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Digital Learning of Regional Languages through the Bahasa Nusantara Application Based on Persuasive Systems Design to Support Language Revitalization

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ABSTRACT

Regional languages in Indonesia face continuing decline as intergenerational transmission weakens and daily communication increasingly shifts toward Indonesian. This study aimed to design, develop, and formatively evaluate the Bahasa Nusantara application to support regional language revitalization in East Nusa Tenggara, Indonesia. Using design science research, user needs from students, parents or guardians, and institutional employees in Tetun Fehan, Bunaq, and Adang communities were translated through Persuasive Systems Design into interconnected learning components. Formative evaluation with experts, teachers, and children showed stronger credibility and social support, while usability and independent use required further improvement. Effective digital language revitalization should combine trusted learning resources, teacher mediation, child-friendly onboarding, and community participation. The study provides a practical design basis for community-based regional language learning.

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1. INTRODUCTION

Language endangerment is increasingly recognized as an educational issue rather than solely a linguistic concern. A global analysis of spoken languages projected that, without intervention, the rate of language loss could increase substantially within the coming decades. Greater participation in formal schooling can be associated with higher levels of language endangerment when education is dominated by majority languages [1]. Education may contribute to language shift, but it can also provide an important setting for revitalization when regional languages are incorporated into teaching and learning. Language documentation, bilingual education, and community-based programs therefore play important roles in maintaining linguistic diversity.

Indonesia illustrates this challenge clearly. Many parents who speak regional languages increasingly use Indonesian with their children because the national language is often associated with academic success, thereby weakening intergenerational language transmission within families [2]. Among secondary school students, regional languages may still be valued as markers of identity but are used less frequently in everyday communication because Indonesian, local Malay varieties, social media, and peer norms increasingly dominate daily interaction [3]. The national regional language revitalization program has responded by bringing regional language learning into schools and communities. However, its implementation remains strongly dependent on teachers. In Lampung Province, for example, regional language classes are often taught by teachers from other subject areas because specialist regional language teachers remain limited [4]. Regional language revitalization therefore requires learning resources that can support teachers and provide accessible and engaging learning experiences for young learners [4-6]. These resources should also extend learning beyond the classroom by connecting educational activities with families, community participation, cultural practices, and intergenerational language use [7, 8].

These challenges are particularly relevant in East Nusa Tenggara (Nusa Tenggara Timur, NTT), which is home to numerous regional languages with different levels of vitality (<https://petabahasa.kemendikdasmen.go.id/provinsi.php?idp=Nusa%20Tenggara%20Timur>). Most of these languages belong to the Austronesian family, while several Papuan languages are spoken in Alor, Pantar, and Timor. Community-based approaches are particularly important in language revitalization because language maintenance depends on participation beyond formal educational settings [7, 8]. In East Nusa Tenggara, the selected languages represent different vitality conditions, ranging from relatively stable language use to language endangerment, as summarized in **Table 1**. Adang in Alor Regency, for example, has been reported as endangered, as younger speakers increasingly shift toward Indonesian and Alor Malay [9]. These differences have important educational implications. Relatively vital languages may primarily require broader domains of use and stronger documentation, whereas endangered languages require more intensive support for intergenerational learning and transmission [10]. Therefore, regional language learning technologies in NTT should be informed by communities with different vitality conditions rather than designed around a single sociolinguistic situation.

Digital technology has broadened the range of tools available to support language documentation, learning, and revitalization. Language-oriented instructional strategies have also been shown to support students' understanding in educational settings [11]. In the context of digital language resources, previous initiatives include an integrated digital dictionary for Blackfoot [12], a Māori Twitter corpus [13], computational language-processing

approaches [14], and a Javanese learning application used as a supplementary teaching module in Indonesia [15].

Nevertheless, only a small proportion of the world's languages have a meaningful digital presence [16]. Moreover, technological availability alone does not ensure successful revitalization. Digital tools are more meaningful when speaker communities maintain control over the purposes, content, and use of their language resources [10, 17]. Reviews of Indigenous language learning applications have also shown considerable variation in their pedagogical design and level of community involvement [18]. Many digitalization initiatives continue to emphasize technical preservation rather than use-oriented learning design [19]. Consequently, digital dictionaries, corpora, learning applications, and communication platforms often remain separated, leaving the connections among language documentation, learning, and actual language use dependent largely on human effort.

Educational technology offers mechanisms for strengthening these connections, but most existing approaches have been developed for dominant languages and individual learners. Mobile-assisted and gamified language learning can improve learner motivation, attitudes, engagement, and selected language skills [20, 21]. Studies of Duolingo have also demonstrated how features such as points, streaks, and leaderboards can encourage continued language practice [22]. However, the motivational effects of gamification may decline over time, while competitive mechanisms can reduce motivation among some learners [21]. Furthermore, many applications marketed as educational for children provide limited support for active, engaged, meaningful, and socially interactive learning [23]. More importantly, mainstream language-learning applications generally target individual learners of widely spoken languages. Regional language revitalization differs because language transmission depends strongly on interaction among generations within families and communities [24, 25] and on teachers who mediate learning activities in schools [4]. Digital regional language learning therefore requires more than individual practice; it requires an environment that connects learners, teachers, families, communities, and credible language resources.

Effective educational technology also depends on teachers' digital competence and their ability to integrate technology into instructional practice [26]. Persuasive Systems Design (PSD) provides a theoretical foundation for designing technology under these conditions. PSD organizes persuasive system features into primary task support, dialogue support, social support, and system credibility support [27]. In educational settings, persuasive systems have been used to support learning motivation through mechanisms such as personalization, feedback, social interaction, and gamification [28]. In other fields, particularly digital health, PSD applications tend to emphasize primary task and dialogue support, including self-monitoring and reminders, whereas social support and some credibility mechanisms are less frequently implemented [29, 30]. Regional language revitalization presents a different persuasive context because the target behavior, including learning, speaking, and transmitting a language, is inherently social and collective. In addition, the credibility of language resources and the legitimacy of those who produce, validate, and teach them are important for their acceptance by learners, teachers, families, and communities.

Previous studies have begun to demonstrate how digital systems can support both language preservation and learning. Mirza and Sundaram developed mobile applications using collective intelligence to support the preservation, curation, and learning of endangered

languages [31, 32]. However, preservation and learning were separated across applications, and the systems were not specifically designed for teacher-mediated or intergenerational learning. This limitation reflects a broader challenge in digital language revitalization. Existing technologies may support documentation, learning, communication, or dissemination, but these functions are rarely integrated into a continuous educational process in which community-generated language resources become learning materials, learning leads to authentic language use, and the outcomes of language use contribute to further documentation and dissemination.

Four interconnected research gaps remain at the intersection of regional language revitalization, educational technology, digital language learning, and PSD. First, few digital learning systems connect community-generated language documentation with structured learning, authentic language use, and dissemination as a continuous process. Second, persuasive and gamified language learning has rarely been designed specifically for teacher-mediated and intergenerational learning, even though these processes are central to regional language transmission. Third, it remains unclear how PSD principles operate when the persuasive target is collective language learning rather than individual behavior. Fourth, relatively few digital learning systems are systematically grounded in the empirical needs of learners, parents or guardians, educators, and institutions from regional language communities, particularly in eastern Indonesia, where language vitality conditions are diverse.

To address these gaps, this study designed, developed, and formatively evaluated Bahasa Nusantara, a web-based application for regional language learning based on PSD to support language revitalization in NTT. The application translates empirically identified user needs into four interconnected pillars: corpus collection, e-language learning, language activity management, and digital campaign. These pillars connect language documentation, structured learning, authentic language use, and dissemination while positioning the intergenerational learning community at the center of the process.

The study was guided by three research questions:

- (i) What learning and revitalization needs do students, parents or guardians, and institutional employees express regarding regional language learning technology in East Nusa Tenggara?
- (ii) How can these needs be translated into a learning ecosystem and PSD-based mechanisms in the Bahasa Nusantara application to support learning progression, practice, motivation, social learning, teacher guidance, and content credibility? and
- (iii) How do experts, teachers, and children evaluate the functional prototype of the Bahasa Nusantara application, and what are the implications of this evaluation for the design of regional language learning technology?

This study makes three main contributions. First, it provides an empirical needs base from regional language communities with different vitality conditions. Second, it proposes a four-pillar learning ecosystem that connects language documentation, structured learning, authentic language use, and dissemination within an intergenerational learning cycle. Third, it translates PSD principles into educational mechanisms and application features and examines their realization in a functional prototype. Because the evaluation was formative, the study focuses on design realization, usability, and user experience rather than claiming effects on learning outcomes, changes in language use, or intergenerational transmission.

2. METHODS

2.1. Research Design

This study employed a design science research approach because its primary objective was to design, develop, and evaluate a technological artifact addressing a practical educational problem. The research procedure followed the Design Science Research Methodology (DSRM), which consists of problem identification and motivation, definition of solution objectives, design and development, demonstration, evaluation, and communication [33]. Within this framework, PSD [27] served as the theoretical basis for translating educational and revitalization requirements into persuasive mechanisms and application features. The research process consisted of eight stages organized into four main phases: needs assessment, development of the learning ecosystem, PSD-based design and application development, and formative evaluation. These stages were aligned with the DSRM activities, as illustrated in **Figure 1**. Each stage produced an output that informed the subsequent stage, thereby establishing a traceable process from user needs to application design and evaluation.

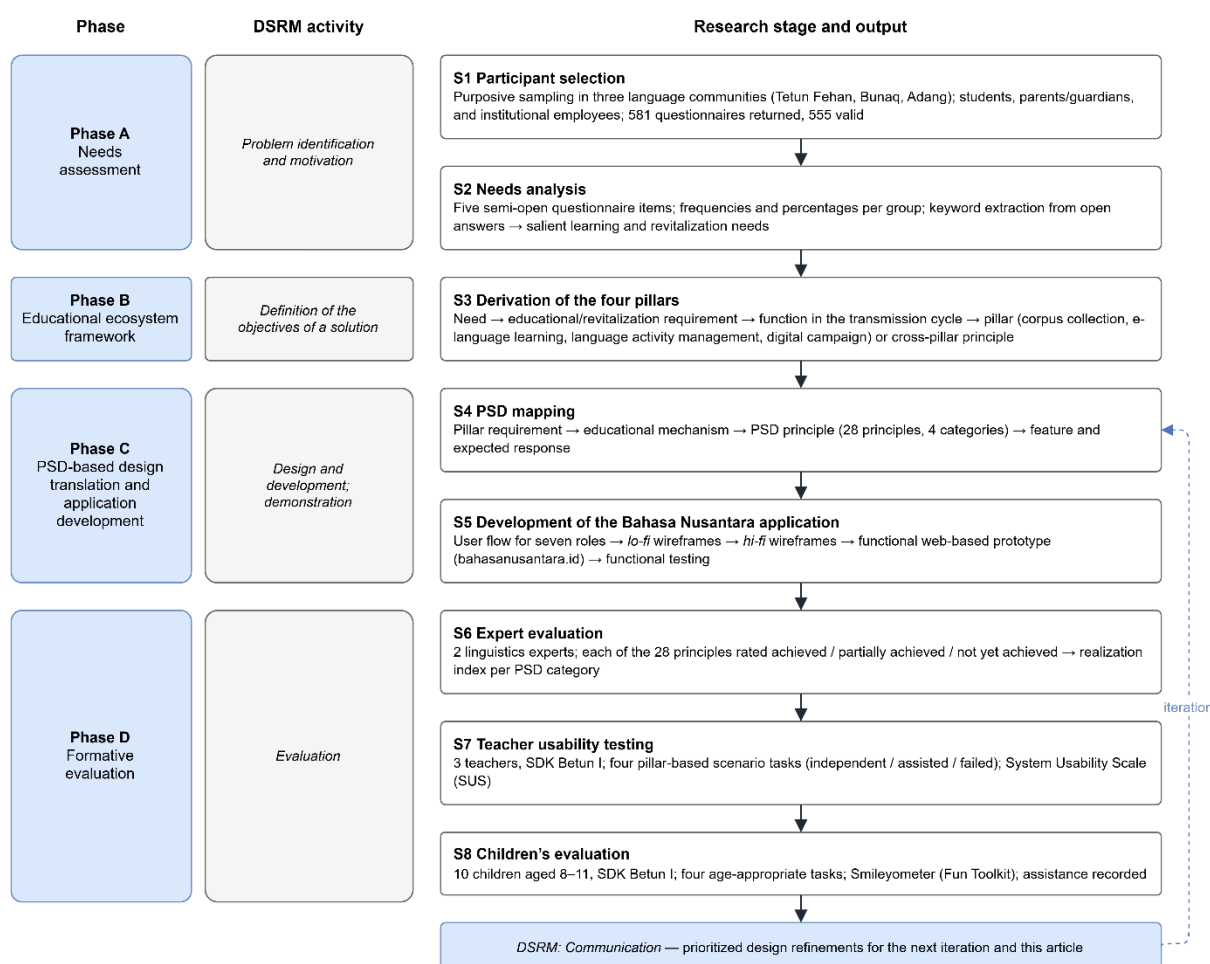


Figure 1. Research workflow from needs assessment to PSD-based design, development of the Bahasa Nusantara application, and formative evaluation mapped to the DSRM activities.

2.2. Study Context and Language Selection

The needs assessment was conducted in three regencies of East Nusa Tenggara, Indonesia, representing regional languages with different levels of vitality: Tetun Fehan in Malaka

Regency, Bunaq in Belu Regency, and Adang in Alor Regency. These languages were selected to capture a range of sociolinguistic conditions from relatively stable language use to language endangerment. The vitality classifications reported by different sources were not always identical. Tetun Fehan was classified as vulnerable by the regional language authority but as relatively stable in other assessments. Bunaq ranged from stable to threatened or vulnerable, whereas Adang was consistently classified as endangered or shifting. The three languages were therefore used to represent diverse language vitality conditions rather than a single sociolinguistic setting. Their classifications are summarized in **Table 1** using available institutional and international language vitality sources (see <https://www.ethnologue.com/>; <https://glottolog.org/glottolog/language>; <https://www.endangeredlanguages.com/>). The needs assessment covered all three language communities, whereas the subsequent formative evaluation was conducted at SDK Betun I in Malaka Regency within the Tetun Fehan-speaking community.

Table 1. Status of the three regional languages according to different language vitality assessment frameworks.

NO	REGENCY	LANGUAGE	BBP NTT	Ethnologue ^a	Glottolog ^b	ELCat ^c
1	Malaka	Tetun Fehan	Vulnerable	Stable	Not endangered	Not available
2	Belu	Bunaq	Vulnerable	Stable	Threatened	Vulnerable
3	Alor	Adang	Endangered	Endangered	Shifting	Endangered

Notes: ^a Ethnologue language status based on the unit of Language Vitality: Institutional, Stable, Endangered, and Extinct. ^b Glottolog language status based on Agglomerated Endangerment Status (AES): Not endangered, Threatened, Shifting, Moribund, Nearly extinct, and Extinct. ^c Endangered Languages Catalogue (ELCat) language status based on the Language Endangerment Index (LEI): Vulnerable, Definitely Endangered, Severely Endangered, Critically Endangered, and Extinct.

2.3. Needs Assessment

In the first stage, participants were selected using purposive sampling from the three language communities. Three respondent groups were defined because they represent different roles in regional language learning and transmission: students as learners, parents or guardians as family members supporting intergenerational transmission, and institutional employees as individuals involved in formal or community-based programs. The student group included elementary, junior secondary, and senior secondary school students. A paper-based questionnaire was administered offline from November 12 to 28, 2025. Participation was voluntary. A total of 581 completed questionnaires were collected, of which 555 were retained after screening for completeness and response consistency. The final sample comprised 221 students, 190 parents or guardians, and 144 institutional employees. In this study, the term *students* refers to respondents participating in the needs assessment, whereas *children* refers specifically to participants aged 8-11 years involved in the formative evaluation. The questionnaire contained five items designed to identify user preferences related to regional language revitalization technology. The items addressed: (i) desired features, activities, and menus; (ii) preferred access platforms; (iii) preferred system type; (iv) preferred access mode; and (v) preferred appearance and interface characteristics. Items concerning features and platforms allowed multiple responses, whereas the system type and access mode items required a single response. The appearance item was open-ended. The questionnaire items, response formats, and analytical procedures are summarized in **Table 2**.

Table 2. Needs assessment questionnaire items, response formats, and analytical procedures.

NO	ITEM	RESPONSE FORMAT	ANALYSIS
1	Features, activities, and menus that a revitalization system should provide	Semi-open; more than one of 14 options may be selected, plus an “Others” option	Frequency and percentage per group
2	Platforms for accessing the system	Semi-open; more than one of 12 options may be selected, plus an “Others” option	Frequency and percentage per group
3	Preferred type of system	Semi-open; single choice (application, website, or a combination of both), plus an “Others” option	Percentage per group
4	Preferred access mode	Closed; single choice (online or offline)	Percentage per group
5	Appearance or design considered comfortable and attractive	Open-ended; answered in the respondents’ own words	Keyword extraction and frequency (n = 450 answers)

The responses were analyzed descriptively because the questionnaire was exploratory and intended to identify preferences rather than measure psychometric constructs. Frequencies and percentages were calculated for the closed and semi-open items for each respondent group. For the open-ended item, recurring keywords were extracted from the available responses and their frequencies were calculated. The identified options were subsequently classified into three groups. A response was considered a primary need when it ranked among the most frequently selected options, exceeded the predefined selection threshold in at least one respondent group, or appeared among the most frequent keywords. Primary needs were used to construct the learning ecosystem. Less frequently selected options were treated as supporting evidence and were used to enrich the features associated with existing pillars. Needs related to print or broadcast channels that could not be implemented directly within an interactive learning application were classified as complementary channels. An option was classified as a primary need when it met at least one of the following criteria: it ranked among the three most frequently selected options within an item for at least one respondent group, was selected by at least 20% of respondents in any group, or appeared among the ten most frequent keywords.

2.4. Development of the Four-Pillar Learning Ecosystem

In the next stage, the primary needs identified from the questionnaire were translated into educational and revitalization requirements. This process involved four analytical steps.

First, each primary need was reformulated as a capability required by learners, teachers, families, or communities for regional language learning and transmission. Second, each requirement was associated with one of four functions in the language revitalization process: documenting the language, learning the language, using the language in authentic activities, or disseminating and increasing the visibility of the language. Third, requirements serving similar functions were grouped into a common pillar. This process resulted in four pillars: corpus collection, e-language learning, language activity management, and digital campaign. Requirements that applied across the four functions, such as mobile access and interface simplicity, were classified as cross-pillar design principles. Fourth, the relationship between the pillars was defined by identifying how the output of one pillar could serve as input for another, thereby forming an integrated learning cycle. The grouping and interpretation were conducted by the research team through discussion until consensus was reached. The

complete traceability from user needs to educational requirements and subsequent application features is presented in the Results section.

2.5. PSD-Based Design and Application Development

After the learning ecosystem had been established, the educational requirements were mapped to the PSD principles. For each requirement, the research team first identified the educational mechanism required to support the intended behavior. These mechanisms included learning progression, practice and rehearsal, feedback and self-regulation, motivation, teacher guidance, social and intergenerational learning, social recognition, and credibility of learning content. Each educational mechanism was then matched with the PSD principle whose conceptual definition most closely represented the intended function [27]. The principle was subsequently translated into a concrete application feature and an expected learner, teacher, or community response. All PSD principles were retained during this stage to ensure that each category was systematically considered rather than selecting only principles that were convenient to implement. The resulting design was implemented in the Bahasa Nusantara web application through four development steps. First, user flows were specified for seven roles: administrator, teacher, student, expert, community member, government, and private sector. Second, low-fidelity wireframes were developed to establish the information structure and task sequence. Third, high-fidelity wireframes were produced to define the visual and interaction design. Finally, the high-fidelity design was implemented as a functional web-based prototype. Before formative evaluation, the main functions associated with the four pillars were examined using black-box testing to confirm that the tasks required during evaluation could be performed successfully. The resulting functional prototype served as the artifact evaluated in the subsequent stages.

2.6. Formative Evaluation

The participant groups, tasks, instruments, and analytical measures are summarized in **Table 3**. The formative evaluation was conducted on the functional prototype of Bahasa Nusantara and involved three participant groups: experts, teachers, and children. Different evaluation procedures were used for each group because the purpose, task, and expected interaction with the application differed across user roles. Matching evaluation methods to the artifact and the intended user group is consistent with current design science evaluation practice [34]. Small participant groups can be appropriate for formative evaluations aimed at identifying usability and design problems, although findings from such evaluations are not intended for statistical generalization [35]. The evaluation was conducted at SDK Betun I, Malaka Regency, on 3 September 2026, using internet-connected laptops and mobile phones. Accounts corresponding to participant roles and sample Tetun Fehan content were prepared before testing. Each participant attended a short introductory session followed by a task-based evaluation session. Instructions were delivered in Indonesian by members of the research team.

2.6.1. Expert Evaluation

Two experts from the East Nusa Tenggara Provincial Language Center evaluated the functional prototype against the PSD principles. They were selected because of their expertise in regional languages of East Nusa Tenggara and their relevance to the content validation process within the proposed ecosystem. Each expert independently rated every PSD principle using a three-level scale: achieved, partially achieved, or not yet achieved, corresponding to scores of two, one, and zero, respectively. The experts also provided qualitative suggestions

for improvement. A realization index was calculated for each PSD category and for the overall system by dividing the obtained score by the maximum possible score. Each category contained seven principles rated by two experts, resulting in a maximum category score of 28. Across the complete set of principles, the maximum possible score was 112. The experts additionally rated four general aspects of the application: system credibility, clarity of flow, support for behavior change, and suitability for language revitalization, using a 5-point scale.

Table 3. Formative evaluation design for the functional prototype of Bahasa Nusantara.

STAGE	PARTICIPANTS	TASKS	INSTRUMENTS	MEASURES AND ANALYSIS
S6: Expert evaluation	2 experts	Reviewing the prototype against the 28 PSD principles	Three-level rating sheet for each principle (0 = not yet achieved, 1 = partially achieved, 2 = achieved) and improvement notes; ratings of four general aspects on a 1-5 scale	Realization index per category and overall; mean scores for the general aspects
S7: Teacher usability testing	3 teachers, SDK Betun I	Four scenario tasks, one per pillar: entering vocabulary, completing a module, creating or joining an activity, and sharing content	Task-completion observation sheet; 10-item System Usability Scale (SUS); open-ended feedback	Status of each task (independent, assisted, failed); SUS score of 0-100
S8: Children's evaluation	10 children aged 8-11 years, SDK Betun I	Searching for a word in the dictionary, opening a lesson, doing an exercise, and viewing an activity or content	Smileyometer 1-5 per task; overall ratings of fun and ease of use; willingness to use the application again; facilitator notes	Mean, minimum, and maximum scores; number of children completing tasks independently or with assistance

2.6.2. Teacher Usability Testing

Three teachers responsible for the local content subject at SDK Betun I participated in the usability evaluation. Each teacher completed four scenario-based tasks corresponding to the four pillars: entering a vocabulary item into the corpus, completing and managing an e-learning module, creating or joining a language activity, and sharing digital content. For each task, the facilitator recorded whether it was completed independently, with assistance, or not completed. After completing the scenarios, the teachers filled out the System Usability Scale (SUS), a ten-item instrument rated on a five-point Likert scale and converted into a score ranging from zero to one hundred. Open-ended feedback was also collected to identify problems experienced during use.

2.6.3. Children's Evaluation

Ten children aged 8-11 years from grades four and five of SDK Betun I participated in the child-centered evaluation. All participants used Tetun Fehan. They completed age-

appropriate tasks consisting of searching for a word in the dictionary, opening a lesson, completing an exercise, and viewing an activity or digital content. After completing each task, the children rated their experience using the Smileyometer, a five-point pictorial scale for evaluating children's interaction with technology. The children also rated the overall fun and ease of use of the application and indicated whether they would like to use it again. These measures complement usability-oriented evaluations in which perceived ease of use and intention to continue using an educational application are important indicators of technology acceptance [36]. The facilitator recorded whether each child completed the tasks independently, required assistance, or was unable to complete the task. Permission was obtained from the school, and consent was obtained from parents or guardians and from the participating children. Sessions were kept short, each child was accompanied by a facilitator, and participants were allowed to discontinue the activity at any time.

2.7. Data Analysis

Data were analyzed according to their type. Needs assessment data were summarized using frequencies and percentages for each respondent group. PSD realization indices were calculated from the expert ratings using the procedure described above. Teacher SUS scores were calculated using the standard scoring procedure and interpreted against the commonly used benchmark value [37, 38]. Children's Smileyometer ratings were summarized using means, minimum values, and maximum values. Because the formative evaluation involved small participant groups, no inferential statistical tests were conducted. Instead, quantitative findings were triangulated with task-completion records, expert comments, facilitator observations, and participants' open-ended feedback to identify recurring design problems and their educational implications.

3. RESULTS AND DISCUSSION

3.1. User Needs and the Four-Pillar Learning Ecosystem

The needs assessment revealed a consistent preference for language documentation resources across the three respondent groups. As shown in **Table 4** and **Figures 2-4**, the regional language-Indonesian dictionary and multimodal language corpus were the two most frequently selected features. The dictionary was selected by 61.5% of students, 55.3% of parents or guardians, and 83.3% of institutional employees, while the multimodal corpus was selected by 55.7, 62.1, and 75.7%, respectively. Respondents regarded accessible and reliable language resources as the foundation of regional language learning. The strong demand for documentation is particularly relevant in communities where teaching materials and specialist regional language teachers remain limited [4]. It also supports previous arguments that documentation should be connected with educational and community-based activities rather than treated solely as a preservation activity [1, 10].

Learning-related preferences formed a second group of needs. Students showed relatively stronger interest in curricula and interactive teaching materials, language education games and exercises, and virtual classes with learning trackers. Social and community-oriented preferences also differed across respondent groups. Students showed greater interest in an internal regional language social media platform, whereas parents or guardians and institutional employees placed relatively greater emphasis on literary, cultural, and language contests. Regional language learning should accommodate both learner-centered digital activities and community-based opportunities for authentic language use.

Table 4. Selected needs by respondent group, n (%).

ITEM AND OPTION	STUDENTS, n (%)	PARENTS/GUARDIANS, n (%)	INSTITUTIONAL EMPLOYEES, n (%)
1. Features, activities, and menus (multiple choice)			
Number of respondents who answered (N)	221	190	144
Regional language-Indonesian dictionary	136 (61.5%)	105 (55.3%)	120 (83.3%)
Language corpus (text, image, audio, video)	123 (55.7%)	118 (62.1%)	109 (75.7%)
Internal regional language social media	63 (28.5%)	35 (18.4%)	30 (20.8%)
Literary, cultural, and language contests	42 (19.0%)	37 (19.5%)	37 (25.7%)
Curriculum and interactive teaching materials	51 (23.1%)	26 (13.7%)	29 (20.1%)
Language education games and exercises	47 (21.3%)	30 (15.8%)	30 (20.8%)
Virtual classes and learning tracker	37 (16.7%)	21 (11.1%)	14 (9.7%)
Community discussion forum	29 (13.1%)	18 (9.5%)	24 (16.7%)
Workshops or seminars	20 (9.0%)	22 (11.6%)	21 (14.6%)
2. Access platforms (multiple choice)			
Number of respondents who answered (N)	221	190	142
Social media	145 (65.6%)	100 (52.6%)	104 (73.2%)
Android/iOS applications	104 (47.1%)	72 (37.9%)	72 (50.7%)
E-book	81 (36.7%)	50 (26.3%)	48 (33.8%)
Website	61 (27.6%)	52 (27.4%)	66 (46.5%)
Physical books	35 (15.8%)	24 (12.6%)	65 (45.8%)
3. System type (single choice)			
Number of respondents who answered (N)	221	190	144
Application	97 (43.9%)	61 (32.1%)	40 (27.8%)
Website	71 (32.1%)	45 (23.7%)	42 (29.2%)
Combination of application and website	53 (24.0%)	74 (38.9%)	62 (43.1%)
Others/did not select any option	0 (0.0%)	10 (5.3%)	0 (0.0%)
4. Access mode (single choice)			
Number of respondents who answered (N)	221	190	144
Online	175 (79.2%)	144 (75.8%)	129 (89.6%)
Offline	46 (20.8%)	46 (24.2%)	15 (10.4%)
5. Keywords on appearance (open-ended answers)			
Number of open-ended answers (N)	200	131	119
app	31 (15.5%)	17 (13.0%)	31 (26.1%)
online	16 (8.0%)	11 (8.4%)	9 (7.6%)
TikTok	22 (11.0%)	12 (9.2%)	0 (0.0%)
image	6 (3.0%)	3 (2.3%)	24 (20.2%)
cellular	13 (6.5%)	5 (3.8%)	9 (7.6%)
understood	6 (3.0%)	4 (3.1%)	13 (10.9%)
simple	0 (0.0%)	6 (4.6%)	13 (10.9%)
magazine	15 (7.5%)	4 (3.1%)	0 (0.0%)
learning	11 (5.5%)	5 (3.8%)	1 (0.8%)
video	5 (2.5%)	3 (2.3%)	9 (7.6%)

Access preferences further emphasized the importance of digital delivery. Social media was the most frequently selected access platform, followed by mobile applications, while most respondents preferred online access. Open-ended responses also frequently referred to applications, online access, TikTok, images, mobile devices, simplicity, learning, and video. These patterns are consistent with the increasing influence of digital and social media on young people's language choices [3]. However, reliance on familiar digital platforms alone is insufficient. Educational applications may provide limited opportunities for active, meaningful, and socially interactive learning [23]. Therefore, the challenge is not merely to digitize language resources but to organize them into an educational process.

The primary needs were subsequently translated into four interconnected pillars, as summarized in **Table 5**. The demand for dictionaries and multimodal language resources formed the corpus collection pillar. Needs related to curricula, teaching materials, exercises, games, and virtual classes formed the e-language learning pillar. Preferences for contests, forums, workshops, and other activities were translated into language activity management, while interest in social media and digital content supported the digital campaign pillar. Mobile-first access and interface simplicity were treated as cross-pillar principles because they applied to all components of the application.

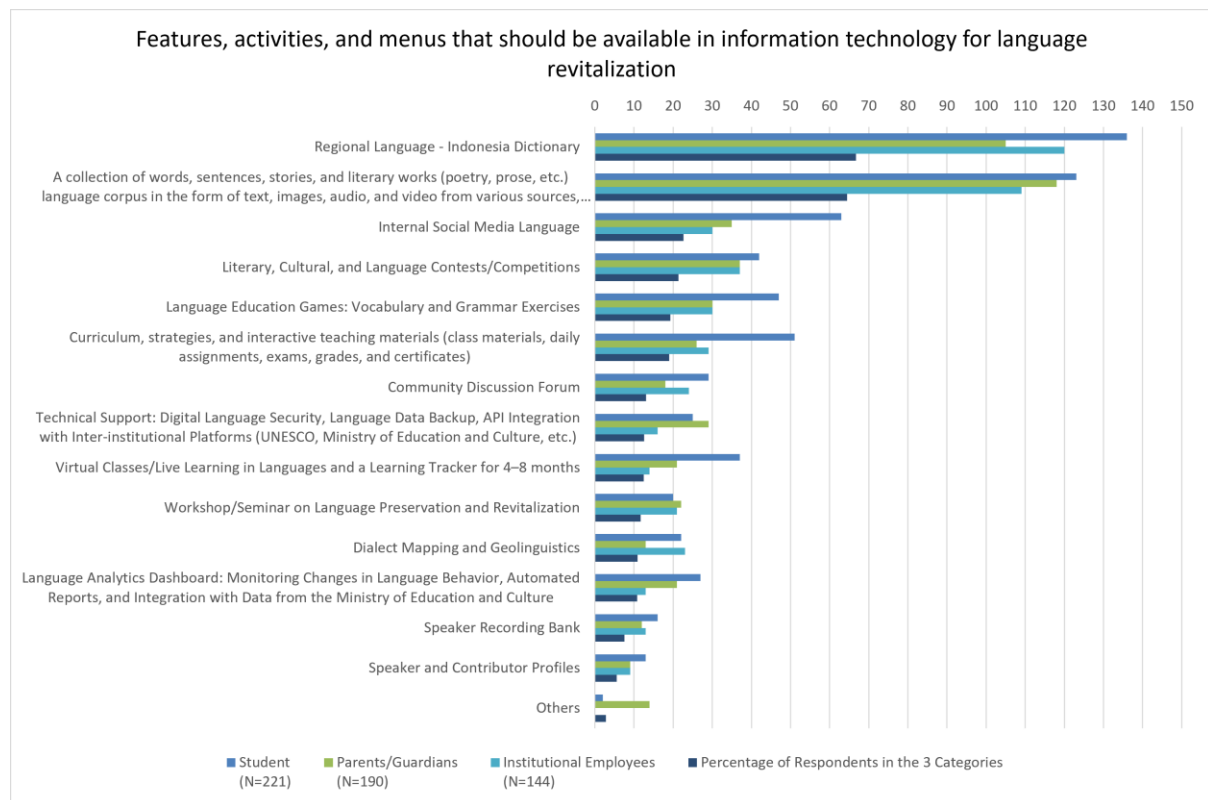


Figure 2. Features, activities, and menus expected in a regional language revitalization system, by respondent group (%).

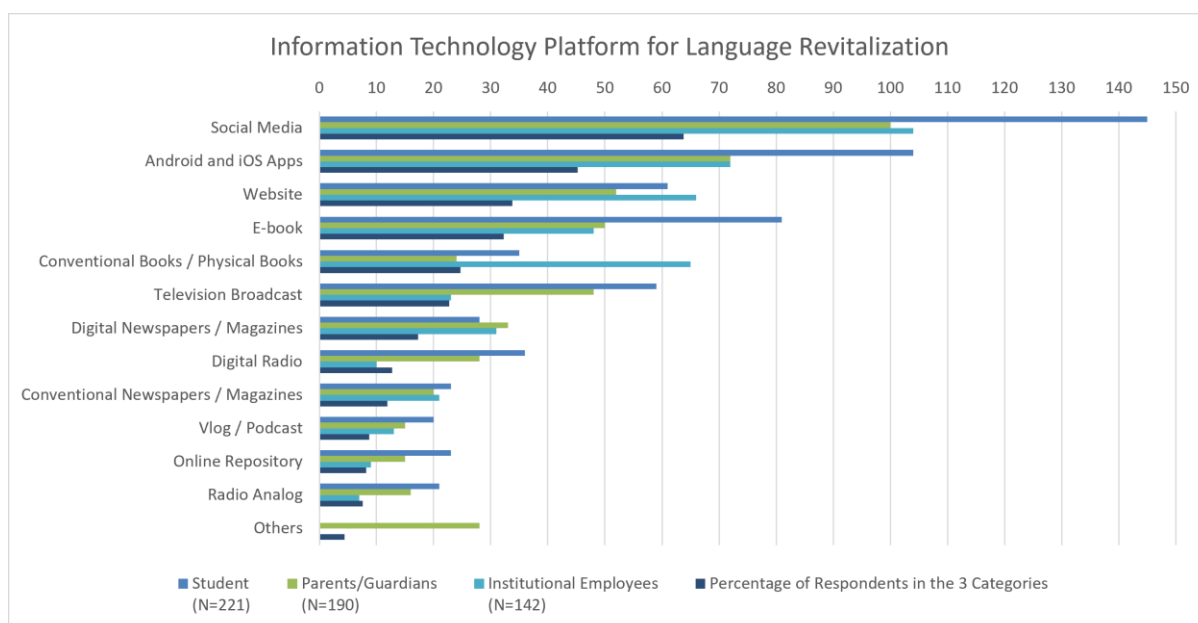


Figure 3. Preferred access platforms, by respondent group (%).

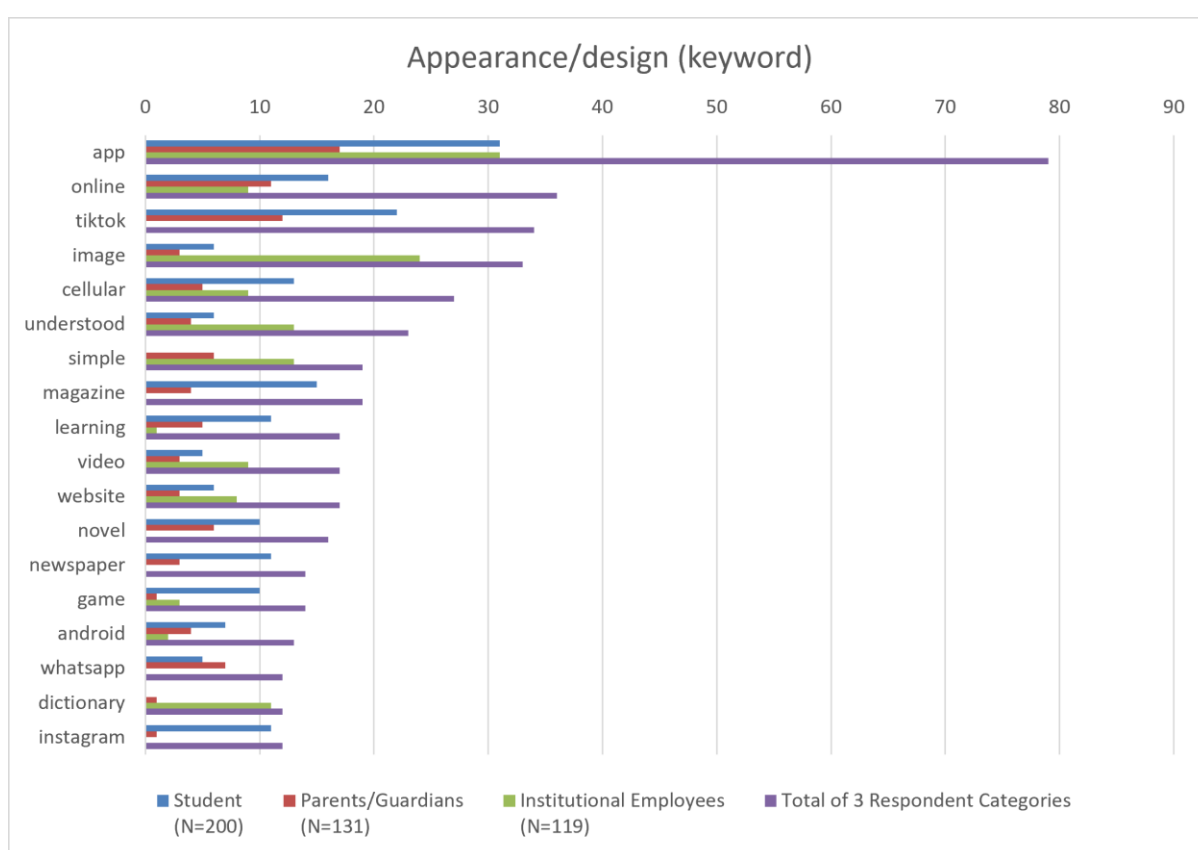


Figure 4. Keywords in open-ended answers on the preferred appearance and design of the system (n = 450).

Table 5. Traceability chain from user needs to educational requirements, pillars, PSD principles, and features.

SALIENT NEED	EDUCATIONAL OR REVITALIZATION REQUIREMENT	PILLAR	KEY PSD PRINCIPLES	FEATURES IN THE APPLICATION
Dictionary (55.3-83.3%) and multimodal corpus (55.7-75.7%), ranked as the top two needs in all groups	A verified reference containing words, meanings, and pronunciation that teachers and learners can use as learning material	Corpus collection	Reduction, tunneling, expertise, verifiability, trustworthiness	Corpus submissions with verification status; Language Corpus; Dictionary with language-based search; Validation menu
Teaching materials (13.7-23.1%), games and exercises (15.8-21.3%), virtual classes (9.7-16.7%); keywords “learning” and “magazine”	Structured and progressive learning with practice, progress tracking, readable content, and teacher feedback	E-language learning	Tunneling, tailoring, self-monitoring, rehearsal, praise, rewards, social role	Curriculum; language-based classes and sub-classes; assessment and evaluation; student data
Contests (19.0-25.7%), forums (9.5-16.7%), and workshops (9.0-14.6%)	Opportunities to use the language in authentic school and community activities beyond lessons	Language activity management	Cooperation, competition, recognition, social learning, authority	Event Management with draft, approved, revised, and rejected status flow
Social media as the leading platform (52.6-73.2%), internal social media (18.4-28.5%); keywords “TikTok”, “image”, and “video”	Visibility and prestige of the language among young people and dissemination of learner and community works	Digital campaign	Social facilitation, normative influence, social comparison, third-party endorsements	Content Management; content discussion; Social Media; Share
Preference for applications and combined access; online access preferred by 75.8-89.6%; keywords “app”, “cellular”, and “online”	Learning accessible from learners’ own devices	Cross-pillar principle	Reduction, surface credibility	Online web application
Keywords “understood” and “simple”	Low cognitive load and learnability for children and non-specialist teachers	Cross-pillar principle	Reduction, tunneling, liking	One main goal per page; labeled menus; consistent icons

The resulting framework is presented in **Figure 5**. The four pillars were designed as a continuous learning cycle rather than as independent modules. Corpus collection provides verified words, meanings, pronunciation, and supporting resources that can be used in e-language learning. Learning activities prepare users to apply regional languages in school and community events. These activities can generate new texts, recordings, and other digital resources that enrich the corpus and provide materials for wider dissemination. The digital

campaign then increases the visibility of the language and its users, potentially attracting further learners and contributors into the cycle.

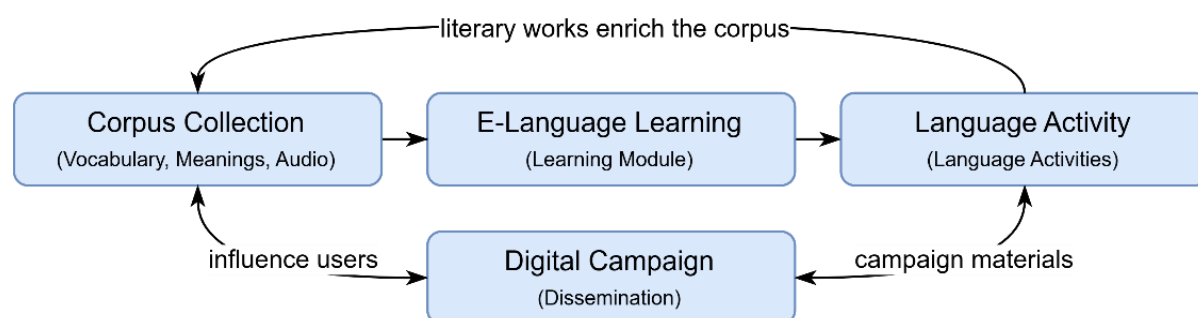


Figure 5. The four-pillar learning ecosystem for regional language learning and revitalization: a continuous cycle of documentation, learning, use, and dissemination centered on an intergenerational learning community.

This structure extends existing approaches in which dictionaries, corpora, learning applications, and digital communication tools are often developed separately [12-15, 18]. More importantly, the model places an intergenerational learning community at its center. Children and students participate as learners, teachers guide learning activities, parents and elders contribute language knowledge, and language experts support content validation. This arrangement is consistent with evidence that family and community interaction plays an important role in sustaining language transmission [24, 25]. The model therefore positions digital technology not as a replacement for community interaction but as an infrastructure that connects documentation, learning, authentic use, and dissemination.

3.2. PSD-Based Educational Mechanisms and Application Design

The user needs and four-pillar structure were further translated into educational mechanisms using Persuasive Systems Design. **Table 6** summarizes how the PSD principles were connected with learning progression, practice, self-regulation, motivation, teacher guidance, social interaction, recognition, and content credibility. PSD can function as more than a collection of interface features. In this study, the principles were used to define how the application should support particular educational behaviors.

Primary task support was used to simplify learning and contribution activities. Reduction, tunneling, and tailoring were applied to divide tasks into manageable steps and organize learning materials according to user needs. Rehearsal and simulation supported repeated practice through flashcards, exercises, and assessment preparation. Self-monitoring and personalization were associated with progress indicators, learning histories, contribution counters, and individual targets. These mechanisms are consistent with instructional principles that reduce unnecessary cognitive demands and support progressive learning [27].

Dialogue support principles were primarily associated with motivation and feedback. Praise, rewards, suggestions, reminders, liking, similarity, and social role were translated into mechanisms such as appreciation messages, badges, certificates, learning prompts, and teacher feedback. However, persuasive mechanisms cannot simply be transferred from other application domains without considering their educational consequences. Competitive and reward-based elements may increase engagement for some learners but can have weaker or even negative effects for others [21]. For this reason, the design emphasized support, recognition, and guided participation rather than competition alone.

Table 6. Synthesis of the PSD principles by educational mechanism.

EDUCATIONAL MECHANISM	PSD PRINCIPLES (CATEGORY)	DESIGNED FEATURES	EXPECTED LEARNER, TEACHER, OR COMMUNITY RESPONSE
Learning progression and manageable load	Reduction, tunneling, tailoring (PT)	Single-page vocabulary form; one learning objective per module; meetings unlocked in sequence; everyday vocabulary for beginners and cultural texts and folklore for advanced learners	Learners progress step by step; newcomers can contribute without special training
Practice and rehearsal	Rehearsal, simulation (PT)	Flashcards with spaced repetition; unlimited practice quizzes with varied items; exam simulation with readiness prediction; dictionary card preview	Repeated retrieval practice; reduced uncertainty before assessment
Feedback and self-regulation	Self-monitoring, personalization (PT); suggestion, reminders (DS)	Progress bar per module; score history; contribution counter; personal target; task reminders; suggestions for under-documented categories	Learners monitor and regulate their own learning and contributions
Motivation and affect	Praise, rewards, liking, similarity (DS)	Appreciation messages after contributions or meetings; contributor badges; certificates; friendly minimalist interface; greetings in the regional language	Positive affect and identification with the language
Teacher guidance	Social role (DS)	The system conveys teachers' assessment and feedback to each learner in the class	Learners receive guidance; teachers remain mediators of learning
Social and intergenerational learning	Social learning, cooperation, social facilitation (SS)	Content discussion forum; collective contribution targets; user presence indicators	Peer and intergenerational exchange; shared ownership of the language
Social recognition	Social comparison, normative influence, competition, recognition (SS)	Contributor leaderboard; weekly notifications of top contributors and scores; weekly competitions; monthly recognition of contributors and contest winners	Public valuing of language use, applied cautiously with children
Credibility of learning content	Trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, verifiability (SC)	Provenance metadata; validation by linguists; consistent bilingual content; administrator contacts; partner institution logos and recognition; testimonials and media coverage; traceable content history	Teachers and parents trust entries as teaching materials; legitimacy within the community

Notes: PT = primary task support; DS = dialogue support; SS = social support; SC = system credibility support. Each PSD principle appears once.

Social support principles were particularly important because regional language revitalization depends on collective participation. Social learning, cooperation, and social facilitation were incorporated through discussion, collective contribution targets, and

indicators of user participation. Social comparison, normative influence, competition, and recognition were connected with visible contributions and community acknowledgement. These mechanisms differ from many individual-oriented digital learning applications because language revitalization requires interaction among learners, teachers, families, and other community members. System credibility support was also embedded throughout the design. Language entries included provenance and verification information, experts were assigned content validation roles, institutional partners were displayed within the application, and content histories could be traced. Credibility is especially important in regional language education because teachers and families need confidence that vocabulary, meanings, pronunciation, and cultural content are appropriate for instructional use. Community control and trustworthy representation are also important considerations in digital language revitalization [10, 17].

The implementation of these mechanisms in the functional prototype is illustrated in **Figure 6**. After logging in, users access functions according to their assigned roles. Corpus collection is supported through corpus submission, language corpus, dictionary, and validation menus. E-language learning includes curriculum, classes, assessments, and student management. Language activity management supports the creation and approval of community or school activities, while the digital campaign provides content management, social media, and sharing functions.

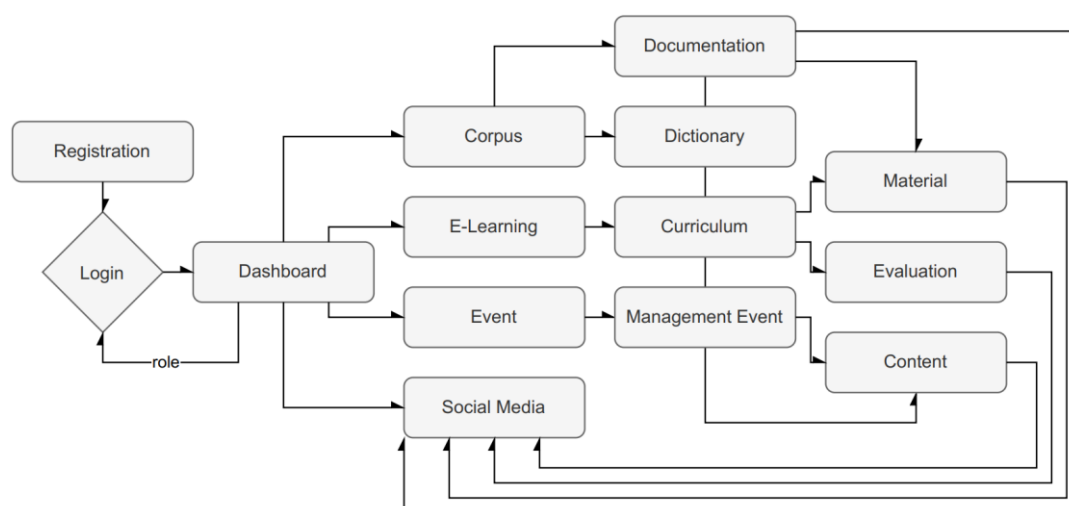
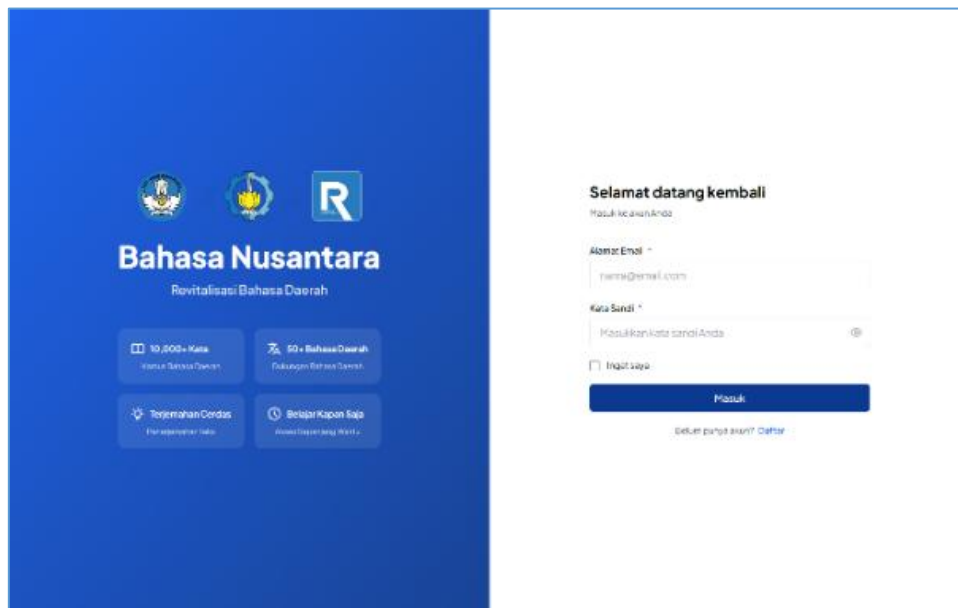
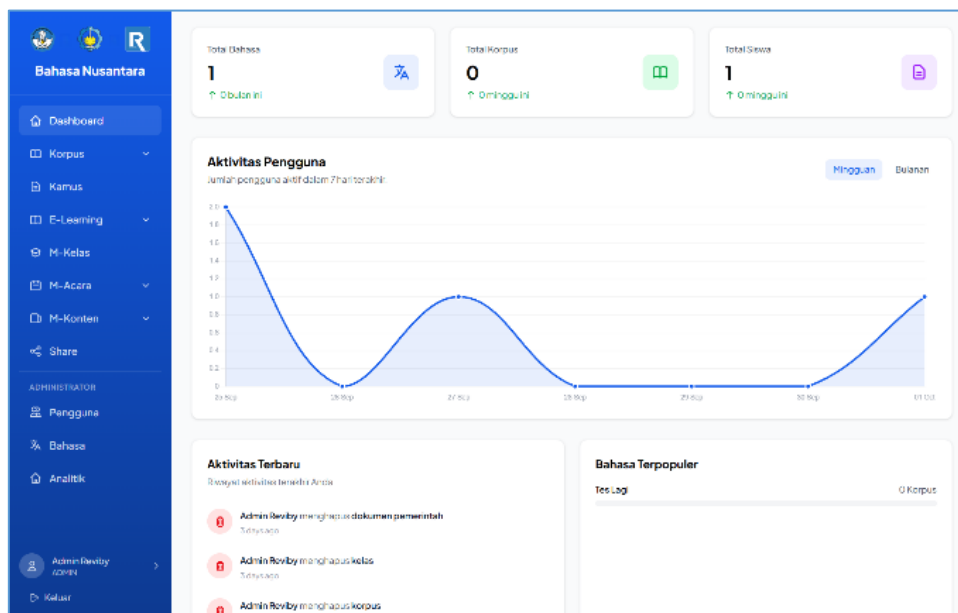


Figure 6. User flow of the Bahasa Nusantara application.

The interface also demonstrates how the four pillars were translated into practical workflows. Verified corpus entries can be searched through the dictionary and reused as learning resources. Classes can be organized by language, while activities and digital content can be managed and shared through the system. Institutional logos, content verification, and authorization status provide visible indicators of credibility. Examples of the application interface are shown in **Figures 7(a) and 7(b)**. The mapping therefore provides a traceable relationship from user needs to educational requirements, PSD principles, application features, and expected user responses. This traceability is important because persuasive design should not be implemented simply by adding isolated gamification or motivational features. Instead, each mechanism should have a clear educational purpose and should respond to the characteristics of the learners and the language community.



(a)



(b)

Figure 7. Appearance in the system: (a) Login interface of Bahasa Nusantara, and (b) Dashboard interface of Bahasa Nusantara.

3.3. Formative Evaluation with Experts, Teachers, and Children

The formative evaluation provided complementary evidence from experts, teachers, and children. The expert evaluation showed an overall PSD realization index of 59%, as presented in **Table 7**. System credibility support showed the highest realization at 71%, followed by social support at 64%, dialogue support at 54%, and primary task support at 46%. Several principles, including personalization, rehearsal, suggestion, similarity, recognition, and third-party endorsements, had not yet been fully realized.

Table 7. Realization of the PSD principles according to the two experts.

PSD CATEGORY	ACHIEVED	PARTIALLY ACHIEVED	NOT YET ACHIEVED	REALIZATION INDEX	NOT YET ACHIEVED BY BOTH EXPERTS
Primary task support	3	7	4	46%	Personalization, rehearsal
Dialogue support	6	3	5	54%	Suggestion, similarity
Social support	6	6	2	64%	Recognition
System credibility support	8	4	2	71%	Third-party endorsements
Total	23	20	13	59%	Six principles

Notes: Each category contains seven principles rated by two experts. Realization index = $(2 \times \text{achieved} + 1 \times \text{partially achieved}) / (2 \times \text{number of ratings})$.

The relatively high realization of credibility and social support is notable because previous PSD research, particularly in digital health, has often emphasized primary task and dialogue support while making less use of social and credibility mechanisms [29, 30]. Direct comparison should be made cautiously because previous reviews examined the frequency with which principles were selected across multiple interventions, whereas the present study evaluated the realization of the complete set of principles within a single prototype. Nevertheless, credibility and social participation may deserve particular attention in community-based language learning. Language resources need to be trusted, and their production and use depend on participation by multiple community actors.

The lower realization of some primary task and dialogue principles may also reflect the developmental stage of the prototype. Personalization, rehearsal, suggestions, reminders, and recognition become more meaningful after repeated use and the accumulation of learner data. A short formative evaluation cannot fully demonstrate these dynamic functions. Therefore, the results should be interpreted as indicators of design maturity rather than as evidence that certain PSD categories are inherently less appropriate for regional language learning.

Teacher evaluation also identified usability challenges. The three teachers obtained a mean SUS score of 68.3, close to the commonly used average benchmark [37, 38]. As shown in **Table 8**, all teachers completed the corpus collection task independently, but assistance was required for several e-learning, event management, and digital campaign tasks. Simple, clearly guided tasks were easier to complete than workflows involving multiple menus, roles, or authorization stages.

Table 8. SUS scores and scenario task outcomes of the teachers.

TEACHER	SUS SCORE	CORPUS COLLECTION	E-LANGUAGE LEARNING	LANGUAGE ACTIVITY MANAGEMENT	DIGITAL CAMPAIGN
Teacher 1	67.5	Independent	Assisted	Failed	Assisted
Teacher 2	70.0	Independent	Assisted	Assisted	Independent
Teacher 3	67.5	Independent	Assisted	Assisted	Assisted
Summary	68.3	3 independent	3 assisted	2 assisted, 1 failed	1 independent, 2 assisted

This finding is important because regional language education may depend on teachers who are not language or technology specialists [4]. If teacher-facing functions remain complicated, technological systems may unintentionally increase rather than reduce the burden of implementing regional language programs. Reduction and tunneling should therefore be applied not only to student activities but also to teacher workflows. Templates, guided steps, clearer navigation, and integrated functions may reduce the need for technical assistance. The children's evaluation produced a similar pattern. As shown in **Table 9**, all children completed the assigned tasks, but only one did so independently. The mean Smileyometer rating across tasks was 3.1, while the application was rated more positively for fun than for ease of use. Opening a lesson received the lowest task rating, indicating that accessing learning materials was less intuitive than viewing activities or content.

Table 9. Children's Smileyometer ratings for the four scenario tasks (n = 10).

TASK (PILLAR)	MEAN (1-5)	MIN	MAX
Searching for a word in the dictionary (corpus collection)	3.0	2	4
Opening a lesson (e-language learning)	2.9	2	4
Doing exercises (e-language learning)	3.0	2	4
Viewing events or content (activities and campaign)	3.4	3	5
Mean across all tasks	3.1	2	5

The difference between enjoyment and ease of use indicates that motivational appeal alone does not ensure independent interaction. The children were interested in the application and expressed willingness to use it again, but most required assistance during first use. The observed task difficulties and facilitator notes provide important complementary evidence because usability and accessibility remain important considerations in educational mobile applications [39]. Age-appropriate onboarding, visual cues, audio prompts, direct access to lessons, and gradually reduced scaffolding are therefore needed. At the same time, assistance from parents, teachers, or older family members may provide opportunities for intergenerational co-learning rather than being treated solely as a usability problem [24, 25]. Across the three participant groups, a consistent issue emerged: onboarding and guided use were important for successful interaction. Experts requested clearer guidance, teachers reported a need for technical support, and children showed confusion during initial use. The formative evaluation therefore indicates that the application already provides a functional foundation for credibility and community participation, but greater attention is required to learner support, teacher workflows, and independent navigation.

3.4. Educational Implications and Future Development

The findings have four main implications for the design of digital learning technologies for regional language revitalization:

- (i) Documentation as a learning resource. Dictionaries and multimodal corpora should not function only as repositories but should be connected to structured learning, authentic language use, and digital dissemination within the four-pillar ecosystem.
- (ii) PSD as an educational mechanism. PSD principles can support learning progression, feedback, motivation, social participation, and content credibility, extending their role beyond persuasive interface features.
- (iii) Teacher mediation. Simple teacher workflows and professional support remain essential, particularly where specialist regional language teachers are limited [4].

Teacher-facing design should therefore be treated as part of the educational intervention.

- (iv) Child-centered design. Engagement should be balanced with learner autonomy through simplified navigation, direct access to learning activities, visual and audio guidance, and gradually reduced scaffolding. Guided use with parents, teachers, or older family members may also support intergenerational learning.

The priority improvements identified from the formative evaluation are summarized in **Table 10**, including stronger practice and feedback functions, simplified teacher workflows, a student-specific interface, and role-based onboarding. However, the study has several limitations. The formative evaluation involved small groups from a single school, and the functional prototype was tested only within the Tetun Fehan community. Moreover, the study assessed PSD realization, usability, and user experience rather than learning outcomes, language use, or intergenerational transmission. Future research should therefore implement the proposed refinements and conduct broader summative and longitudinal evaluations across different language communities to examine learning achievement, sustained participation, language use at school and home, and intergenerational interaction.

Table 10. Formative findings, educational implications, and priority refinements.

FORMATIVE FINDING	SOURCE	EDUCATIONAL IMPLICATION	PRIORITY REFINEMENT
Lowest realization in primary task support (46%) and dialogue support (54%); personalization, rehearsal, suggestion, and similarity not yet achieved	Experts	Learners do not yet receive sufficient repeated practice and feedback to sustain learning between lessons	Implement planned features, prioritizing flashcards, practice quizzes, learner progress bars, and reminders
Corpus task completed independently; e-learning tasks required assistance; event-management tasks involved assistance or failure; campaign tasks also frequently required assistance; mean SUS = 68.3	Teachers	Multi-step and role-dependent workflows are difficult for non-specialist teachers to complete without assistance	Ready-to-use class and meeting templates; step-by-step guides for creating classes and submitting events; explanations of event approval statuses; integration of Content, Social Media, and Share into a single sharing flow
Fun rating higher than ease-of-use rating; nine of ten children required assistance; opening a lesson received the lowest task rating	Children	Motivation is present, but operational autonomy remains limited	Student-specific interface with direct entry points to lessons; icons and audio prompts; gradually faded scaffolding; parent-child co-learning mode
Requests for guidance, need for technical support, and confusion during first use	All groups	Onboarding is a prerequisite for independent learning and teaching	Role-specific onboarding flow and beginner guides

4. CONCLUSION

This study developed and formatively evaluated the Bahasa Nusantara application to support regional language revitalization through digital learning. User needs were translated into four interconnected pillars covering corpus collection, e-language learning, language activities, and digital campaigns. Persuasive Systems Design helped organize educational

mechanisms related to learning progression, motivation, social interaction, and content credibility. The evaluation showed relatively strong credibility and social support, while teacher workflows, learner guidance, and independent use still require improvement. The findings highlight the importance of combining digital technology with teacher mediation, child-friendly onboarding, community participation, and trusted language resources for sustainable regional language learning and revitalization.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper is free from plagiarism.

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