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A Study on Systematic Language Learning Construction Driven by Interaction Design: A Case Study of Duolingo

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Abstract. This study takes Duolingo as a case study and, drawing on Second Language Acquisition (SLA) theories, examines the role of language-learning applications in the construction of a systematic language learning framework. It systematically analyzes the impact of interface interaction design on second language learning processes. Through an examination of Duolingo's User Interface Design principles, learning task organization, and interactive feedback mechanisms, this study summarizes the app's strengths in facilitating language input, enhancing learners' attentional focus, and sustaining learning motivation. The study further identifies several limitations of Duolingo, including insufficient systematic representation for less commonly taught languages, limited support for productive skills, and a lack of coherence in learning pathways. Overall, this research provides theoretical insights for interface design and curriculum development in language-learning applications.

Keywords: User Interface Design, Duolingo, Second Language Acquisition, Noticing Hypothesis

1. Introduction

The widespread adoption of mobile internet technologies has led to the rapid growth of language-learning applications. However, many existing apps focus primarily on isolated functions such as vocabulary memorization or grammar drills, resulting in fragmented learning pathways and a lack of systematic models for language competence development. As a result, learners often struggle to form an integrated linguistic knowledge structure, a challenge that is particularly evident for learners of less commonly taught languages.

In foreign language learning contexts where authentic language environments are limited, learners rely heavily on applications to provide a comprehensive learning cycle encompassing input, output, feedback, and consolidation. Nevertheless, many language-learning apps suffer from poor User Interface Design (UI), hindering the integration of phonological, lexical, grammatical, and discourse-level knowledge.

As one of the largest language-learning applications by global user base, Duolingo has had a profound influence on the development of digital language education products. Existing research, however, has largely focused on user engagement or the development of individual language skills, while paying relatively little attention to the theoretical foundations underlying interface interaction design and curriculum structure.

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Therefore, this study adopts Duolingo as a case study and integrates core SLA theories to analyze how UI design influences the construction of systematic language learning frameworks. It further explores future directions for the digital application of language-learning platforms. The paper aims to provide references for educational product designers and to promote the transition of language-learning applications toward more digitalized, system-oriented designs.

2. Literature review

2.1 Second Language Acquisition theories and the construction of systematic language competence

Second Language Acquisition (SLA) theories provide valuable insights into how learners' language skills develop in digital environments. According to SLA theory, learners construct a second language system based on their first language. Second language acquisition is not a simple accumulation of vocabulary items or grammatical rules; it involves a dynamic, organized system that is built, adjusted, and stabilized over time. From this perspective, building a language system involves gradually forming a rule-governed, stable network of linguistic knowledge through input and output. In this process, an application's UI, task design, and feedback may significantly influence the developmental trajectory of learners' internal language systems.

First, Selinker's Interlanguage Theory provides a foundation for understanding the construction of language systems. Interlanguage refers to the internal linguistic system gradually formed by learners during second language acquisition. This system is dynamic, systematic, and stage-based, shaped by both first-language transfer and continuous reorganization through input, feedback, and practice [1]. While Krashen's Input Hypothesis establishes the necessity of comprehensible input (i+1) for acquisition [2], Schmidt's Noticing Hypothesis clarifies that conscious attention to linguistic forms is a prerequisite for this input to be effectively processed [3].

In addition, Pienemann's Processability Theory emphasizes that language acquisition follows a psycholinguistic processing sequence, in which learners must acquire lower-level structures before they can process more complex ones [4]. If an application's curriculum design ignores this processing order and presents abrupt increases in difficulty or disorganized structural sequences, the construction of a systematic language system may be hindered.

Furthermore, Swain's Output Hypothesis highlights the role of language production in helping learners identify gaps in their interlanguage, thereby promoting restructuring and deeper processing [5]. Output not only serves as a means of testing linguistic hypotheses but also strengthens the integration of grammar, vocabulary, and discourse-level knowledge. Together, these theories provide a solid theoretical foundation for analyzing how interface structure, interaction patterns, and task design in language-learning applications support systematic language development.

2.2 UI design theories and language-learning applications

UI design facilitates information comprehension and the construction of cognitive structure. Research has shown that interface design influences learners' attention allocation, cognitive load, selection of learning strategies, and the sustainability of learning motivation [6-7].

Structural organization forms the foundational layer of UI design in language-learning applications, encompassing information architecture and cognitive load management. Its primary function is to establish clear content organization and learning pathways through well-designed information structures. By arranging grammatical progression and hierarchical relationships among

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vocabulary and syntax, UI design can support learners in constructing language systems in accordance with the principle of progressing from simple to complex and from parts to wholes [8]. Cognitive Load Theory further requires that interface design adopt a simplified, focused approach. This means minimizing distracting visuals and reducing the mental effort needed to process language rules. The goal is to free up learners' cognitive resources for understanding and internalizing linguistic elements [7].

Second, UI design is closely aligned with theories of output and attention guidance. Krashen's Input Hypothesis emphasizes that comprehensible input slightly above learners' current proficiency level (i+1) is central to language acquisition [2]. Swain's Output Hypothesis argues that producing language enables learners to identify weaknesses in their language systems and promotes restructuring and deeper learning [5]. In addition, visual hierarchy design, through the use of color, size, spatial positioning, and white space, highlights key linguistic features and enhances learners' sensitivity to structural differences. This visual guidance effectively increases learners' attention to language forms, thereby facilitating the internalization and reorganization of linguistic rules [3].

Finally, the maintenance of learning behaviors and motivation is closely related to the mechanisms of gamification and age-appropriate design. Gamified elements such as points, badges, and leaderboards can enhance learners' engagement and sense of achievement [9]. However, gamification must be aligned with educational objectives and cognitive mechanisms. Otherwise, while it may increase motivation and participation, it can also increase cognitive load and impair learning effectiveness [10]. Therefore, the challenge is to find a balance between motivational design and substantive content.

In summary, the UI design of language-learning applications should provide comprehensive cognitive support for the construction of systematic language competence through the coordinated effects of structural organization, interaction mechanisms, and motivational maintenance. This theoretical framework also serves as the basis for analyzing the strengths and limitations of Duolingo's interface design in the present study.

3. Effectiveness of Duolingo's interface interaction design from a systematic language construction perspective

Duolingo's UI design not only serves the functions of presenting linguistic input, organizing grammatical sequences, supporting attentional processing, and providing feedback, but also regulates learners' behavioral patterns through gamification elements, task pacing, and reward mechanisms. As a result, a complex interaction is formed among learning efficiency, motivation, and the depth of systematic language development.

3.1 Tree-structured progressive design and system construction

Duolingo's curriculum is implemented through a core interface feature: the tree-structured skill progression. It advances step by step from vocabulary to short sentences and then to grammatical structures [8]. After selecting a course, learners are presented with a corresponding "skill tree," which serves as a visualized learning map.

Within this interface, the learning pathway can be distinguished: lessons are marked as complete (golden), in progress (colored), or locked (gray), with gem chests embedded at different levels. This visual design transforms learning content into a sequence of progressively unlocked tasks, providing learners with a clear and predictable progression framework. Such an organization helps prevent

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abrupt jumps in grammatical complexity and ensures a stable supply of comprehensible input (i+1) [8].

At the same time, the interface integrates multimodal input, including text, images, and audio. Through visual enhancement strategies such as color highlighting, red-marked errors, dynamic prompts, audio synchronization, and card-based layouts, learners' attention is directed toward linguistic forms. The immediate feedback mechanism explicitly displays error types, further increasing the salience of language forms and contributing to a closed-loop learning process..

3.2 Gamified reward mechanisms and closed-loop learning

Duolingo's gamified reward mechanisms fundamentally regulate learner behavior [9]. Among these mechanisms, the daily streak and check-in system plays a central role. When learners enter the learning interface, their current streak is prominently displayed at the top of the screen, accompanied by flame animations.

If a streak is interrupted, the interface uses changes in character expressions and prompts to encourage learners to restore their progress. Maintaining a streak is further rewarded with experience points and gems. In this way, learning persistence is transformed from a self-regulated behavior into a game-based goal centered on loss avoidance. Upon completing daily tasks, learners are rewarded with full-screen celebratory animations and sound effects, and longer streaks unlock special badges. These intermittent and visually rich forms of positive feedback effectively stimulate dopamine release and reinforce learning behaviors [10]. In addition, ranking systems and competitive features further stimulate users' comparative tendencies. Each completed exercise earns a fixed number of experience points (XP), encouraging frequent engagement and extended use, particularly among adolescent users. To a certain extent, such task designs help cultivate daily learning habits and thereby support the continuity of language acquisition.

3.3 Technological empowerment through AI-assisted systems

Beyond its core learning mechanisms, Duolingo relies on AI-assisted systems as an important technological foundation for optimizing learning experiences and expanding its functional boundaries. In the listening modules, a designated character, Lin, guides learners through tasks, expressing impatience or praise to simulate real conversational contexts. In addition, AI-supported customized exercises help overcome the limitations of standardized curricula by providing learners with more targeted content. Through these functions, AI enables Duolingo to further advance its goals of personalized task generation and real-time feedback, thereby enhancing learning adaptability and effectiveness [8].

3.4 Standardized interface design for multilingual coverage

To meet the adaptability demands of a global user base, Duolingo adopts a fully standardized interface and task template. Regardless of whether users choose to learn Spanish, Japanese, or German, the overall layout of the main interface remains consistent. The top of the screen uniformly displays a status bar showing experience points, gems, and heart-based life values. Learning paths are consistently organized around the skill tree structure and share identical reward mechanisms.

During actual learning tasks, drag-and-drop matching exercises are frequently used. The interface is typically divided into two columns, with target-language words on one side and native-language translations or images on the other, allowing learners to connect corresponding items. Because

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interaction patterns remain consistent across different courses, learners can study multiple languages without needing to relearn interface operations. This design not only reduces development and maintenance complexity but also ensures operational efficiency for users, forming a critical foundation for Duolingo's rapid global expansion.

4. Limitations of Duolingo's interface design from a systematic language construction perspective

Despite its advantages in accessibility and user engagement, Duolingo's interface design exhibits several limitations when examined from the perspective of systematic language competence construction.

4.1 Fragmented organization of linguistic knowledge

Although Duolingo employs a skill-tree learning path that effectively lowers entry barriers, enhances contextual adaptability, and accommodates fragmented learning scenarios, this design simultaneously leads to fragmentation of linguistic knowledge. From a design logic perspective, the platform prioritizes thematic organization over grammatical or structural sequencing. While this approach increases content appeal and perceived practicality, it disrupts the intrinsic relationships among vocabulary, syntax, and semantics, preventing learners from intuitively perceiving the systemic structure of the target language.

Moreover, in order to accommodate learners at different proficiency levels, Duolingo's course design does not strictly adhere to the i+1 principle of Second Language Acquisition [2]. Certain complex grammatical structures, such as the subjunctive mood, are introduced prematurely, exceeding learners' processing capacity. In addition, insufficient repetition of key language points and the lack of a systematic consolidation pathway further intensify the problem of fragmentation. This limitation is particularly evident in the English courses. For example, perfect tenses—commonly regarded as challenging grammatical structures—are often introduced rapidly within a single lesson lasting less than 30 minutes. Such presentations typically lack explicit explanation, systematic recycling, and structured practice. As a result, learners receive inadequate support for constructing higher-level grammatical networks, making it difficult to develop a coherent and integrated language system.

4.2 Incentive mechanisms and the suppression of deep learning

While Duolingo's strategies, such as points, streaks, and levels, successfully increase user retention, it also risks reshaping learners' psychological orientation toward learning. Users prefer focus on their grades and reputations. Under pressure to maintain streaks or rankings, learners sometimes repeatedly complete familiar review tasks that can be finished quickly rather than engaging with new or challenging content. Some learners may also rely on trial-and-error strategies, such as rapidly testing different word orders to obtain correct answers without fully processing the linguistic rules involved [9].

This design tendency directly contradicts the Noticing Hypothesis and deep processing principles in SLA theory [2,5]. Although external motivation is effectively stimulated, the design undermines a core requirement of second language acquisition: only through active, output-driven construction of linguistic forms can learners internalize grammatical rules and advance their interlanguage systems.

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4.3 Stability limitations of AI-assisted systems

As Duolingo's AI-assisted systems are still under continuous development, issues related to feedback accuracy and stability frequently arise. For instance, when learners produce sentences with minor word-order errors, the system may occasionally judge them as "fully correct" based on overall semantic intelligibility. Such issues are particularly pronounced in languages outside the Indo-European family, including agglutinative languages and right-to-left writing systems, for which training data and linguistic modeling remain insufficient.

Meanwhile, speaking assessment, error correction, and other functions sometimes are inconsistent or even convey inaccurate grammatical rules. This instability not only weakens learners' trust in system feedback but may also contribute to the fossilization of interlanguage errors, contradicting the SLA principle that precise input and accurate feedback are essential for effective language acquisition.

4.4 Fundamental conflicts in multilingual adaptation

More critically, Duolingo's standardized task templates struggle to accommodate the core typological features of different languages. The standardized interface typically presents only base forms or a limited set of inflected options, preventing learners from visualizing the complete declension or conjugation system. In languages such as Russian or German, for example, noun or adjective completion requires complex inflectional changes based on gender, case, and number. As a result, learners are forced to rely on isolated memorization rather than developing a systematic understanding of morphological structures. For other languages, the conflict is even more evident. Arabic's right-to-left writing system operates alongside an interface predominantly designed for left-to-right processing, leading to a mismatch between UI layout and authentic reading and parsing practices.

The root cause of these multilingual adaptation issues lies in Duolingo's design philosophy of applying a single interface logic to all languages. The platform's underlying architecture is largely based on Indo-European language features and overlooks fundamental structural differences across language types. To ensure operational convenience for a global user base, Duolingo relies heavily on standardized task formats such as word selection, matching, and fixed word-order gap filling. However, these formats are ill-suited to agglutinative morphology, flexible word order, or right-to-left visual processing.

Algorithm-generated tasks and feedback often fail to accurately reflect the structural properties of non–Indo-European languages, reinforcing the constraints of a unified interface.

5. Interface optimization strategies for Duolingo based on second language acquisition theory

5.1 Structuring the presentation of language systems

To address the problem of fragmented knowledge organization, Duolingo needs to move beyond its current modular design logic. Introduction of visualized language maps that present vocabulary, grammar, sentence patterns, and communicative functions as an interconnected network is one direction. In addition, the development of H5-based situational dialogue modules and the reduction of redundant animated elements could facilitate a shift from passive recognition to active language construction.

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Meanwhile, visual strategies such as color coding and dynamic annotations can be combined with short dialogues and micro-narratives as discourse-level materials to enhance contextualized input. By guiding learners to establish stronger links between linguistic form and meaning

5.2 Enhancing output tasks and optimizing incentive logic

More support should be provided for output-oriented tasks, particularly those involving higher cognitive demands, such as writing. For example, writing tasks could incorporate collapsible keyword prompts or expandable hint layers, lowering task initiation barriers through interaction design. At the same time, traditional score-based feedback could be replaced by more meaningful incentive mechanisms, such as progress-based points and achievement badges. These incentives should be presented through longitudinal visual progress charts, helping learners track their development over time and reinforcing intrinsic motivation rather than short-term performance goals.

5.3 Optimizing AI-supported adaptive design

To incorporate data visualization dashboards that present AI-generated, personalized learning plans as clickable, trackable task nodes or learning stages. In addition, animated virtual characters could be developed into interactive conversation partners, simulating authentic communicative scenarios and providing learners with immersive speaking practice environments. Given that modern large language models are trained on multilingual data, it is also essential to expand the training corpora for less commonly taught languages, including agglutinative and non-Latin-script languages, to improve AI performance in feedback accuracy and task generation.

5.4 Improving multilingual adaptability

Duolingo's current design philosophy emphasizes the use of minimal, standardized interaction patterns to cover the widest possible range of languages. As a result, improvements in multilingual adaptability should focus primarily on interface functions and layout adjustments. For teaching units involving free word order or language-specific pragmatic categories (such as honorifics), comparative task designs are recommended.

For instance, in Russian courses, learners could be presented with multiple word-order variants expressing the same proposition and asked to rearrange elements and explain semantic or pragmatic differences. For languages using non-Latin scripts, such as Arabic and Hindi, interface layouts could accommodate right-to-left or script-specific formatting, fully reflect writing conventions, and provide explicit guidance. By introducing specialized practice modules, the distinctive structural features of different language types can be more adequately represented and learned.

6. Conclusion

This study takes Duolingo as its primary case and, drawing on Second Language Acquisition theory, analyzes both the strengths and limitations of its interface design from the perspectives of structured curricula, gamified reward mechanisms, AI-assisted systems, and multilingual adaptability. The findings indicate that Duolingo's tree-structured skill progression and immediate incentive mechanisms effectively enhance user engagement, while gamification and AI integration further increase learner participation and motivation.

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The study also reveals that these design choices contribute to fragmented knowledge organization, an imbalanced motivational orientation, unstable AI feedback, and insufficient multilingual adaptation. In turn, it constrains the development of learners' deeper language competence. In response, this paper proposes enhancing output-oriented tasks, incorporating typological language adaptation, and other strategies..

This study has several limitations. Without considering the influence of individual learner differences on interface effectiveness, it focuses on a single app. Future research should compare with other types of language-learning applications. And deepen interface adaptation research based on specific language types.

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