SPELLINGUAL: A Gamified Approach to Enhance Multilingual Spelling Skills

Caitlin R. Parrott and Elham Ebrahimi[a]

Computer Science Department, University of North Carolina University, Wilmington, NC, U.S.A.

Abstract: This project introduces Spellingual, an educational application aimed at enhancing the spelling abilities of second-grade multilingual children who are verbally fluent in Farsi. This web-based application acts as a platform for fostering foreign language learning, focusing on spelling proficiency as a fundamental aspect of language acquisition. Spellingual seeks to encourage these skills through a gamified and multimedia-rich environment. With its highly adaptable nature, the application is designed to aid multilingual children of varying proficiency levels while allowing them to work at their own pace. Central to Spellingual is its emphasis on accessibility and visual appeal, improving motivation and fostering a desire to learn. By incorporating feedback mechanisms, level progression, point accumulation, and a hint system, the application ensures sustained engagement and helpful tools for learners through positive reinforcement. This approach is informed by comprehensive research demonstrating the effectiveness of game-based learning strategies in keeping children interested and motivated over time. Additional research supporting this project includes the benefits of multilingualism in children and the lack of accessible tools to assist with spelling proficiency in a non-native language.

1 INTRODUCTION

Multilingualism is increasingly recognized for its cognitive and social advantages, especially when it is incorporated into early education. By providing a means to become proficient in a foreign language, children are presented with a strong foundation for success throughout their lives. In the age of digital education, applications focusing on foreign language acquisition are more prevalent than ever. However, the focus of these applications is predominantly on general language skills like pronunciation, sentence formation, and vocabulary - often overlooking foreign language spelling skills like forming words and letter recognition. Existing applications that do address spelling are either inaccessible or not specifically designed for elementary children, particularly those who are multilingual.

This project intends to address these issues with the introduction of a web-based educational application designed specifically for 7-10 year-old multilingual children who are verbally fluent in Farsi. Spellingual incorporates gamification elements and multimedia content to enhance Farsi spelling skills

through an effective and engaging learning process. The application is designed to be inclusive, catering to varying levels of spelling proficiency and familiarization with the Farsi writing system. It aims to improve motivation and sustained engagement through interactive elements, feedback mechanisms, and a hint system tailored to early elementary needs. This approach is intended to provide a positive learning environment that continuously encourages interaction with the application, thus reinforcing spelling proficiency in Farsi.

The development of Spellingual is supported by an extensive review of recent research on multilingualism, foreign language education, vocabulary learning applications, mobile-assisted language learning (MALL), and gamification in education. This review ensures relevance and efficacy in the current e-learning environment. These applications have surpassed traditional classroom instruction and conventional textbooks in recent years, using technology to engage learners in innovative ways. Gamification, or the incorporation of game design elements into non-game contexts, has become a powerful factor in applications for the development of foreign language spelling skills. It does this by providing a sense of

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[a] https://orcid.org/0000-0001-9431-557X

"achievement and progression" that fulfills the psychological needs of competence, autonomy, and relatedness (Bitrián et al., 2021). Gamification elements like rewards, interactivity, feedback mechanisms, and progressive levels also play a pivotal role in sustaining learners' engagement and commitment to the learning process (Wang et al., 2021). The potential of gamification in foreign language learning, particularly in the development of spelling skills among young multilingual children, holds great promise and has proven effective in application. Gamified education applications on mobile devices leverage the prevalence of technology to offer a flexible and accessible means of learning, free from constraints related to time and location (Mortazavi et al., 2021).

2 LITERATURE REVIEW

In contemporary education and training, educational applications have emerged as indispensable tools. They remove geographical limitations, render education accessible to a global audience, and promote inclusivity by accommodating diverse learning styles. Their adaptability and convenience empower learners to engage with content at their own pace and on their schedules, catering to the varied demands of learners with diverse lifestyles. An intriguing aspect of educational applications is their capacity to incorporate gamification elements, which enhance engagement and aid in information retention, as corroborated by research in this field. Multilingualism or bilingualism in children has proven to provide significant improvements in cognitive and social-emotional skills as well as vocabulary and writing studies compared to monolinguisitic children (Pransiska, 2016).

Some studies found that linguistic skills translate best between languages that "used similar writing systems" (Barac and Bialystok, 2011). This brings to question how to provide additional support to multilingual children who switch between different forms of writing to continually provide the same benefits. One such study on Hangul and English writing systems found that young children gradually improve their writing system letter identification by "highlighting their knowledge of the similarities and differences between writing systems" (Nam, 2018). This evidence further supports the case to expose children to foreign language writing systems in early elementary, providing additional opportunities to improve social and cognitive skills by taking advantage of their adaptability during this age.

Foreign Language Learning (FLL) in early education skills require a "clear, interesting, and well-placed learning environment" with personal investment and engaging learning activities (Oga-Baldwin et al., 2017). Modern models of learning a foreign language rely on applications to assist learners in "developing their reading, listening, writing, and speaking skills as well as providing them with new vocabulary and grammar structures" (Casañ-Pitarch, 2018). This is possible due to the relationship between learner motivation and emotion, which can determine the success of FLL and the interpersonal motivation factors that engage learners with a foreign language: cooperation, competence, and recognition (Casañ-Pitarch, 2018). If these requirements are satisfied, then the success of FLL significantly improves. It is important to note that proficiency levels were found in early-start programs regardless of age but have been cited to begin as early as age six (Baumert et al., 2020).

Vocabulary Learning Applications. The integration of multimedia technology in vocabulary learning applications has consistently demonstrated its effectiveness, particularly among young learners. Research in this area consistently highlights the positive impact of these applications on reading and writing skill acquisition in foreign languages, achieved through interactive exercises and multimedia-rich content. Users benefit from their high accessibility, contextualization features, and the incorporation of multimedia elements such as visuals and interactive components (Wang et al., 2021). Vocabulary learning applications enriched with multimedia have shown promise in enhancing vocabulary comprehension and memorization (Mortazavi et al., 2021). The inclusion of visuals, audio pronunciations, and interactive exercises offers a multi-sensory learning experience that is particularly advantageous for young learners (Panfilova et al., 2022). These applications facilitate improvement in reading and writing skills by providing an engaging and enjoyable learning process, especially for children (Elaish et al., 2019; Polakova and Klimova, 2022).

Research findings indicate that students hold a strong appreciation for vocabulary learning applications. In a study involving a substantial number of English as a foreign language (EFL) students, a notable 86% of participants recognized mobile applications as highly effective tools for vocabulary acquisition (Wang et al., 2021). It is important to note that the standard assessment measure of success is academic achievement, but additional measures include behavioral and cognitive engagement. Based on the results of these measures, they were reliant on individual differences, meaningful gamification, and diversified element selection (Luo, 2023).

Gamification in Education. Within the realm of gamification, several elements come into play to enrich the educational experience. One of these elements involves implementing a points system, whereby learners accumulate points as they advance through tasks or modules. These points often correlate with rewards like badges, certificates, or virtual items, capitalizing on individuals' innate desire for recognition and accomplishment (Sandberg et al., 2014). Additionally, progress tracking elements, such as progress bars or indicators, visually represent learners' advancement, evoking a sense of achievement and motivating them to persevere during the educational process (Zeybek and Saygı, 2024). Dividing the learning material into challenges or levels offers a structured approach to the educational process. Each new challenge presents an opportunity to apply knowledge and attain mastery, further enhancing motivation. Lastly, interactivity and immediate feedback are indispensable gamification elements. Learners are prompted to actively engage with the content through puzzles, quizzes, or simulations and receive real-time feedback on their actions, promoting critical thinking and the adjustment of learning strategies (Zainuddin et al., 2020).

Multimedia Elements. Multimedia integration within vocabulary learning applications stands as a cornerstone in augmenting language acquisition. These applications ingeniously blend visual and interactive elements to create a comprehensive and engaging learning experience. Visual elements are instrumental in fortifying vocabulary acquisition. The inclusion of images within gamified vocabulary applications enables learners to associate words with visual representations. By intertwining language with tangible images, these applications facilitate not only heightened comprehension but also extended retention (Mortazavi et al., 2021). Blending textual information with images that illustrate the meaning of words converts abstract vocabulary into tangible concepts, facilitating the learners' understanding of the language.

Integrating gamification elements with multimedia enhances the educational experience, adding an extra layer of engagement and effectiveness while also catering to diverse learning styles and preferences. This combination improves learner motivation and accommodates individual approaches to learning. Multimedia components, encompassing visuals like images and info-graphics, not only enhance comprehension but also render learning visually captivating. Interactive simulations create a risk-free environment for learners to experiment with complex concepts, thereby facilitating a deeper grasp of the subject matter. 15 existing applications that share a common emphasis on vocabulary learning were investigated. Among them, numerous gamified elements such as Characters, Challenges/Levels, Interactivity/Feedback, Rewards, and Time Limits are currently incorporated, all of which have documented successful outcomes (Wang et al., 2021).

Several forms of multimedia are used to enhance the learning process among the 15 existing applications investigated (Wang et al., 2021): Video (3/15), Audio (14/15), Image (5/15), and Text (15/15). These applications facilitate improvement in challenges that not only encourage but require the practical application of freshly acquired vocabulary, providing learners with immediate feedback that reinforces their comprehension (Wang et al., 2021). Consequently, what was once passive vocabulary acquisition processes have become dynamic learning experiences. These gamification elements, such as rewards, points, and level progression, serve as motivators that drive learners to actively participate with the application (Chen et al., 2019).

3 METHODOLOGY

The methodology section of this project summarizes the strategic approach by describing the requirements and limitations identification and iterative prototype. It also includes the pilot data collection methods and analytical techniques for evaluating the application's impact on spelling skills.

Gamification Elements. Gamification components were integrated to motivate and engage the target audience through the use of a level progression system, points, streak bonuses, and feedback mechanisms. Amidst the numerous gamification elements made available to incorporate into educational applications, Spellingual leverages a select few based on their previous success. Figure 1 displays the gamification elements incorporated into the application. These elements were determined based on the literature review and their success. Interactivity and feedback encompass the vast majority of Spellingual as a means to guide how they interact with the application. This involves sounds to signify confirmation of interaction, the outcome of a result, or confirmation of a task. For example, when a user clicks the button to 'guess' their attempt to complete a level (1) they hear a click sound to confirm they clicked the button; (2) a celebratory sound or warning sound signifies the result of their guess; (3) they are asked what task they would like to do next depending on the result.

Additional elements like Levels, Points, Progression View, and Unlockable Content are combined to create a player pace and to prevent overwhelming the player. The player will see their Points before and during their attempts to complete Levels and earn Points by completing Levels. The Points can be used to purchase Hints as Unlockable Content to provide additional material to progress. The Progression View is made available in the form of Level Select, allowing the player to see how many levels they have completed, where they are now, and how many levels remain ahead.

3.0.1 Limitations

Spellingual is designed with a specific audience and purpose in mind, which introduces certain limitations. These were directly affected by the project's scope, time frame, and objectives. These limitations allowed for informed decision-making with a priority focused on the application's key aspects in functionality and user experience.

Multimedia Inclusion. The application has limited multimedia features. User interface sounds as feedback mechanisms and audible pronunciation of words were incorporated, but additional audio elements or the word pictures were not included.

Age Range. The application is designed exclusively for children in early elementary school. It does not cater to the more advanced needs of an older audience.

Content Depth. Spellingual is intended to provide a basic vocabulary learning platform focusing on a specified target audience with the intention of improving spelling skills. It is intended as a supplementary resource for a more complex language learning environment.

The prototype for Spellingual served as the initial version of the application with a focus on core functionalities and the user experience. It provided a clear representation of the application's intended usage and user engagement. The functionalities are centered around spelling challenges introduced as levels. These levels provide a word in English and the letters to spell the word in Farsi. To complete the challenge, the user spells the word by tapping or clicking each letter to place it or remove it from the spaces representing the completed Farsi spelling of the word. The user is tasked to spell the word correctly using the tools provided within the interface (See Figure 3).

"Spellingual" integrates a touch-based interaction mechanism, allowing users to intuitively spell words by tapping or clicking on letters. This method, which enables the addition and removal of letters seamlessly, significantly reduces cognitive and physical ef-

fort, thereby minimizing frustration and enhancing the learning experience. This approach is particularly beneficial for the application's target demographic, offering an engaging, efficient, and user-friendly interface (Holz and Meurers, 2021).

The hypotheses serve as the foundation for this research by posing key questions about the expected impact of project elements, including gamification and multimedia integration. The expected outcomes provide a glimpse into the results and benefits that the application delivers to its target audience.

The following hypotheses form the basis for evaluating the project's success and its impact on the intended audience.

- H1: Regular user feedback sessions, along with iterative development, will lead to continuous improvements in the application's usability and effectiveness.

- H2: The application will demonstrate its effectiveness in improving foreign language spelling skills among young, multilingual children verbally fluent in Farsi during the pilot testing and feedback phases.

4 PILOT STUDY

This section describes the project phases from inception to its completion while highlighting key development milestones, iterative improvements, and significant adjustments required due to an evolving scope. This section also covers the testing methodologies employed, the analysis of results, and a reflective summary of the entire experiment.

Functionality Testing. Gathering comprehensive feedback from users was accomplished through observed user testing as the primary data collection method. Observations centered around hands-on interaction with Spellingual were conducted with consenting participants. Initial user testing was performed through adult participants who participated in feedback and reported any issues encountered. Throughout early testing, changes were made based on this feedback to improve the application before testing with the target demographic. The intention of early testing was to determine if the gamification elements included in the application improved the acquisition of spelling skills through observed interaction.

Additionally, the hands-on interaction during early testing was observed to determine improved performance and motivation through the progression of the application. These sessions allowed for the monitoring of user behavior and engagement levels and to

Element	Implementation.
Interactivity/Feedback	Visual and audible validation of an action to guide interaction.
Levels	An individual piece of interactive content used to guide progress.
Points	Accumulated numerical value based on progress and performance.
Progression View	Visual element depicting and encouraging progress.
Rewards/Streaks	Incentive based on level accuracy to encourage improvement.
Unlockable Content	Incentive to gain points to unlock support systems.

Figure 1: Gamification Elements Incorporated into Application.

determine challenges encountered during use. Real-time feedback was also encouraged during interactive simulations within Spellingual, along with directed tasks where necessary. Participants were given the opportunity to provide immediate impressions and suggestions, helping to capture thoughts and insights as they engaged with the content.

Early design decisions included a user-friendly design with multimedia elements for engagement with a focus on early childhood development. Colors suitable for grabbing and keeping the attention of a young audience were used, along with easy-to-read text. No icons were used in place of text for any user-interface elements to promote clarity for young users, and contrast was considered in all aspects of the application. Additionally, audio was identified as a requirement to provide helpful feedback and alert users of interactions and results.

The initial version of the prototype design, as development commenced, is depicted in the figures below. Figure 2.a displays the early design of the Level Select screen, where levels are distinguished by color according to the word category, with the number of levels varying by availability, complexity, and term. Figure 2.b presents the preliminary design for the Level screen itself, highlighting the word in English, the letters for spelling the word in Farsi, and the player's input. These elements are interactive and change in response to the player's actions. Figure 2.c illustrates the original feedback modal, designed to inform the player about the outcome of the Level.

Figure 2.d displays the Level Select screen as of Version 1 after applying simple styling using Bootstrap Version 5 and custom styling. On this screen, the user can view their accumulated points and ongoing streaks, with streaks awarded for consecutive levels completed correctly on the first try. Figure 2.e displays the Level screen as of Version 1, where selecting a letter populates a blank space below the word in English to spell the word in Farsi. Letters are populated into the spaces from right to left as they are spelled in Farsi.

Figure 2.f displays the Level Modal screen for Version 1, detailing user performance on level at-

tempts. At this development phase, audio for clicks was included, while correct and incorrect guesses were not due to challenges in selecting suitable sounds and integrating them effectively. Importantly, this version omitted background music, a decision driven by the complexity of integrating non-intrusive yet helpful audio feedback and hints, avoiding any potential conflict or distraction from essential audio cues. The design changes from the prototype to Version 1 focus on improving usability and accessibility. Background music was removed to highlight feedback audio, letter and font sizes were adjusted for clarity, and navigation was simplified with a back button near the check button. Level Modals were refined for functionality, and levels are now organized by increasing difficulty.

Version 2 of the project, introduced substantial enhancements to both the application's core architecture and its user interface. Through regular feedback sessions on usability and desired features, significant modifications were integrated. The design changes from Version 1 to Version 2 are a Landing screen for username input, a Level screen with points and a future hint purchase feature, and reset options for both individual levels and overall progress. Additionally, a "View Alphabet" button helps users review Persian letters, and a logo in the Menu provides quick navigation back to the Landing screen.

Many minor changes were made through early user testing, improving the functionality of the Version 3 live prototype of Spellingual. The enhancements introduced during this period included the implementation of three distinct types of hints, the reorganization of how levels were categorized, and significant upgrades to the word dictionary. Following the integration of all essential functionalities, Spellingual underwent further refinement. This refinement process included the improvement of on-screen text clarity, the provision of complimentary hints for the initial levels to assist young learners, and the offering of additional points for the completion of levels already cleared by users.

One of the standout achievements of this development phase was the introduction of the Hint system,
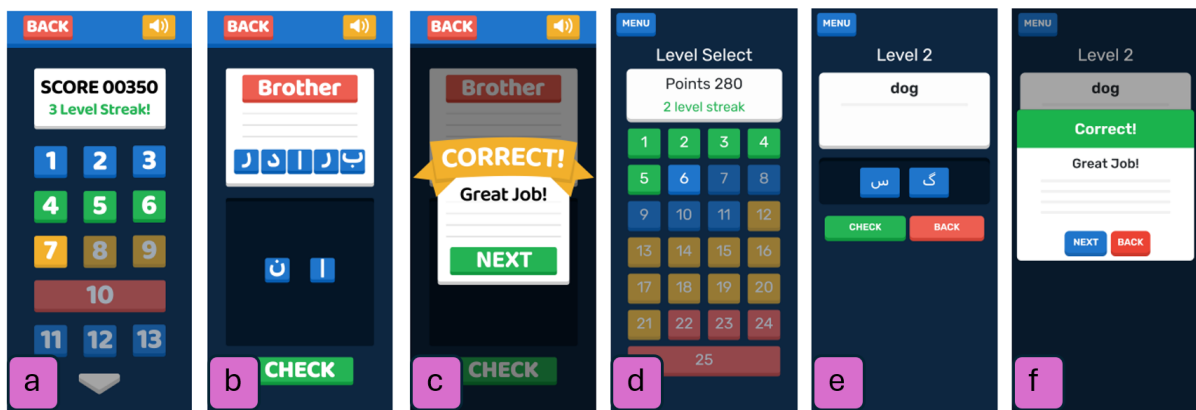
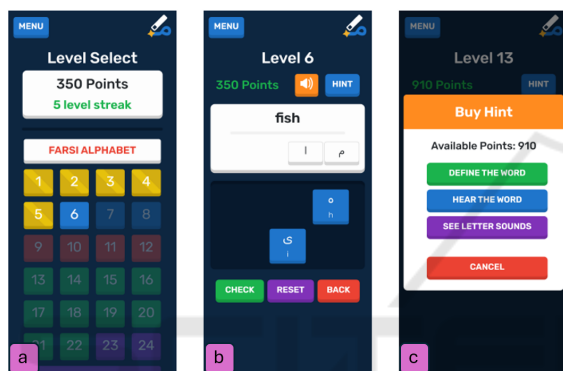Figure 2: Screenshots of the application prototypes.

Figure 3: Screenshots of the final version of the application.

which has proven to be a major support mechanism, making Spellingual more suitable for its intended demographic. The provided hints comprise word definitions, which address the potential for words to have multiple meanings in English but specific ones in Farsi; audio pronunciations to assist users in confirming the Farsi word; and letter sounds, designed to aid in phonetic spelling by demonstrating the English pronunciation of each Farsi letter. Collectively, these hints offer substantial benefits to the user, working in tandem to ensure that players are well-equipped to progress through each level given sufficient time. Figure 3 illustrates the application's development during the final iterations and refinement.

Figure 3.a displays the Level Select screen for Version 3, highlighting updated levels, the modified 'View Alphabet' button, levels' new arrangement, and the visual update for completed levels, which now feature a gold color to signal progress and indicate where users left off. Levels are organized to introduce users to smaller word sets with initially free hints. As progress is made, hints gradually become purchasable with points, encouraging strategic use and learning. Figure 3.b displays the Level screen for Version 3, demonstrating the use of all three hints. The

word's definition appears below the English spelling for clear viewing, while the pronunciation of each letter is shown under the corresponding Farsi character in the blocks provided. Additionally, a clickable audio icon next to the hint button enables users to listen to the word's pronunciation as often as necessary, facilitating understanding of the word's meaning and its phonetic breakdown.

Figure 3.c displays the Hint Modal screen for Version 3, accessible via each level during gameplay. This screen allows users to buy one of three hints, each priced differently. After selecting and confirming their purchase, users are taken back to the level screen where the newly acquired hint is ready for use. Purchased hints stay accessible for the corresponding level without expiration unless the user opts to reset their progress via the Menu.

4.1 Pilot Testing

The testing involved direct user interaction with the application and included collecting behavioral observations and participant feedback. Preparatory steps included assessing participants' current proficiency in English and Farsi spelling, accompanied by an introductory session on the Farsi alphabet. The testing sessions were designed to simulate a natural usage environment: children, guided by a native Farsi-speaking parent, interacted freely with the application. Each participant was allocated approximately one hour to explore the application, with no restrictions on how they navigated through its levels. Participants were recruited via a series of IRB-approved social media campaigns and through professional networks. The testing sessions consisted of children residing within the United States who will be observed and provided feedback in-person or remotely via online video-sharing platforms. We were able to collect data from three young participants due to the small

group of participants who met the requirements of the study (age between 7-10 and fluent in both Farsi and English with being able to read and write in English). However, we tested the functionality of the application with 15 adult participants.

Observational strategies focused on utilizing the features within Spellingual to monitor improvements and behaviors, assessing engagement, motivation, and comfort levels of the participants. Behavior was observed closely and verbal feedback from the parent.

Direct Metrics. Metrics such as in-game scores in the case of one participant provided quantitative data on the application's impact. Future testing should involve resetting progress and progressing through the game a second time to determine the immediate recognition of letters and words based on the first playthrough. However, quantitative data was gathered through direct observation and parental insights based on the known behavior of the participant.

Quantitative metrics included the frequency and helpfulness of hints, parental reporting of the participant's familiarity with the Farsi alphabet pre- and post-playthrough, and the speed at which the participant recognized Farsi letters or words. Additionally, memory recall of letters was determined based on observation, establishing how frequently the participant would exhibit concentration, hesitation, or confidence levels. Though direct values for hint utilization were not gathered, immediate recognition of frequency was seen through the incentive provided by the point system and the participant's reluctance to utilize them to buy hints over time. This is due to the participant's preference to collect points to gain a higher score over using them to obtain hints.

4.2 Observation Results

Feedback from three participants highlighted the application's success in engaging children while facilitating their language learning. Participants squarely within the intended age range demonstrated high enthusiasm and notable improvements in letter recognition, suggesting that the game's design effectively captures and maintains the interest of young learners. Participant's increased interest in learning more Farsi letters, as noted by their parents, and their eagerness to continue playing beyond the testing sessions illustrate the game's strong engagement and educational potential. Notably, the point system provided a strong incentive to improve Farsi letter recognition and spelling skills by motivating participants to forego hints to gain a higher score, proving the effectiveness of this gamification element. The level system also caused a progressively increasing difficulty

level that kept the attention of the participants, particularly with participants one and two.

However, the feedback also brought to light several areas for improvement. Participant Two, who was slightly older (10 years old), provided more nuanced feedback that led to actionable suggestions, such as introducing verbal pronunciation aids and a pre-test to customize the learning experience based on the user's reading level. These suggestions point to the need for adaptive features that can cater to diverse learning paces and styles. The feedback from all participants collectively suggested enhancements that could make the game not only more engaging but also more educationally effective by addressing specific learning challenges.

In conclusion, the pilot testing confirmed that Spellingual effectively meets its educational aims by teaching the Farsi alphabet and improving spelling skills while maintaining high levels of learner engagement. The detailed feedback provided has led to targeted improvements in the game's design and functionality, making it more user-friendly and educationally relevant. These enhancements, informed by direct user and expert insights, position the game well for future integration into the educational curriculum and highlight its adaptability to evolving educational methodologies.

5 CONCLUSIONS

The primary goal of Spellingual was to provide a platform that was motivating, user-friendly, and engaging for the target demographic. By integrating interactive elements and feedback mechanisms, the application encourages continual improvement in spelling skills. This interactive approach caters to the needs of young learners, making the learning process both fun and effective. Spellingual effectively utilizes a point system and other gamification techniques to motivate users to engage with the application. These elements are designed to challenge participants, urging them to concentrate on accurately spelling words to earn points. This gamification approach is particularly effective in educational settings as it mirrors the reward systems that children encounter in games, making the learning process enjoyable and rewarding.

Throughout the development and initial testing phases, the application was refined based on feedback from users and educational experts. This feedback highlighted areas for interface improvement and enhanced user experience, such as the optimization of button placement and the organization of Farsi alphabet characters by phonetic similarity. These

changes aimed to minimize cognitive load and make the learning tools more intuitive. Adjustments were made to ensure that interactions within the application were straightforward to reduce potential frustration and optimize learning outcomes. This responsive approach to design highlights the project's focus on user-centered development and continuous improvement.

5.1 Future Work

For future projects, extending the capabilities of Spellingual is suggested, such as incorporating a broader vocabulary set that spans a larger range of elementary grades and could be integrated into academic institutions. Simpler enhancements could include the addition of gamification elements like badges for progression milestones, custom content for improved user interaction, more animations to increase engagement, a friend system to encourage collaborative learning experiences, and more user testing. Insights from pilot testing suggest the application would benefit from features that allow for more personalized learning paths, such as adaptive difficulty levels or content that adjusts to a user's existing language proficiency. Additionally, connecting with educational institutions for broader feedback and integration into school curricula could provide a more structured learning environment using Spellingual.

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