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Making PBL Sustainable for L2 Beginners: An Anki-Based Approach to Motivation and Autonomy in Elementary Hindi Learning

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Abstract

This study examines the motivational and sustainability effects of an Anki-based, individualized project-based learning (PBL) model in an elementary Hindi language course. Conventional PBL approaches in language education typically rely on collaborative, production-focused tasks that can be demanding for novice learners and usually conclude when the final project is submitted, leaving little structured support for continued practice. In this study, script, vocabulary, expression, sentence patterns, and pronunciation are not treated as background work but defined as the core pedagogical problem. Over the semester, each learner builds and refines a personalized Anki deck—a multimedia flashcard system based on spaced repetition—designed to support Devanagari word and sentence recognition, pronunciation practice, listening comprehension, and vocabulary retention. Each student constructed an individual deck aligned with course content, selecting vocabulary items, creating example sentences, and developing personalized memory cues that matched their learning pace and needs. Motivation was measured with a modified Instructional Materials Motivation Survey (IMMS) using only positively worded items to enhance reliability. Results showed consistently high scores across all ARCS domains, particularly for Confidence (M = 3.86) and Satisfaction (M = 3.93). Female students reported higher average scores, but gender showed no association with motivational grouping. Strong correlations among ARCS dimensions indicated consistent engagement across motivational components. Cluster analysis identified two groups of learners: highly motivated learners who treated deck creation as an ongoing learning resource, and less motivated learners who still maintained scores above the neutral midpoint—engaged enough to manage typical beginner challenges. The findings suggest that Anki-based PBL can make project-based learning workable at the novice level. By positioning deck creation as both the problem students solve and the tool they build, the model integrates continuous, self-paced practice into the project structure rather than treating it as a one-time deliverable. This design responds to a familiar gap in beginner language instruction: what happens when formal scaffolding ends. Unlike conventional PBL, which concludes with project submission, this approach creates a resource learners can use independently over time, embedding ongoing vocabulary retention and autonomous practice into the learning experience itself.

Keywords: sustainable language learning; educational innovation; project-based learning (PBL); beginner language learners; Anki; spaced repetition; individualized task design; learner autonomy

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1. Introduction

Contemporary language education has witnessed a fundamental movement from traditional, teacher-centered models towards learner-centered approaches that emphasize student autonomy, active engagement, and collaborative knowledge building [1–3]. This shift has emerged from a growing awareness that effective second language (L2) acquisition requires learners to assume active control over their learning process, making informed decisions about content selection, pacing, and practice methods that align with their individual needs, interests, and proficiency levels [4–6]. Self-determination theory provides a key theoretical foundation for learner-centered education. It argues that the basic psychological needs for autonomy, competence, and relatedness drive intrinsic motivation and sustain engagement necessary for continued educational progress [6,7].

Despite this theoretical and empirical emphasis on learner-centered methods, many beginner-level language programs still rely heavily on teacher-led instruction, repetitive drills, and rote memorization, which have been shown to undermine the sustainability of learner motivation and hinder the development of self-regulatory skills [8–11]. While traditional instructional methods may support the development of basic language skills, they often result in lower learner engagement and fail to adequately prepare students for autonomous and authentic communication in real-world situations [12,13]. This reliance on conventional methods creates pedagogical tension. The strategies used to build a basic linguistic foundation can at the same time hinder the development of the learner autonomy, which is essential for long-term language learning.

These tensions prove particularly acute for absolute beginners, who must simultaneously acquire new phonological systems, foundational vocabulary, grammar, and basic pragmatic conventions—an array of interdependent elements that generates high intrinsic cognitive load within cognitive load theory [14]. Under such conditions, approaches that rely on minimal guidance or dense input risk inadvertently excluding novices. For instance, extensive-reading and incidental-vocabulary programs are typically recommended only once learners have built up a sufficiently large vocabulary base to infer meanings from context with adequate lexical coverage [15]. Similarly, mobile-assisted vocabulary interventions, including recent m-learning designs, tend to be evaluated with learners who already possess basic L2 literacy rather than absolute beginners [16]. As a result, pedagogical innovations frequently serve learners who are already relatively well prepared, while those at the very beginning of their L2 trajectory remain largely confined to more traditional, teacher-led instruction.

1.1. Problem-Based Versus Project-Based Learning in Language Education

To address the limitations of traditional instruction, educators have increasingly turned to innovations such as flipped classrooms, task-based language teaching (TBLT), and project-based learning (PBL) in response to the limitations of traditional instruction. These approaches aim to enhance engagement, autonomy, and learning outcomes [9,17,18]. Among these, PBL has received particular attention for positioning students at the center of authentic, complex problem-solving tasks. The method encourages independent research, collaborative inquiry, and practical solution-building; studies indicate that it supports critical thinking and yields more meaningful learning experiences that sustain motivation [19–21].

Implementing PBL in language education is complicated by an important conceptual distinction that must be clarified before focusing on its use with beginner learners. Although both “problem-based” and “project-based” learning share constructivist foundations and the same acronym, they differ significantly in scope, process, and expected outcomes—differences that carry meaningful implications for language teaching.

Problem-based learning, developed in medical education in the 1960s, engages small groups with ill-structured cases that drive self-directed study and collaborative problem solving, typically without a strong emphasis on producing a tangible product [21,22]. In this approach, the problem drives learning, and solutions may be conceptual rather than concrete.

Project-based learning centers instruction on extended projects that culminate in concrete products created through sustained learner involvement [23]. In language education, this typically involves students working over several weeks to produce outcomes such as newsletters or videos, guided by a central question and supported through cycles of planning, research, drafting, and presentation [24]. Within this tradition, the "P" in PBL has come to signify the project as the primary organizing unit, even when implicitly driven by an underlying problem or challenge.

This distinction matters in language education. In practice, successful project-based language learning (PBLL) applications are clustered overwhelmingly at intermediate and advanced levels [23]. Learners at these stages are presumed to have the linguistic capacity to manage complex project demands and articulate their problem-solving in the target language. Consequently, the field has seen a dominance of what might be termed "project-oriented PBL"—focused on tangible creation—rather than authentic problem-solving. This tendency reflects practical necessity, not pedagogical preference: beginners are simply screened out, lacking the linguistic tools to engage in the complex diagnosis that true problem-based learning demands [25].

In this study, therefore, we adopt the notion of PBL as defined within second and foreign language education, while acknowledging the problem-solving dimension inherent in our approach. This framework allows us to address both the "problem" (the problem of beginners quickly forgetting newly learned vocabulary and struggling to consolidate related expressions, sentences, and pronunciation) and the "project" (personalized learning tool creation) in a manner accessible to absolute beginners.

1.2. The Sustainability Challenge: Making PBL Workable for Absolute Beginners

Before examining specific implementation challenges, it is important to clarify how the term "sustainable" is used in this study. In this study, sustainable PBL refers not to environmental themes, but to the durability and scalability of the learning activity itself. In particular, it refers to the project's capacity to provide beginners with learning tools and routines that continue to support vocabulary, expression, sentence, and pronunciation development after the course and its scaffolding have ended. This perspective aligns with recent work on technology-enhanced PBLL emphasizing learner autonomy and the creation of viable, long-term tools [26]. Such an emphasis on sustainability in instructional design is crucial because language acquisition inherently unfolds over years, not semesters, yet most PBL research focuses only on immediate project outcomes.

In second and foreign language contexts, PBL has been applied through various tasks, including the development of authentic communication materials, multimedia projects for cultural exchange, collaborative translation or storytelling tasks, and activities tailored to learner needs and real-world audiences [23,27,28]. Research shows these approaches can increase learner motivation, foster teamwork skills, and promote genuine language use, particularly among intermediate and advanced learners [23,29].

When applying conventional PBL approaches to absolute beginner language learners, however, significant challenges arise. Absolute beginners must simultaneously develop basic phonological awareness, foundational vocabulary, and elementary grammatical structures. Because they face several demanding learning tasks at once, the cognitive and linguistic requirements of identifying problems, conducting research, and articulating solu-

tions in PBL often exceed their readiness [20,25]. Task complexity research demonstrates that when learners must allocate attention to multiple demanding dimensions—language production, problem analysis, and collaborative negotiation—performance across all dimensions suffers, particularly for novices with limited processing capacity [30,31]. When confronted with complex collaborative tasks that demand competence beyond their current capabilities, the result is often uneven participation, frustration, and limited learning outcomes [32–34].

The main difficulty therefore lies less in learners' abilities than in how instruction is designed. Traditional PBL assumes learners can articulate their thinking, negotiate meaning, and express complex ideas—all in the target language. For a beginner struggling to produce a basic sentence, these demands are not a productive challenge; they become an extraneous cognitive burden that impedes learning. Moreover, the collaborative nature of PBL, intended to build competence, often becomes a source of anxiety for novices who lack the linguistic confidence to contribute.

These implementation challenges are compounded in large classroom settings, where teachers struggle to deliver the personalized scaffolding necessary for every student to engage effectively in project-based or collaborative problem-solving activities. The result is often uneven support and differential engagement [35–37]. Furthermore, while mobile applications and digital tools can support vocabulary practice and discrete skill development, they frequently fail to align with curriculum goals or provide the individualized learning experiences required for successful PBL integration [38–41].

A more fundamental concern about the sustainability of PBL in beginner contexts lies beyond these implementation difficulties. Conventional PBL designs typically culminate in a final project submission, after which structured learning support ceases. This creates a sustainability gap: learners lose access to scaffolded practice precisely when autonomous skill consolidation becomes critical. In beginner language courses, this gap manifests as rapid vocabulary attrition, difficulty consolidating basic expressions and sentence patterns, and reduced engagement in self-directed study (including pronunciation practice)—outcomes that undermine the long-term viability of early L2 investment. For novices facing steep forgetting curves and limited self-regulatory capacity, these sustainability dimensions are particularly urgent, yet they are rarely addressed in PBL research. Addressing this gap requires pedagogical innovations that embed continuous practice mechanisms within the PBL framework itself, transforming projects from endpoint assessments into persistent learning tools that support vocabulary retention, the consolidation of expressions and sentences, and autonomous development beyond formal instruction [42,43].

1.3. Bridging the Gap with Anki-Based PBL

The solution we propose is an adaptation of PBL that is explicitly designed to address the challenges faced by beginning language learners. Within this framework, we use the term individualized PBL to describe a project structure in which each learner develops an individually owned artifact—in our case, a personalized digital deck—while still working within a common course timeline and shared assessment criteria. This approach departs from conventional PBLL, which typically centers on a co-constructed group product. By treating language learning itself as both the problem to be solved and the domain of the project, the process of creating learning tools becomes a vehicle for language acquisition.

Recent technological advancements in computer-assisted language learning (CALL) have introduced a range of tools with the potential to address both the cognitive challenges and sustainability gaps outlined above. Spaced repetition systems have been shown to enhance long-term vocabulary retention, both in general cognitive research [42] and specifically in L2 learning contexts [43]. Building on this foundation, research on deliberate

learning and self-regulated study highlights the importance of learner-driven engagement and intentional repetition in vocabulary acquisition [44,45]. Among such platforms, Anki—an open-source flashcard system—stands out in language education for its integration of multimedia, customizable review settings, and support for autonomous study practices [46].

In this paper, the term Anki-based project-based learning (Anki-based PBL) is used as a practical label for a specific instructional design rather than as a new theoretical construct. The underlying methodology is PBLL. Consistent with PBLL designs in language education, the course was organized as a semester-long project that culminated in a learner-produced artifact [23,35]. In this context, the artifact is not a group presentation or website but a personalized Anki deck that students build and refine over time. Anki, as a widely used spaced-repetition flashcard program, thus serves both as the project environment and as the concrete product of the PBLL cycle. The pedagogical problem centers on beginners' tendency to forget newly learned vocabulary and their difficulty consolidating related expressions, sentences, and pronunciation; the project is to design a digital tool that addresses this problem through spaced repetition and learner control over content. "Anki-based PBL," then, is simply our term for this framework in which the project task is the creation of the learning tool itself, placing Anki at the center of the pedagogy.

The choice of Anki is grounded in established research on spaced-repetition systems (SRS) and digital flashcards in L2 learning. Empirical studies confirm that computer-based spaced repetition can substantially increase long-term vocabulary retention compared to massed practice—in some cases, nearly tripling it with only a few minutes of daily work [47]. Furthermore, reviews of flashcard software find that tools combining automatic scheduling with learner-created cards (allowing the integration of text, audio, and images) are particularly effective for self-paced vocabulary learning [43,48]. From a sustainability perspective, such tools are highly attractive: they function outside class time, across multiple devices, and over extended periods without requiring continuous teacher intervention. Placing this type of tool at the center of the PBLL design is thus a deliberate pedagogical choice. The project is designed to yield not a one-off product, but a durable, personally meaningful resource that beginners are able and willing to use long after the course ends.

Empirical research has confirmed the effectiveness of Anki in improving vocabulary recall rates and supporting long-term retention across diverse learning contexts [49–51]. However, prior studies have primarily examined Anki as a supplementary vocabulary tool rather than as a core component of a comprehensive pedagogical framework. The present study addresses this gap by treating deck creation not simply as an auxiliary activity but as the authentic PBL project itself, ensuring that the project outcome functions as a persistent learning tool whose relevance and functionality beyond classroom boundaries. This approach transforms what might appear to be a simple technical task—creating digital flashcards—into a complex problem-solving endeavor that requires learners to make decisions about content selection, multimodal representation, mnemonic strategies, and review scheduling. Each of these decisions involves metacognitive reflection and strategic thinking, core components of effective PBL.

The theoretical foundation for integrating Anki-based deck development within a PBL framework draws upon several well-established pedagogical principles that address the complexities of beginner-level language education. First, framing deck creation as both a learning problem and a culminating product promotes metacognitive regulation and self-directed learning grounded in personally meaningful goals [52]. This dual framing is crucial: learners are not simply creating cards to memorize vocabulary but are designing a comprehensive learning system tailored to their individual needs, preferences, and goals. The design process itself becomes a vehicle for deep engagement with the target language,

as learners must evaluate vocabulary importance, consider optimal representations, and anticipate future learning challenges. Second, the approach aligns with research in cognitive science on retrieval-based learning and optimal review spacing, which have been shown to enhance long-term retention and learner motivation [53–56]. Integrating these principles within a PBL framework means that learners are no longer passive recipients of spaced repetition; instead, they design their own spaced learning experiences. This shift from consumer to creator fundamentally alters the learner's relationship with both the technology and the language learning process itself. Third, the individualized and customizable nature of deck creation supports autonomy and inclusivity by catering to varied learner preferences and proficiency levels [6,57,58]. These features directly address the sustainability challenge in beginner-level PBL by embedding mechanisms for continuous engagement and adaptive practice into the project structure itself. Unlike traditional PBL projects that conclude with submission, Anki decks evolve with the learner, requiring ongoing refinement and expansion. This evolutionary aspect ensures that the project remains relevant and challenging throughout the learning journey, addressing the temporal limitations that have constrained PBL effectiveness in language education.

Previous studies have examined conventional PBL in language education [23,27] and confirmed the efficacy of spaced repetition tools such as Anki for vocabulary acquisition [43,46]. Yet no empirical research has investigated whether positioning personalized Anki deck creation as the central PBL task could simultaneously promote sustainable motivation, reduce attrition, and provide scalable support for absolute beginners. This research gap is significant given the large population of beginning language learners worldwide who are currently excluded from PBL innovations. Our study aims to show that by redesigning both the problem and project dimensions of PBL, we can create an inclusive pedagogical framework that extends PBL benefits to learners at all proficiency levels.

PBL has been widely acknowledged as an effective instructional framework that fosters learner autonomy, collaboration, and engagement; its application in beginner-level language education, however, remains underexamined. This is largely due to persistent concerns about the cognitive demands PBL places on novice learners, who often require significant scaffolding and guided instruction to navigate open-ended, collaborative tasks successfully [20,25]. While scaffolding can effectively mitigate these difficulties [59], research has not yet examined whether learner-driven digital tool creation, particularly in low-stakes, personalized formats, can serve both as a sustainable PBL artifact and as a mechanism for differentiated, long-term support in language learning.

1.4. Research Contexts and Objectives

The specific context of this study—an elementary Hindi course for university students learning Hindi as a second language—provides an ideal setting for examining our adapted PBL approach. Hindi, as a less commonly taught language with a non-Roman script, presents unique challenges for beginners, particularly in terms of vocabulary retention, script recognition, and pronunciation. The Devanagari script requires learners to simultaneously acquire new phonological patterns, grapheme–phoneme correspondences, core vocabulary, and basic sentence patterns—a combined cognitive burden that traditional pedagogies often address through short-term rote memorization, leaving many learners prone to rapid forgetting. Our Anki-based PBL approach transforms this challenge into an opportunity for creative problem-solving, as learners must devise strategies for retaining script, vocabulary, expressions, and pronunciation, develop personalized memory cues for character and word recognition, and create multimodal representations that support multiple aspects of language learning simultaneously.

This study draws on Keller's ARCS model of motivational design [60], which emphasizes four key components of learner motivation: attention, relevance, confidence, and satisfaction. The measurement of these dimensions used a culturally adapted version of the IMMS that included only positively worded items, thereby avoiding the potential reliability concerns often associated with negatively phrased questions [61].

This study employs this framework to address a familiar problem in beginner language classes: how to sustain motivation and engagement for first-semester university Hindi learners while supporting the ongoing consolidation of vocabulary, expressions, sentences, and pronunciation beyond class time. An individualized PBL model was designed in which Anki was not treated as an optional supplement, but rather as the core of a semester-long project. The course was organized around each learner's design and gradual refinement of a personal deck, conceived as a durable learning tool that could be used beyond the classroom rather than as a one-off assignment.

The primary research objective is to investigate whether this Anki-based PBL model can serve as a sustainable and inclusive pedagogical approach for elementary Hindi learners by examining its motivational effects and learners' evaluations of its contribution to autonomous practice and the consolidation of vocabulary, expressions, basic sentences, and pronunciation. Based on this pedagogical design, the study addresses the following research questions:

RQ1. What are the overall motivational effects of the Anki-based PBL intervention on beginner Hindi learners across the four ARCS dimensions?

RQ2. Do learners' ARCS motivation scores in the Anki-based PBL model differ by gender and academic achievement level?

RQ3. How do the four ARCS dimensions interrelate within the Anki-based PBL context?

RQ4. How do learners evaluate the Anki-based PBL model compared to traditional lectures and team-based PBL

RQ5. How does the Anki-based PBL model support sustainability as an educational innovation for L2 beginners?

By showing that PBL can be successfully adapted for first-semester L2 learners through careful modification of its core components, this study suggests that PBL can be feasible for novice learners. Moreover, by embedding continuous practice and learner-controlled review mechanisms within the PBL structure itself, the Anki-based model illustrates one way to address the temporal challenges of sustaining vocabulary, expression, sentence, and pronunciation development beyond a single semester. The implications extend beyond the immediate context of Hindi instruction to suggest new possibilities for inclusive, sustainable language pedagogy that serves learners across the proficiency spectrum.

2. Methodology

2.1. Research Design

This study employed a single-group experimental design to examine the motivational effects of the Anki-based PBL approach in an elementary Hindi course. Many studies on PBL omit control groups due to logistical or ethical challenges in school-based implementation, making single-group designs a practical alternative for exploratory research [62]. Similar challenges have been documented, emphasizing that although randomized controlled designs are ideal, exploratory PBL studies in authentic educational settings can still provide valuable insights into pedagogical effectiveness [63]. Accordingly, the present study sought to maximize internal instructional rigor through careful design of an individualized, technology-enhanced PBL model.

The instructional approach was grounded in multiple theoretical frameworks that informed both the pedagogical design and technology integration. Drawing on radical con-

structivism [64] and computer-assisted language learning theory [65], the model positioned each learner as an active constructor of knowledge through the creation of personalized Anki decks. This process embodied sociocultural principles of mediated knowledge construction through purposeful activity [66]. Scaffolding was purposefully arranged to guide students from supported performance towards increasing autonomy, consistent with models of L2 learner autonomy development [67]. Technology integration was governed by the TPACK framework [68], ensuring balanced integration of pedagogical, content, and technological knowledge.

In contrast to conventional group-based PBL tasks, this individualized approach enabled learners to confront authentic early-stage language challenges—including unfamiliar script, pronunciation hurdles, and rapid vocabulary attrition—through a self-directed, mobile-accessible flashcard system that both aligned with course objectives and adapted to each student's forgetting curve. This design addressed the sustainability challenge central to beginner-level PBL by embedding continuous practice mechanisms within the project structure itself.

2.2. Participants and Data Collection

The present study was conducted with 45 students enrolled in "Elementary Hindi (I)" during the spring semester of 2024, spanning 15 weeks from March to June. Despite the course's initial design for novices, the sample population encompassed both first-time learners and returning students with varying prior exposure to Hindi. The instruction focused on cultivating fundamental proficiency in Devanagari script and pronunciation, grammar, vocabulary and expressions, and receptive skills such as reading and listening. Of the participants, 17 were male and 28 were female. Final course grades were used to classify academic achievement into five categories: poor (n = 4), not bad (n = 13), average (n = 13), good (n = 10), and excellent (n = 5). This enabled stratified analyses of motivational patterns across gender and academic performance subgroups.

At the end of week 15, students completed the IMMS [69], administered via the university's LMS (See Appendix A). Survey responses were automatically recorded and matched with final course grades for analysis. Stratification by gender and academic achievement enabled a more nuanced investigation of motivational differences across learner subgroups, an approach that enables examination of motivational patterns across learner subgroups [70].

The instructional model employed in this study was predicated upon a personalized Anki project, which functioned as both the "problem" and "project" in the PBL framework. In contrast to many language-focused PBL courses, which typically encompass collaborative tasks such as the creation of communication materials or the production of multimedia artifacts [35,71], this course placed emphasis on hands-on, individual problem solving by guiding each learner to design and implement their own Anki-based digital flashcard system.

In the first week, students were introduced to the concept of PBL and its relevance for novice language learners. The instructor proposed a self-directed Anki deck project as a more feasible alternative to traditional group-based PBL, drawing on findings that digital flashcards enhance learner autonomy, engagement, and long-term vocabulary retention [72]. The rationale included challenges commonly observed in beginner classrooms, such as uneven group participation, logistical difficulties, and the inability of novice learners to define authentic problems. Each student was tasked with designing a flashcard set aligned with their own proficiency level and learning pace, utilizing spaced repetition to support long-term retention and self-regulated learning [72].

In accordance with standard PBL practice of presenting a problem scenario [17], the class first articulated the difficulties faced by novice Hindi learners and then conducted a needs analysis to identify the core challenges of traditional beginner-level instruction. The issues identified served as the foundation for the design brief, providing a framework for students to undertake preliminary analyses of the problems (See Table 1).

Table 1. Problem Scenarios in Beginner Hindi Instruction.

Problem	Scenario Context	Traditional Class Limitation
Script difficulty	Devanagari differs from Korean and Latin scripts, but support for individualized recognition is lacking.	No individualized script recognition support
Pronunciation complexity	Hindi contains unfamiliar phonemes, yet learners receive no targeted pronunciation feedback.	No targeted pronunciation correction
Limited individualized feedback	Large class sizes prevent instructors from providing timely, personalized error correction.	Insufficient personalized feedback
Memory decay without review	Without structured review, new content fades quickly from memory.	No structured review schedule
Tool Misalignment	Generic apps do not align with course content or adapt to learner needs.	No integration of adaptive digital tools

Following a thorough analysis of the core challenges outlined in Table 1, the class entered the PBL solution-generation phase. Students and the instructor collaboratively brainstormed targeted interventions to address each identified issue. Table 2 summarizes these proposed solutions, highlighting the key benefits and constraints of each approach.

Table 2. Student and Instructor Solution Proposals to Beginner Hindi Challenges.

Source	Solution	Benefits	Constraints
Students1	Worksheets & flashcards	Easy to use, Low tech barrier	Manual review, No adaptive scheduling
Students2	Voice-recognition chatbot for pronunciation practice	Real-time feedback on pronunciation	Requires advanced programming, Inconsistent recognition undermining learner trust
Students3	Multimedia mini-apps	Highly engaging, Contextual tasks	High development overhead, Static resources hindering adaptive review
Instructor	Anki decks with spaced repetition	Automated, adaptive review, Multimedia support	Initial setup/training required, Sustainable adaptive practice

Once the Anki-based approach was selected as the central instructional intervention, the course moved into the implementation phase. In the second week, a teaching assistant conducted a demonstration on how to make Anki. Students were trained in technical aspects such as typing Devanagari script, attaching audio files, and incorporating multimedia elements into their flashcards.

From weeks 3 to 14, students were tasked with developing and updating personalized Anki decks, ensuring alignment with weekly instructional content. While each learner was responsible for their own progress, informal peer-to-peer collaboration was encouraged, especially when difficulties arose during deck creation. By week 6, the majority of students

had completed the preliminary construction of their decks and had begun the process of refining and expanding them according to their evolving learning requirements. These decks incorporated pronunciation practice, listening exercises, and vocabulary reinforcement, facilitating individualized, self-paced engagement in a technology-supported learning environment.

In the final week of the semester, students presented their Anki decks to their peers and participated in reflective discussions. The result was a learner-generated language learning application that was both aligned with curricular goals and tailored to individual learning preferences. Such outcomes are rarely achieved in novice-level problem-based learning contexts [73,74].

This phased design highlighted key features of the Anki-based PBL model: personalized pacing, multimedia integration, and scaffolded review. These features distinguish the model from both traditional lecture-driven instruction and typical group-based PBL.

2.3. Research Instrument and Reliability

The modified IMMS comprised 34 positively worded items across four domains—attention (10 items), relevance (9), confidence (9), and satisfaction (6)—each rated on a five-point Likert scale. To address concerns regarding the interpretive difficulties of reverse-coded items, all negatively phrased statements were reworded positively before administration [61]. Reliability was evaluated using Cronbach's alpha. All subscales exceeded the 0.80 threshold, indicating high internal consistency, with the full instrument achieving $\alpha = 0.943$ (see Table 3).

Table 3. Instrument Reliability.

Domain	Cronbach's α	Items	M	SD
Attention (A)	0.8965	10	3.73	0.84
Relevance (R)	0.8354	9	3.64	0.72
Confidence (C)	0.9007	9	3.86	0.77
Satisfaction (S)	0.8792	6	3.93	0.73
Overall	0.9427	34	3.78	0.78

3. Results

3.1. Gender Differences in Motivation

An independent samples *t*-test was conducted to examine gender differences across the ARCS domains of motivation. As shown in Table 4, statistically significant differences were found between male and female participants across all domains. Female participants reported higher levels of motivation than male participants in Attention ($t = 4.09$, $p < 0.001$), Relevance ($t = 4.25$, $p < 0.001$), Confidence ($t = 3.78$, $p < 0.001$), and Satisfaction ($t = 4.15$, $p < 0.001$). These findings align with prior research indicating that gender differences can significantly shape learner motivation [75].

3.2. Academic Achievement Effects

A one-way analysis of variance (ANOVA) was conducted to examine differences among achievement groups across the ARCS domains. Students were classified into five levels based on final course grades: Excellent (Group A, $n = 5$), Good (Group B, $n = 10$), Average (Group C, $n = 13$), Not Bad (Group D, $n = 13$), and Poor (Group E, $n = 4$). As presented in Table 5, significant differences were identified in all domains: Attention, $F(4, 40) = 6.39$, $p < 0.001$, $\eta^2p = 0.39$; Relevance, $F(4, 40) = 6.80$, $p < 0.001$, $\eta^2p = 0.40$; Confidence, $F(4, 40) = 6.34$, $p < 0.001$, $\eta^2p = 0.39$; and Satisfaction, $F(4, 40) = 8.36$, $p < 0.001$, $\eta^2p = 0.46$.

Post-hoc comparisons using Scheffé's test showed that for Attention and Relevance, Group B actually outscored Group A, with lower-achieving groups following in order (B > A > C > D > E). This counterintuitive result probably stems from the small Group A sample (n = 5), though it raises the possibility that moderately successful students experienced more optimal task difficulty. Confidence and Satisfaction, by contrast, followed a straightforward hierarchy (A > B > C > D > E).

Table 4. Gender Differences in ARCS Motivation Domains.

Domain	Male M (SD)	Female M (SD)	t	p
Attention	3.55 (0.84)	3.87 (0.81)	4.09	<0.001
Relevance	3.47 (0.70)	3.77 (0.72)	4.25	<0.001
Confidence	3.70 (0.81)	3.99 (0.71)	3.78	<0.001
Satisfaction	3.73 (0.75)	4.09 (0.67)	4.15	<0.001
Overall	3.60 (0.79)	3.92 (0.74)	7.96	<0.001

Table 5. Academic Achievement Effects on ARCS Motivation.

Domain	F (4, 40)	p	η^2p	Post-Hoc (Scheffé)
Attention	6.39	<0.001	0.39	B > A > C > D > E
Relevance	6.80	<0.001	0.40	B > A > C > D > E
Confidence	6.34	<0.001	0.39	A > B > C > E > D
Satisfaction	8.36	<0.001	0.46	A > B > C > D > E

Despite these hierarchical differences, the significant effects across all groups suggest that the Anki-based approach engaged students at varying achievement levels. While the data generally show patterns consistent with research linking motivational patterns to achievement in language learning [76], the domain-level variations hint at more complex dynamics worth exploring.

3.3. Correlations Among ARCS Domains

Pearson correlations showed strong positive associations between attention and relevance (r = 0.785, $p < 0.001$), moderate correlations between attention and confidence (r = 0.536, $p < 0.001$), and smaller but significant correlations between satisfaction and the other three dimensions (attention: r = 0.496, relevance: r = 0.466, confidence: r = 0.442; all $p < 0.001$) (See Table 6). These results confirm that the four motivational constructs are related yet distinct, consistent with the ARCS framework [69].

Table 6. Intercorrelations Among ARCS Dimensions.

Domain	Attention	Relevance	Confidence	Satisfaction
Attention	1.000	0.785 **	0.536 **	0.496 **
Relevance	0.785 **	1.000	0.473 **	0.466 **
Confidence	0.536 **	0.473 **	1.000	0.442 **
Satisfaction	0.496 **	0.466 **	0.442 **	1.000

** $p < 0.001$.

3.4. Motivation Group Classification and Comparative Analysis

Participants were divided into three motivation levels based on their overall ARCS scores: low (≤3.5), moderate (>3.5 to <4.0), and high (≥4.0). A chi-square test showed no

association between gender and motivation level, $\chi^2(2) = 3.54$, $p = 0.170$, confirming that motivation grouping was independent of gender. To compare ARCS subscale scores across these groups, *t*-tests were performed (See Table 7).

Table 7. ARCS Subscale Comparisons Across Low, Moderate, and High Motivation Groups.

Domain	Group Comparison	t-Value	*p*-Value
Attention	High vs. Moderate	5.33	<0.001
	High vs. Low	13.61	<0.001
	Moderate vs. Low	6.15	<0.001
Relevance	High vs. Moderate	6.27	<0.001
	High vs. Low	13.08	<0.001
	Moderate vs. Low	4.88	<0.001
Confidence	High vs. Moderate	5.76	<0.001
	High vs. Low	13.41	<0.001
	Moderate vs. Low	5.93	<0.001
Satisfaction	High vs. Moderate	2.04	0.044
	High vs. Low	8.62	<0.001
	Moderate vs. Low	5.01	<0.001

A subsequent cluster analysis identified two distinct learner segments. Independent *t*-tests confirmed that the high-motivation cluster scored significantly higher than the low-motivation cluster on all ARCS dimensions (see Table 8). This pattern is consistent with findings that learner motivation profiles differ in engagement and achievement outcomes [76].

Table 8. Motivation Differences: High- vs. Low-Motivation Clusters on ARCS Dimensions.

Domain	Cluster 0 (M ± SD)	Cluster 1 (M ± SD)	t	*p*
Attention	3.31 ± 0.50	4.06 ± 0.35	−5.69	<0.001
Relevance	3.27 ± 0.32	3.94 ± 0.33	−6.98	<0.001
Confidence	3.43 ± 0.48	4.21 ± 0.37	−5.95	<0.001
Satisfaction	3.50 ± 0.37	4.28 ± 0.46	−6.305	<0.001

These significant cluster differences support the presence of distinct motivational profiles among learners (See Table 9).

The descriptive statistics demonstrate that, across all ARCS dimensions, high-motivation students attained scores that significantly exceeded those of moderate- and low-motivation peers, with especially pronounced differences in confidence and satisfaction. Even low-motivation learners averaged above the neutral midpoint (3.0), indicating that the Anki-based PBL intervention provided baseline motivational support for all participants.

Table 9. Distribution of Learners Across Motivation Levels by ARCS Domain Performance.

Domain	Motivation Level	M	SD
Attention	High (≥4.0)	4.18	0.64
	Moderate (>3.5–<4.0)	3.72	0.80
	Low (≤3.5)	3.13	0.73
Relevance	High (≥4.0)	4.05	0.60
	Moderate (>3.5–<4.0)	3.56	0.67
	Low (≤3.5)	3.15	0.58
Confidence	High (≥4.0)	4.30	0.57
	Moderate (>3.5–<4.0)	3.83	0.70
	Low (≤3.5)	3.29	0.62
Satisfaction	High (≥4.0)	4.23	0.49
	Moderate (>3.5–<4.0)	4.01	0.74
	Low (≤3.5)	3.46	0.61

4. Discussion

4.1. Overall Motivational Impact and Foundations for Sustainable Engagement (RQ1)

The Anki-based PBL intervention had a generally positive effect on beginner Hindi learners' motivation across the four ARCS dimensions. Mean scores across all domains were above the midpoint of the Likert scale, indicating that the model successfully sustained learner interest, promoted perceived value, supported self-efficacy, and generated emotional satisfaction [69]. This pattern is consistent with self-determination theory, which emphasizes the motivational role of autonomy and competence [7].

High-motivation learners reported particularly strong confidence and satisfaction, suggesting that the iterative, personalized nature of deck creation fostered self-regulated learning behaviors [77]. Even learners with lower motivation maintained above-neutral scores, confirming that the model provided a baseline of inclusive motivational support. This supports the view that problem-based instructional designs can enhance engagement when tasks are meaningful and personally relevant [78].

Cluster analysis revealed two motivational profiles, with the largest gap observed in relevance. This underscores the importance of learner-centered content selection in fostering goal alignment, consistent with prior research on motivation in second language acquisition [79]. Notably, high satisfaction scores across subgroups indicated that learners experienced deck creation as intrinsically rewarding, not merely a course requirement.

The results show that the Anki-based PBL approach effectively supported motivational engagement through autonomy, personalization, and task relevance, even among novice-level language learners. It also created an environment conducive to sustained practice over time. Confidence emerged as key to keeping students engaged, while satisfaction played an important role in promoting tool persistence. Thus, the motivational patterns observed in RQ1 form the psychological basis for the sustainability outcomes examined in RQ5, connecting immediate engagement with long-term persistence in beginner-level PBL learners.

4.2. Gender and Achievement Level Differences in Motivation and Implications for Inclusive Sustainability (RQ2)

The analysis showed that learner motivation varied by gender and academic achievement. Female students consistently reported higher levels of motivation across the ARCS

dimensions compared to male peers, a finding consistent with prior research on gender differences in academic motivation [80]. However, a chi-square test found no significant association between gender and motivational cluster membership. This means that while female students had higher average motivation scores, males and females were distributed relatively evenly across the low, moderate, and high motivation categories [80].

Academic achievement was also related to motivational patterns. One-way ANOVAs showed that higher achievers reported stronger motivation across all ARCS dimensions, with post-hoc tests revealing a hierarchy of high, moderate, and low achievers [81]. Even the lowest-achieving group demonstrated scores that exceeded the midpoint in all domains (see Table 5). This result suggests that the model provided baseline motivational support regardless of academic trajectory. This inclusivity is important for developing pedagogy that can reach diverse learners, rather than only high achievers.

The relationship between achievement and motivation varied across dimensions. High achievers scored highest in confidence and satisfaction, whereas moderate achievers occasionally matched or surpassed high achievers in attention and relevance. This pattern supports the assertion that problem-based instructional designs may provide optimal motivational scaffolding for mid-level learners, who benefit from structured engagement and incremental success, while high achievers may draw more on prior knowledge and self-regulatory strategies [78]. From this perspective, the model's personalized structure engages students at different readiness levels without requiring substantial extra work from the teacher—a feature particularly useful in large beginner classes.

This result emphasizes the necessity for sustainable educational innovation to address inclusivity across multiple dimensions, supporting both high and low achievers and appealing to learners of different genders. Overall, the fact that the Anki-based PBL model maintained motivation above neutral for all subgroups, while offering special benefits to moderate achievers, suggests it has real potential for supporting sustainable language instruction at the beginner level.

These patterns carry practical implications for course design. Instructors can set modest baseline requirements for deck building and provide structured examples early on, then gradually increase learner choice as confidence grows. Brief check-ins during the first few weeks help identify students struggling with the tool or uncertain of its value, allowing timely support before they disengage. Meanwhile, highly motivated learners can expand their decks and experiment with formats without requiring additional instructor input. This approach offers a safety net for weaker students while giving stronger ones room to work independently.

4.3. Interrelationships Among ARCS Dimensions and Their Implications for Sustainable Engagement (RQ3)

Analysis of interrelationships among the ARCS motivation components showed strong internal consistency and meaningful associations between subscales, supporting the multidimensional structure of learner motivation. The highest correlation emerged between attention and relevance, suggesting that when instructional strategies successfully captured learners' curiosity, the content was also more likely to be perceived as personally meaningful. This finding aligns with the view that motivational constructs within the ARCS framework are conceptually interconnected [60].

Moderate associations were observed between attention and confidence, and between relevance and satisfaction. These relationships support findings from motivation research indicating that cognitive engagement facilitates the development of self-efficacy [82], while perceived task value enhances emotional satisfaction [83]. Interestingly, the relationship between confidence and satisfaction, although significant, was the weakest, suggesting that self-efficacy and emotional rewards may operate somewhat independently in self-regulated,

technology-enhanced environments. This distinction is consistent with the interpretation of self-determination theory, which treats competence and intrinsic motivation as related but distinct psychological needs [7]. For sustainable design, this suggests that confidence must be built through manageable, iterative tasks, such as personalized deck creation. Confidence can sustain practice even when the activity is not always enjoyable.

The motivational group comparisons indicated that attention and confidence were the most discriminating factors between high- and low-motivation learners. This highlights the importance of maintaining engagement and fostering capability in learner-centered, digital environments such as Anki-based PBL. These results are consistent with research emphasizing autonomy-supportive design and personally relevant content in mobile and technology-assisted learning [84,85]. Moreover, the findings suggest that keeping beginner-level language learners engaged requires more than just initial motivational appeal; it depends on learners cultivating the confidence to engage in autonomous practice over time. The Anki-based model, by combining spaced repetition and adaptive feedback, directly supports this process, enabling learners to achieve incremental success that reinforces self-efficacy and sustains practice beyond the classroom.

4.4. Educational Implications of the Anki-Based PBL Approach for Sustainable Language Learning (RQ4)

To clarify the distinct educational value of the Anki-based PBL model, particularly its contribution to sustainable language learning practices, Table 10 presents a comparison of traditional instruction, typical PBL, and the individualized Anki-based design. This framework highlights how the Anki model uniquely addresses beginner learners' needs through enhanced autonomy, adaptive pacing, continuous practice support, and digital sustainability.

Table 10. Comparison of Traditional, Typical PBL, and Anki-based PBL Instructional Approaches.

	Traditional Language Instruction	**Typical PBL Language Instruction**	**Anki-Based PBL Language Instruction**
Learning Approach	Teacher-centered	Team-based, learner-centered	Individualized, learner-centered
Engagement	Passive participation	Collaborative problem-solving	Independent, self-directed practice
Scope & Pace	Fixed, uniform	Group-paced, theme-based	Personalized & adaptive
Practice Mode	Rote, isolated drills	Context-based tasks	Multimedia spaced repetition
Content Focus	Prescribed, standardized	Authentic group tasks	Learner-curated content
Task Structure	Standardized	Translation/corpus projects	Personalized, Feasible for Beginners
Biginners Learner Autonomy	Limited	Moderate	Enhanced
Beginner Accessibility	Minimal support	Often too complex	High
Learning Support	Grammar-focused drills, unstructured repetition	Facilitator guidance	Scaffolded spaced repetition, personalized feedback
Learning Tools	Analog tools	General digital tools	Adaptive SRS technology
Assessment	Standardized	Group evaluation	Self-tracking & dynamic review
Sustainability of Practice	Ends with course	Ends with project	Persists beyond course

Unlike traditional instruction, which relies on uniform delivery and rote practice, or typical PBL models centered on collaborative projects, the Anki-based approach allows learners to engage in personalized, self-directed tasks aligned with their language level and cognitive readiness. This individualized structure facilitates sustained engagement and minimizes the cognitive overload that can hinder novices in open-ended group tasks [25,59]. More importantly, unlike conventional approaches where structured support terminates with project submission, the Anki-based model embeds continuous practice mechanisms that extend beyond formal instruction, addressing the sustainability gap in beginner-level language education.

Cluster analysis identified two motivational profiles (See Table 8). Learners with high motivation showed stronger relevance and satisfaction, highlighting the benefits of personalization, a key design feature of the Anki project. By constructing their own decks with vocabulary, phrases, and multimedia elements relevant to their needs, learners exercised ownership, which research has linked to increased responsibility and engagement in PBL contexts [86]. This ownership lasted beyond the semester: highly motivated learners treated their decks as evolving learning tools rather than completed assignments, reflecting the model's capacity to foster sustainable, self-directed practice.

Student voices further emphasized this shift. Open-ended responses revealed strong affective connections to the Anki task, with comments such as, "I enjoyed creating Anki cards rather than just learning the language" and "Creating Anki cards helped me feel more confident in the course" (Table 7, items A3, C9). These reflections illustrate the transition from passive consumption to active construction, from teacher-led to learner-owned development [7].

Achievement-level comparisons showed that the benefits of this approach extended beyond top-performing students (See Table 5). Moderate achievers reported higher attention and relevance scores than high achievers in some domains, suggesting that scaffolded personalization through Anki supported diverse learners effectively. This balance between learner autonomy and structured support highlights the model's scalability and inclusivity [85].

The Anki-based PBL approach redefines what a "project" means in PBL—it's both a real-world challenge (retaining unfamiliar script and vocabulary) and a personalized digital solution. By combining spaced repetition with learner-centered design, the approach provides a scalable alternative to traditional and group-based PBL methods, aligning closely with foundational language education needs [85,87]. More fundamentally, it extends PBL beyond a one-time project to an ongoing learning system, supporting retention, autonomous practice, and self-directed development long after the course ends. For beginner learners facing rapid forgetting and requiring sustained support, this adaptability is essential.

4.5. Motivational Profiles and Sustainability of Anki-Based PBL (RQ5)

Cluster analysis identified two distinct motivational profiles based on ARCS scores (Table 8). The high-motivation group, characterized by subscale means exceeding 4.0, reflects the attributes of self-regulated learners who engage actively and persistently in language learning tasks [76]. In contrast, the low-motivation cluster, while maintaining scores above the neutral midpoint, reported notably lower ratings in relevance and confidence. This pattern is consistent with earlier findings that motivational profiles often reflect imbalances between autonomous and controlled regulation depending on contextual support [88].

Learners with stronger self-regulation readily integrated Anki-based PBL into their study routines, treating deck creation not as a terminal deliverable but as a persistent

resource that extended beyond the semester. The continuity of practice was reinforced by an algorithm-driven spaced repetition system, which ensured that vocabulary review adapted to individual forgetting curves. This approach addressed the sustainability gap often observed when traditional PBL projects conclude without follow-up. For less intrinsically motivated learners, the model still provided above-neutral engagement (Table 9: lowest M = 3.13), but sustaining their practice required additional scaffolding. Research on personalized learning environments suggests that adaptive feedback and targeted support can improve learners' confidence and perceived relevance—dimensions low in this group [89]. This assertion is substantiated by findings that fostering autonomy, competence, and relatedness can transform learners' motivation from controlled to autonomous regulation [90]. Integrating supports such as peer mentoring, progress check-ins, or embedded guidance within the Anki environment has the potential to extend the model's inclusivity and sustainability across diverse motivational profiles. These supports can be built into everyday classroom routines. To narrow the confidence gap among lower-motivation learners, instructors can set a modest baseline target for deck size, with the option of extension goals. Peer modeling can be encouraged through brief, structured moments in which students show sample cards and explain how they designed them, giving others concrete examples to follow. Relevance can be strengthened by linking vocabulary choice to learners' personal interests or future plans. At the beginning of the course, a small set of starter templates can help to ease the initial load; these scaffolds can then be gradually withdrawn as students gain confidence and begin to work more independently with the tool. The significance of combining structured guidance with learner ownership, particularly in technology-mediated contexts, has been emphasized in research on autonomy-supportive instruction [91].

This pattern shows that while highly motivated learners naturally engaged in sustained practice, the structural features of the Anki-based model—personalized pacing, algorithmic review, and learner-generated content—helped lower-motivation learners maintain baseline engagement and develop ownership over their learning tools. By reducing reliance on continuous teacher scaffolding, this balance between individualization and support makes Anki-based PBL more scalable in larger beginner-level classes where instructional resources are limited.

Beyond motivation, the project also helped learners build transferable self-regulatory skills needed for lifelong language learning. As they created and refined their decks, learners engaged in metacognitive planning, resource selection, and self-monitoring, and many described this personalized tool-building as genuinely satisfying rather than merely another course requirement. For sustainable implementation, the model's differentiated yet scalable structure allowed students at different levels of readiness to stay engaged without requiring a corresponding increase in teacher workload, which is crucial in large beginner-level classes. Learners' attention was largely sustained because they regarded the tasks as personally relevant, while the distinct motivational profiles showed both where the approach worked particularly well for highly motivated learners and where additional scaffolding was still needed for those with lower confidence and perceived relevance. When considered alongside the motivational patterns (RQ1), group differences by gender and achievement (RQ2), and the ARCS interrelationships and design implications (RQ3 and RQ4), these findings suggest that sustainability in beginner-level PBL depends on weaving together intrinsic satisfaction, persistence, scalable differentiation, and tool-based self-regulation within the project structure itself. From this perspective, the Anki-based PBL model links engagement during the course with continued language development once formal instruction ends.

5. Conclusions and Current Research Limitations

This study investigated the motivational effects of an innovative Anki-based PBL model within an elementary Hindi course, offering a distinctive alternative to both traditional language instruction and conventional team-based PBL. Implemented with 45 undergraduate students over a 15-week semester, the course treated individualized Anki deck creation as the central problem and final project, with a particular focus on helping beginners cope with rapidly forgetting new vocabulary, expressions, sentences, and pronunciation. A key design decision in this course was to treat the Anki deck not as a supplementary study aid but as the main product of the PBL project. In this format, card creation was positioned not as a mechanical exercise but as a space for self-directed experimentation: students used their decks to work with Devanagari script, new vocabulary, and situational expressions, and some also added simple audio for listening practice. This arrangement maintained the clear structure of traditional instruction while incorporating the personal choice and autonomy associated with PBL, offering a model that remains manageable for teachers yet flexible enough to scale to novice-level classes.

The modified, positively worded version of the IMMS proved reliable and theoretically robust, capturing strong motivation across all ARCS domains, with particularly strong scores in confidence and satisfaction, which suggests that combining spaced repetition with learner-generated content can support beginners' sense of progress and capability. Analyses by gender and achievement, together with the cluster analysis, indicated two clear motivational profiles and highlighted the need for differentiated scaffolding if engagement is to be sustained across learner subgroups. These patterns help to locate the Anki-based model pedagogically: rather than relying solely on fixed teacher-led routines or demanding group projects, it invites learners to assemble their own practice tools at an appropriate level of complexity, supported by digital technology and targeted guidance.

At the same time, the model speaks directly to the "sustainability gap" often seen in conventional PBL. In this design, the project does not end with a one-off product; it becomes the tool that learners continue to use. In principle, the deck's spaced-repetition algorithm can help vocabulary, expressions, and basic sentence patterns remain active after the course, while the ongoing work of building and adjusting cards can foster self-regulatory habits. The findings therefore challenge the view that beginners face difficulties with PBL, but they do indicate that when the project is framed as the creation of a personalized, adaptive learning tool and success is understood in terms of continued use and engagement, PBL can be made workable for novice learners.

Despite its contributions, the study has several limitations that suggest important directions for future research. The absence of a control group limits causal inference, and learning outcomes were only measured through self-reported motivation, not objective language gains. Additionally, the study did not include longitudinal follow-up to assess whether learners continued using their Anki decks beyond the course or whether sustained use correlated with long-term proficiency development. The course also blended PBL with conventional instruction, making it difficult to disentangle the effects of each component. Future work should therefore incorporate comparison groups to isolate the specific contribution of the Anki-based model, combine self-report data with objective measures such as vocabulary retention, recognition of basic expressions and sentence patterns, script reading, or simple communicative performance, and follow students across subsequent semesters to examine whether continued deck use is associated with measurable gains. Comparative studies that vary the balance between direct instruction and project-based elements could further clarify which features are most beneficial for beginners with limited prior language experience.

Nevertheless, the hybrid structure used here reflects the practical needs of novice learners and shows how educational innovation can take shape through adaptable, technology-enhanced formats that balance structure and autonomy.

In conclusion, the Anki-based PBL model appears to have strong potential as a sustainable and learner-centered instructional strategy in early-stage language education. When students build and maintain their own decks, the same activity that supports practice during the semester also leaves them with a tool they can continue to use afterwards. This approach does not remove all the difficulties associated with beginner-level PBL, but it offers a practical way of connecting vocabulary, expression, sentence, and pronunciation work to a project that has a life beyond the course. Further research in other languages and institutional settings will help to examine how this design can be adapted, and to what extent its effects can be replicated.

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Institutional Review Board Statement: The study was reviewed and approved by the Institutional Review Board (IRB) of Hankuk University of Foreign Studies (Approval No. NZ2023BKSB20230031-00026; approval date: 15 December 2023). I also confirm that the study was conducted in accordance with the Declaration of Helsinki and institutional ethical guidelines for research involving human participants.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Students were informed in advance about the integration of Anki-based PBL into the Elementary Hindi course through the course syllabus, which was distributed before the semester began on 2 March 2024. In addition, prior to data collection, students were notified via the university's e-Class platform that the course would incorporate Anki-based PBL into Hindi learning and that they would be expected to bring a laptop or tablet.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author. The data are not publicly available due to privacy restrictions. Classes and surveys were conducted with student consent according to the research protocols approved by the university IRB.

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Appendix A

The Instructional Materials Motivation Survey (IMMS) by Keller.

Code	Measurement Items	5	4	3	2	1
A1	There were interesting aspects in this course that captured my attention.					
A2	The PBL-oriented instruction grabbed my attention.					
A3	I enjoyed not only learning the language but also creating Anki cards.					
A4	I was able to maintain my interest because the PBL class was concrete and relatable.					
A5	I found the PBL class engaging and appealing.					
A6	The way the content was presented in the PBL course helped me stay interested.					
A7	The PBL class stimulated my curiosity.					
A8	The varied content in this course kept me interested throughout.					
A9	I learned more than I expected through the PBL class.					
A10	Compared to traditional classes, the PBL course helped me sustain long-term interest.					
R1	The content presented in the PBL class was something I already knew.					
R2	The task of creating Anki cards in this course was important to me.					
R3	Successfully completing the PBL class mattered to me.					
R4	The content of the PBL class was related to my areas of interest.					
R5	The course provided explanations or examples on how to apply what I learned.					
R6	This instructional method gave me the impression that studying was worthwhile.					
R7	I felt the PBL class content was new and worthwhile to learn.					
R8	The PBL-based course was connected to things I had seen, done, or thought about before.					
R9	The structure and content of the course will be helpful to me.					
C1	When I first learned about this course, it seemed like it would be easy.					
C2	Creating Anki cards was as easy as I expected.					
C3	After hearing that this was a PBL course, I was confident there would be something to learn.					
C4	I found it easy to remember the key points presented.					
C5	I felt confident that I could master the course content while studying.					
C6	Designing Anki cards for this course was manageable for me.					
C7	I felt confident that I was effectively learning the language through my participation.					
C8	I understood the purpose and value of a PBL-based approach.					
C9	Creating Anki cards helped me feel more confident in the PBL course.					
S1	I felt a sense of accomplishment when creating Anki cards through PBL.					
S2	I enjoyed the PBL course and wanted to find out more about related topics.					
S3	I genuinely enjoyed studying in this course.					
S4	I felt that my efforts were recognized through the PBL class.					
S5	I was satisfied with successfully completing the course.					
S6	I was glad to have taken the course because the instructional design was excellent.					

5 = very true; 4 = mostly true; 3 = moderately true; 2 = slightly true; 1 = not true.

References

1. Dörnyei, Z.; Al-Hoorie, A.H. The motivational foundation of learning languages other than Global English. *Mod. Lang. J.* **2017**, *101*, 455–468. [CrossRef]
2. Little, D. Language learner autonomy: Some fundamental considerations revisited. *Innov. Lang. Learn. Teach.* **2007**, *1*, 14–29. [CrossRef]

3. Nsenga, C.S.; Andala, H.O. Learner centred teaching techniques and students' engagement in English subject in public secondary schools in Musha Sector, Rwamagana District, Rwanda. *J. Educ.* **2022**, *5*, 27–40. [CrossRef]
4. Huang, J. Teacher autonomy in language learning: A review of the research. In *Research Studies in Education, Volume 3: The Eighth Postgraduate Research Conference, 2005, Faculty of Education, The University of Hong Kong*; Katyal, K.R., Lam, H.C., Ding, X., Eds.; Office of Research, Faculty of Education, The University of Hong Kong: Hong Kong, China, 2005; pp. 203–218.
5. Reeve, J. A self-determination theory perspective on student engagement. In *Handbook of Research on Student Engagement*; Christenson, S., Reschly, A., Wylie, C., Eds.; Springer: Boston, MA, USA, 2012; pp. 149–172. [CrossRef]
6. Ryan, R.M.; Deci, E.L. *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*; Guilford Press: New York, NY, USA, 2017. [CrossRef]
7. Ryan, R.M.; Deci, E.L. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* **2000**, *55*, 68–78. [CrossRef]
8. Benson, P. Autonomy in language teaching and learning. *Lang. Teach.* **2007**, *40*, 21–40. [CrossRef]
9. Ellis, R. *Task-Based Language Learning and Teaching*; Oxford University Press: New York, NY, USA, 2003. Available online: https://alad.enallt.unam.mx/modulo7/unidad1/documentos/CLT_EllisTBLT.pdf (accessed on 20 October 2025).
10. Tragant, E.; Victori, M. Language learning strategies, course grades, and age in EFL secondary school learners. *Lang. Aware.* **2012**, *21*, 293–308. [CrossRef]
11. Zhang, J.; Yanfeng, M. Task engagement in Chinese university EFL classrooms: A comparative analysis of student and teacher perspectives. *Cogent Educ.* **2025**, *12*, 2492652. [CrossRef]
12. Ellis, R. Principles of instructed language acquisition. *System* **2005**, *33*, 209–224. [CrossRef]
13. Littlewood, W. Communicative and task-based language teaching in East Asian classrooms. *Lang. Teach.* **2007**, *40*, 243–249. [CrossRef]
14. Sweller, J. Cognitive load during problem solving: Effects on learning. *Cogn. Sci.* **1988**, *12*, 257–285. [CrossRef]
15. Hunt, A.; Beglar, D. A framework for developing EFL reading vocabulary. *Read. A Foreign Lang.* **2005**, *17*, 23–59. [CrossRef]
16. Rodríguez-Arce, J.; Vázquez-Cano, E.; Cobá Juárez-Pegueros, J.P.; González-García, S. Comparison of learning content representations to improve L2 vocabulary acquisition using m-learning. *Sage Open* **2023**, *13*, 21582440231216819. [CrossRef]
17. Hmelo-Silver, C.E. Problem-based learning: What and how do students learn? *Educ. Psychol. Rev.* **2004**, *16*, 235–266. [CrossRef]
18. Strelan, P.; Osborn, A.; Palmer, E. The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels. *Educ. Res. Rev.* **2020**, *30*, 100314. [CrossRef]
19. Dochy, F.; Segers, M.; Van den Bossche, P.; Gijbels, D. Effects of problem-based learning: A meta-analysis. *Learn. Instr.* **2003**, *13*, 533–568. [CrossRef]
20. Hung, W. Problem-based learning: Conception, practice, and future. In *Authentic Problem Solving and Learning in the 21st Century. Education Innovation Series*; Cho, Y., Caleon, I., Kapur, M., Eds.; Springer: Singapore, 2015; pp. 3–17. [CrossRef]
21. Savery, J.R. Overview of problem-based learning: Definitions and distinctions. *Interdiscip. J. Probl.-Based Learn.* **2006**, *1*, 5–15. [CrossRef]
22. Tamim, S.R.; Grant, M.M. Definitions and uses: Case study of teachers implementing project-based learning. *Interdiscip. J. Probl.-Based Learn.* **2013**, *7*, 72–101. [CrossRef]
23. Stoller, F. Establishing a theoretical foundation for project-based learning in second and foreign language contexts. In *Project-Based Second and Foreign Language Education: Past, Present, and Future*; Beckett, G.H., Miller, P.C., Eds.; Information Age: Greenwich, CT, USA, 2006; pp. 19–40.
24. Fried-Booth, D.L. *Project Work*, 2nd ed.; Oxford University Press: Oxford, UK, 2002.
25. Kirschner, P.A.; Sweller, J.; Clark, R.E. Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educ. Psychol.* **2006**, *41*, 75–86. [CrossRef]
26. Dooly, M.; Sadler, R. Becoming little "scientists": Technologically-enhanced project-based language learning. *Lang. Learn. Technol.* **2016**, *20*, 54–78. [CrossRef]
27. Beckett, G.H. Teacher and student evaluations of project-based instruction. *TESL Can. J.* **2002**, *19*, 52–66. [CrossRef]
28. Fragoulis, I. Project-based learning in the teaching of English as a foreign language in Greek primary schools: From theory to practice. *Engl. Lang. Teach.* **2009**, *2*, 113–119. [CrossRef]
29. Gülbahar, Y.; Tinmaz, H. Implementing project-based learning and e-portfolio assessment in an undergraduate course. *J. Res. Technol. Educ.* **2006**, *38*, 309–327. [CrossRef]
30. Robinson, P. Task complexity, task difficulty, and task production: Exploring interactions in a componential framework. *Appl. Linguist.* **2001**, *22*, 27–57. [CrossRef]
31. Skehan, P. Task-based instruction. *Annu. Rev. Appl. Linguist.* **1998**, *18*, 268–286. [CrossRef]
32. Dörnyei, Z.; Kormos, J. The role of individual and social variables in oral task performance. *Lang. Teach. Res.* **2000**, *4*, 275–300. [CrossRef]

33. Foster, P.; Ohta, A.S. Negotiation for meaning and peer assistance in second language classrooms. *Appl. Linguist.* **2005**, *26*, 402–430. [CrossRef]
34. Mackey, A.; Goo, J. Interaction research in SLA: A meta-analysis and research synthesis. In *Conversational Interaction in Second Language Acquisition*; Mackey, A., Ed.; Oxford University Press: Oxford, UK, 2007; pp. 407–453.
35. Beckett, G.H.; Slater, T. The project framework: A tool for language, content, and skills integration. *ELT J.* **2005**, *59*, 108–116. [CrossRef]
36. Blatchford, P.; Bassett, P.; Brown, P. Examining the effect of class size on classroom engagement and teacher–pupil interaction: Differences in relation to pupil prior attainment and primary vs. secondary schools. *Learn. Instr.* **2011**, *21*, 715–730. [CrossRef]
37. Hattie, J. *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*; Routledge: London, UK, 2009.
38. Chapelle, C.A.; Sauro, S. *The Handbook of Technology and Second Language Teaching and Learning*; John Wiley & Sons: Hoboken, NJ, USA, 2017. [CrossRef]
39. Godwin-Jones, R. Mobile apps for language learning. *Lang. Learn. Technol.* **2011**, *15*, 2–11. [CrossRef]
40. Stockwell, G. Using mobile phones for vocabulary activities: Examining the effect of platform. *Lang. Learn. Technol.* **2010**, *14*, 95–110. [CrossRef]
41. Stockwell, G. Technology and motivation in English-language teaching and learning. In *International Perspectives on Motivation. International Perspectives on English Language Teaching*; Ushioda, E., Ed.; Palgrave Macmillan: London, UK, 2013; pp. 156–175. [CrossRef]
42. Karpicke, J.D.; Bauernschmidt, A. Spaced retrieval: Absolute spacing enhances learning regardless of relative spacing. *J. Exp. Psychol. Learn. Mem. Cogn.* **2011**, *37*, 1250–1257. [CrossRef]
43. Nakata, T. Computer-assisted second language vocabulary learning in a paired-associate paradigm: A critical investigation of flashcard software. *Comput. Assist. Lang. Learn.* **2011**, *24*, 17–38. [CrossRef]
44. Elgort, I. Deliberate learning and vocabulary acquisition in a second language. *Lang. Learn.* **2011**, *61*, 367–413. [CrossRef]
45. Kornell, N.; Bjork, R.A. The promise and perils of self-regulated study. *Psychon. Bull. Rev.* **2007**, *14*, 219–224. [CrossRef]
46. Godwin-Jones, R. Emerging technologies: From memory palaces to spacing algorithms: Approaches to second-language vocabulary learning. *Lang. Learn. Technol.* **2010**, *14*, 4–11. [CrossRef]
47. Chukharev-Hudilainen, E.; Klepikova, T.A. The effectiveness of computer-based spaced repetition in foreign language vocabulary instruction: A double-blind study. *CALICO J.* **2016**, *33*, 334–354. [CrossRef]
48. Altiner, C. Integrating a computer-based flashcard program into academic vocabulary learning. *Turk. Online J. Educ. Technol.* **2019**, *18*, 44–62. [CrossRef]
49. Ashcroft, R.J.; Imrie, A.C. Learning vocabulary with digital flashcards. In *JALT2013 Conference Proceedings*; Sonda, N., Krause, A., Eds.; JALT: Tokyo, Japan, 2014.
50. Cooper, S.; Twardowski, N.; Vogel, M.; Perling, D.; Ryznar, R. The effect of spaced repetition learning through Anki on medical board exam performance. *Int. J. Med. Stud.* **2023**, *11*, 271–275. [CrossRef]
51. Karpicke, J.D.; Grimaldi, P.J. Retrieval-based learning: A perspective for enhancing meaningful learning. *Educ. Psychol. Rev.* **2012**, *24*, 401–418. [CrossRef]
52. Panadero, E. A review of self-regulated learning: Six models and four directions for research. *Front. Psychol.* **2017**, *8*, 422. [CrossRef] [PubMed]
53. Bjork, R.A. Memory and metamemory considerations in the training of human beings. In *Metacognition: Knowing About Knowing*; Metcalfe, J., Shimamura, A.P., Eds.; MIT Press: Cambridge, MA, USA, 1994; pp. 185–205.
54. Bjork, R.A.; Dunlosky, J.; Kornell, N. Self-regulated learning: Beliefs, techniques, and illusions. *Annu. Rev. Psychol.* **2013**, *64*, 417–444. [CrossRef] [PubMed]
55. Cepeda, N.J.; Pashler, H.; Vul, E.; Wixted, J.T.; Rohrer, D. Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychol. Bull.* **2006**, *132*, 354–380. [CrossRef]
56. Karpicke, J.D. Retrieval-based learning: A decade of progress. In *Learning and Memory: A Comprehensive Reference*; Wixted, J.T., Ed.; Academic Press: Cambridge, MA, USA, 2017; pp. 487–514.
57. Deci, E.L.; Ryan, R.M. The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychol. Inq.* **2000**, *11*, 227–268. [CrossRef]
58. Tomlinson, C.A.; Imbeau, M.B. *Leading and Managing a Differentiated Classroom*; ASCD: Alexandria, VA, USA, 2010.
59. Hmelo-Silver, C.E.; Duncan, R.G.; Chinn, C.A. Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educ. Psychol.* **2007**, *42*, 99–107. [CrossRef]
60. Keller, J.M. *Motivational Design for Learning and Performance: The ARCS Model Approach*; Springer: New York, NY, USA, 2010. [CrossRef]

61. Cook, D.A.; Pankratz, V.S. Validation of the Instructional Materials Motivation Survey among medicine resident physicians. *MedEdPublish* **2024**, *14*, 58. [CrossRef]
62. Condliffe, B.; Quint, J.; Visher, M.G.; Bangser, M.R.; Drohojowska, S.; Saco, L.; Nelson, E. *Project-Based Learning: A Literature Review*; MDRC: New York, NY, USA, 2017. Available online: https://www.pblworks.org/research/research-project-based-learning-literature-review (accessed on 20 October 2025).
63. Bell, S. Project-Based Learning for the 21st Century: Skills for the Future. *Clear. House A J. Educ. Strateg. Issues Ideas* **2010**, *83*, 39–43. [CrossRef]
64. von Glasersfeld, E. An introduction to radical constructivism. In *The Invented Reality: How Do We Know What We Believe We Know?* Watzlawick, P., Ed.; W.W. Norton & Company: London, UK, 1984; pp. 17–40.
65. Chapelle, C.A. *Computer Applications in Second Language Acquisition*; Cambridge University Press: Cambridge, UK, 2001. [CrossRef]
66. Swain, M. The output hypothesis and beyond: Mediating acquisition through collaborative dialogue. In *Sociocultural Theory and Second Language Learning*; Lantolf, J.P., Ed.; Oxford University Press: Oxford, UK, 2000; pp. 97–114.
67. Oxford, R.L. Toward a more systematic model of L2 learner autonomy. In *Learner Autonomy across Cultures*; Palfreyman, D., Smith, R.C., Eds.; Palgrave Macmillan: London, UK, 2003; pp. 75–91. [CrossRef]
68. Mishra, P.; Koehler, M.J. Technological pedagogical content knowledge: A framework for teacher knowledge. *Teach. Coll. Rec.* **2006**, *108*, 1017–1054. [CrossRef]
69. Keller, J.M. Development and use of the ARCS Model of instructional design. *J. Instr. Dev.* **1987**, *10*, 2–10. [CrossRef]
70. Guilloteaux, M.J.; Dörnyei, Z. Motivating language learners: A classroom-oriented investigation of the effects of motivational strategies on student motivation. *TESOL Q.* **2008**, *42*, 55–77. [CrossRef]
71. Guo, P.; Saab, N.; Post, L.S.; Admiraal, W. A review of project-based language learning in higher education: Student outcomes and contexts. *Int. J. Educ. Res.* **2020**, *102*, 101586. [CrossRef]
72. Teymouri, R. Recent developments in mobile-assisted vocabulary learning: A mini review of published studies focusing on digital flashcards. *Front. Educ.* **2024**, *9*, 1496578. [CrossRef]
73. Hearn, B.J.; Hopper, P.F. Instructional strategies for using problem-based learning with English language learners. *MEXTESOL J.* **2008**, *32*, 39–46.
74. Ansarian, L.; Mohammadi, F.S. Problem-based learning in action: Review of empirical studies. *Pertanika J. Soc. Sci. Humanit.* **2018**, *26*, 13–32.
75. Dörnyei, Z.; Ushioda, E. *Teaching and Researching Motivation*, 2nd ed.; Pearson: Harlow, UK, 2011.
76. Papi, M.; Teimouri, Y. Language learner motivational types: A cluster analysis study. *Lang. Learn.* **2014**, *64*, 493–525. [CrossRef]
77. Zimmerman, B.J. Becoming a self-regulated learner: An overview. *Theory Into Pract.* **2002**, *41*, 64–70. [CrossRef]
78. Hung, W. Theory to reality: A few issues in implementing problem-based learning. *Educ. Technol. Res. Dev.* **2011**, *59*, 529–552. [CrossRef]
79. Dörnyei, Z. *Motivational Strategies in the Language Classroom*; Cambridge University Press: Cambridge, UK, 2001. [CrossRef]
80. Meece, J.L.; Glienke, B.B.; Burg, S. Gender and motivation. *J. Sch. Psychol.* **2006**, *44*, 351–373. [CrossRef]
81. Hidi, S.; Harackiewicz, J.M. Motivating the academically unmotivated: A critical issue for the 21st century. *Rev. Educ. Res.* **2000**, *70*, 151–179. [CrossRef]
82. Pajares, F. Self-efficacy beliefs in academic settings. *Rev. Educ. Res.* **1996**, *66*, 543–578. [CrossRef]
83. Wigfield, A.; Eccles, J.S. Expectancy–value theory of achievement motivation. *Contemp. Educ. Psychol.* **2000**, *25*, 68–81. [CrossRef]
84. Dörnyei, Z. The L2 motivational self system. In *Motivation, Language Identity and the L2 Self*; Dörnyei, Z., Ushioda, E., Eds.; Multilingual Matters: Bristol, UK, 2009; pp. 9–42. [CrossRef]
85. Viberg, O.; Grönlund, Å. Cross-cultural analysis of users' attitudes toward the use of mobile devices in second and foreign language learning in higher education: A case from Sweden and China. *Comput. Educ.* **2013**, *69*, 169–180. [CrossRef]
86. Krajcik, J.S.; Blumenfeld, P.C. Project-based learning. In *The Cambridge Handbook of the Learning Sciences*; Sawyer, R.K., Ed.; Cambridge University Press: Cambridge, UK, 2006; pp. 317–334. [CrossRef]
87. Thomas, J.W. *A Review of Research on Project-Based Learning*; Autodesk Foundation: San Rafael, CA, USA, 2000. Available online: http://www.bobpearlman.org/BestPractices/PBL_Research.pdf (accessed on 20 October 2025).
88. Gillet, N.; Vallerand, R.J.; Rosnet, E. Motivational clusters and performance in a real-life setting: A self-determination perspective. *Motiv. Emot.* **2009**, *33*, 49–62. [CrossRef]
89. VanLehn, K. The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educ. Psychol.* **2011**, *46*, 197–221. [CrossRef]

90. Vansteenkiste, M.; Ryan, R.M. On psychological growth and vulnerability: Basic psychological need satisfaction and need frustration as a unifying principle. *J. Psychother. Integr.* **2013**, *23*, 263–280. [CrossRef]
91. Reeve, J. Autonomy-supportive teaching: What it is, how to do it. In *Building Autonomous Learners*; Liu, W., Wang, J., Ryan, R., Eds.; Springer: Singapore, 2016; pp. 129–152. [CrossRef]