specific. The study provides evidence about the usability and preliminary potential of the media in the UPTD Disability Services of Sidoarjo Regency, rather than evidence that the media is equally appropriate for all deaf children or all educational settings.

3.2.8 Limitations of the Study

This study has several important limitations that should be considered when interpreting the findings. First, the study involved only five deaf children. The small sample was related to the limited number of participants who met the predetermined criteria at the research site. Although saturated sampling was appropriate for this developmental context, the sample is insufficient to support statistical generalization to a broader population of deaf children. Second, the research was conducted at one service site, namely the UPTD Disability Services of Sidoarjo Regency. Differences in educational environment, teacher experience, communication approaches, participant characteristics, and available facilities may influence implementation outcomes. Therefore, the findings should not be assumed to apply automatically to other schools or disability service settings. Third, the study used a one-group pretest–posttest design without a control group.

Consequently, the observed increase in storytelling performance cannot be attributed exclusively to the developed media. Other factors, including concurrent instruction or individual development, may have contributed to the change. Fourth, the implementation was conducted within a short research period of less than two months, which limits the ability to determine whether the observed improvement would be maintained over a longer period. The available study documentation also does not establish long-term retention or transfer of storytelling skills to other stories and contexts. Fifth, testing effects may have influenced the posttest performance because participants had previously completed a pretest. Familiarity with the assessment format, storytelling expectations, or related narrative material could have contributed to improved performance independently of the intervention. The original study does not provide evidence that would allow this potential effect to be separated from the intervention effect. Finally, the study did not experimentally separate the individual components of the media. Consequently, it is not possible to determine whether visual scaffolding, linguistic scaffolding, narrative sequencing, vocabulary support, or sign-language support contributed most strongly to the observed improvement. Future studies should use larger samples, multiple sites, comparison groups, longer implementation periods, and component-level comparisons to examine these mechanisms more rigorously. Overall, the findings should therefore be regarded as preliminary evidence from a limited developmental trial. They support the feasibility and potential of integrating visual and linguistic scaffolding into digital storytelling media for the participating deaf children, but they do not establish broad effectiveness for deaf children as a population.

4. CONCLUSION

The development of the Digital Storytelling Intervention Media with Adaptive Visual and Linguistic Features indicates that the developed media meets the criteria of validity and practicality in the context of a limited developmental trial. The media received very valid ratings from both media experts (95.00%) and subject-matter experts (93.33%), while teacher and participant responses indicated that the media was very practical, with scores of 95.14% and 95.00%, respectively. In terms of storytelling improvement, the mean score increased from 50.00 in the pretest to 87.40 in the posttest, with an average N-Gain of 0.75, categorized as high. These findings suggest preliminary improvement in storytelling performance following the use of the media, particularly in understanding story content, sequencing events, vocabulary use, and coherent retelling. However, these findings are based on a limited trial involving only five deaf children and a one-group pretest–posttest design without a comparison group; therefore, they should not be interpreted as broad evidence of media effectiveness or a definitive causal effect. A key limitation of this study is the small sample from a single service setting and the absence of a control or comparison group. Future research should involve larger samples, multiple educational or service settings, and a comparison group to provide stronger evidence regarding the potential effectiveness and broader applicability of the developed digital storytelling media.

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