

TRIP a-Bike: An Interactive Educational System for Learning English as a Second Language

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Abstract– This article presents TRIP a-Bike, an innovative solution addressing the persistently low levels of English proficiency in Colombia. Leveraging artificial intelligence and gamification, TRIP a-Bike is a multi-dimensional teaching model for mobile devices and stationary bikes. In response to historical language teaching challenges, the app seeks to engage students through aerobic activities and a specially designed video game focusing on grammar, vocabulary, reading, and conversation skills. Inspired by the theory of embodied cognition, the app uses body movements to enhance knowledge acquisition. The playful approach includes scores, challenges, and avatar improvements, encouraging motivation and interaction. Initial implementation shows promising results, underscoring the potential of TRIP a-Bike to revolutionize language learning in Colombia, especially in contexts with limited educational resources.

Keywords– Educational game, Language acquisition and language learning, Interactive tasks, Game-based approach, Artificial intelligence.

I. INTRODUCTION

In an increasingly globalized world, proficiency in the English language has become a crucial skill for achieving success in the workplace. However, many students struggle to acquire it, especially in regions like Latin America, where Anglo-Saxon vocabulary commonly used elsewhere is systematically translated into the local language [1].

Among all the countries that make up the Spanish-American territory, Colombia registers a relatively low level of English proficiency, both among adolescent students [2] and professional workers, for whom there has been no progress since 2007 [3]. Recent data shows that only 6% of Colombian students reach a B1 level or higher in English, well below the Latin American average.

The reasons underlying these poor results may be manifold. Some may regard the language policies enacted in the 1990s by the local government, which promoted English language teaching within public schools starting from the primary level, but without considering the poor preparation of the teachers working there [4]. Another essential variable concerns Colombians' consideration towards education, which still needs to be seen as a resource aimed at progress and personal growth [5].

A further variable to consider lies in the economic possibilities of Colombians themselves. Students with more significant resources tend to undertake their educational path in private school facilities, thus achieving better English knowledge than their peers attending public schools [6].

Moreover, the lack of technological innovation and gamification mechanisms in English language teaching could be contributing to the poor results.

One possible solution to this problem could be to adopt an innovative multidimensional teaching model [7], which could leverage artificial intelligence to support the teaching experience, exploiting its ability to provide an adaptive sequence of questions and activities characterized by personalized and continuous feedback [8]. Furthermore, adopting the gamification methodology could enhance student motivation [9]. By taking inspiration from typical game design techniques of video games, which include the possibility to challenge classmates through single-player or multiplayer activities, establishing scores, gaining points, and leveling up, it would increase the involvement of the whole classroom, as the interaction would be enhanced [10]. Also, an educational approach that leverages the principles of Embodied Cognition Theory, i.e., the ability of the body to improve learning through its movements in space and its perceptual system, could help promote the acquisition of knowledge [11].

Numerous studies in the literature already focused on using the body for learning, involving low-intensity [12] and high-intensity [13] training protocols. However, some of them, including moderate-intensity aerobic exercise, seem particularly compelling. Even after a single training session, this methodology significantly facilitates learning mechanisms in the visual and motor domains, with positive effects that can persist for at least 30 minutes after the exercise. It suggests that this type of physical activity could promote brain plasticity [14].

In this regard, the research team intends to develop a multidimensional teaching support aided by artificial intelligence called TRIP a-Bike, which provides a game-based approach that uses the body for learning.

We designed this software for mobile devices, but it includes moderate aerobic activities instead of encouraging sedentary behavior. A system of electrical cables establishes a connection between a stationary bike and a screen in front of the rider. TRIP a-Bike means using a video game created to facilitate the learning of the English language, offering content focused on grammar, vocabulary enrichment, reading, and conversation skills, promoting students' interest in this discipline.

Through incentives such as earning credits and avatar upgrades, the game aims to motivate learners so that we can observe steady progress. Moreover, artificial intelligence

technology guarantees a gaming experience with an adaptive sequence of questions and teaching activities characterized by personalized and continuous feedback. It ensures each learner has a difficulty level that adapts based on their performance. Instant feedback on grammar also helps identify individual student difficulties and possible areas for improvement.

TRIP a-Bike aims to raise students to B2 level English proficiency through an interactive system that integrates artificial intelligence and gamification, leveraging the body's natural learning mechanisms. By encouraging engagement and rewarding progress, it addresses language challenges crucial for personal growth, especially in challenging contexts such as Colombia. This milestone equips students, including those in technical fields such as engineering, with fluent communication skills vital for international collaboration and access to academic and professional resources according to the Common European Framework of Reference for Languages (CEFR).

II. RELATED WORK

Gamification, which incorporates game elements in non-gaming contexts, has emerged as an innovative strategy to enhance learning. In language teaching, gamification has boosted student motivation, engagement, and performance.

Castrillon highlights the importance of introducing games with real communicative situations in English classes to reduce the affective filter and improve the process of learning a second language [17]. Based on the theory of Groos, who relates play to the development of thinking and preparation for adult life, it highlights how play fulfills an educational and formative function throughout life as an essential means to organization and personal growth.

Aguilera highlights how gamification can improve student motivation, engagement, and performance [15]. The Duolingo platform is a successful example of gamification in teaching a second language. It also emphasizes the need to perform knowledge tests before and after to measure the effectiveness of these tools, which is a crucial point.

In research on integrating mobile devices, gamification, and augmented reality in language teaching, specific tools such as Augmenty Author and Zookazam stand out, which improve vocabulary learning and immersion in linguistic environments [16]. Training teachers to effectively use these technologies and highlight the advantages they offer to motivate students, create more flexible learning environments, and encourage meaningful interactivity is essential to achieve this goal. Castrillon mentions the importance of establishing clear rules, defined objectives, and the need to make games attractive and fun for students [15].

On the other hand, Gonzales focuses his work on gamification and its motivating function in learning English in Primary Education. Highlighting the relationship between motivation and appropriate learning, supported by teacher surveys emphasizing the importance of keeping students motivated [18]. For his part, Barros offers a guide to take

advantage of the didactic potential of games and video games in language teaching through gamification. He differentiates between didactic game, video game, and gamification, presenting a planning model in four key moments [19]. Additionally, different types of game users and their characteristics are analyzed. It advises considering principles of active and critical learning.

In her thesis, Moya presents research focused on applying gamification techniques to improve English vocabulary learning in high school students. The thesis uses a descriptive, exploratory, and relational approach with qualitative and quantitative methods. The results indicate that gamification effectively acquired new vocabulary in English, supporting the idea that this technique can effectively motivate students and improve the teaching-learning process [20].

The above literature supports the need for innovative approaches to improve English proficiency. TRIP a-Bike seeks to address this need and interconnect technology, gamification, and artificial intelligence to offer a comprehensive and effective solution.

Our approach aligns with the theory of embodied cognition. It considers lessons from previous studies, highlighting the importance of motivation, interactivity, and flexibility in language teaching. Thus, we present TRIP a-Bike as a proposal that complements and advances the understanding and application of innovative educational strategies.

III. ARCHITECTURE OVERVIEW

To understand the overall architecture of TRIP a-Bike, we will explore three fundamental aspects:

1. The project requirements and coverage.
2. The architecture development.
3. The immersive gaming experience.

A. Project Requirements and Coverage

To ensure optimal performance and meet the desired quality and performance attributes in the TRIP a-Bike game, we have identified significant requirements in several key areas:

1. Performance and Scalability

The system must efficiently manage concurrent users, ensuring fluid and fast responses. We will seek to minimize loading times, pauses, or interaction delays. We designed the architecture to be scalable and support an increase in the number of users and their workload.

2. Intuitive and Attractive Interface

The application should offer an intuitive and visually appealing interface with clearly defined and easy-to-understand instructions and controls. The design focuses on ease of use to provide a pleasant experience to users.

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3. *Cross-platform Compatibility*

Guaranteeing fluid and enjoyable gameplay for participants, we design the application to be compatible with different mobile devices, ensuring good connectivity and communication in its interface.

4. *Data Security and Protection*

We implement appropriate security measures to protect user data, complying with regulatory data protection regulations and ensuring the privacy of personal information.

5. *Integration of Artificial Intelligence*

The integration of artificial intelligence (AI) within TRIP a-Bike is fundamental to the creation of dynamic questions aligned with the proposed educational methodology. Leveraging AI, questions are generated adaptively, tailoring themselves to each student's performance and progress. This ensures a personalized and effective learning experience, where activities are not only automatically created but also tailored to individual user needs.

6. *Project Requirements Coverage*

The project architecture addresses various fundamental requirements for its operation and future development, strategically designed to tackle the identified deficiencies in English language education in Colombia. Coverage includes:

- **Interactive Game:** The architecture manages levels, user interactions, and game mechanics to provide an engaging and educational interactive experience.
- **Multiple Subject Learning:** Although the initial focus is English, we designed the architecture to address multiple subjects in the future, offering specific challenges and questions in areas such as English, Italian, literature, and environmental education.
- **Integration of Language Learning with Physical Activity:** TRIP a-Bike ingeniously intertwines physical activity with language learning, providing an immersive experience where students propel their virtual cyclist avatar through diverse levels and environments. This unique approach not only engages students but also enhances language acquisition by seamlessly integrating language challenges into the gaming experience.

B. Architecture Development

We base our project architecture on a carefully planned and executed approach across five key stages: Research and Planning, Design and Prototyping, Development, Testing and Fixes, and finally, Release and Tracking shown in Fig. 1.

1. *Research and planning.*

In the initial stage of the project, we focus on understanding the needs and exploring appropriate methodologies and tools. This process covered the following crucial aspects.

We conduct extensive studies to understand the requirements and expectations of the TRIP a-Bike project, focusing mainly on user interaction and educational objectives for children and young people.

This analysis involved detailed research into the capabilities and best practices of the game engines available on the market. Ultimately, we selected Unity because of its flexibility, cross-platform compatibility, and active community. Unity allows developers to create games in both 2D and 3D, spanning a variety of styles and genres. In addition, it is compatible with various mobile platforms, including iOS and Android, facilitating the distribution of the game. The Unity community is very active and offers a wide range of learning and support resources, which is especially beneficial for beginning developers.

Simultaneously, we planned the game architecture, defining the general structure that included functionalities and features and adopting specific architectural approaches for the game engine. This comprehensive approach allowed us to establish a solid foundation for development, ensuring we effectively addressed the project needs and leveraged the optimal capabilities of the selected platform.

2. *Design and Creation of Prototypes*

With the foundation in place, our focus shifted toward UI design, game mechanics, and prototyping, intending to validate concepts. Key stages in this process included:

- **User Interface Design and Game Mechanics:** We are dedicated to designing the user interface and game mechanics to guarantee an engaging and educational experience. We adopt a modular approach with the vision of facilitating future expansions and improvements to the system.
- **Prototyping Screens and Mechanics:** We developed prototypes to visualize and test the design ideas, ensuring they aligned with the specific educational objectives of the project, shown in Fig. 2. This phase allowed for a practical evaluation of the feasibility and effectiveness of our proposals, enabling adjustments and refinements before moving to the full implementation stage.

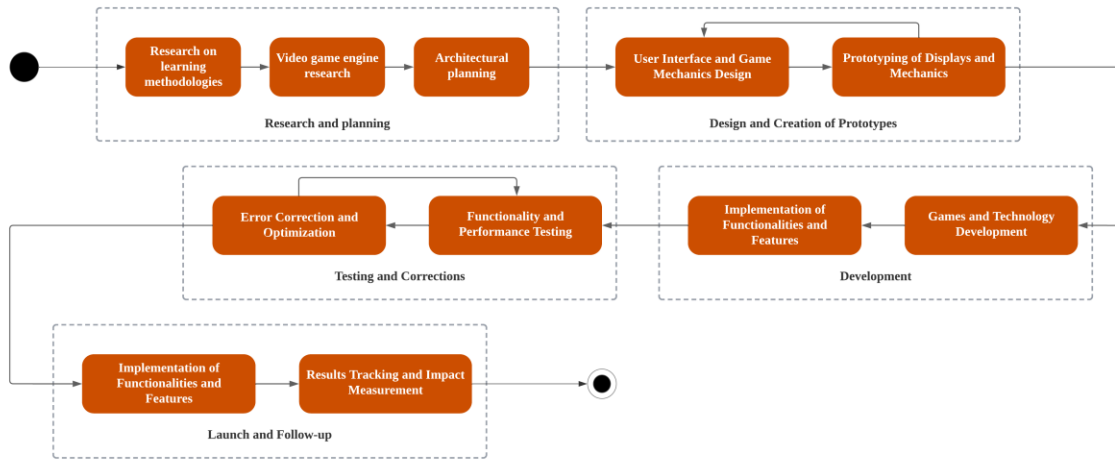


Fig. 1 Key Phases in Project Architecture

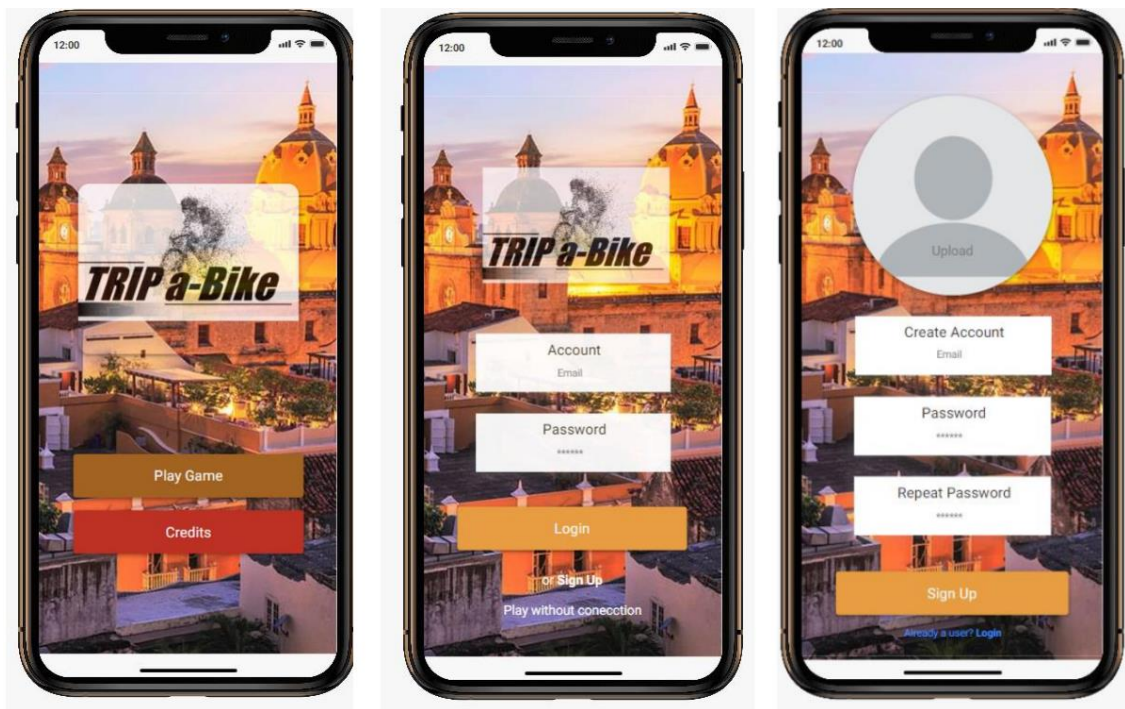


Fig. 2 App prototype

3. Development

In this crucial phase, we dive headlong into the implementation of the game and associated technologies, deploying a series of essential sub-stages:

- **Game and Technology Development:** We execute the implementation of the game logic and user interface in Unity, following the best practices and architectural patterns suggested by this platform.
- **Implementation of Functionalities and Features:** We developed the functionalities and features previously defined during planning into reality, ensuring a coherent

and efficient integration that enhanced the user experience.

4. Tests and Corrections

The search for excellence in game quality is key, so we rigorously dedicate time to testing and correcting possible problems. The substages included:

- **Functionality and Performance Tests:** We conduct evaluations to guarantee optimal game performance, optimizing crucial aspects such as speed, fluidity, graphics, and animations.

- Bug Fixes and Optimization: We identify and correct any errors detected while optimizing the user experience to ensure smooth and uninterrupted gameplay.

5. Launch and Follow-up

The culminating phase focuses on launching the game and continuously monitoring its performance. The key substages they addressed:

Video Game Launch: We implement the game's launch, ensuring a smooth and uncomplicated presentation for users to access without setbacks.

- Results Tracking and Impact Measurement: We proactively monitor game results, evaluate their impact, and generate detailed reports for stakeholders. These reports serve as a basis for future iterations and improvements, ensuring the constant evolution of the game.

6. Immersive Gameplay Experience

Our educational game provides an engaging and immersive experience, intertwining physical activity with language learning. We ingeniously designed the core game mechanics, requiring students to pedal an exercise bike, propelling their virtual cyclist avatar through diverse levels and environments.

Students encounter English questions that evaluate grammar, vocabulary, and reading skills throughout this dynamic journey. Integrating language challenges seamlessly into the gaming experience ensures a holistic approach to language acquisition.

Students must accurately answer these questions to progress in the game, earning points that unlock new levels and coveted incentives such as badges, trophies, or prizes. This rewarding system not only motivates students but also adds an element of gamification to the language learning process.

The game strategically scales in difficulty across three levels (easy, medium, and hard), accommodating various age groups and proficiency levels. This adaptive approach ensures that learners of different capabilities find an appropriate level of challenge, fostering a personalized and effective learning environment Fig. 3.

IV. RESULTS

In this section, we present the outcomes of our evaluation of the educational game's impact on students' English language proficiency. We employed the Communicative Language Teaching (CLT) approach and task-based learning in conjunction with two evaluation methodologies.

Methodology of Evaluation

To assess students' progress effectively, we implemented continuous evaluation, allowing measurement of their advancement throughout the game. Additionally, formative

assessment was utilized to provide students with feedback on their performance and errors made during gameplay.

In alignment with our assessment approach, we employed the following techniques to measure language proficiency:

- Multiple-choice selection: Students engaged with questions featuring multiple-choice options, earning points for accurate answers. This method offered insights into their grasp of language concepts encountered during gameplay.
- Writing exercises: Given the contextual relevance, we assessed spelling and basic language structure through concise writing tasks. These exercises provided a practical evaluation of language application within the game's scenarios.

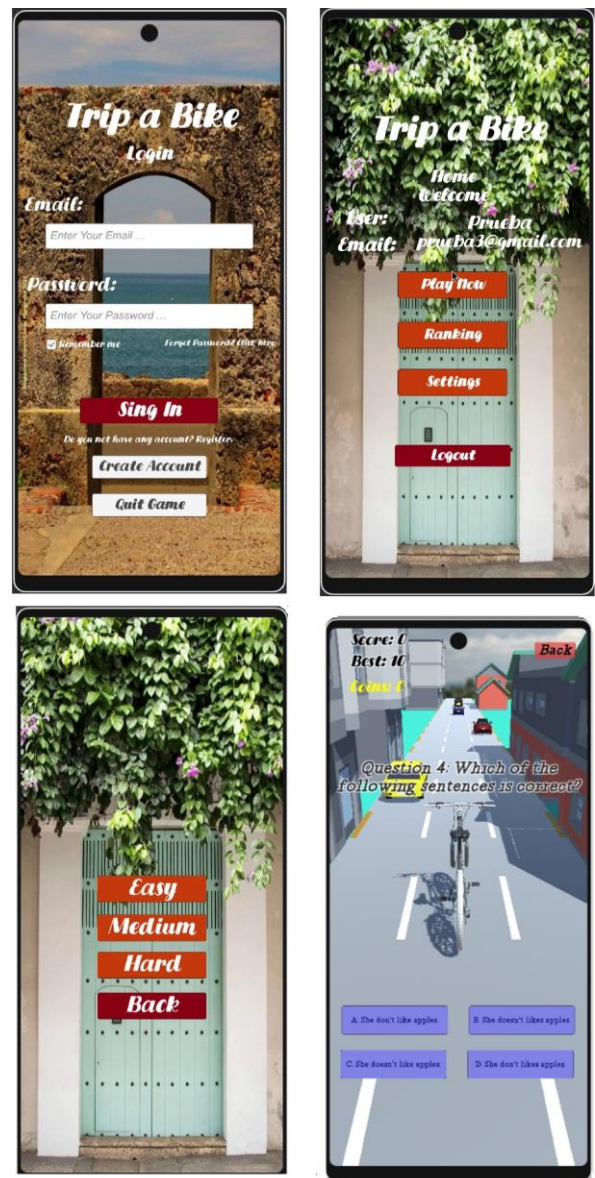


Fig. 3 Gameplay Overview: Login, Home, Difficulty Selection, and In-Game

Impact Measurement

Recognizing the pivotal role of English proficiency in the contemporary globalized landscape, the educational game's impact transcends the classroom's boundaries. The ability to communicate effectively in English enhances educational prospects. It contributes to Colombia's participation in the international economy and cultural exchanges.

To measure the transformative impact of the game, we adopt a comprehensive approach:

- Pre- and post-assessment: we administer a standardized test before and after students engage with the game, allowing us to gauge improvements in their English language proficiency quantitatively.
- Surveying students: Besides quantitative data, we will gather students' perceptions and opinions through surveys. This qualitative feedback will shed light on the game's influence on motivation, engagement, and perceived language learning effectiveness.
- Enhancing future implementation: Insights from the assessment and surveys will inform iterative improvements in the game's design and implementation. We aim to create a more impactful tool for English language acquisition by continually refining our approach.

V. LIMITATIONS

The TRIP a-Bike project has been developed as a minimum viable product (MVP), focusing on creating a functional prototype with a limited user sample for validation. While efforts have been directed towards iterating and improving the system based on initial results, the proposal's validation has been conducted through a case study to collect data and feedback from participating users. As TRIP a-Bike evolves, expanding the user sample and implementing more detailed assessment tools are considered crucial for ensuring its effectiveness in educational settings.

A. Proposed Changes for Future Research

Given the limitations inherent to a few evaluations, we propose the following changes in approach:

- Repeated Evaluation Sessions: Conducting multiple evaluation sessions over time will allow for a more complete perspective on the effectiveness of the program and its possible changes over time.
- Expansion of Participants: Incorporating more students in future evaluations will help evaluate the results' consistency and applicability to a broader group.

B. Addressing Bias

To address possible biases in the study, we propose the following strategies:

- Peer Assessment: Introducing peer assessments will help reduce potential bias and gain a more objective perspective on student performance.

- Variety in Questions: Ensuring that questions cover a variety of language skills will obtain a more balanced assessment of students' language abilities.

These suggestions seek to improve the robustness and applicability of future studies, recognizing the current limitations of a single evaluation.

VI. CONCLUSIONS

The preliminary implementation of TRIP a-Bike has yielded promising results, despite being based on a limited number of student evaluations. It has underscored the educational potential of TRIP a-Bike, demonstrating the positive impact of gamification and the program's adaptability on students' language skills. Key elements such as gamification, rewards, the multimodal approach coupled with physical activity, and interactive language practice, augmented by artificial intelligence to provide personalized learning experiences and instant feedback, have significantly bolstered student motivation and engagement in the learning process.

Crucially, drawing from these initial cases, the study emphasizes the necessity of further exploring TRIP a-Bike's potential. The observed enhancements underscore the importance of additional research to comprehensively grasp the methodology's impact on enhancing English language proficiency. In essence, TRIP a-Bike emerges as a promising pedagogical approach. Despite its limitations, this preliminary investigation suggests that gamification and artificial intelligence hold considerable promise in enhancing language instruction, particularly in settings with restricted educational resources.

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