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Original Article

Design and Validation of Lightweight Educational Software for Vocabulary Teaching Through Gamification

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Abstract *- Traditional vocabulary instruction in primary education often relies on repetition and memorization, which may reduce student motivation and limit immediate feedback during practice. This study presents the design, development, and initial validation of a lightweight educational software application inspired by Hangman to support thematic vocabulary practice through gamification. The novelty of the proposal lies in combining a simple web-based game environment, free technologies, and an iterative user-centered process that integrates Design Thinking and Lean Startup principles for educational software development in resource-constrained contexts. The methodological process includes problem identification, ideation, prototype construction, minimum viable product validation, and continuous improvement. The validation involved 105 participants, including basic-level students, teachers, and parents, selected through purposive sampling. Data were collected using a structured perception questionnaire and open-ended questions. Three educational technology experts provided initial content validation of the instrument and prototype. Quantitative results were analyzed through descriptive statistics and internal consistency estimation, while qualitative responses were examined using ATLAS. ti through coding, category grouping, and triangulation with survey findings. The questionnaire showed high internal consistency, with Cronbach's alpha of 0.90. The results indicate positive perceived usability, motivational potential, pedagogical usefulness, and user acceptance of the proposed software. However, the findings represent initial validation evidence based on perception and expert judgment, not experimental proof of vocabulary learning improvement. Future studies should apply pre-test/post-test designs, control groups, and longitudinal measures to determine the educational effectiveness of the Hangman-based gamified environment.*

Keywords *- Design thinking, Educational software, Gamification, Human-Computer Interaction, Playful learning.*

1. Introduction

Traditional vocabulary teaching in primary education frequently relies on memorization, repetition, and passive exposure to words. Although these practices may support basic recognition, they often provide limited interaction, reduced learner autonomy, and insufficient immediate feedback during practice. These limitations may negatively affect motivation, especially among school-aged children who require visual, playful, and responsive learning environments to sustain attention and reinforce vocabulary use. In this context, vocabulary learning requires not only content presentation but also repeated practice, feedback, and meaningful interaction between the learner and the learning resource.

Gamification has been increasingly discussed as a strategy for improving student engagement by incorporating game elements into educational activities [1, 2]. Educational games and video game-based learning environments have also been associated with active participation, memory reinforcement, vocabulary practice, and positive emotional experiences during learning [3-5]. However, many gamified educational tools and vocabulary learning platforms require stable connectivity, installation procedures, advanced devices, or complex interfaces, which may limit their applicability in schools with restricted technological infrastructure. This situation is particularly relevant in educational contexts where teachers and students need accessible tools that can operate with minimal technical requirements.

Several studies have examined games or game-like programs that have an educational aspect to them; this includes digital learning products, educational/learning software, and user perceptions of Digital Educational Technology [6, 7]. The studies on educational software quality have all focused heavily on usability, accessibility, interface clarity, and relevance from an educational standpoint as critical elements of digital products used for learning [8-10].

However, very little has been written or studied about lightweight vocabulary software that can provide an educational experience by using an easy-to-use game interface, limited technical resources, and a user-centered approach; using an online version of the traditional Hangman Game can be beneficial in this instance because it provides an opportunity to develop vocabulary through a familiar set of rules and instant feedback without any complex technical requirements.

This work looks at developing a web-based version of the traditional game of Hangman that is easy to use and creates a user-friendly environment for practicing vocabulary by using category-based vocabulary practice. Users can select a category, enter a letter, receive instant feedback, see their error(s), and add the score they earn while playing; unlike more complex educational platforms, this type of software will put a greater emphasis on being accessible, having minimal technical requirements, and functioning through a web browser without the need to download or install anything.

The methodological approach taken is to combine Design Thinking and the Lean Startup methodology; Design Thinking facilitates the process of identifying user needs, developing ideas, creating prototypes, and testing ideas while the Lean Startup methodology provides guidance on the development of a Minimum Viable Product (MVP), how to measure the outcome(s), how to use the outcome(s) to provide feedback, and how to improve the MVP through iterations of the MVP [11, 12, 13]. It also utilises a combination of validation methods, including quantitative data from end-user perceptions, expert analysis, analysis of internal consistency, and qualitative coding supported by ATLAS.ti.

The study aims to develop a lightweight version of Hangman-based software for teaching vocabulary using gamified methods. The study proposes a web-based vocabulary learning solution that can be easily accessed and provides validation through several means: usability, motivation, perceived pedagogical usefulness, acceptance, expert review and qualitative feedback. The study does not claim to demonstrate empirical evidence of vocabulary learning improvements through its use; rather, it aims to provide initial validation evidence to help support future studies using pre-test and post-test designs along with control groups and longitudinal evaluation.

2. Literature Review

There is a large volume of literature related to the five overlapping categories of gamification in education, including educational video games created to assist with vocabulary learning, lightweight educational software, the various methodological approaches for developing software, and validation procedures for educational technologies. This organization establishes a clearer understanding of the theoretical foundations for the developed software and shows how this software differs from previously tested models.

2.1. Gamification and Educational Engagement

Gamification is being used extensively in education to motivate, involve and support persistently learning. It can be used in any educational context, not just those that have digital devices with complex applications; gamification can simply mean including game elements in your educational environment to help students learn; these game elements include goals, feedback, challenges, progressions and the like [1, 2]. When teaching vocabulary, gamifying the environment will allow learners to transform what would typically be considered boring (repetitive practice) into an interactive, engaging experience, where learners receive immediate feedback and stay focused on the task at hand.

Research has shown the benefits of using game-like environments to help learners focus their attention, strengthen their memory and produce positive responses while learning through play [3, 4]. However, it should be noted that games will provide educational value only to the extent that they are well-aligned with the objectives of the lesson. A game may be fun for students and have a high level of user appeal, but if the educational objectives are not being met (practice, providing feedback and engaging learners with content), the potential impact will be minimal. Thus, a gamified vocabulary program must not only provide entertainment value, but also ensure clarity of use and pedagogical coherence.

2.2. Educational Video Games and Vocabulary Learning

Over the years, researchers have explored the potential of using educational video games as a means to promote language learning and vocabulary development. Overall, systematic reviews and studies have found that when such games are designed with identified and clear educational goals, they provide learners with an opportunity to engage with active participation and maintain active attention. Although digital/video games may be able to provide learners with both intentional and incidental (both planned and unexpected) exposure to vocabulary while engaging in interaction with the vocabulary itself, the word, the meaning of the word, the category of the word and receiving feedback regarding the word, the evidence suggests that this type of learning opportunity may be enhanced through repeated or successive interactions with the vocabulary and its various features.

Most studies of language games and other digital/vocabulary resources have produced positive perceptions from learners, coupled with potential benefits to vocabulary practice; however, many of the studies reviewed have examined a broad digital/video gaming platform or a range of digital media resources that may require more extensive computer and internet connections, a greater level of capacity on the computer, and a significant level of mediation from the teacher. Due to the existence of limited access to technology in some school environments, there is still a need for simpler educational software products that provide for vocabulary-intensive practices without requiring students to have sophisticated hardware setups, lengthy installation processes or a wide range of processes for interacting with that software.

2.3. Hangman-based Learning and Lightweight Educational Software

Hangman is a well-known game using letters that can be implemented for the study of vocabulary. To play Hangman, students must be able to validate the letters that they have identified as well as make predictions about what their possible words will be based on category-based hints. Prior research has explored the use of Hangman as a method to enhance students' vocabulary development, as it offers a readily available and well-known vehicle for learning [15, 16]. The relationship among word validation, understanding why errors occur, practice through repetition, and receiving immediate feedback illustrates the relationship that Hangman has for improving vocabulary.

The current research, on the other hand, builds on previous investigations in Hangman by not only incorporating it as a method of classroom learning; it develops a lightweight web-based educational software tool that incorporates the following elements: thematic categories, scoring, visual accountability, interaction flow and validation of the user.

This software tool will run on standardized web technologies, which makes it independent of specialized software platforms. The ability of this tool to run on web technologies, rather than being tied to specific platforms, is critical since, in addition to content accuracy, the quality of educational software must incorporate other elements such as ease of use, platform accessibility, simplicity of use, clarity of interface, and contextual appropriateness [8-10].

2.4. Design Thinking and Lean Startup in Educational Software Development

The application of design thinking to education technology projects facilitates user empathy, problem definition, ideation, prototyping and testing [9]. An ongoing user-centered design process begins with the needs and limitations of students, their teachers, and other end users about their use of the educational software, instead of beginning with the software only being a technical capability. In contrast, lean startup focuses more on developing an MVP, or minimum viable product, for testing rapidly, collecting feedback rapidly, learning rapidly and continually improving on the MVP through iterations [10, 11]. The use of design thinking combined with lean startup in this research supports the identification of educational problems as well as user experience requirements in an iterative manner. Both approaches address separate but complementing parts of developing a successful educational software solution.

The design thinking process guides through the educational problem identification phase and user experience requirement phase, while the lean startup process guides through the prototype building phase, measuring success, developing and learning, continually developing additional improvements and releases. Together, the two approaches provide a methodology for forming a successful educational software solution that is technically capable and meets the expectations of users to the extent that the solution has been built within the contextual limitations imposed upon it.

2.5. Validation of Educational Software and Research Gap

To ensure the proper validation of educational software, three dimensions should be taken into account: pedagogical, technical, and user-centered aspects. Studies conducted on the application software used in the educational environment show that educational software's quality, usability, learner perception, accessibility, and educational relevance are among the qualities that define software as a high-quality product [7-10].

Furthermore, the ways that students view educational technology tools are also important, as perceived utility, ease of use, and acceptance of such tools may affect how digital resources are adopted within learning environments [14]. As such, a validation process that focuses solely on technology functionality is insufficient. The validation of educational software must include evaluating how the users of the educational software perceive the software, how easily users can interpret the interface, how the user perceives the motivational value of performing the activities within the software, and whether or not the educational software is viewed by users as being pedagogically valuable.

Despite the growth of research on gamification, educational games, and vocabulary learning, a gap remains in the development and initial validation of lightweight vocabulary software that combines Hangman-based gamification, low technological requirements, Design Thinking, Lean Startup, quantitative perception analysis, expert judgment, and qualitative coding with ATLAS.ti.

Many previous studies focus either on educational games as learning interventions, general perceptions of digital tools, or software quality criteria. In contrast, the present study contributes a practical and methodological proposal for designing and initially validating an accessible vocabulary learning tool for resource-constrained educational contexts.

Therefore, the proposed software is positioned as a complementary educational resource rather than as a replacement for formal vocabulary instruction. Its purpose is to support thematic vocabulary practice, motivation, usability, and immediate feedback through a lightweight gamified environment. However, the current validation is limited to perception, usability, motivational potential, pedagogical usefulness, expert judgment, and qualitative feedback. Experimental evidence of learning improvement requires future studies with pre-test/post-test designs, control groups, and longitudinal assessment.

3. Methodology

This study used a design-based mixed-methods approach to develop and conduct an initial validation of a lightweight educational software application for vocabulary practice through Hangman-based gamification. The methodology combined elements of Design Thinking with Lean Startup to take the project from identifying a problem to building a prototype to validating it as a minimal viable product, as well as making improvements through iteration.

Quantitative data collected in the study included user perceptions of usability and motivation, along with their perception of the educational value of the application. Qualitative data were collected in terms of open-ended feedback through ATLAS.ti. This study was not designed as a true experimental intervention; therefore, no pre- or post-tests, no comparisons with a control group, nor any statistical analyses were conducted to determine the effectiveness of the application in increasing vocabulary learning. The evidence for the validation of the application was limited to initial data based on expert opinions, user opinions, internal consistency of the questionnaire used to gather user opinions, and qualitative feedback provided from the open-ended comments that were submitted by the users.

3.1. Methodological Design

The research design was structured as an initial educational software validation study. The development process was based on five sequential and iterative phases: empathize and define, ideation and prototyping, MVP construction, validation and measurement, and learning for continuous improvement. These phases allowed the software to be designed according to user needs and progressively refined through feedback.

Design Thinking was used to identify the educational problem, understand user needs, and generate prototype alternatives. Lean Startup was used to construct the Minimum Viable Product, measure user responses, and define improvement actions based on validated learning. This integration was considered appropriate because educational software development requires both user-centered design and iterative validation before broader implementation [11-13].

Table 1. Integration of design thinking and lean startup in the software development process

Stage	Methodological approach	Main activity	Output generated
Empathize and define	Design Thinking	Identification of educational needs through interviews, observation, and user feedback	Definition of the vocabulary learning problem and user requirements
Ideate and prototype	Design Thinking	Selection of the Hangman game logic and design of thematic categories	Initial prototype and interface structure
Build MVP	Lean Startup	Construction of a functional web-based prototype using HTML, CSS, and JavaScript	Minimum Viable Product with category selection, letter input, feedback, errors, and scoring
Measure and validate	Lean Startup	Application of questionnaires, expert judgment, and open-ended questions	Quantitative perception data and qualitative feedback
Learn and improve	Lean Startup	Analysis of user responses and identification of improvement actions	Improvement plan for future software iterations

3.2. Software Development Procedure

The software that is being proposed was built on a web-accessible basis using education software elements taken directly from the original classic Hangman Game. In total, there were four different categories of games (Animals, Singers, Countries and Films) available in the prototype. Users interacted with the system by selecting a category, playing the game (choosing letters), seeing how many correct and incorrect choices they made, and getting instant feedback and scores.

The web-based system was developed using lightweight web technologies, including HTML for structure, CSS for visual presentation, and JavaScript for dynamic interaction.

The software was designed based on these technologies in order to minimise the installation burden and provide a common interface for accessing the software from multiple devices via any standard Web browser.

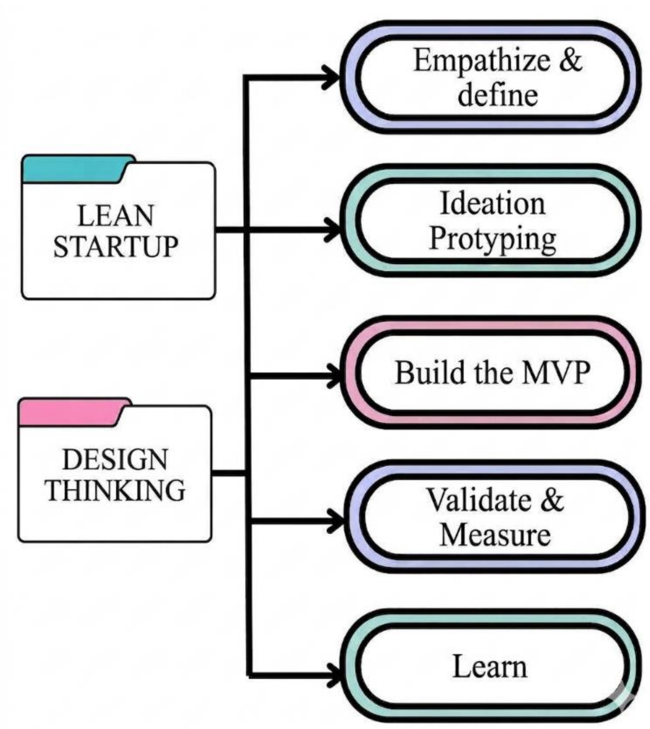

Fig. 1 Workflow of the Hangman-based educational software

3.3. Participants and Sampling

The validation involved 105 participants selected through purposive sampling. The sample included basic-level students, teachers, and parents who participated in brief assisted interaction sessions with the prototype. According to the sample distribution, approximately 62% of participants were basic-level students, 21% were teachers related to telecommunications and ICT areas, and 17% were parents. This sampling strategy was appropriate for an initial validation because the objective was to collect perceptions from users directly or indirectly involved in the educational use of the software. However, the sample should not be interpreted as statistically representative of all primary education contexts.

3.4. Instruments

Two complementary instruments were used for the initial validation of the MVP. First, a structured perception questionnaire was applied using a four-level Likert-type scale. The questionnaire evaluated dimensions associated with vocabulary practice, operational or logical thinking, usability, motivation, and perceived pedagogical usefulness. Second, open-ended questions were included to collect qualitative feedback regarding satisfaction, difficulties, and suggestions for improvement. The structured questionnaire provided quantitative evidence of user perception, while the open-ended questions allowed a deeper understanding of how participants experienced the software during interaction. This combination supported methodological triangulation between numerical trends and qualitative feedback.

3.5. Expert Judgment Validation

The educational technology panel consisted of three experts who reviewed the prototype (whether it matched the definition) as a preliminary validation on content. Their judgement of the instrument was done according to four factors: interface clarity, educational relevance of the content, usability of the overall system, and how motivating it was for students. Each factor was rated based on a five-point scale, where 1 was very poor and 5 was excellent.

The expert panel felt that three experts were sufficient for preliminary content validation because the objective was to verify whether the instrument and prototype were clear, coherent, and pedagogically relevant before broader application. However, this panel of experts did not perform a full psychometric validation. To provide greater strength to the instrument, future studies should have more experts as well as additional indicators of validity.

3.6. Data Collection Procedure

Participant interaction with the Functional MVP, followed by data collection. Assisted Interaction sessions allowed participants to explore available Categories, enter letters, receive feedback from the System, and check scores and errors tracked by the System.

After the Assisted Interaction phase, participants filled out the Perception Questionnaire and answered open-ended questions regarding their experience. A separate validation of the Prototype and Evaluation Instrument by three Experts was used to evaluate Clarity, Coherence, Usability, Educational Relevance, and Motivation Potential of the Prototype and Evaluation Instrument according to established criteria.

3.7. Quantitative Analysis

Descriptive statistics were used to assess how frequently each type of response occurred among the users, as well as the average ratings given by experts for each of the four validation criteria. In addition, Cronbach's alpha was calculated in order to determine the internal consistency of the questionnaire. This reliability coefficient was employed to assess the coherence of the items on the questionnaire within each of the dimensions of the questionnaire. There were no inferential statistical tests performed because random assignment, a control group, and a pre-test/post-test design were not included in the study. Therefore, the quantitative data should be interpreted only as an indication of the initial levels of perception, acceptance, and reliability, but not as proof of statistically significant improvement in learning.

3.8. Qualitative Analysis with ATLAS.ti

Qualitative analysis is done with ATLAS.ti on data from the open-ended questions. The qualitative analysis process followed these four main steps. The first step was to review the open-ended participant responses for relevant comments about their experiences with the software. The second step was to perform open coding of the participant responses to identify patterns in the comments (e.g., common themes, types of difficulties, and suggestions made by multiple participants). The third step was to group and cluster similar open codes across other participant responses into larger categories. Finally, qualitative categories were compared with quantitative survey data.

The coding process revealed three categories of participant feedback on the prototype: Satisfaction, Difficulty, and Improvement Opportunity. These three categories offered insight into the positive attributes of the prototype (i.e., Playful Motivation / Visual Design), as well as those things that need to be improved (i.e., Clarity of Instructions, Broader Vocabulary Lists, Audio Support, and Adaptation to Users with Limited Computer Skills).

3.9. Methodological Scope

The methodology provides an early validation framework to use lightweight educational software, but there are limitations already established as part of this study. As part of the findings, this study looks at the participant perceptions, usability, motivation levels, perceived pedagogical value, expert assessments and subjective impressions surrounding the software rather than looking at actual vocabulary acquisition improvements due to experimentation with the software; hence, future research should include the use of pre-test/post-test designs, include control group analysis, larger population size and follow-ups that are longitudinal as it pertains to evaluating how well the proposed gamified Hangman-like learning space is educationally sound..

4. Results

The results are presented according to the development and initial validation process of the lightweight Hangman-based educational software. The section integrates qualitative findings, prototype evidence, expert judgment, questionnaire reliability, and user perception results. This organization responds to the need to present the findings with greater analytical depth, supported by editable tables and clear figures. The results should be interpreted as initial validation evidence related to usability, motivation, perceived pedagogical usefulness, and acceptance, rather than as experimental evidence of vocabulary learning improvement.

4.1. Participant Profile

The MVP was evaluated by 105 participants selected through purposive sampling. The sample included basic-level students, teachers, and parents who interacted with the prototype during brief assisted sessions. Students represented the largest group of participants, followed by teachers and parents. This distribution allowed the validation process to include direct users and educational stakeholders involved in the learning context.

Table 2. Participant profile in the validation process

Participant group	Percentage	Approximate frequency	Role in the validation process
Basic-level students	62%	65	Direct interaction with the vocabulary game
Teachers related to telecommunications and ICT	21%	22	Educational and technical perception of the prototype
Parents	17%	18	External perception of usability and accessibility
Total	100%	105	Initial validation sample

The frequencies are approximate values calculated from the percentages reported for the total sample of 105 participants. The sample provides useful exploratory evidence for prototype validation; however, it should not be interpreted as statistically representative of all primary education contexts.

4.2. Qualitative Findings from ATLAS.ti

The qualitative analysis was conducted using ATLAS.ti to examine the open-ended responses provided by participants after interacting with the Hangman-based educational software. This analysis complemented the quantitative perception results by identifying recurring user opinions, perceived strengths, difficulties, and suggestions for future improvement. First, the responses were reviewed to identify meaningful statements related to the user experience. Then, open coding was applied to label repeated ideas associated with motivation, usability, visual design, perceived educational usefulness, and improvement needs.

Finally, related codes were grouped into broader categories to support interpretation and triangulation with the questionnaire results. Figure 2 presents the ATLAS. ti code network was generated from the qualitative responses. The network shows the relationship between the most recurrent codes and the emerging categories identified during the analysis.

The most recurrent positive codes were playful motivation, educational achievements, and visual design. Playful motivation registered 23 mentions, followed by educational achievements with 21 mentions and visual design with 19 mentions. These findings indicate that participants perceived the software as engaging, visually accessible, and useful as a complementary resource for vocabulary practice.

The qualitative analysis also identified improvement opportunities, particularly the need to include pronunciation audio, expand vocabulary categories, and provide clearer instructions for users with limited digital skills.

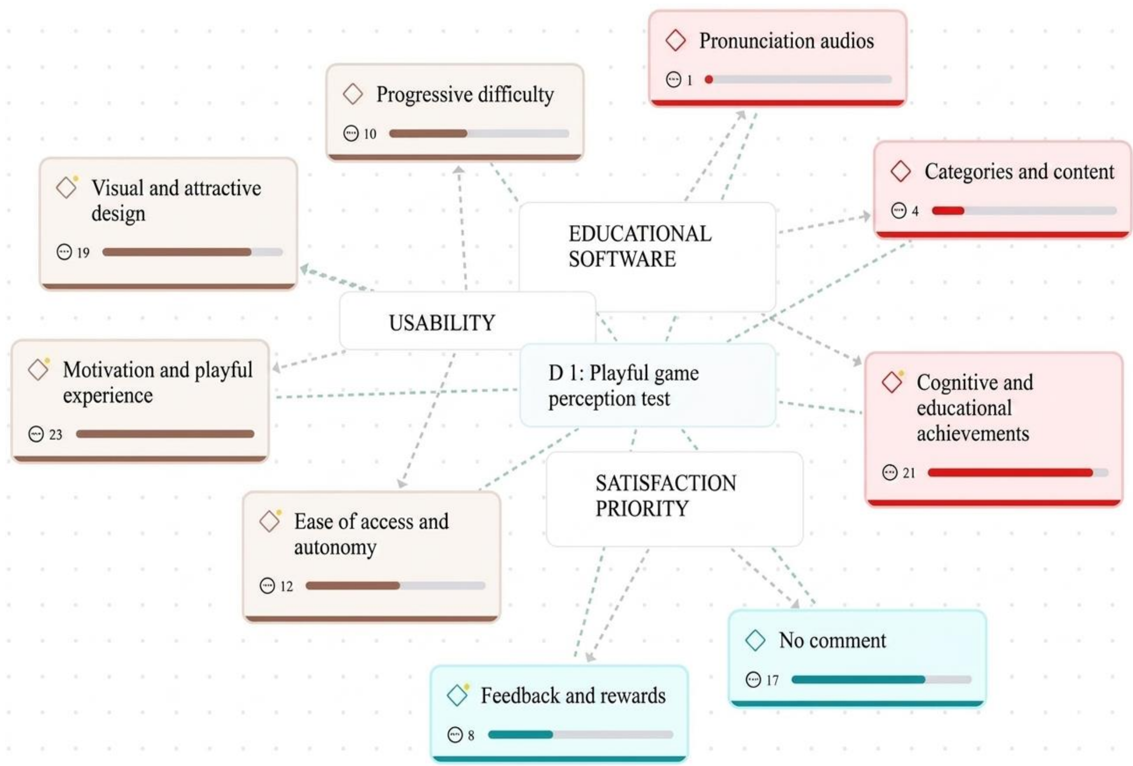

Fig. 2 Code map generated in ATLAS.ti - Perception of the educational game

Table 3. Qualitative categories and codes identified through ATLAS.ti

Category	Code	Frequency	Interpretation
Usability and satisfaction	Playful motivation	23	Participants perceived the game format as engaging and motivating.
Perceived pedagogical usefulness	Educational achievements	21	Participants associated the software with vocabulary practice and learning support.
Interface perception	Visual design	19	Participants valued the visual structure and presentation of the interface.
Improvement opportunities	Pronunciation audio	Not quantified	Participants suggested adding audio support to reinforce pronunciation and interaction.
Improvement opportunities	Expanded vocabulary categories	Not quantified	Participants suggested increasing the number of thematic categories and word lists.
Improvement opportunities	Clearer instructions	Not quantified	Participants indicated the need for more explicit guidance during the game interaction.

The ATLAS.ti findings support the quantitative results by showing that users valued the motivational and visual characteristics of the software. At the same time, the identified improvement opportunities provide a clear direction for the next development cycle. Therefore, the qualitative analysis contributed to the validation process by linking user perception with specific design decisions for future iterations of the MVP.

4.3. Prototype Interface and Functional Evidence

The prototype was implemented as a lightweight web-based game using HTML, CSS, and JavaScript. Its functional structure allowed users to select a thematic category, start the game, enter letters, receive immediate feedback, track incorrect attempts, and visualize the accumulated score. These functions were aligned with the purpose of supporting vocabulary practice through a simple and accessible gamified environment.

Figure 3 shows the initial interface of the software. This screen allows users to select the available thematic categories, access the instructions, and start the game. The interface was designed to reduce interaction complexity and facilitate use by children and educational users.

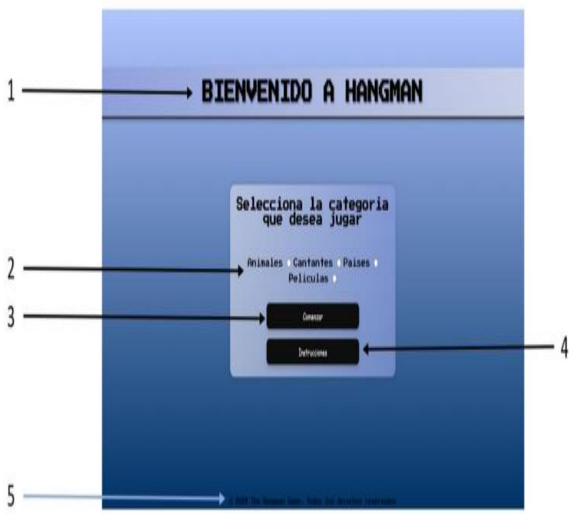

Fig. 3 Game start interface

Figure 4 presents the game interface during execution. In this stage, the user enters letters to guess the hidden word, while the system displays correct and incorrect attempts, the hangman figure, status messages, and the accumulated score. This interaction flow supports repeated vocabulary practice and immediate feedback.

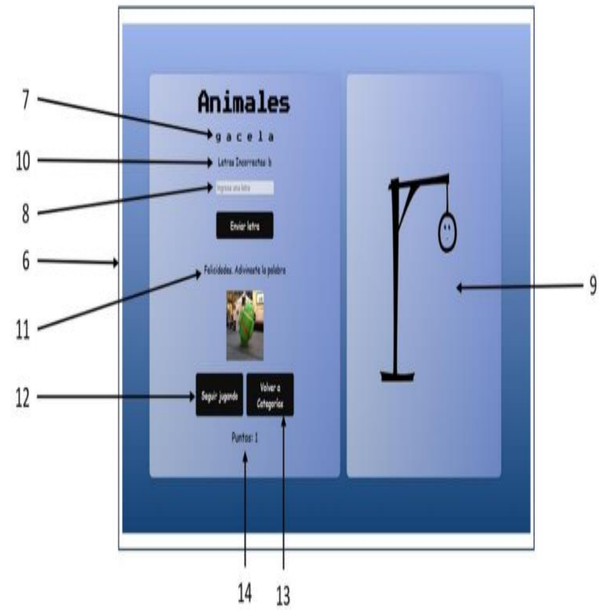

Fig. 4 Game interface in progress

Table 4 summarizes the main functional components identified in the prototype interface. This editable table complements Figures 3 and 4 by explaining the pedagogical and operational role of each interface element.

Table 4. Functional components of the interface

No.	Identified Element	Functional Description
1	Game title	Main header that welcomes the user.
2	Game categories	Buttons to choose between “Animals,” “Singers,” “Countries,” or “Movies.”
3	“Start” button	Starts the game with the selected category.
4	“Instructions” button	Displays the game rules and instructions for the user.
5	Footer	Bottom section with copyright information.
6	Hidden word	Shows the word to guess with underscores.
7	Letter input field	Space for the player to enter a letter.
8	Incorrect letters	Letters entered by the player that are not in the word.
9	Hangman image	Graphic representation of progress (hangman figure).
10	Status message	Indicates whether the player guessed correctly, won, or lost.
11	“Keep playing” button	Starts a new word within the same category.
12	“Back” button	Returns to the main game menu.
13	Accumulated score	Displays the number of points obtained based on correct answers.

The interface evidence indicates that the MVP achieved the minimum functional requirements expected for a lightweight vocabulary practice tool.

Nevertheless, this functional validation does not demonstrate vocabulary learning gains; it only confirms that the prototype operated as intended during the initial validation sessions.

4.4. Representative Code Components

The technical structure of the prototype was organized through lightweight web components. HTML was used to define the structure of the game, CSS was used to define visual presentation and responsive behavior, and JavaScript was used to support user interaction. Table 5 presents representative code components and their function within the user experience.

Table 5. Representative fragments of the system and its function

Function	Pseudocode	Description
Initial game structure (HTML)	<html><head><title>Juego... </title></head><body>...	Creates the basic structure of the game, including the header, body, and navigation elements.
Menu and instructions (HTML)	<button onclick="instrucciones() ">Instrucciones</button>	Implements functional buttons that display game instructions and available categories.
Global game style (CSS)	body { font-family: Arial; background-color: #f0f0f0; }	Applies general visual styles such as font, background, margins, and color.
Central container (CSS)	#contenedor { display: flex; align-items: center; }	Structures the main game area and supports the visual alignment of elements.
Action buttons (CSS)	button { background-color: #3498db; color: white; border: none; }	Defines the visual appearance of the buttons used for interaction.
Responsive design (CSS)	@media (max-width: 768px) { ... }	Allows the interface to adapt to mobile devices and tablets.
Hangman aesthetics (CSS)	#muñeco { width: 100px; height: 150px; border: 2px solid black; }	Defines the visual space for the hangman figure during game progression.
Footer (CSS)	footer { text-align: center; font-size: 0.8em; color: gray; }	Applies visual formatting to the footer section.

These technical components show that the software was designed as a simple browser-based application. This technical simplicity is relevant because it reduces installation barriers and supports access in educational contexts with limited technological infrastructure.

4.5. Expert Judgment Evaluation

The completed functional prototype was evaluated by three educational technology experts as part of an initial content validation process.

The expert judgment focused on four criteria: interface clarity, educational relevance of the content, overall system usability, and motivational potential for students. Each criterion was evaluated using a five-point scale, ranging from 1, very poor, to 5, excellent.

Table 6. Expert judgment evaluation

Evaluated Criterion	E1	E2	E3	Average
Interface clarity	5	4	5	4.67
Educational relevance of content	5	5	4	4.67
Overall system usability	4	5	4	4.33
Motivational potential for students	5	5	5	5.00
Overall average				4.67

As shown in Table 6, all evaluated criteria obtained mean scores above 4.3. The highest-rated criterion was motivational potential for students, with a mean score of 5.00.

Interface clarity and educational relevance of content reached mean scores of 4.67, while overall system usability obtained a mean score of 4.33. These results suggest that the prototype and the instrument were positively assessed by the expert panel during the initial validation stage.

Although the expert judgment results were favorable, they should be interpreted as preliminary content validation. The use of three experts supports an initial review of clarity, coherence, usability, educational relevance, and motivational potential; however, it does not represent a complete psychometric validation. Future studies should include a larger expert panel and additional validity indicators.

4.6. Questionnaire Reliability

The internal consistency of the structured perception questionnaire was estimated using Cronbach's alpha. The instrument obtained a reliability coefficient of $\alpha = 0.90$, which indicates high internal consistency among the evaluated items. This result supports the coherence of the questionnaire for measuring user perception in the dimensions associated with vocabulary practice, operational or logical thinking, usability, and motivation.

Table 7. Internal consistency of the questionnaire

Instrument	Evaluated dimensions	Reliability coefficient	Interpretation
Structured perception questionnaire	Vocabulary practice, operational or logical thinking, usability, and motivation	Cronbach's alpha = 0.90	High internal consistency

The reliability result is favorable for an initial validation study. However, Cronbach's alpha indicates internal consistency of the questionnaire and should not be interpreted as evidence of vocabulary learning improvement or educational effectiveness.

4.7. General User Perception

The user perception results showed a favorable trend toward acceptance of the proposed software. The evaluation considered participants' perceptions regarding vocabulary practice, operational or logical thinking, usability, motivation, and perceived pedagogical usefulness. These dimensions were relevant because the objective of the validation was to examine how users perceived the software after interacting with the Hangman-based educational environment.

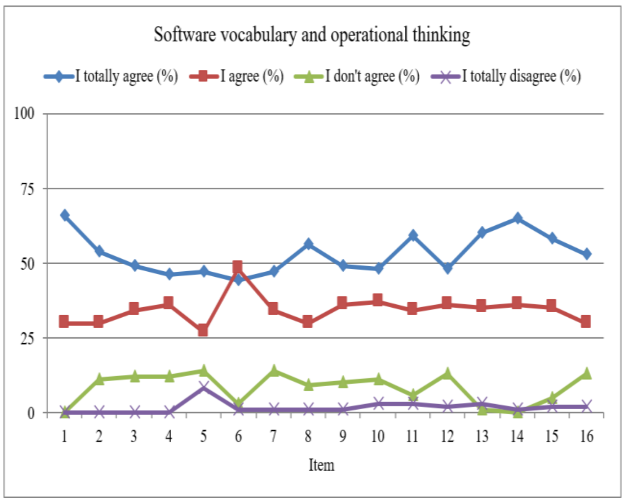

Fig. 5 User perception of vocabulary practice and operational thinking dimensions

As shown in Figure 5, the results indicate a positive perception of the software as a complementary tool for vocabulary practice and logical interaction. The visual trend suggests that participants valued the possibility of practicing words through category selection, letter input, immediate feedback, and score visualization. These elements were perceived as useful for maintaining attention and supporting repeated practice during interaction with the game. The manuscript reports that 45% of users expressed strong agreement with the evaluated aspects, while 15% expressed disagreement. These findings indicate that a relevant proportion of participants perceived the software positively in terms of usability, motivation, and pedagogical usefulness. However, part of the sample also identified improvement needs, which were later considered in the continuous improvement plan.

Table 8. General user perception trend

Response trend	Reported percentage	Interpretation
Strong agreement	45%	Favorable perception of the evaluated aspects
Disagreement	15%	Presence of usability or improvement needs in part of the sample
Other response levels	40%	Intermediate perception levels not disaggregated in the available data

The user perception results should be interpreted with caution because the available data do not include a pre-test/post-test comparison, a control group, or inferential statistical analysis. Therefore, Figure 5 and Table 8 support initial acceptance and perceived usefulness, but they do not confirm measurable vocabulary learning gains.

4.8. Improvement Actions Derived from Validation

The validation process generated specific improvement actions for future iterations of the software. These actions were grouped into accessibility and functionality improvements, as shown in Table 9.

Table 9. Improvement actions for future software iterations

Improvement area	Identified need	Proposed action
Accessibility	Some users may require clearer guidance during interaction.	Improve written instructions and simplify game guidance.
Accessibility	Users with different learning styles may need auditory support.	Add pronunciation audio and sound feedback.
Accessibility	Users with limited digital skills may need a more guided experience.	Include visual prompts and assisted navigation elements.
Functionality	The current category set is limited.	Expand vocabulary categories and word lists.
Functionality	The current version focuses on individual interaction.	Evaluate multiplayer or collaborative functions in future versions.
Research validation	The current validation is perception-based.	Apply pre-test/post-test and control group designs in future research.

These improvement actions are consistent with the Lean Startup principle of validated learning, because user and expert feedback were used to define the next development cycle.

4.9. Scope of the Results

Overall, the results provide initial evidence that the proposed Hangman-based software is usable, motivating, pedagogically relevant, and accepted by participants. The findings also show that the software offers a simple interaction structure, immediate feedback, thematic vocabulary categories, and accessible web-based functionality. However, the results do not demonstrate statistically significant vocabulary learning improvement. The absence of a pre-test/post-test design, a control group, and longitudinal follow-up limits the interpretation of educational effectiveness. Consequently, the results should be understood as an initial validation of the MVP and as a basis for future experimental studies.

5. Discussion

The findings of this study provide initial evidence that a lightweight Hangman-based educational software application can be perceived as usable, motivating, and pedagogically useful for thematic vocabulary practice. The results obtained from expert judgment, user perception, questionnaire reliability, and qualitative feedback suggest that the proposed software is acceptable as a complementary learning resource. However, these findings should not be interpreted as experimental evidence of vocabulary learning improvement, because the study did not include a pre-test/post-test design, a control group, or longitudinal measurement of learning outcomes.

The positive perception of the proposed software is consistent with previous studies indicating that gamification and educational games can support engagement, attention, and active participation when game mechanics are aligned with learning objectives [1-5]. The findings of this study suggest that the Hangman-based environment supported vocabulary practice by allowing students to practice using a number of different features, including categories of words to be learned, a place to enter letters, the ability to receive immediate feedback, the ability to track mistakes, and the use of scoring as a way to measure success. These features may increase student motivation by allowing students to see their progress while practicing vocabulary, as well as receive immediate feedback after entering a letter. However, the findings only indicate that there was a perceived increase in motivation and acceptance, and no evidence of increased vocabulary knowledge.

In comparison to a larger population of educational video games, the proposed program provides a more focused context and therefore a more relevant contribution to the field of vocabulary learning. Past studies examining the use of video games or digital media as a means for learning vocabulary have demonstrated the benefits associated with interaction, repetition and student involvement [3-6]. However, many digital learning tools have requirements that exceed the ability of some students, such as being connected to the Internet, installing software on their own computer, or using advanced technology, as well as a greater level of involvement from their instructor. The present study's contribution should not be viewed as a claim of superiority over the other forms of learning; rather, it is intended as a more efficient and effective alternative to more complicated digital learning tools. This advantage of providing an easy-to-use, web-based tool may be particularly beneficial in educational settings that lack access to advanced learning platforms.

While the proposed method uses the logic of the Hangman game, this differs from other, much more sophisticated gamification systems. Previous research on Hangman-based vocabulary activities has found that they are an effective and easy-to-use strategy for the classroom [15, 16]. The current study will further develop this area of research by creating a functional web prototype that provides: Thematic categories; Immediate feedback; Visual interaction; Scoring; Structured software validation process. As such, the software will be considered a supplementary resource for vocabulary development, not a substitute for formal vocabulary instruction.

From a methodological standpoint, Design Thinking + Lean Startup were instrumental in guiding the development of a user needs- MVP validation and improvement plan. Design Thinking illustrated how educational users interact and what type of interactive features would be required, while Lean Startup was used to build the prototype, measure the results, and validate learning via ongoing feedback [11-13]. This comes into play with respect to the design and development of educational software because of the sensitivity that has to be taken into consideration with respect to pedagogy and the iterative refinement of the software through technology. This study was methodologically significant because both methodologies were employed in conjunction with a low complexity educational software solution as opposed to a highly developed/infrastructure-reliant solution.

The findings of the study were strengthened by the mixed validation methods. Quantitative results showed evidence of positive perceptions and a high degree of internal consistency for the results of the questionnaire, as demonstrated by a Cronbach's Alpha = 0.90. Additionally, experts' evaluation of the interface was scored positively in terms of clarity, educational relevance, usability, and motivational potential. Using ATLAS.ti software, an exploratory analysis of the data produced by the research project was conducted to identify qualitative codes that frequently appeared across all collected data sets in relation to the following themes: Playful Motivation, Educational Achievement, Visual Design and Improvement Opportunities. As a result of this triangulation, it was possible to establish connections between user comments and numerical trends (i.e., how often users found specific items in the software helpful) and to highlight the particular improvements that should be made to future versions of the software, including the potential addition of Pronunciation Audio, more Vocabulary Categories, more Explicit Instructions, and more Support for Users with Limited Digital Skill Levels.

Interpreting the findings of this study in relation to previous research literature should be done with caution. While the current study does not provide evidence that the software produces superior learning outcomes to those produced by state-of-the-art educational games or vocabulary platforms, nor does it provide any data from an experimental comparison, it does indicate that this software has practical usability and acceptance advantages in the areas of Accessibility and Simplicity. The findings also provide evidence that these advantages will likely be beneficial to users in resource-constrained settings where simple browser access and minimal installation requirements are critical for adoption considerations. Thus, the current study contributes to and builds upon previous studies that have been conducted using more sophisticated Game-Based Learning (GBL) or Digital Learning (DL) environments [7-10].

There are several important limitations to this study. First, the sample was purposively recruited, which restricts the generalizability of the findings. Second, the validation was performed within a specific educational setting; therefore, the results cannot be generalized to all primary education settings. Third, while the validation included three expert reviewers, this should be viewed as an initial content validation and not as a complete psychometric validation. Fourth, the study did not include a control group, nor did it include a pre-test/post-test comparison, inferential statistical analysis or long-term follow-up on the effects of the prototype on vocabulary acquisition. Fifth, while the qualitative analysis yielded useful evidence of user perception of the software and how it would help in learning English vocabulary, it did not produce evidence of actual vocabulary acquisition.

Future studies should continue to examine the implementation of the software and make it available to a larger, more diverse sample of users and include additional expert reviewers to validate the content. Future research should also include the development of validated instruments to assess the software, implement pre-test/post-test study designs to evaluate the effectiveness of the software in improving vocabulary acquisition, and include control or comparison groups to enable a better understanding of the efficacy of the software in improving vocabulary acquisition. Future versions of the software should also contain Pronunciation Audio, Adaptive Levels of Vocabulary, Broader Thematic Categories, and Accessibility Improvements, enabling more comprehensive evaluation of the Educational Effectiveness of the Software in a Hangman-Based Gamified Learning Environment. In summary, this study contributes to educational software research by presenting a lightweight and accessible vocabulary practice tool developed through an integrated Design Thinking and Lean Startup approach. Its main value lies in its simplicity, low technical requirements, perceived motivational potential, and initial validation through quantitative and qualitative evidence. The findings support its use as a complementary educational resource; however, experimental studies are still required to determine its actual impact on vocabulary learning outcomes.

6. Conclusion

This study presented the design, development, and initial validation of a lightweight educational software application for vocabulary practice through Hangman-based gamification. The proposed software was developed using free web technologies and an iterative process that integrated Design Thinking and Lean Startup principles. This methodological integration supported the identification of user needs, prototype construction, MVP validation, and the definition of improvement actions based on user and expert feedback. The validation results indicate favorable initial evidence regarding usability, motivational potential, perceived pedagogical usefulness, and user acceptance. The expert judgment process showed positive evaluations for interface clarity, educational relevance, usability, and motivational potential. Likewise, the questionnaire obtained high internal consistency, with Cronbach's alpha of 0.90. The qualitative analysis was conducted with ATLAS. ti complemented these findings by identifying recurrent perceptions related to playful motivation, educational achievements, visual design, and improvement opportunities.

The main contribution of the study lies in proposing an accessible and low-complexity educational software solution that can support thematic vocabulary practice without requiring installation procedures or sophisticated technological infrastructure. In this sense, the software may be useful as a complementary resource in educational contexts where lightweight, browser-based, and easy-to-use tools are needed. However, the findings should be interpreted within the scope of an initial validation study. The results do not demonstrate direct vocabulary learning improvement or educational effectiveness, because the study did not include a pre-test/post-test design, a control group, inferential statistical analysis, or longitudinal follow-up. Therefore, the evidence supports perceived acceptance, usability, motivation, and pedagogical usefulness, but not measured learning gains.

Future research should evaluate the educational effectiveness of the Hangman-based gamified environment through larger and more diverse samples, expanded expert validation, pre-test/post-test designs, control or comparison groups, and longitudinal measurements. Future software versions should also consider pronunciation audio, broader vocabulary categories, adaptive levels, clearer instructions, and accessibility improvements for users with limited digital skills.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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