TEACHER AUTONOMY SUPPORT FOR YOUNG BEGINNERS' APP-BASED LANGUAGE LEARNING BEYOND THE CLASSROOM: A SELF-DETERMINATION THEORY PERSPECTIVE

By

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ABSTRACT

With the importance of second language (L2) learning beyond the classroom (e.g., Reinders et al., 2022), language learning apps (e.g., *Mango Languages*, *Duolingo*) have shown potential for promoting self-directed L2 learning. Despite research indicating a positive relationship between the extent of in-app activities and L2 proficiency gains (e.g., Loewen et al., 2020), high attrition rates pose a significant challenge to this learning method in self-study contexts (Hwang et al., 2024). Thus, teacher support is crucial for developing learners' agency in their independent use of technology out of class (Godwin-Jones, 2019).

In self-determination theory (SDT, Ryan & Deci, 2017; Noels et al. 2019a in L2 contexts), autonomy—a fundamental human psychological need—refers to a sense of volition and self-endorsement in one's action. When this need is satisfied, learners take ownership of their own learning and engage in activities out of interest and enjoyment. This, in turn, leads to greater learning success and well-being. In this dissertation, I explored how teachers can support L2 learners' autonomy need for app-based language learning out of class, thereby influencing their app engagement, app usage, and L2 learning. Particularly, the study examined the moderating role of learners' initial motivation for English learning in this process.

Additionally, recognizing the potential influence of socio-ecological structures, I investigated the implementation of app-based language learning in South Korea's distinctive educational context. In South Korea, the high-stakes nature of English tests often leads learners to rely on *hagwons*—for-profit, private educational institutions. Within this landscape, language learning apps are one of many resources available for English learning. Building on this, I explored whether learners' perceived opportunity cost of using language learning apps (i.e., the sense of sacrificing other valued learning activities to use apps) affects their out-of-class app usage, and how teacher autonomy support can help mitigate this perceived opportunity cost.

Participants were seventh-grade beginner learners ($N = 258$) in South Korea. While learners independently used a commercially available language learning app over 13 weeks, their teachers provided Reeve and Cheon's (2021) autonomy-supportive instructional behaviors to enhance out-of-class app usage. Using questionnaires, I measured learners' (a) initial L2 motivation, (b) perceived teacher autonomy support, (c) autonomy need satisfaction, (d) app engagement (behavioral, emotional, cognitive, and agentic dimensions), and (e) perceived opportunity cost. Additionally, in-app usage and learning gain data were collected.

Using structural equation modeling, I conducted mediation and moderated mediation analyses, revealing three key findings: (1) greater app usage positively predicted vocabulary learning gains; (2) teacher autonomy support indirectly increased app usage by enhancing autonomy need satisfaction and reducing perceived opportunity cost; and (3) teacher autonomy support was effective even for learners with controlled L2 motivation.

These findings suggest that classroom-based autonomy support encourages L2 learners to use technology beyond the classroom and builds their resilience against disengagement from it, enabling sustained self-directed L2 learning. Pedagogical implications are discussed regarding the importance of creating a structured learning climate to ensure consistent and reliable teacher autonomy support.

This dissertation is dedicated to my family.
Thank you for always believing in me.

ACKNOWLEDGEMENTS

On August 16th, 2021, we arrived at a small airport in Lansing, Michigan. It is strange how I can vividly recall that day yet struggle to remember recent events. We were burdened with large suitcases, and after a 15-hour flight, my 2-year-old son was whining, exhausted, and asleep on his mother’s back. Jealously watching others being greeted by familiar faces, we felt utterly alone, as we were the only people we knew in this foreign country. We took an Uber, driving past the sign for 1855 family housing, and entered our new home. An unfamiliar scent greeted us as we opened the door. Bo-ram and I started unpacking and cleaning, while Ha-jun explored his new surroundings with curiosity. Lying in bed that night, we struggled to fall asleep amid the noisy train sounds coming from nearby and the discomfort of being in an unfamiliar place. The overnight change in everything felt surreal, almost dreamlike, leaving us full of nervous excitement and wonder about what the coming days would bring.

Over the last four years, I’ve come to acknowledge that not every day is filled with happiness and joy. There have been stressful struggles, constant efforts to improve, and moments of wondering when I would finally reach the end of this long tunnel. However, looking back on our time here, my family has made wonderful friends who have always been kind to us and stood by us through both good times and bad. It’s clear that we have been able to live safely and thrive without major concerns over the past few years. The good memories we’ve made with them have been a true blessing in our lives and will stay with us forever. We are no longer alone.

To celebrate the completion of this significant milestone, I want to express my sincere gratitude for the help, care, guidance, and encouragement I have received from those around me. First and foremost, I am deeply grateful to my family for their unconditional love throughout this journey. Bo-ram and Ha-jun moved to the U.S. with me, leaving behind their lives in Korea to support my dream. They have been wonderful companions along the way, and I deeply appreciate their sacrifices. My parents also deserve special recognition for their unwavering love and support, which have laid the foundation for my successes and shaped me into the person I am today. Their presence in my life has been a constant source of strength, inspiration, and perseverance. I am proud to be their son.

I consider myself incredibly fortunate to have shared my academic journey with my Fall 2021 cohort, the Three Idiots—Matt and Vashti. These comrades have been a tremendous blessing, providing not only intellectual engagement but also deep personal connections that have enriched both my life and my family's. Our friendship, humor, and support, along with unforgettable cohort meals, made my PhD experience all the more enjoyable.

Professionally, I have been profoundly influenced by the dedication and support of my dissertation committee. My advisor, Dr. Shawn Loewen, has been an incredible mentor and unwavering supporter in all circumstances. His commitment goes beyond academic guidance; he has been a steadfast source of support and advocacy during difficult times, enabling me to 'keep calm and carry on.' I am also immensely indebted to Drs. Charlene Polio, Paula Winke, Aline Godfroid, and Yuichi Suzuki, whose insights and encouragement have not only strengthened my research, including this dissertation, but have also played a pivotal role in shaping my expertise and perspectives as a junior researcher.

I feel truly blessed to be part of the SLS community and to cherish the memories I've shared with Ryo, Curtis, Robert, Kiyo, Dylan, Kevin, Brittany, Amr, Yingzhao, Ayşen, Carlo, Steve, Adam, Philip, and Won-Young. They have generously shared their 'secret sauce' for thriving in the program, offering invaluable survival skills that have enriched my well-being, productivity, and sense of belonging. They are not just friends but also mentors, making my academic journey both enjoyable and fulfilling. Another highlight of my time in Wells Hall has been my interactions with Dr. Fred Poole. He is an incredibly kind, smart, down-to-earth, and humorous person, and I truly love our water-cooler conversations. He has introduced me to the world of technology and has been an endless source of new research ideas and creativity.

Outside the SLS program, I am especially grateful to Kaitlyn Tagarelli for her tremendous support and feedback on my research and for generously allowing me to use *Mango Languages* in multiple projects. Working with her has provided me with invaluable hands-on experience and insights into the synergy between research and industry collaboration. I am also deeply thankful to my friend Rob Mucklo, who has always welcomed me with open arms whenever I visit Pittsburgh, making the city feel like a second home in this country.

Last but not least, I deeply appreciate the faculty at Korea National University of Education, where this journey first began. It was there that my foundational knowledge, skills, mindset, and identity as a teacher were nurtured. In particular, Dr. Sang-Ki Lee has had a profound impact on my growth, inspiring and encouraging me to aim higher in my academic pursuits.

This dissertation would not have been possible without the generous financial support of the Mango Languages Dissertation Award, the Language Learning Dissertation Grant, the NFMLTA/MLJ Dissertation Writing Support Grant, and the MSU graduate school Dissertation Completion Fellowship. I am also deeply grateful to the Korean-American Educational Commission for the Fulbright scholarship and to the Sejong City Office of Education for supporting my academic pursuits. Their endorsement has enabled me to fully dedicate myself to research and make meaningful contributions to the field.

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INTRODUCTION

With a growing emphasis on second language (L2) learning beyond the classroom (Reinders et al., 2022), mobile technology has emerged as a valuable tool in facilitating L2 learning in self-study contexts by providing flexible and diverse learning opportunities. In particular, language learning apps (e.g., *Mango Languages*, *Duolingo*) are specifically designed as self-study resources and incorporate curricular components (e.g., lessons, feedback, assessment) to simulate classroom instruction in out-of-class contexts. Unlike general content platforms (e.g., *YouTube*) and auxiliary tools (e.g., online dictionaries), language learning apps are expected to offer a more structured approach to L2 learning beyond the classroom.

Empirical studies demonstrate the benefits of app-based language learning on L2 proficiency (e.g., Bang et al., 2024; García Botero et al., 2021; Jiang et al., 2021, 2024; Kessler et al., 2023; Loewen et al., 2019, 2020; Smith et al., 2024; Sudina & Plonsky, 2024). However, high attrition rates in self-study contexts pose significant challenges, as only a small subset of learners persist long enough to achieve meaningful gains (Hwang et al., 2024). Addressing these issues requires understanding how initial affective and linguistic traits (e.g., L2 motivation, L2 proficiency) and educational contexts influence app usage as well as exploring how teachers can systematically support learners' self-directed L2 learning through apps. Relatedly, learners' agency is crucial for using digital resources effectively beyond the classroom (Godwin-Jones, 2019), yet there is little consensus on how learner autonomy is conceptualized (Chong & Reinders, 2022). In this regard, using self-determination theory (SDT; Ryan & Deci, 2017) as a theoretical framework, I explored how teachers can support learners' autonomy need for app-based language learning out of class, thereby influencing their app engagement, app usage, and L2 learning.

BACKGROUND LITERATURE

Autonomy Support for L2 Learning Beyond the Classroom

Self-determination theory (SDT) is an integrative approach to human motivation and personality (Ryan & Deci, 2017, 2020). As a macro-theory, SDT integrates its six mini-theories, each of which uniquely addresses specific research questions about the nature of human motivation and how social conditions affect it: (a) basic psychological needs theory, (b) cognitive evaluation theory, (c) causality orientations theory, (d) organismic integration theory, (e) goal contents theory, and (d) relationships motivation theory. What unites these mini-theories into a single macro-theory is shared assumptions for humans' inherent nature for personal growth and proactive interaction with the environment to achieve their flourishing.

This dissertation focuses on one of the six mini-theories of SDT: basic psychological needs theory (Ryan & Deci, 2001, 2017; Ryan et al., 2008). The main question of this theory is to understand how need satisfaction or frustration leads to effective functioning and well-being or, conversely, to maladaptive functioning and ill-being. Basic psychological needs theory identifies the three universal psychological needs for (a) autonomy, (b) relatedness, and (c) competence as inherent inner motivational resources. Autonomy concerns a sense of personal ownership during one's action. Relatedness concerns a sense of belonging and emotional connection with others. Competence concerns a sense that one can succeed and grow in one's skills and capacities. A key theoretical implication of basic psychological needs theory is that the satisfaction of these basic psychological needs is fundamental for optimal functioning and healthy development of individuals, while their frustration undermines these outcomes, manifesting as passivity, defiance, and ill-being (Ryan & Deci, 2017).

In L2 contexts, Noels et al. (2019a) proposed a model for the L2 learning motivational process based on SDT. In their model, as demonstrated in Figure 1, socially important others (e.g., family, teachers, L2 community) support learners' psychological needs and shape their L2 motivational orientation, which influences the manner and intensity of L2 engagement, (non-)linguistic outcomes, and psychological wellness. With empirical evidence substantiating this motivational process (e.g., Alamer & Lee, 2019; McEown et al., 2014; Noels et al., 2019b; Oga-Baldwin & Nakata, 2017, 2020; Oga-Baldwin et al., 2017), basic psychological needs are considered as inherent inner motivational resources, whose satisfaction is the essential nutriment for learning and growth (see Al-Hoorie et al., 2022; McEown & Oga-Baldwin, 2019, for the overview of possible applications of SDT to L2 learning research and pedagogy).

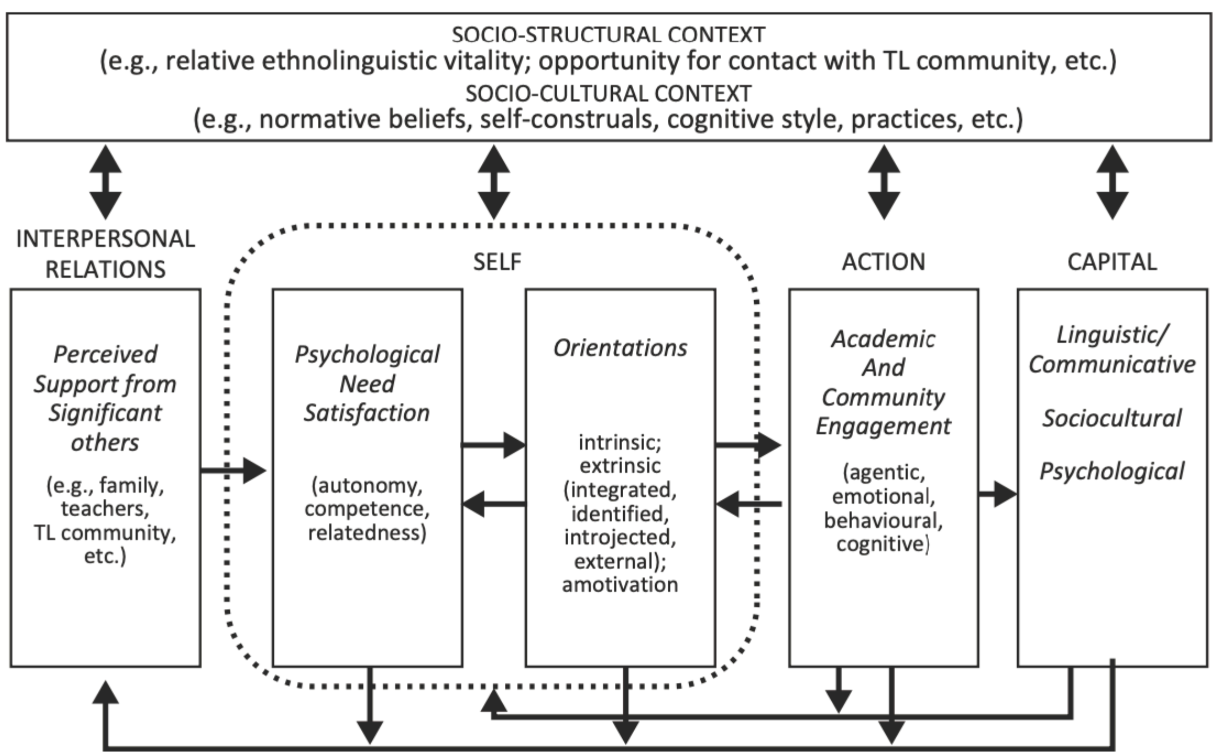


Figure 1 Noels et al.'s (2019a) language learning motivational process (p. 100). Reprinted with permission from the author.

While each psychological need uniquely contributes to human motivation, the focus has primarily been on autonomy need because it is seen as an anchor construct that promotes the satisfaction of the other needs (Reeve, 2022a). Given the importance of autonomy need satisfaction, SDT researchers in educational contexts have explored diverse autonomy-supportive strategies such as classroom climates and educational practice (Ryan & Deci, 2020). Specifically, when autonomy need is satisfied, learners experience a sense of volition and self-endorsement in initiating and regulating their learning. This sense of ownership drives them to get involved in activities out of interest and enjoyment (i.e., intrinsic goal pursuit), further creating opportunities for greater autonomy need satisfaction (Reeve, 2022b). Building on this theoretical assumption, Reeve and Cheon (2021) propose seven strategies for autonomy-supportive instructional behaviors (ASIB).

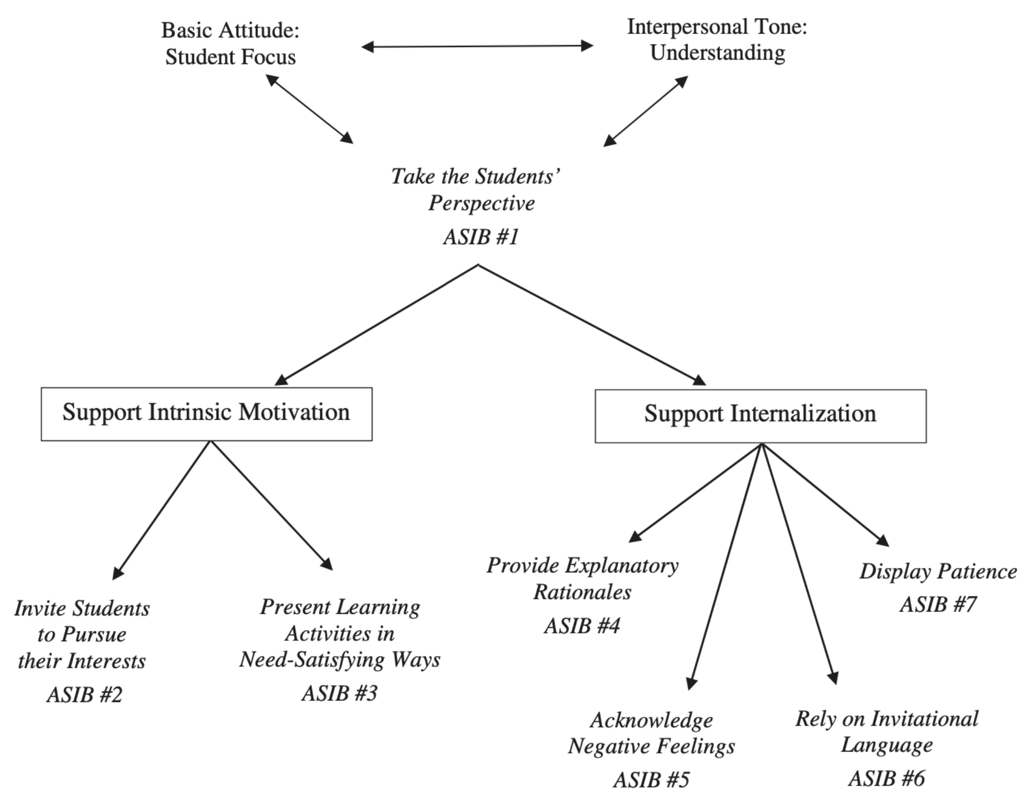


Figure 2 Reeve and Cheon's (2021) seven autonomy-supportive instructional behaviors (p. 56). Reprinted with permission from the author.

As demonstrated in Figure 2, the essence of autonomy-supportive teaching is adopting a learner-centered approach (ASIB #1) with two major goals: (a) support intrinsic motivation, and (b) support internalization. Each goal can be achieved by relevant autonomy support behaviors. First, teachers may support learners' intrinsic motivation by providing them with learning activities that align with their personal interests (ASIB #2) and by allowing them to decide their learning guided by their interests and goals (ASIB #3). Second, teachers can provide four autonomy supports to facilitate learners' internalization, a process of taking in values, beliefs, or behaviors from external sources and incorporating them into their own way of thinking and acting. These strategies include explaining the value and personal relevance of learning activities (ASIB #4), acknowledging negative feelings (ASIB #5), using invitational language (ASIB #6), and displaying patience to let learners work at their own pace and in their own way (ASIB #7). Reeve and Cheon's (2021) systematic review provided empirical evidence highlighting the benefits of teacher autonomy support for educationally important outcomes (e.g., learning engagement, academic achievement, prosocial behavior). Overall, the findings highlight that teachers can effectively satisfy learners' autonomy need through autonomy-supportive teaching (see Reeve & Cheon, 2021, for a comprehensive list of empirical studies exploring the effects of autonomy-supportive instructional behaviors and their outcomes).

While existing research on autonomy need support primarily focuses on classroom settings, it holds particular significance in L2 contexts, where much of language learning occurs beyond the classroom (Mynard & Shelton-Strong, 2022). In self-study contexts, external accountability (e.g., teacher guidance, peer pressure) is often absent, requiring learners to manage their learning independently (Reinders & Benson, 2017). In this regard, there is growing scholarly attention to exploring technology as a potential tool to facilitate autonomous L2 learning out of class. Empirical research has shown that various types of digital resources can effectively support learners' autonomy need, thereby enhancing their self-directed L2 learning (e.g., Alamer & Al Khateeb, 2023, for a social networking app; Dincer & Işık, 2022, for digital resources in general; Hsu, 2023, for language massive open online courses; Jeon, 2022, for a speaking-practice app; Zeng & Fisher, 2024, for Duolingo's gamification). Overall, it is noteworthy that these studies primarily focused on resource-based autonomy need support where features within technologies are the source of need-satisfying experiences (i.e., autonomy need satisfaction through technology usage).

However, there is a lack of research exploring how teachers can support autonomy need for technology usage in self-study contexts (i.e., teacher-provided autonomy support to enhance out-of-class technology use). To truly fulfill learners' autonomy need through technology usage, teachers first need to create autonomy-supportive environments that encourage L2 learners to take ownership of using technology and managing their learning behaviors and strategies beyond the classroom. Applying Noels et al.'s (2019a) motivational process model to technology-mediated L2 learning contexts, I investigate how teacher autonomy support can promote a sense of volition and ownership of technology use for L2 learning beyond the classroom, as well as its effects on technology engagement, actual usage, and L2 learning outcomes. Among diverse digital resources available, language learning apps are the focal technology in this study, as they are specifically designed for self-study purposes.

L2 Motivation as the Precondition in App-Based Learning

Research on app-based language learning has shown that the extent of in-app activities (e.g., total time spent on apps, the number of lessons completed) is a positive predictor of L2 proficiency gains (e.g., Bang et al., 2024; García Botero et al., 2021; Jiang et al., 2021, 2024;

Kessler et al., 2023; Loewen et al., 2019, 2020; Smith et al., 2024; Sudina & Plonsky, 2024). However, high dropout rates are a significant challenge of this learning method, particularly in self-study settings, where learners often need to find other reasons to persist (Hwang et al., 2024). For example, García Botero et al. (2019) found that among 574 university students introduced to a focal app, 149 reported using it, and only 12 completed a language course on the app over a year. Jeon (2022) showed a similar finding with a younger population. Only nine of 179 primary school students used a focal app for more than a month during a two-month period. Fifty-nine students did not use the app at all. Notably, Hwang et al. (2024) highlighted that a significant portion of dropouts occurred in the early stage of app-based language learning irrespective of individuals' dispositions toward technology. Overall, in real-world scenarios where learners juggle daily responsibilities, these findings suggest that only a small group of learners are likely to use language learning apps long enough to achieve meaningful L2 gains in self-study contexts.

Methodologically, previous studies have applied eligibility criteria to include participants who met minimum usage thresholds (i.e., persistence-based inclusion criteria), thereby excluding those with lower app usage from subsequent analysis. However, this approach may introduce bias by favoring persistent app users whose initial affective and linguistic traits could affect the extent of app usage in the first place. Consequently, the effectiveness of app-based language learning may have been overestimated, suggesting that it is effective only if learners can ensure a certain level of usage—a condition that many learners in self-study contexts find challenging to meet. This potential bias, where individuals predisposed to persistent behaviors are overrepresented in data and inflate the apparent efficacy of interventions, has been documented in other research fields. This phenomenon is known as the *healthy initiator effect* or *healthy* *adherer effect*, a well-recognized bias in medicine (e.g., Olawore et al., 2024; Shrank et al., 2011). It occurs when individuals who are more likely to initiate or adhere to a treatment of interest are initially healthier or engage in other healthy behaviors (e.g., screening tests, immunizations) than their non-healthy counterparts. This predisposition to healthier behaviors, unrelated to the intervention itself, increases the likelihood of sustained participation in medical research, with their data being included on adherence-based inclusion criteria (e.g., those who take medicine for more than three months). As a result, individuals who are initially healthier may be overrepresented, leading to an overestimation of the effectiveness of a medical intervention. Therefore, persistence-based inclusion criteria in app-based language learning research may conflate app effectiveness with pre-existing individual traits (e.g., L2 motivation, technology acceptance) that affect persistence. In this regard, this raises the question of whether the potential benefits of app-based language learning beyond the classroom are conditional on individual differences existing before using apps.

Despite increasing attention to understanding digital resources for L2 learning from technology acceptance perspectives (e.g., Hwang et al., 2024), little research systematically considers L2-specific variables as preconditions for the benefits of app-based language learning. One typical example of such a variable is L2 motivation. For example, Loewen et al. (2020) found that learners with greater L2 motivation were likely to use the app more, which in turn, led to greater growth in oral proficiency. Similarly, Sudina and Plonsky (2024) reported that diverse in-app usage indices were positively correlated with initial L2 motivation level and L2 proficiency gains, respectively. However, they did not find clear associations between L2 motivation and L2 proficiency gains. To sum up, these studies suggest that L2 motivation existing before learners start using apps may provide an initial advantage in app-based language learning. This emphasizes the importance of considering learners' initial L2 motivation to better understand potential causal relationships between app usage and L2 gains.

It is noteworthy that L2 motivation was conceptualized as a single-dimensional construct indicated by high or low levels (e.g., *I work hard at studying French/Spanish*, *I am interested in learning Spanish*) in previous studies (e.g., Loewen et al., 2020; Sudina & Plonsky, 2024). In contrast, as demonstrated in Figure 3, the SDT framework arranges different forms of motivation along an autonomous-controlled continuum, reflecting their relative satisfaction of autonomy need for an activity (Ryan & Deci, 2017).

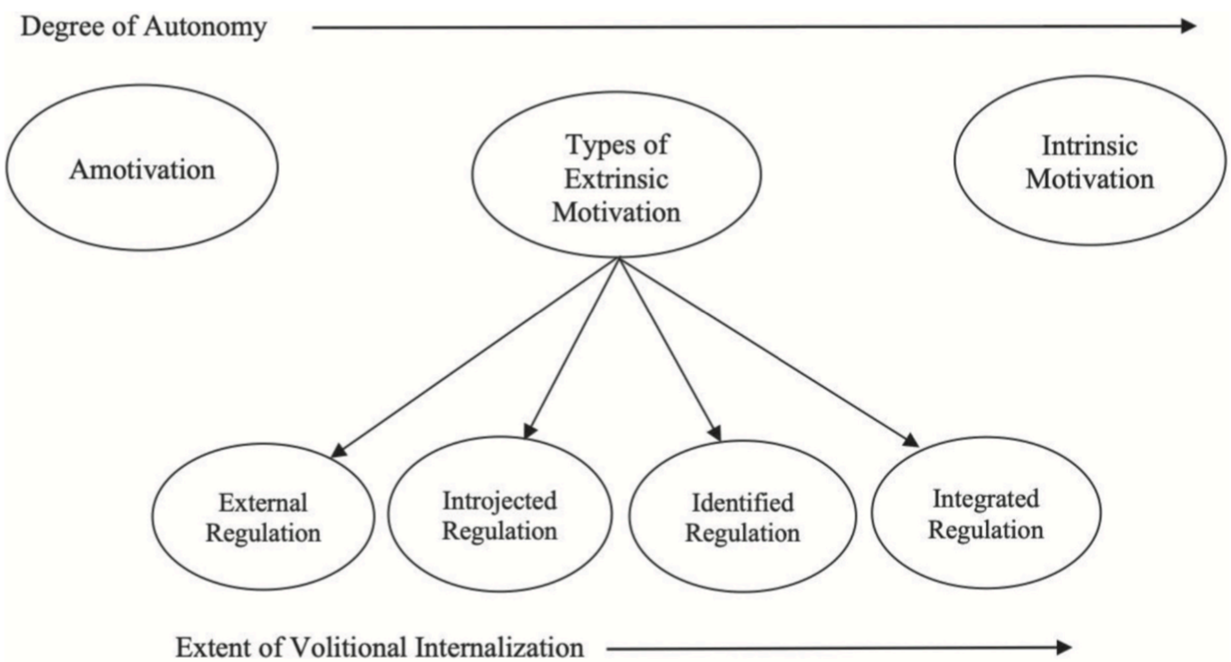


Figure 3 Taxonomy of motivation on the self-determination continuum (Reeve, 2022a, p. 21). Reprinted with permission from the author.

At the one end of this continuum, intrinsic motivation involves engaging in activities 'for their own sake,' while at the other end, amotivation refers to a lack of interest and value when an activity is perceived as personally irrelevant. In between, extrinsic motivations exist, which concern reasons other than inherent interest and enjoyment, and are divided into four subtypes:

integration, identification, introjection, and external regulation. Each is characterized by the degree to which motive is seen as coming from within an individual's sense of value for an activity or from externally imposed sources (e.g., rewards). Integrated and identified regulations are autonomous extrinsic motivations, whereas introjected and external regulations are controlled forms of extrinsic motivation (Noels et al., 2019a). While most intentional behaviors involve both autonomous and controlled motivation simultaneously (Ryan & Deci, 2020) and the unique role of controlled motivation in supporting autonomous motivation is acknowledged (Al-Hoorie, 2024), a large body of empirical research has demonstrated that more autonomous types of motivation predict greater learning engagement and positive outcomes (Ryan & Deci, 2020; see Alamer & Alrabai, 2023; Alamer & Lee, 2019; Alrabai & Alamer, 2024; McEown et al., 2014; Noels et al., 2019b; Oga-Baldwin et al., 2017; Shirvan & Alamer, 2024, for L2 learning).

In this study, grounded in the SDT framework, I defined L2 motivation as the extent to which learners are willing to take ownership of their L2 learning (i.e., levels of autonomy need satisfaction for L2 learning), ranging from autonomous to controlled motivation. Given the critical role of autonomous L2 motivation in shaping out-of-class L2 learning experiences (e.g., Hoang et al., 2022), I hypothesized that pre-existing L2 motivation might influence app-based language learning beyond the classroom, leading to varying levels of app engagement and usage.

Opportunity Cost of App-Based Language Learning in a Test-Driven Context

The present study was conducted in South Korea, where English is taught as a foreign language. English education in South Korea is predominantly test-oriented, with school English tests primarily assessing reading and grammar skills. While a strong emphasis is placed on achieving high grades to secure better educational and career opportunities, the participants in the study received only two 45-minute English classes per week at school, which is insufficient for test preparation. This limitation makes it almost mandatory for learners to study English out of class to supplement in-class instruction. Yet, such independent learning can be particularly challenging for young learners who lack effective self-study skills and strategies. As a result, parents and learners often turn to *hagwons*—for-profit private educational institutions—for additional support to excel in tests. In this context, language learning apps may offer a practical alternative to promote self-directed English learning, potentially reducing reliance on *hagwons*.

As the importance of integrating dynamic real-world contexts into language teaching and learning is emphasized in The Douglas Fir Group (2016) and Noels et al.'s (2019a) motivation process model (i.e., socio-structural and socio-cultural components in Figure 1), it is essential to consider a specific local context, beyond the confines of research design, that may determine the success of app-based language learning. In this regard, learners' perceived opportunity cost of using language learning apps could influence their app usage. In economics, opportunity cost refers to the value of the alternative that you give up when making a choice.

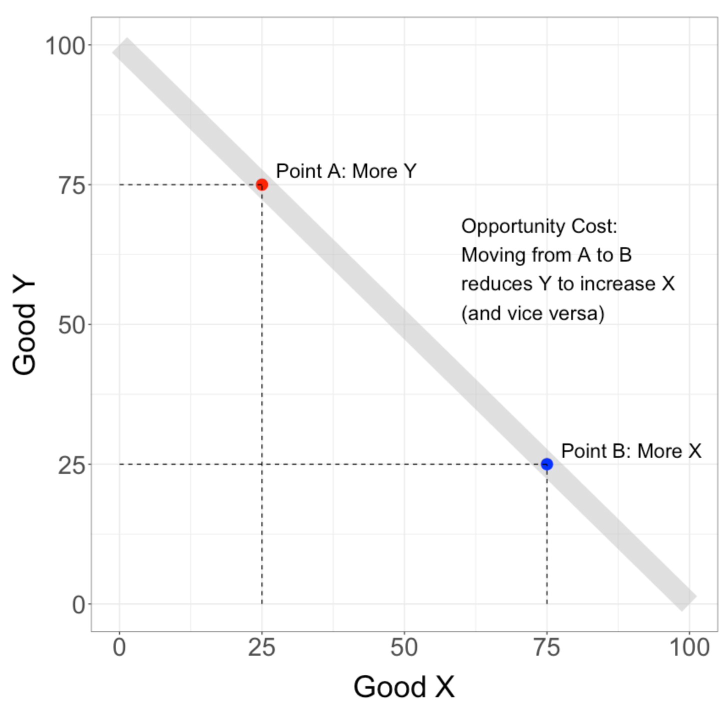


Figure 4 Constant opportunity cost between goods X and Y.

Figure 4 visualizes the concept of opportunity cost with two goods: Good X (e.g., books) and Good Y (e.g., meals). The line demonstrates the trade-offs involved in reallocating resources between the production of the two goods under conditions of constant opportunity cost. For instance, at Point A, more resources are allocated to Good Y, resulting in the production of 75 meals, while fewer resources are allocated to Good X, producing only 25 books. Conversely, at Point B, the allocation shifts to prioritize Good X, resulting in the production of 75 books but only 25 meals. The dashed lines connecting the points to the axes visually emphasize the opportunity cost. Moving from Point A to Point B involves sacrificing 50 meals to produce 50 additional books, and vice-versa. This trade-off highlights the fundamental principle of opportunity cost, which underscores the efficient use of limited resources such as time, energy, or money, and the necessity of making choices when resources are scarce.

In educational contexts, the concept of opportunity cost has been explored within the situated expectancy-value model of motivation (Eccles & Wigfield, 2020; Gladstone et al., 2022). This model includes two main components: expectancy, which examines one's perceived ability to perform an activity, and value, which evaluates whether one finds the activity worthwhile. Within this framework, 'cost' is a subcomponent of value, including components such as the perceived amount of effort required to complete a task, and the extent to which engaging in one activity limits the ability to participate in other valued tasks (i.e., loss of resources). Empirically, higher perceived costs associated with an activity can lower the overall value of the activity, leading to a decline in motivation and an increase in avoidance of the activity (e.g., Jiang et al., 2018; Robinson et al., 2019). Recent research has elevated cost to an independent component to propose the expectancy-value-cost model (Barron & Hulleman, 2015; Kosovich et al., 2015). While SDT does not explicitly address the concept of cost, it highlights the role of teacher autonomy support in developing an initial sense of value and personal relevance for a task to facilitate the internalization process (i.e., ASIBs #4 to #7) by explaining its utility value aligned with learners' perspective, rather than teacher's (Reeve & Cheon, 2021). Therefore, I relied on the expectancy-value(-cost) model to explore the perceived opportunity cost of app-based language learning.

In the context of this study, Korean learners typically face tightly packed extracurricular schedules, including various (non-)academic subjects. With limited available time and energy, every additional activity must justify its value in terms of opportunity cost. As such, learners must make deliberate choices to prioritize activities that maximize academic performance or personal enjoyment, reflecting the trade-offs between competing options. In this respect, language learning apps represent one of many available tools for improving English skills, and these apps must compete with well-established non-app learning resources (e.g., *hagwons*), which are integral to learners' routines and offer a proven return on investment. For language learning apps to be meaningfully used out of class, their perceived benefits must outweigh the opportunity cost of time and effort diverted from other alternative non-app learning methods through a cost-benefit analysis. Based on this understanding, I hypothesize that a high perceived opportunity cost associated with language learning apps will negatively influence learners' app usage, whereas a lower perceived opportunity cost will lead to greater app usage. Furthermore, I aim to explore the extent to which teacher autonomy support could alleviate such perceived opportunity cost, potentially promoting greater app engagement and usage out of class.

THE PRESENT STUDY

Mediation and Moderated Mediation

Figure 5(a) demonstrates a mediation relationship. With variables X, Y, and M, X has a direct effect on Y (i.e., $X \rightarrow Y$). When the effect of X on Y is transmitted through an intervening variable M (i.e., $X \rightarrow M \rightarrow Y$), M mediates the relationship between X and Y. In this case, M serves as both an outcome of X and a cause of Y, with its effect on Y being conditional on X. For example, if M positively affects Y (i.e., $M \rightarrow Y$), X indirectly affects Y by increasing M (i.e., $X \rightarrow M$). When X has both direct and indirect effects on Y, this is known as partial mediation. If X affects Y only through M, it is full mediation.

For example, in the present study, perceived teacher autonomy support (X) may directly influence out-of-class app usage (Y). Additionally, this relationship may involve an indirect effect of perceived teacher autonomy support through autonomy need satisfaction (M). While higher autonomy need satisfaction can directly lead to greater app usage (i.e., the direct effect of M on Y), it is perceived teacher autonomy support that determines the levels of autonomy need satisfaction from the outset. In other words, the extent to which perceived teacher autonomy support influences autonomy need satisfaction (i.e., $X \rightarrow M$) indirectly shapes the strength of the relationship between autonomy need satisfaction and app usage (i.e., $M \rightarrow Y$). This reflects a mediation effect where the impact of X on Y is partially or fully transmitted through M.

However, one key assumption of mediation analysis is that there are no omitted confounders for any pair of variables among X, Y, and M. This means that the relationship between X and M should not be affected by any other unobserved variables. Omitted confounders (cf. healthy initiator and adherer effects) can introduce bias into the estimated mediation effect, making it difficult to accurately assess the role of M as a mediator between X and Y. Violating this assumption could mean that the observed relationships could be spurious.

If indirect effects are driven by unmeasured variables, the use of the term 'mediation' is not warranted. In this case, both mediation and moderation can be estimated in the same analysis. Figure 5(b) demonstrates moderated mediation, where X directly affects Y, and W moderates the indirect effect of X on Y through M. When the indirect effect of X on Y through M depends on a moderator W, this reflects how the strength or direction of causal mechanisms depend on individual differences or situation (Kline, 2023). In a moderated mediation model, X and W interact in their effects on M in addition to their direct effects, indicating that the direction or strength of the relationship between X and M may vary over the levels of W.

In the earlier example, learners' initial L2 motivation may serve as a moderator (W). Specifically, learners with more autonomous L2 motivation may respond more meaningfully to teacher autonomy support than those with more controlled L2 motivation. Consequently, for the autonomous L2 motivation group, greater autonomy need satisfaction could be achieved with the same level of perceived teacher autonomy support compared to the controlled L2 motivation group.

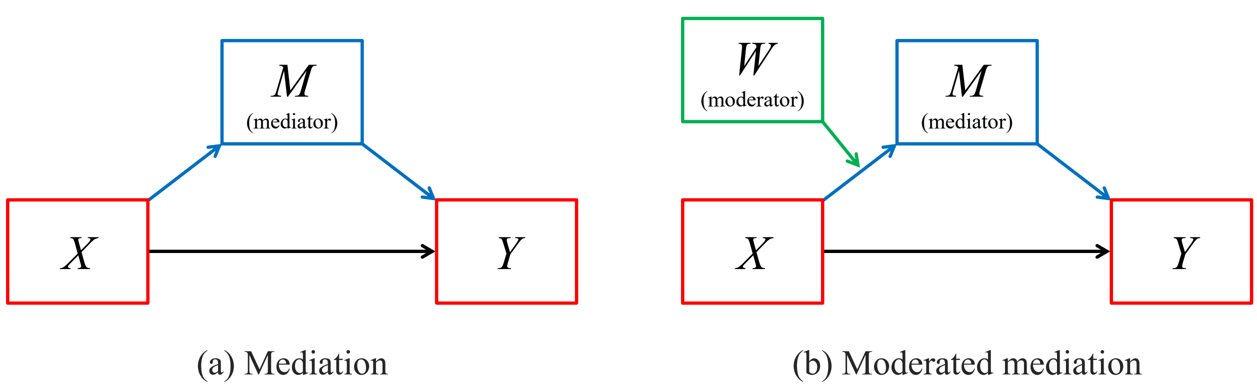


Figure 5 Skeletal diagrams for mediation and moderated mediation.

Research Questions and Hypotheses

In self-study settings, where learners' agency in using digital resources is crucial for successful L2 learning (Godwin-Jones, 2019), autonomously motivated L2 learners are more likely to respond positively to teacher autonomy support for app-based language learning beyond the classroom. This support can effectively satisfy their autonomy need for app usage, leading to higher-quality app engagement. In turn, this engagement may proactively recruit further autonomy support from teachers (cf. Reeve et al., 2020), creating a positive self-reinforcing loop that enhances app usage and L2 learning. Under this assumption, teacher autonomy support will directly influence app usage, which serves as a predictor of L2 learning gains. To ensure the robustness of these gains, non-app English learning experiences out of class are controlled for in the analysis. Autonomy need satisfaction, app engagement, and perceived opportunity cost are included as mediators, transmitting the effect of teacher autonomy support to app usage in unique ways. Additionally, learners' initial levels of self-determined (i.e., autonomous) motivation for English learning will moderate these relationships. Figure 6 presents a skeletal diagram of these hypotheses, where the + signs indicate positive relationships between variables, and the – signs represent negative relationships. The research questions and corresponding hypotheses of the present study are provided as follows:

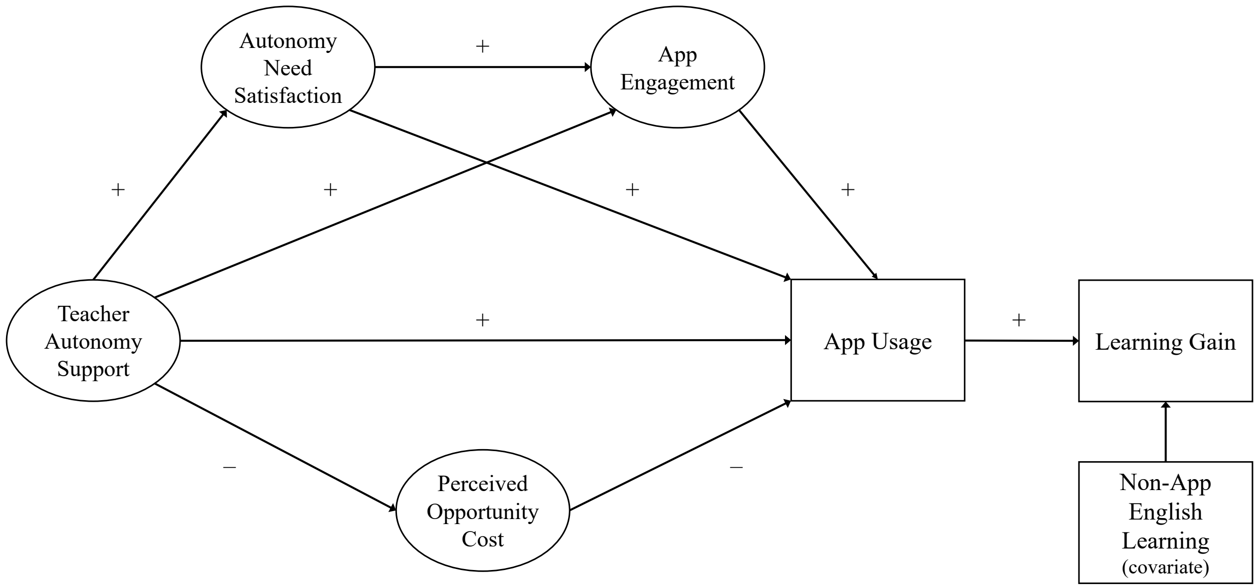


Figure 6 Hypothesized model for the present study.

Research Question 1. To what extent does teacher autonomy support affect autonomy need satisfaction, app engagement, perceived opportunity cost, and app usage?

Hypotheses 1a, 1b and 1c. Teacher autonomy support will positively predict autonomy need satisfaction, app engagement, and app usage, respectively.

Hypothesis 1d. Teacher autonomy support will negatively predict perceived opportunity cost.

Research Question 2. To what extent does autonomy need satisfaction affect app engagement and app usage?

Hypotheses 2a and 2b. Autonomy need satisfaction will positively predict app engagement and app usage, respectively.

Hypotheses 2c and 2d. Autonomy need satisfaction will mediate the relationship between teacher autonomy support and app engagement, and between teacher autonomy support and app usage, respectively.

Research Question 3. To what extent does app engagement affect app usage?

Hypothesis 3a. App engagement will positively predict app usage.

Hypothesis 3b. App engagement will mediate the relationship between teacher autonomy support and app usage.

Hypothesis 3c. App engagement will mediate the relationship between teacher autonomy support and app usage through autonomy need satisfaction.

Research Question 4. To what extent does perceived opportunity cost affect app usage?

Hypothesis 4a. Perceived opportunity cost will negatively predict app usage.

Hypothesis 4b. Perceived opportunity cost will mediate the relationship between teacher autonomy support and app usage.

Research Question 5. To what extent does app usage affect learning gains from app-based learning?

Hypothesis 5. App usage will positively predict learning gains after non-app English learning experiences are controlled.

Research Question 6. To what extent does initial L2 motivation influence the relationships among the variables?

Hypothesis 6. Greater autonomous L2 motivation will positively moderate the relationships among the variables (i.e., moderated mediation).

METHOD

Participants

I recruited two Korean English teachers and their combined group of 305 seventh graders (aged 12-13) from the same public middle school in South Korea. These young adolescent learners have been studying English for at least five years in school as required by the national curriculum. Additionally, they have participated in varying levels of private English learning activities out of class. Such informal English learning experiences, independently from the school curriculum, have resulted in a diverse range of English ability and motivation profiles among the learners.

To measure the breadth of receptive vocabulary knowledge as a proxy of learners' initial English proficiency prior to app-based language learning, I administered the updated Vocabulary Levels Test A (Webb et al., 2017). This test was chosen because it is recommended as a suitable test for measuring the vocabulary size and vocabulary knowledge of elementary and intermediate learners of English as a foreign language. Additionally, due to the overall low proficiency, I adapted the item definitions by translating them into Korean. For example, as shown in Figure 7, the original item definitions—'picture', 'place where things grow outside', and 'cost'—were provided with their Korean equivalents—'사진', '정원', and '가격, 비용', respectively—and presented in blue. In the vocabulary level test, the learners were asked to match correct English-Korean word pairs by choosing corresponding buttons.

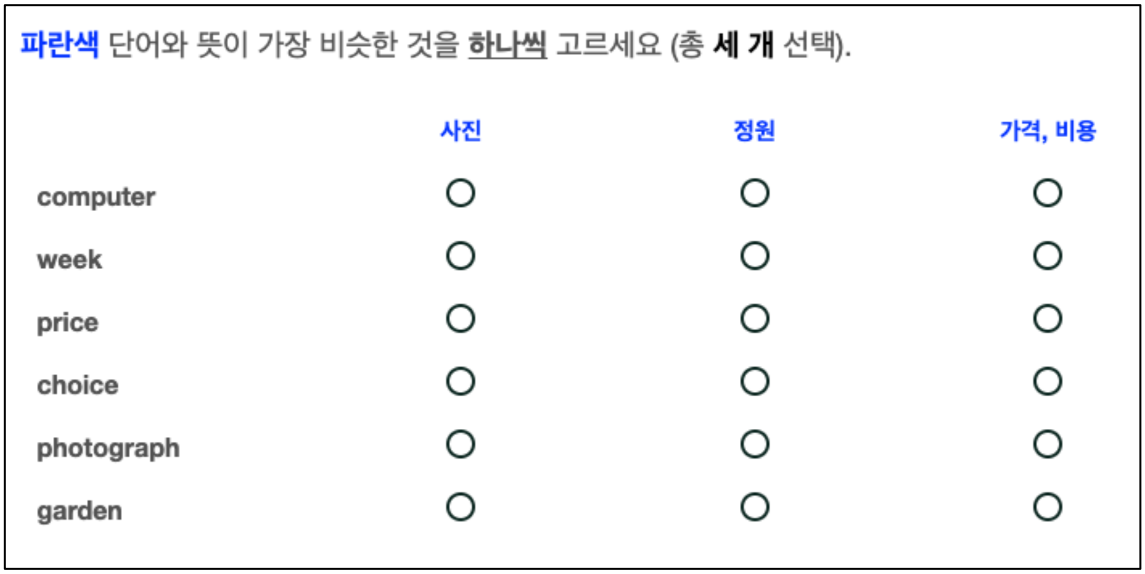

파란색 단어와 뜻이 가장 비슷한 것을 하나씩 고르세요 (총 세 개 선택).

	사진	정원	가격, 비용
computer	○	○	○
week	○	○	○
price	○	○	○
choice	○	○	○
photograph	○	○	○
garden	○	○	○

Figure 7 Example of adapted Webb et al.'s (2017) updated vocabulary levels test.

The test included five frequency levels, and each contained 30 items. As proposed by Webb et al. (2017), I applied a cutoff point of 29/30 for mastery of the 1k, 2k, and 3k levels, and a cutoff point of 24/30 for mastery of the 4k and 5k levels. The result shows that about 73.44% of the learners (224 of 305) had not achieved mastery of the most frequent 1,000-word families, while an additional 13.44% (41 of 305) reached mastery of this level. To explore the impact of app-based language learning on beginner learners, I included only those learners whose vocabulary level was at or below the 1,000-word level, removing 40 participants from the data. Additionally, 11 more participants withdrew during the project. Consequently, a total of 254 learners were included in the present study.

Focal Technology: Mango Languages

The focal app of this study is a commercially available language learning app, *Mango Languages* (https://mangolanguages.com). It provides structured, conversation-based courses that cover reading, listening, speaking, vocabulary, pronunciation, grammar, and culture in over 70 languages. As of March 2024, the app had approximately 100,000 monthly active global users. Learners enrolled in *Mango Languages*' premium course, designed specifically for native

Korean speakers. The course offered 95 English lessons, along with review and assessment features. As illustrated in Figure 8, *Mango Languages* is structured to support learners' self-study of English beyond the classroom.

Mango Languages provided free subscriptions and access to usage data for this study but did not impose any restrictions or exert influence on any aspect of the research process. None of the learners had prior experience with the focal app before this study. Over three months, they used the app independently from their regular school English curriculum.

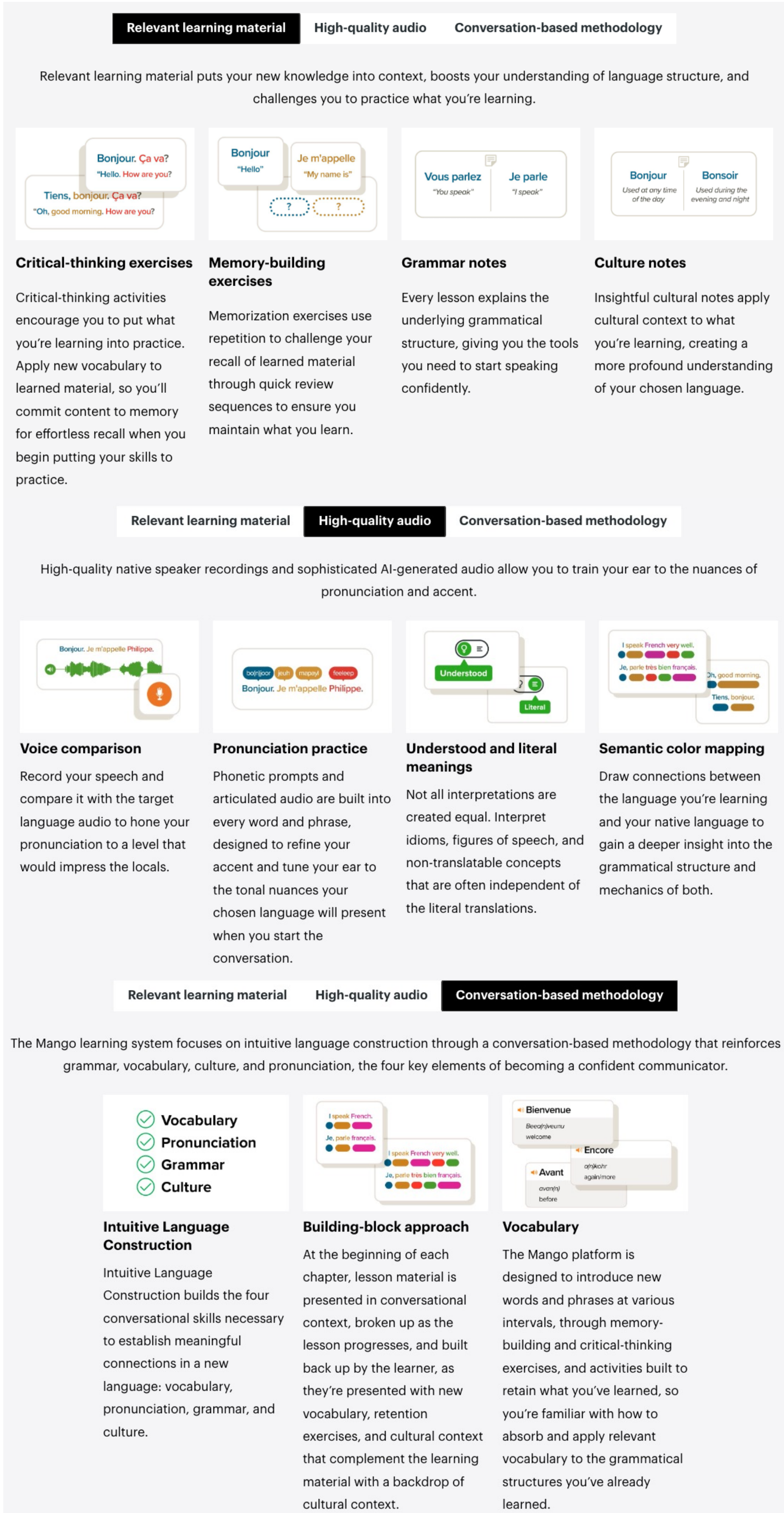


Figure 8 Key self-study features of *Mango Languages* (retrieved from https://mangolanguages.com/how-it-works).

Teacher Autonomy Support for App-Based Language Learning Beyond the Classroom

Based on Reeve and Cheon's (2021) autonomy-supportive instructional behaviors (ASIB), the two English teachers recruited for this study provided various types of classroom-based autonomy support, with the goal of developing a sense of volition and ownership of app-based language learning beyond the classroom. Using their own digital devices, learners used the app in a self-directed way with full freedom to decide how and to what extent they used it (ASIB #2). No external accountability (e.g., rewards, punishments) was imposed for app usage (ASIB #3). The teachers also demonstrated the app's key content and features and helped raise learners' awareness of the value of using the app (ASIB #4), highlighting its potential benefits not available in non-app learning methods (e.g., algorithm-based spaced vocabulary learning, pronunciation practice using visual waveforms). Additionally, the teachers assisted learners by providing strategies for setting both short-term and long-term usage goals (e.g., He & Loewen, 2022). They also made efforts to recognize learners' progress and challenges, either by addressing them publicly during class or privately to build confidence in using the app out of class (ASIB #5, ASIB #6, and ASIB #7). This teacher autonomy support was consistently provided throughout the semester as a routine of regular English classes. This also served as an informal reminder, encouraging learners to stay focused on their app learning goals, being reinforced at least once a week.

Materials

I collected three types of data for this study: (a) app usage time, (b) questionnaire responses, and (c) vocabulary test scores. All questionnaires were rated on a 6-point Likert scale, ranging from 1 ("strongly disagree") to 6 ("strongly agree"), and were administered in learners' L1, Korean. The Korean language versions of the questionnaires are provided in Appendix.

In-App Usage Time

To reliably collect and manage in-app usage data, I used the Mango administrative portal (MAP) system (see Figure 9). Before app-based language learning began, I set up the MAP system and assigned learners to a user group of each teacher, accordingly. As demonstrated in Figure 10, the MAP system allowed the researcher and teachers to track individual learners' in-app activities by providing detailed app usage data in real time. This data included the time spent during each app session (recorded in seconds), organized by date and activity.

After app-based language learning ended on June 30th, I extracted the entire usage data, resulting in 12,126 data points. For ease of interpretation, I transformed the raw time data from seconds into hours, calculating the usage time per day and the total time spent on the app.

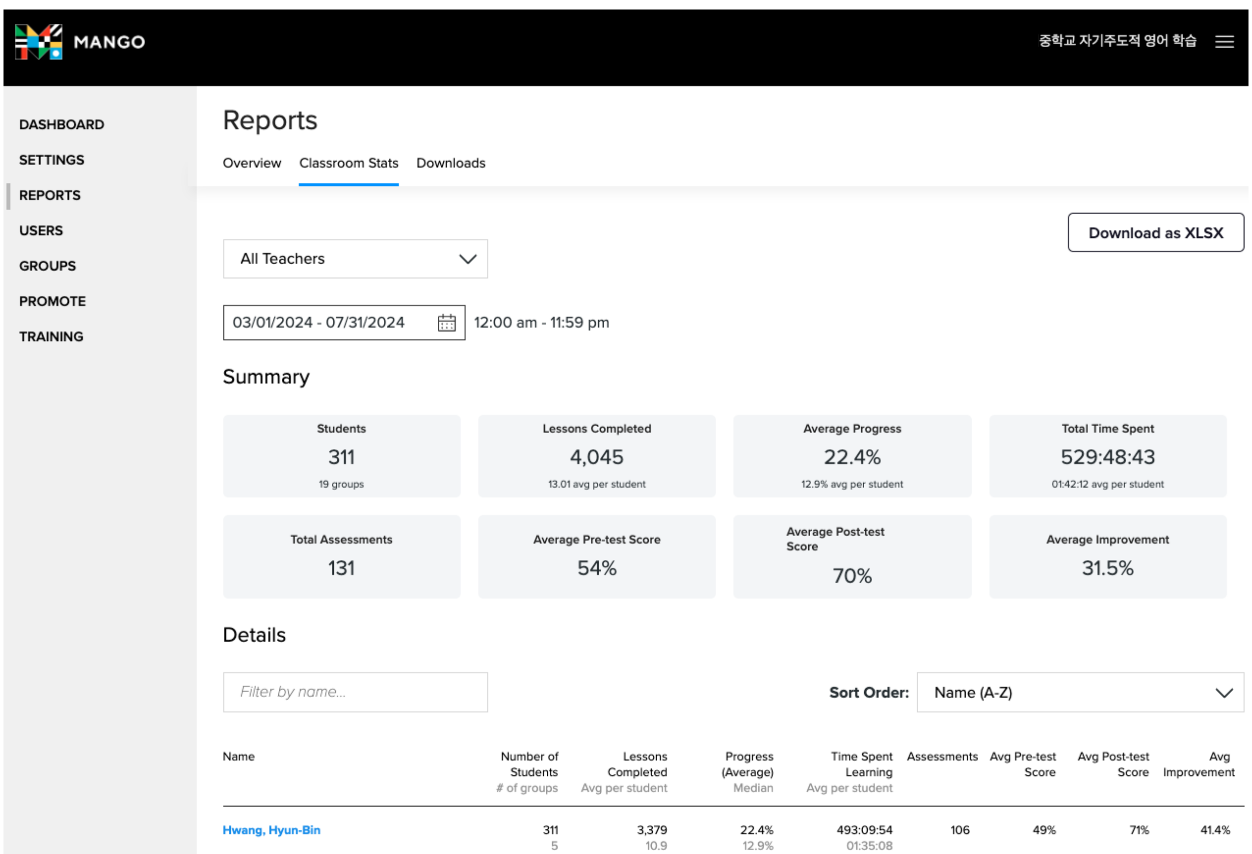


Figure 9 Mango administrative portal (MAP) system interface.

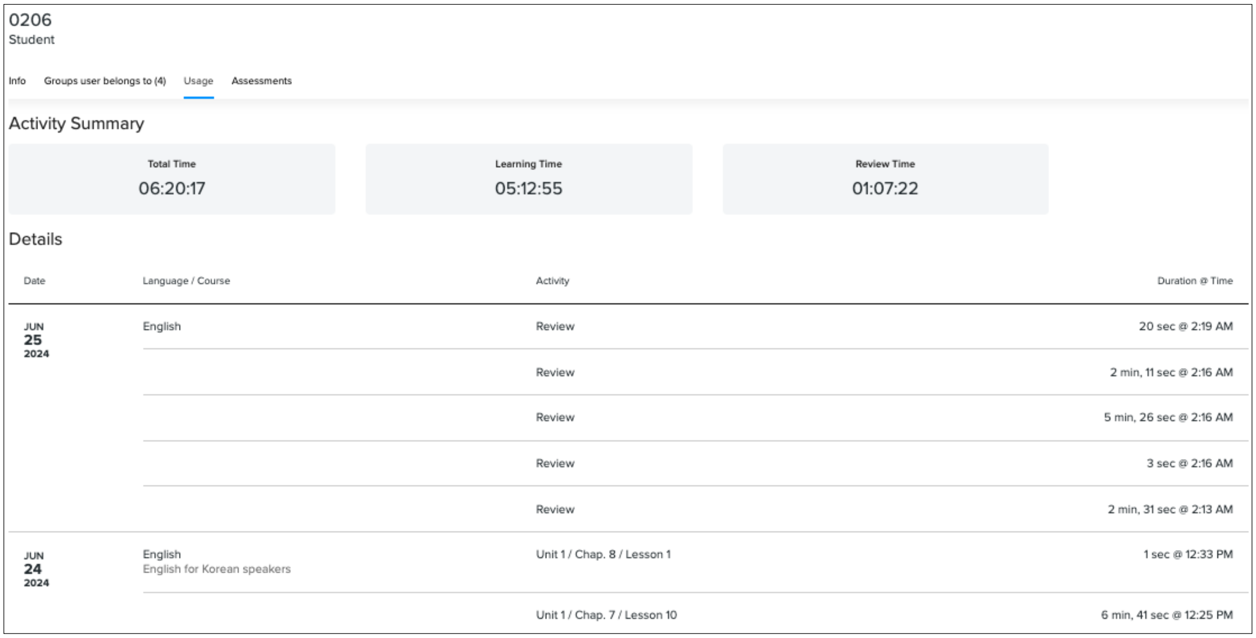


Figure 10 Individual app usage data on the Mango administrative portal (MAP) system.

Perceived Teacher Autonomy Support Questionnaire

Table 1 presents questionnaire items for perceived teacher autonomy support. To measure learners' perceptions of teachers' instructional behaviors as autonomy-supportive—using Reeve and Cheon's (2021) ASIB strategies—for their out-of-class app usage, I adapted items from the learning climate questionnaire (e.g., Jang et al., 2016; Oga-Baldwin et al., 2017). The questionnaire included four items that focus on how teachers created an autonomy-supportive climate for app-based language learning beyond the classroom. Cronbach's alpha value of .89 indicates a high level of reliability.

Table 1 Perceived teacher autonomy support questionnaire

Item	Question
Support1	My teacher has helped me set my own goals for using *Mango*.
Support2	My teacher has supported the ways I use *Mango*.
Support3	My teacher has recognized my efforts to make good use of *Mango*.
Support4	My teacher has carefully responded to my questions about *Mango*.

Autonomy Need Satisfaction Questionnaire

Table 2 presents questionnaire items for autonomy need satisfaction for app-based language learning. To assess the extent to which learners' autonomy need was satisfied for app-based language learning (i.e., their sense of volition and personal ownership in out-of-class app usage), I adapted items from Leeming and Harris' (2022) basic psychological needs satisfaction and frustration scale. The questionnaire included three items. Cronbach's alpha value of .84 indicates a high level of reliability.

Table 2 Autonomy need satisfaction questionnaire

Item	Question
Autonomy1	I feel that I have the freedom to decide whether or not to use *Mango*.
Autonomy2	I feel that I have the freedom to plan my use of *Mango*.
Autonomy3	I feel that I use *Mango* in the way I truly want.

App Engagement Questionnaire

Table 3 presents questionnaire items for app engagement. In contemporary education, engagement is a multidimensional construct (Skinner & Raine, 2022; Hiver et al., 2021, 2024 in L2 contexts). In the context of app-based language learning beyond the classroom, I measured learners' behavioral, emotional, cognitive, and agentic engagement by adapting the scales from previous studies (Oga-Baldwin, 2019; Reeve, 2013; Reeve & Lee, 2014; Zhou et al., 2021). Each engagement dimension included three items, resulting in a total of 12 items. Cronbach's alpha value for each construct indicates a high level of reliability.

Table 3 App engagement questionnaire

Scale	Question
Behavioral Engagement (BE) (α = .94)	
BE1	I used *Mango* diligently.
BE2	I stayed focused while using *Mango*.
BE3	I did my best while using *Mango*.
Emotional Engagement (EE) (α = .95)	
EE1	*Mango* was fun.
EE2	It was interesting to learn new things on *Mango*.
EE3	The learning activities on *Mango* were enjoyable.
Cognitive Engagement (CE) (α = .91)	
CE1	I knew what and how to study while using *Mango*.
CE2	I had a plan for when to use Mango.
CE3	I reviewed what I learned on *Mango*.
Agentic Engagement (AE) (α = .92)	
AE1	I aim to use *Mango* beyond the usage goal I had set.
AE2	When I faced difficulties using *Mango*, I actively sought help from those around me.
AE3	When I had questions while studying on *Mango*, I endeavored to resolve them.

Perceived Opportunity Cost Questionnaire

Table 4 presents questionnaire items for perceived opportunity cost. To evaluate learners' perceived opportunity cost of app usage, I adapted the cost component of the Expectancy-Value-Cost (EVC) Scale (e.g., Kosovich et al., 2015). Four items were used, with higher scores indicating that learners perceive greater app usage as involving a greater loss of valued alternatives in their other daily commitments. Cronbach's alpha value of .82 indicates a high level of reliability.

Table 4 Perceived opportunity cost questionnaire

Item	Question
Cost1	*Mango* requires too much time and effort in my current situation.
Cost2	Due to other academic commitments, I currently do not have time to invest in using *Mango*.
Cost3	In my current situation, I cannot afford the extra time and effort needed to use *Mango* consistently.
Cost4	To use *Mango* diligently, I would have to give up too much of my currently available time.

English Learning Orientation Scale

Table 5 presents the English learning orientation scale. To understand the learners' general English learning motivation within SDT, I adapted Leeming and Harris' (2022) language learning orientation scale. They improved upon the original scale developed by Noels et al. (2000) and further validated it within an East Asian context (i.e., Japan) similar to the present study. The questionnaire included six SDT-based motivational constructs: Intrinsic, integrated, identified, introjected, external motivation, and amotivation (cf. Figure 3). Each construct represents the extent to which their motivation for English learning is driven by themselves (e.g., self-satisfaction, enjoyment) or by outside influences (e.g., external incentives, pressure). The questionnaire consisted of 21 items. Cronbach's alphas for each construct indicate a high level of reliability, except for external motivation whose alpha value is slightly below the .70 benchmark.

Table 5 English learning orientation scale

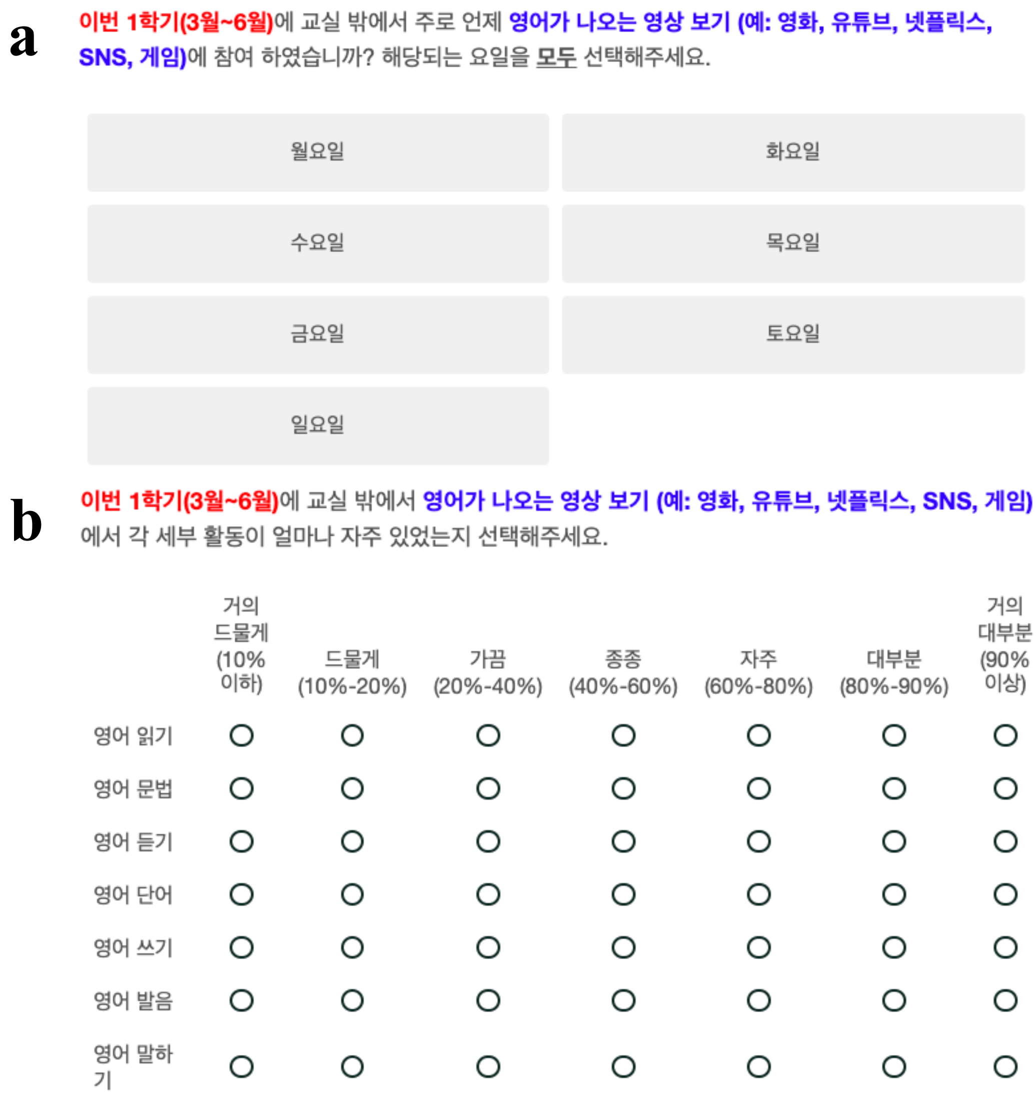
Scale	Question
Intrinsic Motivation (α = .92)	
Item1	Because I like English.
Item2	Because learning English is fun.
Item3	Because I like using English.

Table 5 (cont'd)

Integrated Motivation (α = .83)	
Item1	Because English is an important component in understanding who I am.
Item2	Because English represents the things I consider important in life (values, beliefs).
Item3	Because English is a natural part of my life.
Item4	Because my ability to speak English reflects who I am as a person.
Identified Motivation (α = .81)	
Item1	Because English helps my personal growth and development.
Item2	Because English helps me achieve the goals I aspire to.
Item3	Because English provides me with more opportunities for the future success.
Introjected Motivation (α = .82)	
Item1	Because those around me (family, friends, teachers) have high expectations for my English skills.
Item2	Because the people around me (family, friends, teachers) view me positively when I do well in English.
Item3	Because the people around me (family, friends, teachers) expect me to study English diligently.
Item4	Because I want to be seen as good at English by those around me (family, friends, teachers).
External Motivation (α = .65)	
Item1	Because I want to achieve a good score on my English exams.
Item2	Because English is a required subject that I must take, not a choice I can make.
Item3	Because studying English is mandatory, regardless of how much I like it.
Item4	Because being good at English can help me get into a better upper school (high school, university).
Amotivation (α = .83)	
Item1	Studying English is a waste of time for me.
Item2	English is meaningless to me.
Item3	If possible, I would choose not to learn English.

Non-App English Learning Experiences Beyond the Classroom Questionnaire

Figure 11 shows an example of the questionnaire to measure non-app English learning experiences beyond the classroom. I collected data on learners' non-app English learning activities during the study period. The questionnaire asked learners to report, on average, how many days per week they were involved in each of the following out-of-class activities where English served as the primary medium: reading, listening, watching, and communication (Figure 11a). For each activity type, learners also rated the intensity of specific English skills involved, using a scale from 1 (very rarely: less than 10% of an activity) to 7 (almost always: more than 90% of an activity) (Figure 11b). These skills included reading, grammar, listening, vocabulary, writing, pronunciation, and speaking. To create a single index, I multiplied the number of days for each activity by the intensity of each skill (i.e., frequency × intensity). For example, if a learner reported that listening skill "almost always" occurred during a watching activity, which happened 3 days a week, the listening score for watching was 21 (i.e., 7 × 3). The resulting scores were summed across all activity types. A higher value indicates a greater level of experience of non-app English learning activities out of class.



a

이번 1학기(3월~6월)에 교실 밖에서 주로 언제 영어가 나오는 영상 보기 (예: 영화, 유튜브, 넷플릭스, SNS, 게임)에 참여 하였습니까? 해당되는 요일을 **모두** 선택해주세요.

월요일	화요일
수요일	목요일
금요일	토요일
일요일	

b

이번 1학기(3월~6월)에 교실 밖에서 영어가 나오는 영상 보기 (예: 영화, 유튜브, 넷플릭스, SNS, 게임)에서 각 세부 활동이 얼마나 자주 있었는지 선택해주세요.

	거의 드물게 (10% 이하)	드물게 (10%-20%)	가끔 (20%-40%)	종종 (40%-60%)	자주 (60%-80%)	대부분 (80%-90%)	거의 대부분 (90% 이상)
영어 읽기	○	○	○	○	○	○	○
영어 문법	○	○	○	○	○	○	○
영어 듣기	○	○	○	○	○	○	○
영어 단어	○	○	○	○	○	○	○
영어 쓰기	○	○	○	○	○	○	○
영어 발음	○	○	○	○	○	○	○
영어 말하기	○	○	○	○	○	○	○

Figure 11 Example of non-app English learning experiences questionnaire.

Meaning Recall Test

I measured the impact of app-based language learning with the number of English words learned after using the app. The target words were selected through a multi-step process. Initially, 417 words were extracted from all 95 lessons of *Mango Languages*. Of these, 349 words and their related word families were removed as they either appeared in learners' English textbooks at school used during the study or were basic words likely learned in earlier school stages. From the remaining words, those from the first 18 lessons were excluded because the learners completed these lessons for in-class app training sessions with the teachers. To maximize the benefits of learners' participation, words less relevant to their school curriculum (e.g., busser, locksmith) were excluded. This process resulted in a final set of 40 target words, as listed in Table 6.

Table 6 Final list of the target words

Item	Target Word	Item	Target Word	Item	Target Word	Item	Target Word
1	grocery	11	withdraw	21	shift	31	day off
2	avenue	12	dizzy	22	address	32	midnight
3	direction	13	repair	23	rent	33	drugstore
4	medicine	14	trouble	24	inexpensive	34	license
5	downtown	15	tow	25	available	35	emergency
6	freeway	16	hire	26	compact	36	fix
7	account	17	resume	27	unlock	37	straight
8	exchange	18	reference	28	repeat	38	fever
9	form	19	similar	29	bill	39	metal
10	deposit	20	application	30	stuff	40	sign

In a meaning recall test, the learners were asked to provide Korean translations of target English stimuli. Responses were scored on a binary correct/incorrect scale for the test. The test was administered twice as a pretest (March) and a posttest (July). The order of the items was randomized across learners and testing times. Cronbach's alphas indicated a high level of reliability, with .88 for the pretest and .92 for the posttest. The difference between pretest and posttest scores was used as an indicator of learning gains in the analysis.

Procedure

Figure 12 shows an overview of the study procedure. This research was approved by the institutional review board at Michigan State University (STUDY00010031) in December 2023. During December 2023 and January 2024, I recruited in-service Korean EFL teachers in public schools by advertising nationwide in online English teacher communities. Over two weeks, an initial pool of 47 teacher candidates was created. The selection criteria included teachers who met all of the following: those who (a) were currently teaching more than 100 learners across multiple classes and (b) were willing to promote out-of-class English learning using technology. After reviewing the willing participant pool, two local English teachers from the same public middle school were selected. Both teachers were female; one had eight years of teaching experience, while the other had two years of teaching experience. In Spring 2024, each teacher taught about 150 seventh graders (aged 12-13) across six classes, totaling 305 learners. In February, the two participating teachers and I prepared for the study via online meetings or text chats. During this preparation stage, I shared the purpose of this project and provided a comprehensive overview of *Mango Languages* and its key features. Additionally, I introduced the teachers to Reeve and Cheon's (2021) seven ASIBs and discussed how these autonomy-supportive strategies could be effectively implemented in their classrooms to enhance learners' self-directed app-based language learning.

Before the study began in March, learners and their parents agreed to participate in this study and completed an English learning orientation questionnaire. In March, the teachers introduced the app to learners and provided in-class training sessions to familiarize participants with its functions and usage. During this initial phase, the learners completed a pretest of the meaning recall test. From April through June, they engaged in self-directed app usage for 13 weeks out of class, with consistent classroom-based teacher autonomy support provided throughout the usage period. At the end of May, learners completed a perceived teacher autonomy support questionnaire, and in mid-June, they were asked to fill out an autonomy need satisfaction questionnaire. At the end of June, they completed a perceived opportunity cost questionnaire. The app usage ended as of June 30th, followed by a posttest, along with questionnaires on app engagement and non-app English learning experiences beyond the classroom.

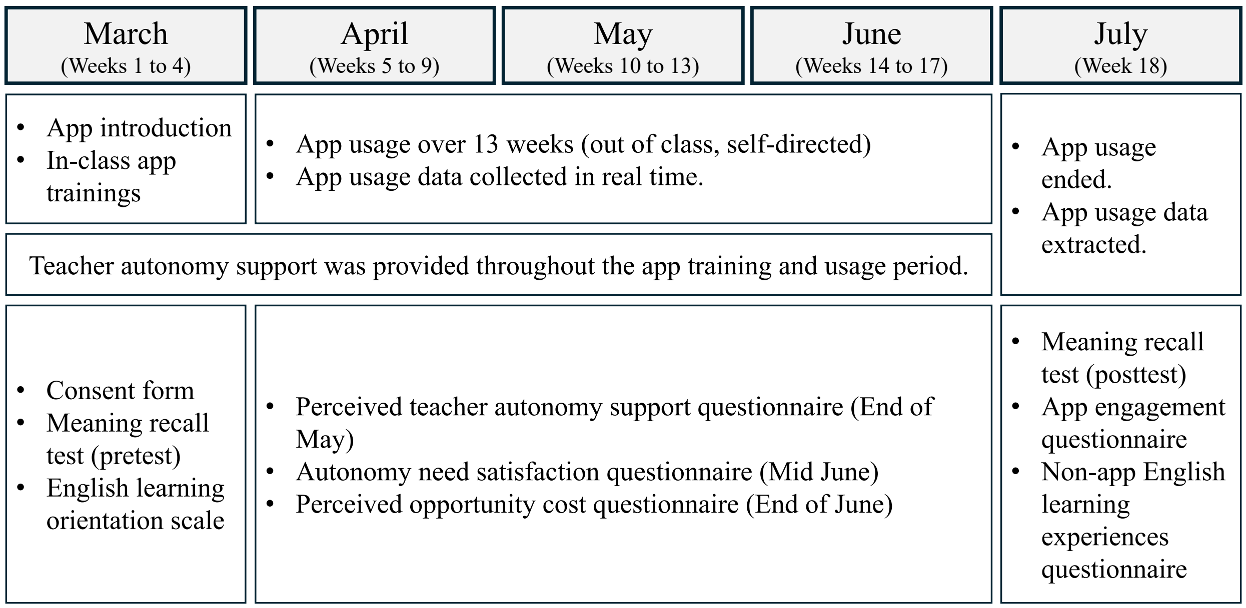


Figure 12 Overview of the study procedure.

Data Analysis

Analysis 1: Mediation Model

To answer research questions from 1 to 5, I built a mediation model within the framework of structural equation modeling (SEM), using the *lavaan* R package. Although the dataset had no missing values, the results of the multivariate non-normality test indicate that the assumption of multivariate normality was not satisfied (see Table 7). To address the nonnormal distributions and accommodate both continuous and ordinal indicators, I applied the robust Maximum Likelihood method with the mean-adjusted Satorra-Bentler scaled chi-square estimator (MLM) (Kline, 2023).

Table 7 Results of multivariate non-normality test

Test	Statistic	*p* value	Normality
Mardia Skewness	6805.73	< .001	No
Mardia Kurtosis	43.14	< .001	No

Next, I used confirmatory factor analysis (CFA) to build and assess the measurement model, establishing construct validity—the degree to which each scale accurately measures its intended construct. This was achieved by ensuring unidimensionality, whereby the indicators of each latent variable represent only that specific variable. I evaluated this through multiple forms of evidence. First, I checked whether the standardized factor loadings of individual indicators were greater than .50. Second, I examined construct reliability (i.e., how consistent the indicators are with each other in measuring the same construct) to confirm that omega (ω) values exceeded the recommended threshold of .70. Additionally, convergent validity (i.e., the extent to which the latent variable explains the variance of its indicators) was supported when the average variance extracted (AVE) for each latent variable was greater than .50. Additionally, discriminant validity, which ensures that a construct is distinct from others, was examined to ensure that each construct is distinct from others by verifying that the square root of each latent variable's AVE was greater than its correlations with other variables. Based on this information, I determined the number of latent variables of the measurement model.

Finally, I compared the relative fit of measurement invariance models to ensure that the questionnaire items were interpreted equivalently across class groups taught by two teachers. The stepwise procedure involved testing for several levels of invariance: configural invariance, which assesses whether the same factor structure holds across groups; weak invariance (i.e., equality of unstandardized factor loadings) to determine if the relationships between items and latent variables were consistent across groups; strong invariance (i.e., equality of unstandardized intercepts) to establish that item response levels were comparable; and strict invariance (i.e., equality of error variances and covariances) to confirm that residual variances were equivalent across groups.

For both the measurement model and the structural model, I evaluated model fit at both the local and global levels. For local fit, I examined normalized residuals, considering values within the range of ±2.0 as acceptable. For global fit, I reported the scaled χ^2 statistic alongside robust versions of three fit indices: Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). In addition, I also reported Standardized Root Mean Square Residual (SRMR). The thresholds for acceptable model fit were CFI and TLI values ≥ .90, and RMSEA and SRMR values ≤ .08, with values up to .10 considered marginally acceptable. Lastly, I compared the hypothesized model in Figure 6 against an alternative model to reduce the risk of confirmation bias.

Analysis 2: Cluster Analysis and Moderated Mediation Model

To answer research question 6, I first identified distinct subgroups among young beginner Korean EFL learners based on their motivation for English learning. I used a hybrid (hierarchical k-means) approach to cluster analysis (e.g., Crowther et al., 2021; Hwang et al., 2024). Using the *NbClust* and *factoextra* R packages, I determined the number of clusters with an agglomerative hierarchical clustering algorithm with Ward's linkage and squared Euclidean distance methods.

Subsequently, I used the resulting clusters as a moderator of the mediation model built in Analysis 1 (i.e., moderated mediation model). To ensure that questionnaire items were interpreted equally across different L2 motivation groups, I checked measurement invariance in a stepwise fashion. Next, I compared a constrained model in which parameters (e.g., path coefficients, intercepts) are constrained to be equal across motivational groups and an unconstrained model in which they are allowed to vary freely. If the chi-square difference between the fit of the constrained and the unconstrained model is significant, it indicates that the structural relationships differ across groups.

RESULTS

Descriptive Statistics

Perceived Teacher Autonomy Support and Autonomy Need Satisfaction

Tables 8 and 9 present the descriptive statistics for perceived teacher autonomy support and autonomy need satisfaction for app-based language learning beyond the classroom, respectively. On the six-point Likert scale used in the survey, mean scores above 4 indicate positive responses, whereas mean scores below 3 are negative responses to corresponding items. As summarized in Figure 13, the overall results show neutral-positive trends for the measured constructs, with mean scores close to 4, suggesting that teachers' instructional behaviors were generally perceived as autonomy-supportive and that learners who felt them as such experienced a sense of volition and personal ownership.

Table 8 Descriptive statistics of perceived teacher autonomy support

Item	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
		LL	*UL*					
Support1	3.96	3.77	4.15	1.55	0.10	4	1	6
Support2	4.11	3.93	4.29	1.47	0.09	5	1	6
Support3	3.35	3.14	3.56	1.71	0.11	3	1	6
Support4	3.91	3.70	4.12	1.70	0.11	4	1	6

Table 9 Descriptive statistics of autonomy need satisfaction

Item	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
		LL	*UL*					
Autonomy1	3.83	3.63	4.04	1.66	0.10	4	1	6
Autonomy2	4.28	4.09	4.46	1.47	0.09	5	1	6
Autonomy3	3.40	3.19	3.61	1.69	0.11	4	1	6

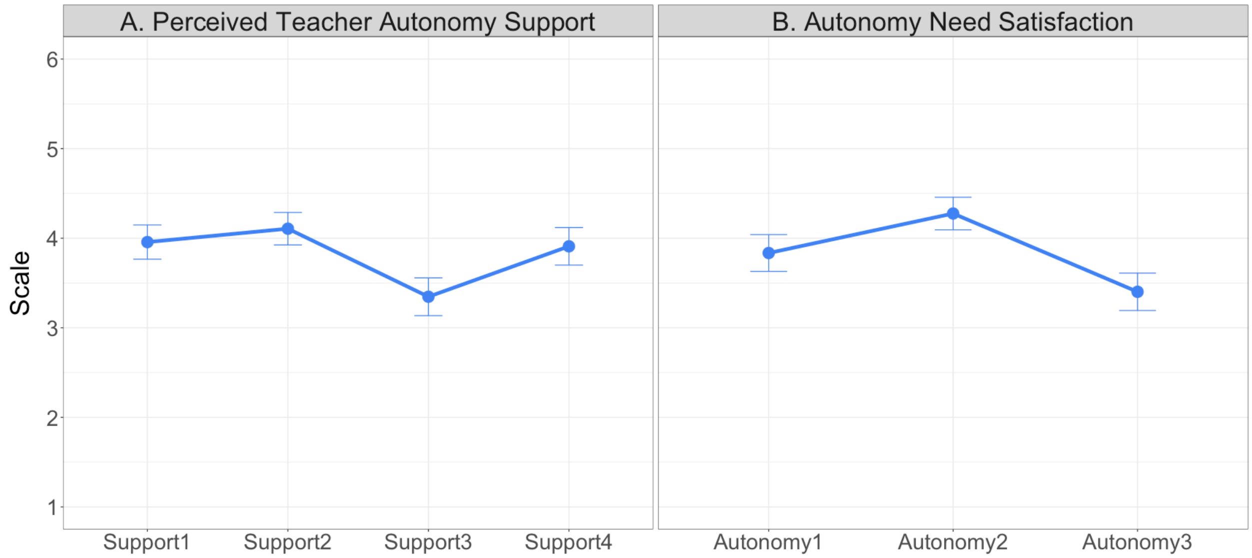


Figure 13 Perceived teacher autonomy support and autonomy need satisfaction: means and 95% confidence intervals.

App Engagement

Table 10 presents the descriptive statistics for app engagement beyond the classroom. Overall, the results indicate low to moderate engagement levels across behavioral, emotional, cognitive, and agentic types, with most mean scores falling below the positive benchmark of 4. Figure 14 summarizes these findings.

Table 10 Descriptive statistics of app engagement

Item	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
		LL	*UL*					
BE1	2.89	2.68	3.09	1.66	0.10	2	1	6
BE2	3.27	3.05	3.48	1.72	0.11	3	1	6
BE3	3.38	3.17	3.59	1.71	0.11	4	1	6
EE1	3.06	2.87	3.26	1.59	0.10	3	1	6
EE2	3.24	3.05	3.44	1.61	0.10	3.5	1	6
EE3	3.23	3.03	3.42	1.59	0.10	3	1	6
CE1	3.47	3.27	3.67	1.61	0.10	4	1	6
CE2	3.08	2.88	3.27	1.57	0.10	3	1	6
CE3	2.83	2.64	3.02	1.56	0.10	2	1	6
AE1	2.93	2.73	3.13	1.60	0.10	3	1	6
AE2	3.05	2.85	3.24	1.59	0.10	3	1	6
AE3	3.22	3.01	3.42	1.66	0.10	3	1	6

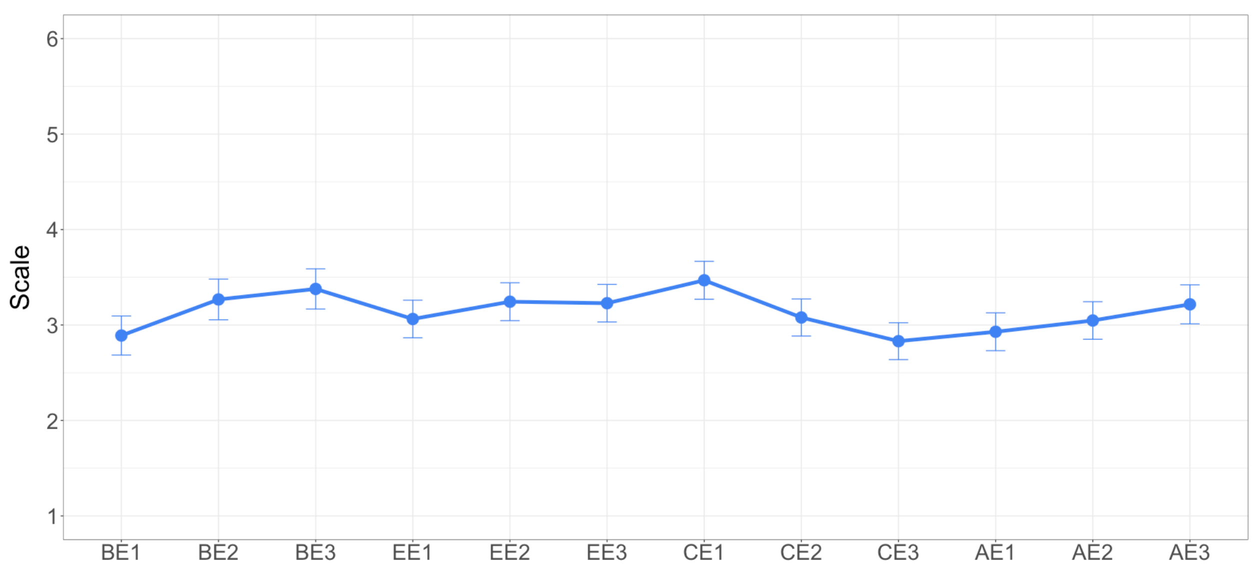


Figure 14 App engagement: means and 95% confidence intervals. The acronyms BE, EE, CE, and AE represent behavioral, emotional, cognitive, and agentic engagement, respectively.

Non-App English Learning Experiences and Perceived Opportunity Cost

Table 11 presents the descriptive statistics for non-app English learning experiences across language skills. The results indicate that listening was the most frequently practiced activity among young beginners beyond the classroom (e.g., listening to English songs) while speaking, pronunciation, and writing skills were the least practiced. However, the wide 95% confidence intervals in Figure 15a suggest substantial variation among the learners.

Table 12 presents the descriptive statistics for perceived opportunity cost of app usage, indicating overall neutral-negative responses, indicating learners did not evaluate using the app as overly time- and effort-intensive. Figure 15b summarizes these trends, showing the mean scores ranged between 3 and 4.

Table 11 Descriptive statistics of non-app English learning experiences

Scale	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
		LL	*UL*					
Reading	16.04	12.89	19.19	25.49	1.60	6	0	189
Listening	21.65	17.85	25.44	30.73	1.93	10	0	189
Writing	11.59	8.79	14.40	22.70	1.42	11.59	0	189
Speaking	10.27	7.54	13.00	22.10	1.39	0	0	189
Grammar	13.14	9.99	16.29	25.48	1.60	0	0	189
Vocabulary	16.63	13.29	19.97	27.03	1.70	3	0	189
Pronunciation	10.36	7.44	13.28	23.61	1.48	0	0	189

Table 12 Descriptive statistics of perceived opportunity cost

Item	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
		LL	*UL*					
Cost1	3.12	2.94	3.29	1.43	0.09	3	1	6
Cost2	3.75	3.55	3.94	1.58	0.10	4	1	6
Cost3	3.37	3.19	3.55	1.45	0.09	3	1	6
Cost4	3.17	2.98	3.37	1.59	0.10	3	1	6

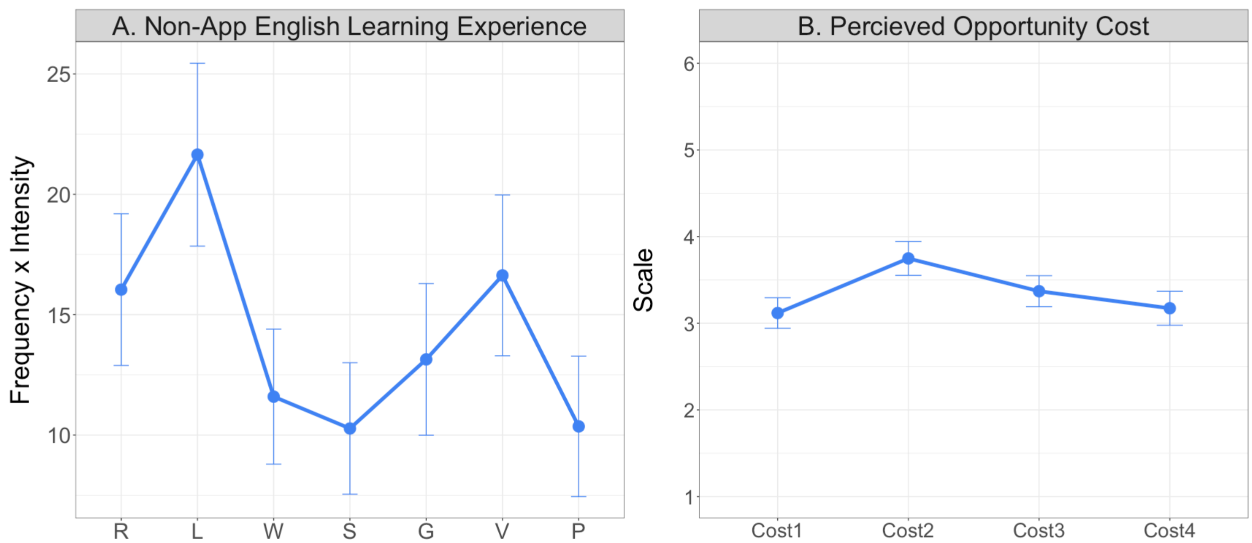


Figure 15 Non-app English learning experiences and perceived opportunity cost: means and 95% confidence intervals. R = Reading; L = Listening; W = Writing; S = Speaking; G = Grammar; V = Vocabulary; P = Pronunciation.

App Usage

Table 13 presents the total amount of time spent on the app. Overall, the learners used the app for 1.65 hours (95% CI [1.36, 1.93]) out of class over 13 weeks. Notably, the learners in the top 10% of app usage (n = 26) showed about 7.02 hours (95% CI [5.36, 8.68]) of app usage on average. As shown in Figure 16, the red trend line indicating the average cumulative app usage over time reveals that the mean values were skewed toward the lower end due to a subset of learners with minimal app usage.

Table 13 Descriptive statistics of app usage

Group	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
		LL	*UL*					
All (n = 254)	1.65	1.36	1.93	2.33	0.15	1.01	0	19.70
Top 10% (n = 26)	7.02	5.36	8.68	4.11	0.81	5.28	3.67	19.70

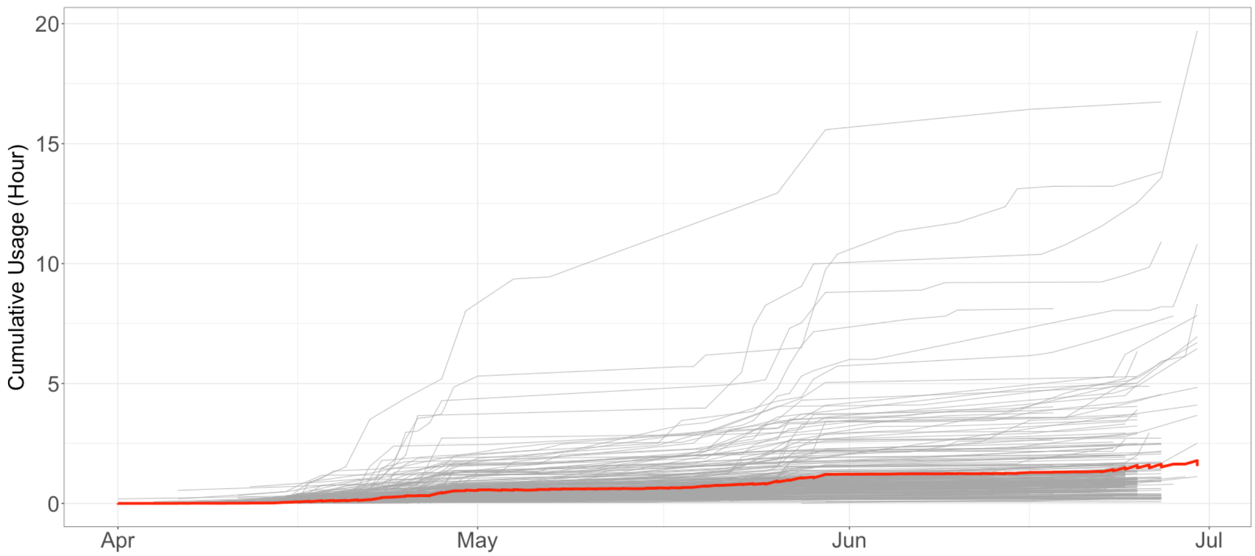


Figure 16 Individual cumulative app usage over time.

Panel A in Figure 17 represents the daily total app usage time at a group level. Overall, the app usage displayed repetitive fluctuations. A nearly two-week period of national holidays in May led to decreased usage as learners did not attend school, suggesting a diminished effect of teacher autonomy support during this time. Similarly, the performance assessment season in June for most school subjects shifted learners' focus away from the app. However, it is noteworthy that the learners repeatedly returned to the app after pauses in their usage, rather than failing to resume app usage once it was disrupted. Panel B in Figure 17 shows the distribution of the total app usage time of individual learners, suggesting great variations among the learners.

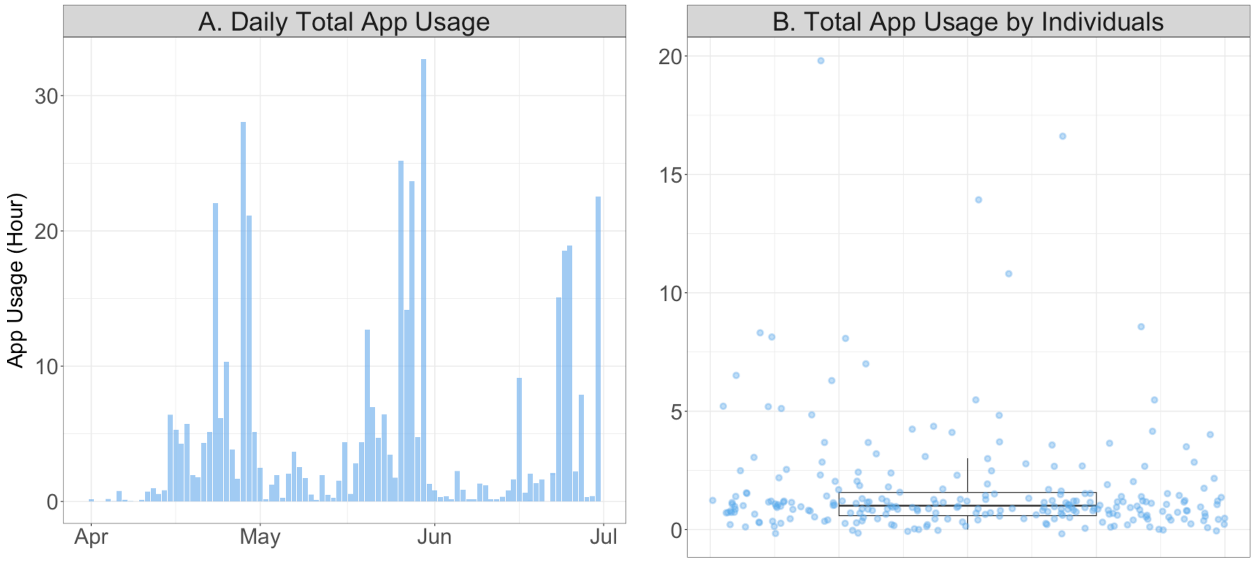


Figure 17 Distribution of app usage data.

Meaning Recall Test

Table 14 and Figure 18 present the results of the meaning recall test. After using the app over 13 weeks, the learners demonstrated an overall improvement on the posttest, with the top 10% app usage group (n = 26) showing greater gains.

Table 14 Descriptive statistics of meaning recall test

Group	Time	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
			LL	*UL*					
All	Pretest	5.61	4.97	6.26	5.19	0.33	4	0	23
(n = 254)	Posttest	9.48	8.57	10.40	7.39	0.46	8	0	28
Top 10%	Pretest	6.23	4.11	8.35	5.26	1.03	4.50	0	16
(n = 26)	Posttest	13.04	9.58	16.50	8.57	1.68	13	0	28

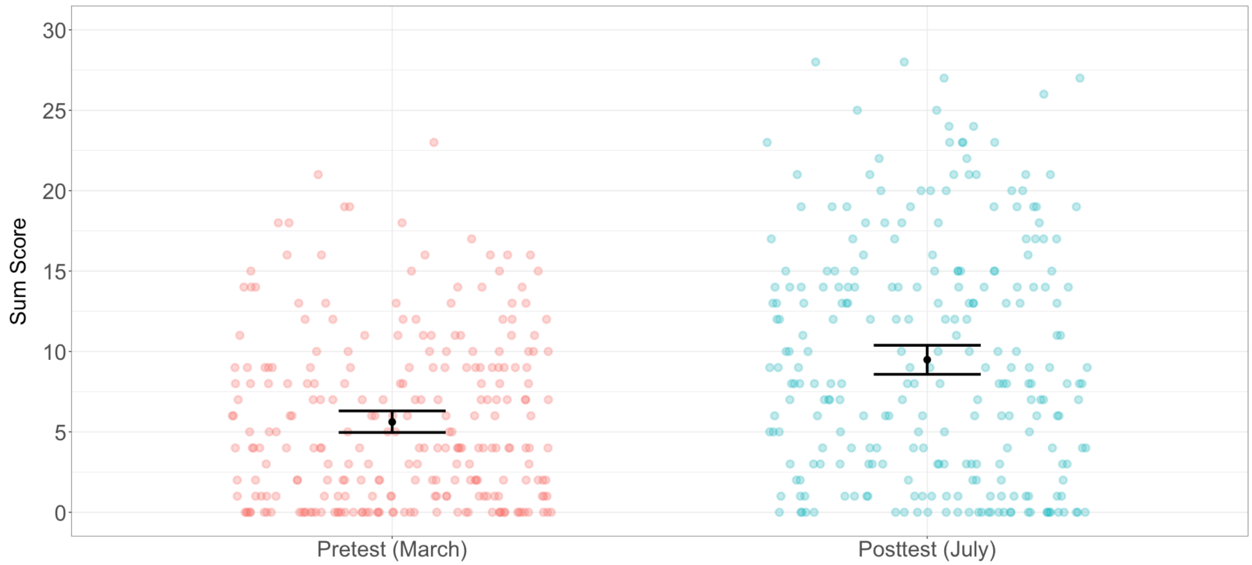


Figure 18 Meaning recall test scores: means and 95% confidence intervals.

Correlational Relationships Among the Variables

Figure 19 displays a correlation plot illustrating the strength of correlations between items. The colors represent the magnitude and direction of the relationships, with stronger positive correlations depicted in blue and stronger negative correlations in red shades. The results reveal three key patterns. First, the items from perceived teacher autonomy support, autonomy need satisfaction, app engagement, app usage time, and learning gains positively correlated with each other. As outlined in Noels et al.'s (2019) motivation process model, these findings indicate a potential positive chain reaction: learners who perceived teachers' instructional behaviors as autonomy-supportive were more likely to experience greater volition and personal ownership in app usage. This, in turn, enhanced their app engagement and increased their actual app usage out of class, ultimately leading to improved learning gains. Second, the items from perceived opportunity cost demonstrated negative correlations with the positively correlated group, indicating that learners who perceived app-based language learning as time- and effort-intensive were more likely to have negative experiences with app usage. Conversely, those who viewed it as requiring less time and effort were more likely to have positive app usage experiences. Finally, non-app English learning activities beyond the classroom showed no clear positive or negative correlations with the other variables.

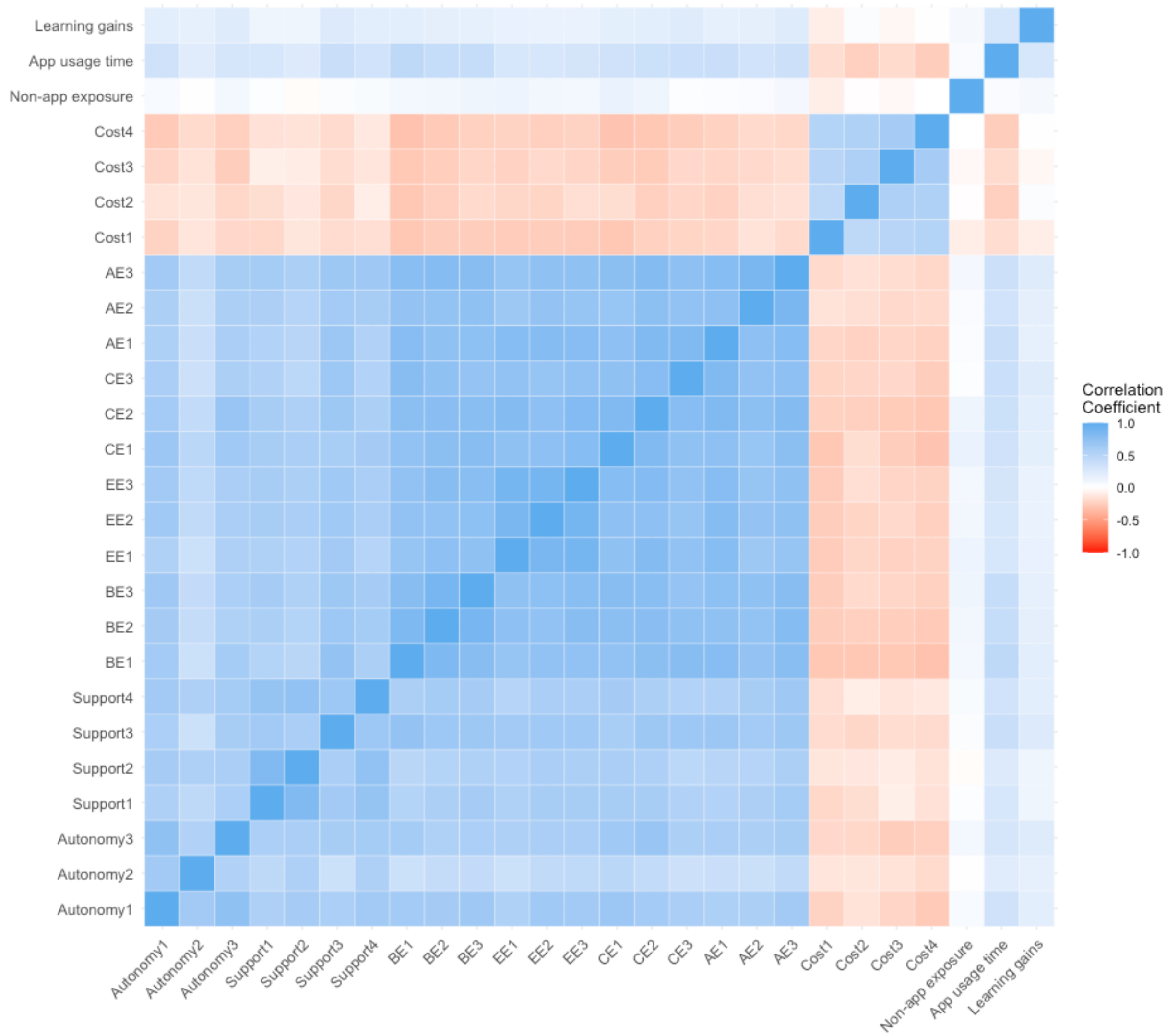


Figure 19 Correlation plot of individual variables.

Four-Factor Measurement Model

Evaluating the measurement model confirms that the observed variables accurately reflect the underlying constructs, establishing a solid foundation for any subsequent structural analysis of relationships among constructs. First, I built a seven-factor measurement model including perceived teacher autonomy support, autonomy need satisfaction, four types of engagement, and perceived opportunity cost. However, this initial attempt revealed methodological issues that required adjustments to the model. Although engagement is a theoretically multidimensional construct (e.g., Hiver et al., 2021, 2024), the factor correlations among the four engagement latent variables were very high, reaching above .90. Such high interdependence indicates that the latent variables measure almost the same underlying construct. Indeed, an exploratory factor analysis with the *oblimin* rotation and the *minres* estimation method in Figure 20 confirmed a single-factor structure of app engagement, with all 12 items strongly loading on a single factor, and parallel analysis scree plots in Figure 21 showed the eigenvalues of any additional factors being negligible. Furthermore, I encountered a convergence issue in a subsequent structural model, which failed to find a proper solution due to possible extreme multicollinearity.

To address this problem, I conceptualized engagement as a single construct, consistent with previous studies (e.g., Oga-Baldwin et al., 2017). Furthermore, I applied a parceling technique by grouping individual items into multiple parcels and used these parcel values as indicators of a latent construct. Parceling, by specifying a target construct with fewer indicators, can help address measurement error associated with individual item-level data, leading to more stable parameter estimates and better model fit (see Little et al., 2013, for a pro-parcel argument for multidimensional constructs). Following Matsunaga's (2008) recommendation, I grouped 12 engagement items into three parcels—Engagement 1, Engagement 2, and Engagement 3—considering an even distribution of item-specific factor loadings across parcels (i.e., factorial algorithm). As summarized in Table 15, these parcels, each comprising four items, served as indicators of a single latent variable, app engagement.

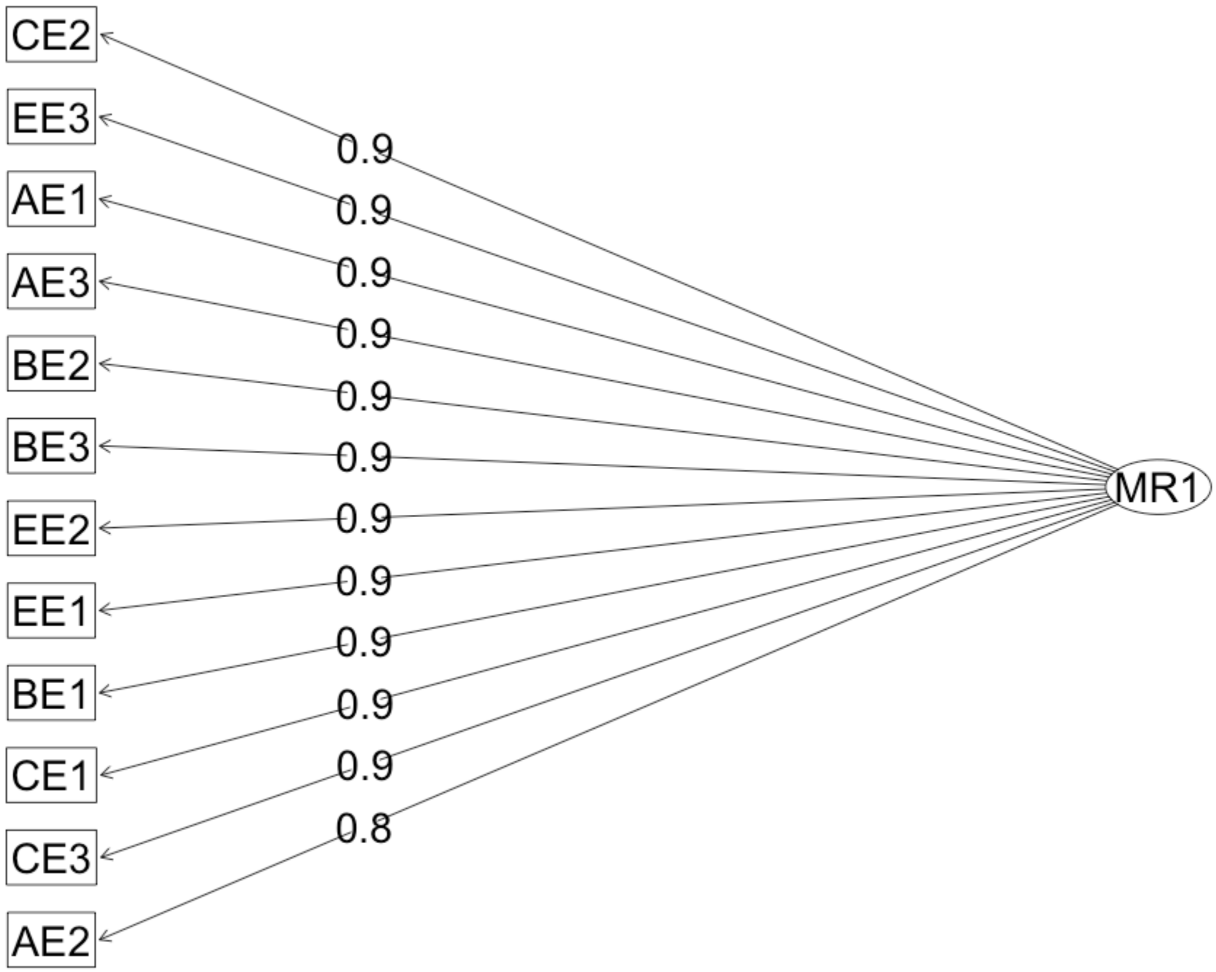


Figure 20 Exploratory factor analysis of app engagement items.

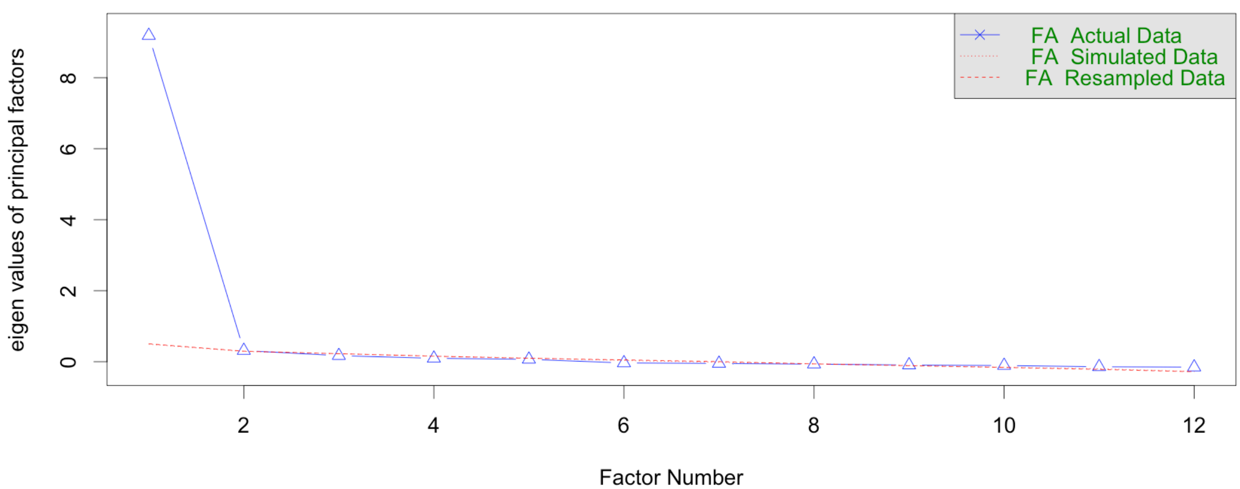


Figure 21 Parallel analysis scree plots.

Table 15 Results of factorial-algorithm-based parceling

Item	Standardized Factor Loading	Parcel
CE2	0.90	Engagement1
EE3	0.90	Engagement2
AE1	0.89	Engagement3
BE2	0.88	Engagement3
BE3	0.88	Engagement2
AE3	0.88	Engagement1
EE2	0.88	Engagement1
EE1	0.87	Engagement2
CE1	0.87	Engagement3
BE1	0.86	Engagement3

To further check the unidimensionality of items within each parcel, I conducted a series of single-factor CFA models for each parcel. The results in Table 16 show that the standardized factor loadings for all indicators were greater than the recommended threshold of 0.7, providing empirical support for aggregating the items into parcels.

Table 16 Results of confirmatory factor analysis by parcel

Parcel	Indicators	b^*	p-value	Error variances
Engagement1	CE2	.86	< .001	.26
	AE3	.94	< .001	.12
	EE2	.81	< .001	.35
	AE2	.90	< .001	.18
Engagement2	EE3	.95	< .001	.11
	BE3	.83	< .001	.32
	EE1	.92	< .001	.15
	CE3	.79	< .001	.38

Table 16 (cont'd)

Engagement3	AE1	.85	< .001	.27
	BE2	.90	< .001	.19
	CE1	.83	< .001	.31
	BE1	.91	< .001	.17

After parceling, I built a four-factor measurement model, consisting of (a) perceived teacher autonomy support, (b) autonomy need satisfaction, (c) app engagement, and (d) perceived opportunity cost. The inspection of normalized residuals of the four-factor measurement model revealed all residuals, except for three cases, remained within the acceptable range of ±2.0, supporting the model's local fit (see Table 17). As shown in Table 18, the standardized factor loadings were statistically significant at $p < .001$ and consistently high across items, with the lowest loading observed at .65 for Cost 1. Figure 22 summarizes the finalized four-factor measurement model. Global fit indices indicated strong model fit (scaled χ^2 (71) = 131.36, $p < .001$; CFI = . 97; TLI = . 96; RMSEA = .07, 90% CI [.05, .08]; SRMR = .04).

Table 17 Normalized residuals for a four-factor measurement model (local fit)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Support1	0.00													
2. Support2	0.67	0.00												
3. Support3	–0.32	–1.06	0.00											
4. Support4	–0.40	–0.14	0.73	0.00										
5. Autonomy1	–1.04	–0.36	0.78	0.50	0.00									
6. Autonomy2	–0.37	0.81	–0.65	1.25	0.29	0.00								
7. Autonomy3	–0.24	–0.23	1.55	0.75	0.00	–0.46	0.00							
8. Engagement1	–0.54	–0.95	2.39	–0.81	–0.72	–1.44	–0.07	0.00						
9. Engagement2	0.00	–0.23	2.46	0.25	0.67	–0.46	0.27	0.01	0.00					
10. Engagement3	–0.17	–0.62	2.22	–0.03	0.29	–0.38	0.07	0.08	–0.07	0.00				
11. Cost1	–1.08	–0.01	–1.22	–0.71	–0.38	0.29	–0.18	–1.07	–0.96	–0.97	0.00			
12. Cost2	–0.56	0.20	–1.42	0.68	1.04	0.53	–0.04	0.02	–0.14	0.69	–0.06	0.00		
13. Cost3	0.94	0.76	–0.82	0.09	0.31	0.51	–0.54	–0.06	0.54	0.30	–0.18	0.26	0.00	
14. Cost4	–0.01	0.11	–0.89	0.44	–0.45	0.01	–0.30	0.07	–0.04	0.22	0.10	–0.06	–0.06	0.00

Note. Residual values within the range of ±2.0 are acceptable.

Table 18 Robust maximum likelihood estimates for a four-factor measurement model

Parameter	*b*	*SE*	*b**	*SE*	*z*
Factor Loadings					
Perceived Teacher Autonomy Support					
Support1	1.00		0.87	0.03	34.08
Support2	0.96	0.05	0.88	0.03	32.50
Support3	0.93	0.05	0.73	0.03	21.72
Support4	1.05	0.04	0.84	0.03	32.24
Autonomy Need Satisfaction					
Autonomy1	1.00		0.89	0.02	37.33
Autonomy2	0.68	0.07	0.68	0.05	12.98
Autonomy3	0.96	0.04	0.83	0.03	30.73
App Engagement					
Engagement1	1.00		0.92	0.02	57.53
Engagement2	1.02	0.03	0.93	0.02	57.90
Engagement3	1.03	0.03	0.95	0.01	69.61
Perceived Opportunity Cost					
Cost1	1.00		0.65	0.05	13.68
Cost2	1.18	0.14	0.70	0.05	12.94
Cost3	1.20	0.13	0.77	0.05	14.70
Cost4	1.35	0.14	0.79	0.04	17.99
Error (Unique) Variances					
Support1	0.56	0.10	0.24	0.05	5.25
Support2	0.47	0.10	0.22	0.05	4.58
Support3	1.33	0.15	0.46	0.05	9.27
Support4	0.85	0.12	0.30	0.04	6.84
Autonomy1	0.60	0.11	0.22	0.04	5.17
Autonomy2	1.16	0.15	0.54	0.07	7.57
Autonomy3	0.88	0.13	0.31	0.05	6.87

Table 18 (cont'd)

Engagement1	0.40	0.07	0.16	0.03	5.39
Engagement2	0.33	0.07	0.13	0.03	4.30
Engagement3	0.24	0.07	0.10	0.03	3.69
Cost1	1.17	0.13	0.58	0.06	9.31
Cost2	1.27	0.20	0.52	0.08	6.87
Cost3	0.85	0.17	0.41	0.08	5.03
Cost4	0.94	0.17	0.38	0.07	5.39
Factor Variances					
Perceived Teacher Autonomy Support	1.82	0.19	1.00	—	—
Autonomy Need Satisfaction	2.16	0.20	1.00	—	—
App Engagement	2.13	0.16	1.00	—	—
Perceived Opportunity Cost	0.86	0.15	1.00	—	—
Covariances					
Perceived Teacher Autonomy Support					
Autonomy Need Satisfaction	1.60	0.17	0.81	0.04	19.02
App Engagement	1.43	0.14	0.72	0.04	20.02
Perceived Opportunity Cost	–0.28	0.11	–0.22	0.08	–2.75
Autonomy Need Satisfaction					
App Engagement	1.56	0.16	0.73	0.05	14.97
Perceived Opportunity Cost	–0.48	0.12	–0.35	0.08	–4.66
App Engagement					
Perceived Opportunity Cost	–0.44	0.11	–0.33	0.07	–4.65

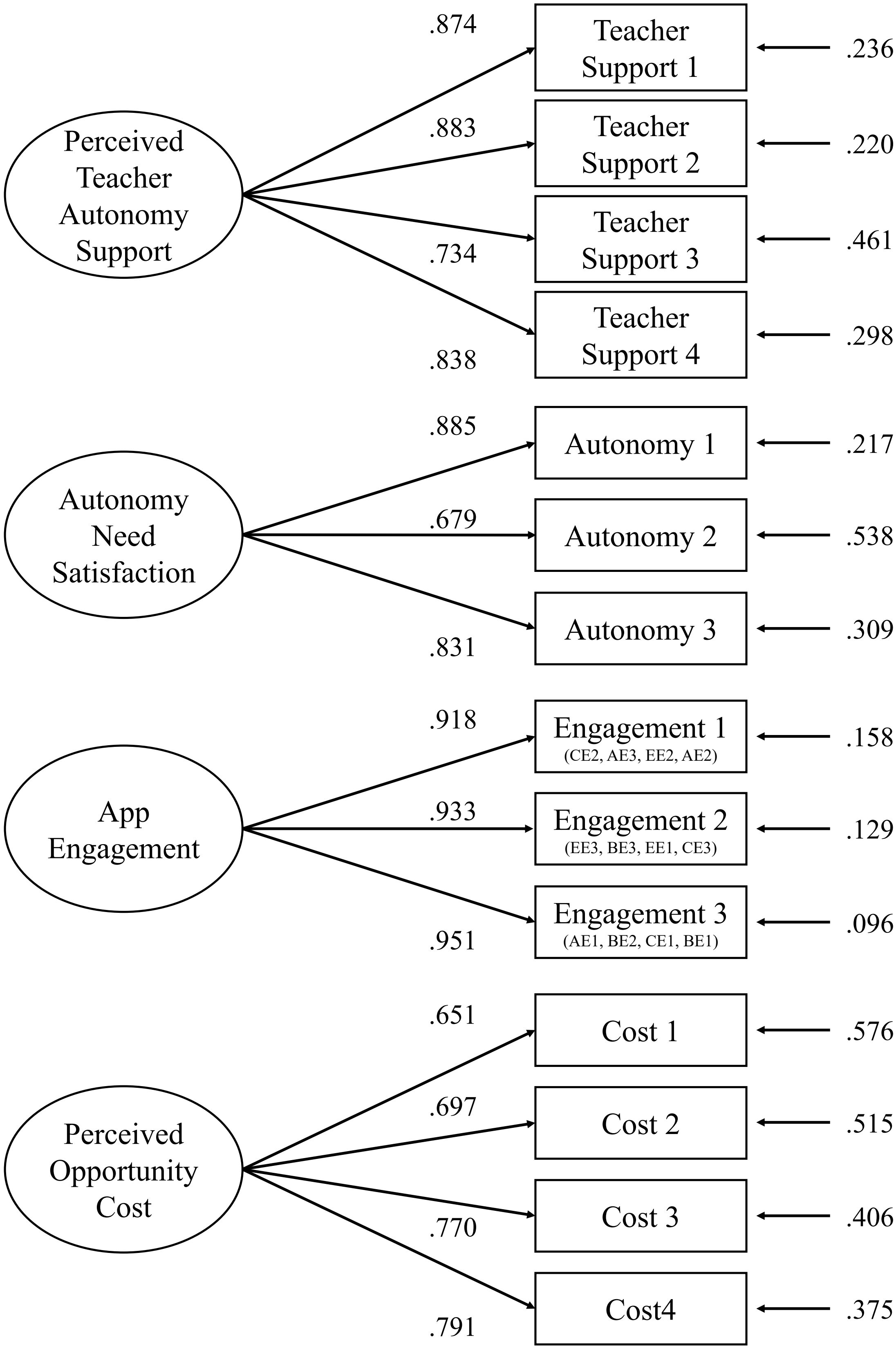


Figure 22 Four-factor measurement model. Covariances are not shown for simplicity.

The findings in Table 19 also confirmed the strong reliability and validity of the four-factor measurement model. The ω values exceeded the recommended threshold of .70 for all latent variables, indicating good construct reliability. Convergent validity was supported by AVE, which surpassed the .50 threshold for all constructs. Additionally, perceived teacher autonomy support, autonomy need satisfaction, and app engagement were positively correlated with one another, while all four latent variables showed negative correlations with perceived opportunity cost. The square roots of AVE were consistently higher than the correlations with other constructs, confirming discriminant validity. These results collectively provide robust evidence for the hypothesized factor structure and unidimensionality of the four latent variables.

Table 19 Reliability and validity of the measurement model

	ω	AVE	1	2	3	4
1. Perceived Teacher Autonomy Support	.89	.69	.83			
2. Autonomy Need Satisfaction	.85	.66	.80	.81		
3. App Engagement	.95	.87	.72	.73	.93	
4. Perceived Opportunity Cost	.82	.54	–.22	–.35	–.33	.73

Note. The shaded values represent the square roots of the AVE for each latent variable. The correlations between latent variables are listed below the shaded diagonal.

As indicated in Table 20, measurement invariance was also established across class groups taught by two teachers. All tested invariance models demonstrated good global fit, and the non-significant chi-square difference test results between models (*p*s > .05) indicated that the configural, weak, strong, and strict invariance models were retained. These findings confirm that the constructs were interpreted and perceived equally across the two teacher class groups.

Table 20 Invariance (multi-group) models across class groups taught by two teachers

Model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	*p*	CFI	TLI	RMSEA	RMSEA 90% CI		SRMR
										LB	*UB*	
Configural	292.17	142	< .001				.96	.95	.08	0.05	0.09	0.05
Weak	304.63	152	< .001	12.72	10	0.24	.96	.95	.07	0.05	0.09	0.06
Strong	310.55	162	< .001	6.28	10	0.79	.96	.96	.07	0.05	0.09	0.06
Strict	327.37	176	< .001	9.85	14	0.77	.96	.96	.07	0.04	0.08	0.06

Structural Model of Mediation for Research Questions 1 to 5

Proposed vs. Alternative Models

As illustrated in Figure 23, I compared the two competing models to reduce confirmation bias. In the originally proposed model, app engagement precedes app usage, which predicts learning gains (i.e., app engagement → app usage → learning gains). In the alternative model, app usage precedes app engagement, which predicts learning gains (i.e., app usage → app engagement → learning gains).

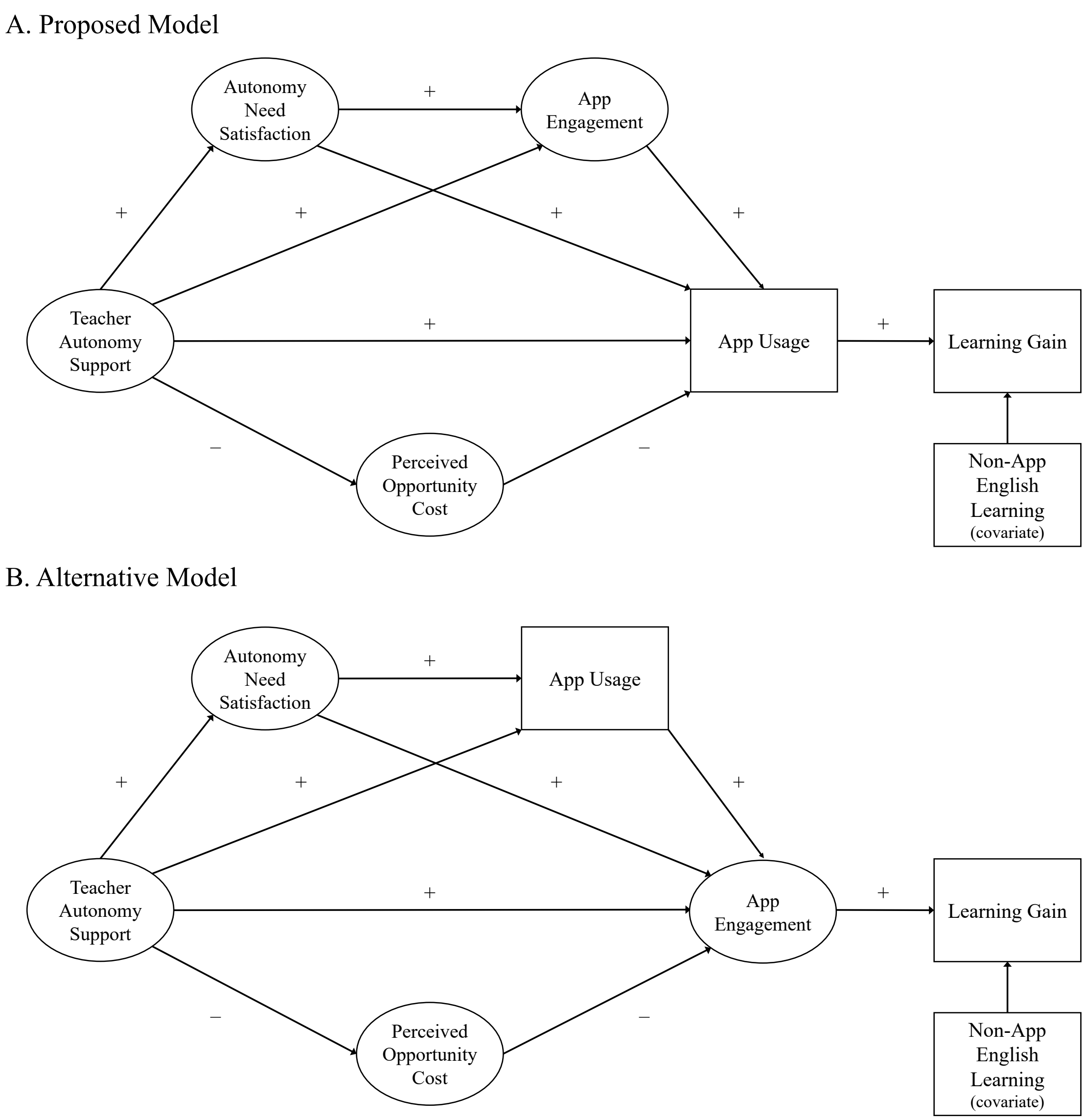


Figure 23 Proposed and alternative models.

The results of the model comparison in Table 21 reveal that the proposed model, with app engagement predicting app usage, explained more variance in app usage (i.e., 18.8%) and learning gains (i.e., 8.1%), with lower information criterion values (i.e., AIC, BIC, SABIC) compared to the alternative model. Therefore, the proposed model was retained for further analysis.

The proposed structural model demonstrated good global fit to the data, as evidenced by scaled $\chi^2(112) = 230.44$, $p < .001$, CFI = .95, TLI = .95, RMSEA = .07 (90% CI [.06, .08]), and SRMR = .07. As shown in Table 22, the model's local fit was supported by the minimal proportion of significant normalized residuals exceeding ±2.0: eight out of 153 total cases.

Table 21 Comparison between the proposed and the alternative models

Model	χ^2	*df*	*p*	AIC	BIC	SABIC	CFI	TLI	RMSEA	RMSEA 90% CI		SRMR
										LB	*UB*	
Proposed	230.44	112	< .001	15998.36	16139.85	16013.04	.96	.95	.07	.06	.08	.07
Alternative	239.76	112	< .001	16008.28	16149.78	16022.97	.95	. 94	.07	.06	.09	.06

Variance Explained (%)

	Autonomy Need Satisfaction	App Engagement	Perceived Opportunity Cost	App Usage	Learning Gains
Proposed	66.5%	66.5%	7.1%	18.8%	8.1%
Alternative	66.4%	68.3%	6.5%	14.1%	4.7%

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; SABIC = Sample-size adjusted Bayesian criterion.

Table 22 Normalized residuals for a structural model: local fit

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	0.00																
2	0.94	0.00															
3	–0.49	–1.12	0.00														
4	–0.38	–0.01	0.42	0.00													
5	–1.07	–0.31	0.46	0.34	0.00												
6	–0.32	0.92	–0.80	1.21	0.37	0.00											
7	–0.29	–0.19	1.24	0.56	–0.06	–0.40	0.00										
8	0.08	–0.54	2.48	0.50	0.24	–0.67	0.75	0.00									
9	–0.32	–1.04	2.53	–0.32	–0.09	–1.02	–0.04	0.00	0.00								
10	–0.66	–1.26	2.74	0.08	0.12	–0.92	0.37	–0.05	0.03	0.00							
11	–0.76	0.29	–0.85	–0.35	–1.49	–0.54	–1.24	–1.53	–2.30	–2.37	0.00						
12	–0.15	0.59	–1.00	1.13	–0.14	–0.44	–1.14	–1.13	–1.10	–1.77	–0.13	0.00					
13	1.32	1.11	–0.41	0.51	–1.03	–0.54	–1.79	–1.17	–1.30	–1.87	–0.10	0.21	0.00				
14	0.42	0.51	–0.44	0.89	–1.87	–1.08	–1.65	–1.51	–1.69	–2.41	0.14	–0.19	0.02	0.00			
15	–0.42	–1.15	1.53	0.37	0.47	–0.25	0.13	–0.04	0.01	0.81	–0.18	–1.05	0.13	–0.90	0.04		
16	0.57	0.43	2.52	1.87	1.84	1.89	2.40	1.55	1.41	1.52	–0.66	1.27	0.20	0.78	0.07	0.02	
17	0.45	–0.33	0.67	0.95	1.12	0.10	1.47	1.58	1.72	1.66	–1.72	–0.15	–0.59	0.03	0.85	0.29	0.00

Note. Residual values within the range of ±2.0 are acceptable; Items 1 to 4 = Support 1 to 4; Items 5 to 7 = Autonomy 1 to 3; Items 8 to 10 = Engagement 1 to 3; Items 11 to 14 = Cost 1 to 4; Item 15 = App usage time; Item 16 = Learning gains; Item 17 = Non-app English learning experiences.

Tables 23 and 24 present direct and indirect path coefficients from robust maximum likelihood estimation for the proposed structural model, respectively. Figure 24 demonstrates the proposed mediation model with standardized path coefficients, where solid and dashed lines indicate significant and non-significant paths at the $p < .05$ level, respectively. Each path is discussed in relation to its corresponding latent variables.

Table 23 Robust maximum likelihood estimates for a structural model: direct effects

Direct Effect Path			*b**	95% CI *UL*	95% CI *LL*	*SE*	*z*	*p*
Perceived Teacher Autonomy Support	→	Autonomy Need Satisfaction	.82	.74	.90	.04	19.92	< .001
	→	App Engagement	.42	.18	.66	.12	3.46	< .001
	→	Perceived Opportunity Cost	–.27	–.42	–.11	.08	–3.38	< .001
	→	App Usage	.07	–.08	.21	.08	0.87	.38
Autonomy Need Satisfaction	→	App Engagement	.44	.18	.69	.13	3.35	< .001
	→	App Usage	.05	–.09	.19	.07	0.72	.47
App Engagement	→	App Usage	.26	.13	.39	.07	3.92	< .001
Perceived Opportunity Cost	→	App Usage	–.18	–.27	–.09	.05	–3.83	< .001
App Usage	→	Learning Gains	.28	.13	.43	.08	3.68	< .001
Non–App English Learning	→	Learning Gains	.06	–.02	.14	.04	1.41	.16

Table 24 Robust maximum likelihood estimates for a structural model: indirect effects

Mediation Path	b^*	95% CI		SE	z	p
		UL	LL			
T → A → E	.36	.15	.56	0.11	3.32	.00
T → A → U	.04	–.07	.15	0.06	0.72	.47
T → E → U	.11	.03	.19	0.04	2.65	.01
T → A → E → U	.09	.02	.17	0.04	2.50	.01
T → C → U	.05	.01	.08	0.02	2.57	.01

Note. T = Perceived teacher autonomy support; A = Autonomy need satisfaction; E = App engagement; C = Perceived cost opportunity; U = App usage; G = Learning gains.

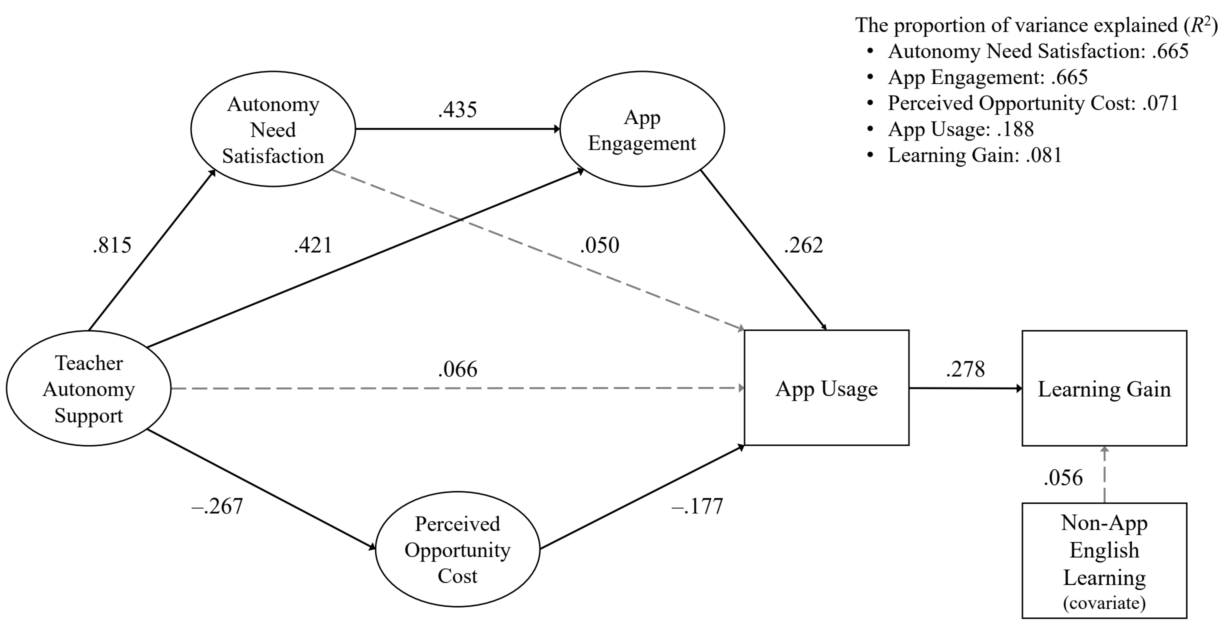


Figure 24 Moderation model. Error terms are not shown for simplicity.

Effects of Perceived Teacher Autonomy Support

Perceived teacher autonomy support positively affected autonomy need satisfaction ($b^* = .815$, 95% CI [.735, .896], $p < .001$) and app engagement ($b^* = .421$, 95% CI [.182, .659], $p = .001$), supporting Hypotheses 1a and 1b, respectively. However, there was no direct effect of teacher autonomy support on app usage ($b^* = .066$, 95% CI [–.082, .214], $p = .383$), rejecting Hypothesis 1c. These findings indicate that learners who perceive teachers' instructional behaviors as autonomy-supportive tend to exhibit higher levels of personal ownership in app usage and greater app engagement. However, this perception of teacher autonomy support does not directly result in increased app usage.

Additionally, teacher autonomy support negatively affected perceived opportunity cost of app usage ($b^* = –.267$, 95% CI [–.421, –.112], $p = .001$), supporting Hypothesis 1d. This finding indicates that learners who perceive greater teacher autonomy support are less likely to view app usage as a trade-off with other valuable learning activities.

Effects of Autonomy Need Satisfaction

Autonomy need satisfaction had a positive effect on app engagement ($b^* = .435$, 95% CI [.181, .690], $p = .001$), but its effect on app usage was not significant ($b^* = .050$, 95% CI [–.086, .185], $p = .472$). These findings support Hypothesis 2a but reject Hypothesis 2b, respectively. These findings indicate that while learners who experience higher volition in app-based language learning are more likely to engage with the app, they do not necessarily demonstrate greater app usage.

Autonomy need satisfaction mediated the effect of teacher autonomy support to app engagement (i.e., teacher autonomy support → autonomy need satisfaction → app engagement) ($b^* = .355$, 95% CI [.146, .564], $p = .001$), supporting Hypothesis 2c. However, autonomy need satisfaction did not mediate the effect of teacher autonomy support to app usage (i.e., teacher autonomy support → autonomy need satisfaction → app usage) (b^* = .041, 95% CI [–.070, .151], p = .473), rejecting Hypothesis 2d. These findings indicate that learners who perceive greater teacher autonomy support are more likely to experience higher levels of autonomy need satisfaction, which, in turn, enhances their app engagement. However, the same effect was not observed for app usage.

Effects of App Engagement

App engagement positively affected app usage (b^* = .262, 95% CI [.131, .393], p < .001). This finding supported Hypothesis 3a, indicating that learners with higher levels of app engagement tend to display greater app usage.

App engagement mediated the effect of teacher autonomy support to app usage (i.e., teacher autonomy support → app engagement → app usage) (b^* = .110, 95% CI [.029, .191], p = .008). In a serial mediation (i.e., teacher autonomy support → autonomy need satisfaction → app engagement → app usage), app engagement mediated the indirect effect of autonomy need support transmitted through autonomy need satisfaction on app usage (b^* = .093, 95% CI [.020, .166], p = .012). These findings support Hypotheses 3b and 3c, respectively, indicating that learners who perceive teachers' instructional behaviors as autonomy-supportive are more likely to engage with the app, which subsequently contributes to higher app usage, both directly and through enhanced autonomy need satisfaction (i.e., a sense of volition and self-endorsement in initiating and regulating their app usage beyond the classroom).

Effects of Perceived Opportunity Cost

Perceived opportunity cost negatively affected app usage (b^* = –.177, 95% CI [–.267, –.086], p < .001), supporting Hypotheses 4a. This finding indicates that learners who perceive a higher opportunity cost—greater time and effort involved in app usage—are less likely to use it.

However, perceived opportunity cost mediated the effect of teacher autonomy support to app usage (i.e., teacher autonomy support → perceived opportunity cost → app usage) (b^* = .047, 95% CI [.011, .083], p = .010), supporting Hypothesis 4b. This finding indicates that learners who perceive greater teacher autonomy support are likely to view app usage as less of an opportunity cost, which, in turn, increases app usage.

Effect of App Usage

App usage had a positive effect on L2 learning gains (b^* = .278, 95% CI [.130, .427], p < .001) after controlling for non-app English learning experiences as a covariate (b^* = .056, 95% CI [–.022, .135], p = .158). This finding supported Hypothesis 5, indicating that learners who use the app more tend to achieve higher L2 learning gains, regardless of their non-app English learning experiences.

Summary of the Findings

Table 25 presents the summary of the findings. Instead of having a direct effect on app usage, perceived teacher autonomy support indirectly impacted it by enhancing autonomy need satisfaction and app engagement (i.e., full mediation). Additionally, higher perceived opportunity cost decreased app usage, but teacher autonomy support mitigated this negative effect. The four variables collectively explained about 18.8% of the variance in app usage, indicating a medium-large effect size. In turn, app usage was a significant predictor of vocabulary learning gains, explaining about 8.1% of its variance—a medium effect size—even after controlling for non-app English learning experiences beyond the classroom.

Table 25 Summary of the findings

Hypothesis	Finding	Meaning
1a	Supported	Positive effect of teacher support on autonomy need satisfaction
1b	Supported	Positive effect of teacher support on app engagement
1c	Rejected	Effect of teacher support on app usage not found
1d	Supported	Negative effect of teacher support on opportunity cost
2a	Supported	Positive effect of autonomy need satisfaction on app engagement
2b	Rejected	Effect of autonomy need satisfaction on app usage not found
2c	Supported	Mediation of autonomy need satisfaction to app engagement
2d	Rejected	Mediation of autonomy need satisfaction to app usage not found
3a	Supported	Positive effect of app engagement on app usage
3b	Supported	Mediation of app engagement to app usage
3c	Supported	Serial mediation of app engagement to app usage
4a	Supported	Negative effect of opportunity cost on app usage
4b	Supported	Mediation of opportunity cost to app usage
5	Supported	Positive effect of app usage on L2 learning gains

Cluster Analysis: Two Types of Initial English Learning Motivation

As shown in Figure 25, nine of 24 clustering validity indices suggested that the optimal number of clusters was two, representing distinct initial L2 motivational orientations among young beginners in South Korea. Following the majority rule, I applied the two-cluster solution to hierarchical k-means clustering. The clusters in Figure 26 contain 117 and 137 learners, respectively.

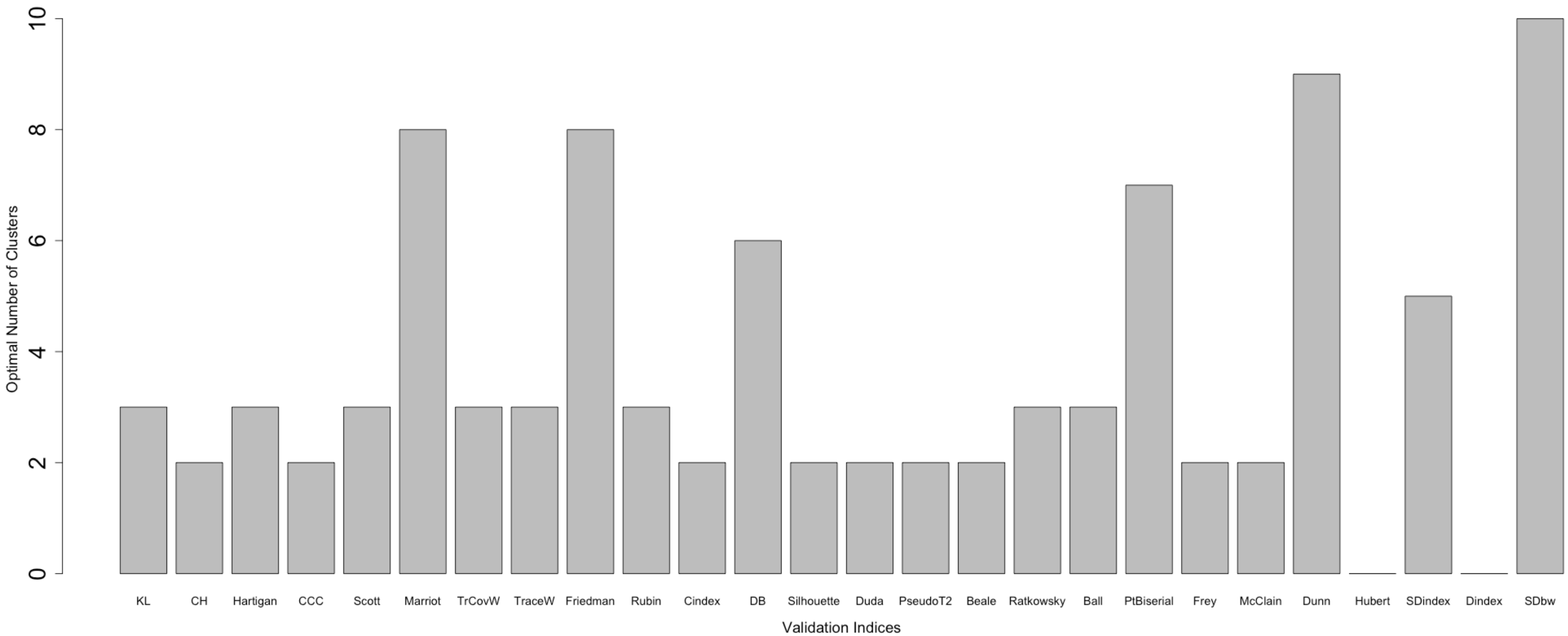


Figure 25 Optimal number of clusters for each validation index.

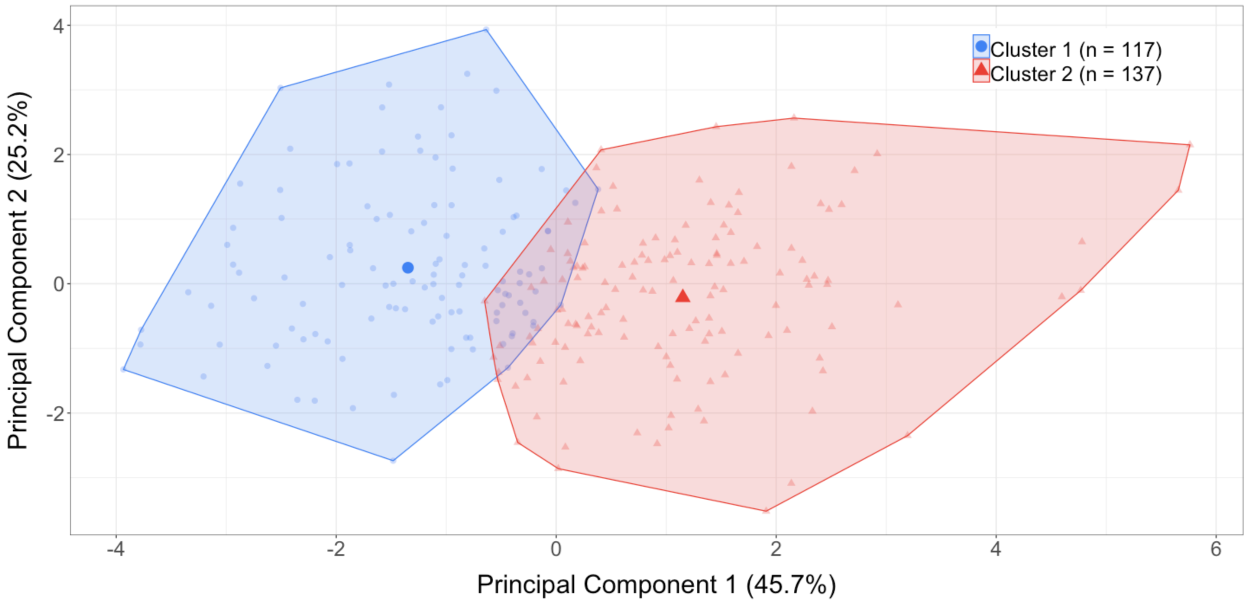


Figure 26 Results of hierarchical k-means clustering with two-cluster solution.

Table 26 and Figure 27 summarize the means and 95% confidence intervals for the corresponding motivational constructs. Cluster 1 displayed positive responses in intrinsic and integrated motivation (i.e., +Autonomous), whereas Cluster 2 showed lower responses to these variables (i.e., –Autonomous). It is noteworthy that both clusters showed high levels of identified and external motivation (i.e., +Controlled), with relatively weaker introjected motivation. Additionally, Cluster 2 showed relatively higher amotivation for English learning. Taken together, Cluster 1 displays a balance of autonomous and controlled motivation for English learning, while Cluster 2 is predominantly driven by controlled motivation, with less reliance on autonomous reasons. I therefore labeled Cluster 1 as the +Autonomous/+Controlled motivation group, and Cluster 2 as the –Autonomous/+Controlled motivation group.

Table 26 Descriptive statistics of English learning orientation scale by L2 motivation group

Group	Scale	*Mean*	95% CI *LL*	95% CI *UL*	*SD*	*SE*	*Median*	*Min.*	*Max.*
+Autonomous/ +Controlled (*n* = 117)	Intrinsic	4.28	4.08	4.49	1.10	0.10	4	1	6
	Integrated	4.26	4.09	4.44	0.96	0.09	4.25	1	6
	Identified	5.16	5.05	5.28	0.62	0.06	5	3.67	6
	Introjected	3.72	3.50	3.94	1.19	0.11	3.75	1	6
	External	4.46	4.29	4.63	0.94	0.09	4.50	1.25	6
	Amotivation	1.72	1.60	1.83	0.62	0.06	1.67	1	3.3
–Autonomous/ +Controlled (*n* = 137)	Intrinsic	2.23	2.10	2.37	0.80	0.07	2.33	1	4
	Integrated	2.92	2.76	3.08	0.93	0.08	3	1	5
	Identified	4.03	3.86	4.21	1.03	0.09	4	1	6
	Introjected	3.27	3.07	3.47	1.16	0.10	3.25	1	6
	External	4.23	4.07	4.39	0.97	0.08	4.25	1	6
	Amotivation	3.08	2.92	3.25	0.99	0.08	3	1	5.67

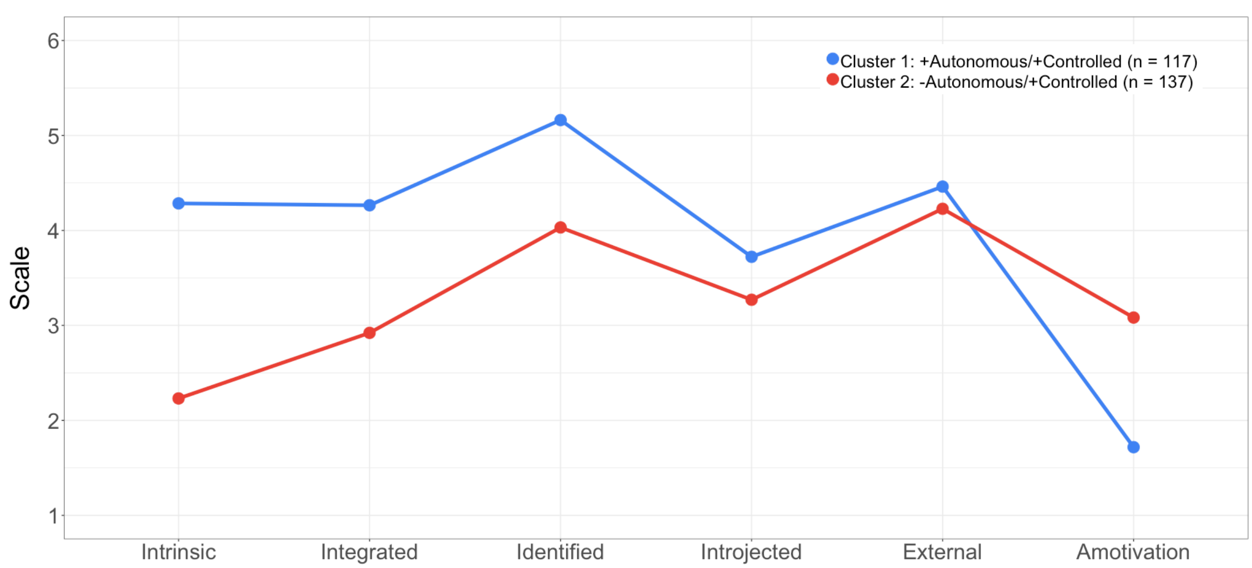


Figure 27 Two groups of English learning orientation: means and 95% confidence intervals.

Descriptive Statistics by L2 Motivation Group

Perceived Teacher Autonomy Support and Autonomy Need Satisfaction

Tables 27 and 28 present the mean scores for perceived teacher autonomy support and autonomy need satisfaction for app-based language learning out of class. As illustrated in Figure 28a, the +Autonomous/+Controlled motivation group reported higher levels of perceived teacher support across all scale items. However, overlapping 95% confidence intervals in autonomy need satisfaction in Figure 28b indicate less pronounced group differences.

Table 27 Descriptive statistics of perceived teacher autonomy support by L2 motivation group

Group	Item	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
			LL	*UL*					
+Autonomous/ +Controlled (*n* = 117)	Support1	4.26	3.99	4.54	1.51	0.14	5	1	6
	Support2	4.41	4.16	4.66	1.36	0.13	5	1	6
	Support3	3.50	3.18	3.83	1.79	0.17	3	1	6
	Support4	4.21	3.91	4.52	1.65	0.15	5	1	6
–Autonomous/ +Controlled (*n* = 137)	Support1	3.69	3.43	3.95	1.53	0.13	4	1	6
	Support2	3.85	3.59	4.10	1.51	0.13	4	1	6
	Support3	3.21	2.94	3.49	1.62	0.14	3	1	6
	Support4	3.65	3.36	3.94	1.69	0.14	4	1	6

Table 28 Descriptive statistics of autonomy need satisfaction by L2 motivation group

Group	Item	*Mean*	95% CI *LL*	95% CI *UL*	*SD*	*SE*	*Median*	*Min.*	*Max.*
+Autonomous/ +Controlled (*n* = 117)	Autonomy1	3.97	3.65	4.28	1.71	0.16	5	1	6
	Autonomy2	4.56	4.30	4.81	1.41	0.13	5	1	6
	Autonomy3	3.58	3.26	3.90	1.73	0.16	4	1	6
–Autonomous/ +Controlled (*n* = 137)	Autonomy1	3.72	3.45	4.00	1.62	0.14	4	1	6
	Autonomy2	4.04	3.79	4.29	1.49	0.13	5	1	6
	Autonomy3	3.25	2.97	3.53	1.64	0.14	3	1	6

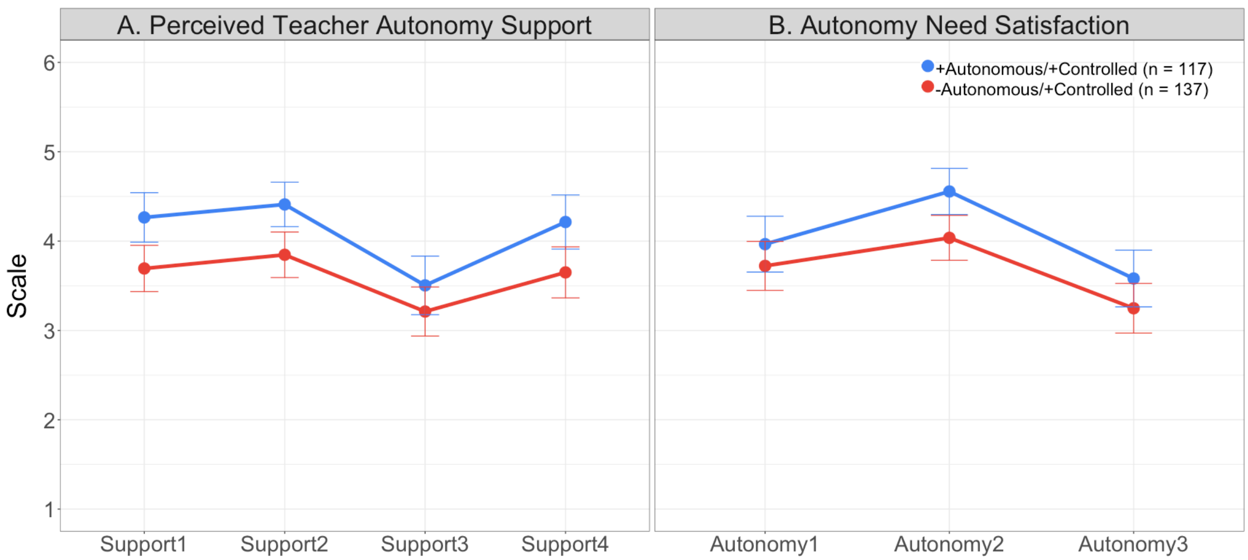


Figure 28 Perceived teacher autonomy support and autonomy need satisfaction by L2 motivation group: means and 95% confidence intervals.

App Engagement

Table 29 and Figure 29 display the mean scores for app engagement beyond the classroom across four engagement constructs. Overall, the +Autonomous/+Controlled motivation group reported higher levels of app engagement across all scale items, with only a small number of 95% confidence intervals overlapping.

Table 29 Descriptive statistics of app engagement by L2 motivation group

Group	Item	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
			LL	*UL*					
+Autonomous/ +Controlled (n = 117)	BE1	3.15	2.83	3.46	1.71	0.16	3	1	6
	BE2	3.61	3.29	3.93	1.75	0.16	4	1	6
	BE3	3.67	3.34	3.99	1.76	0.16	4	1	6
	EE1	3.50	3.19	3.80	1.67	0.15	4	1	6
	EE2	3.66	3.36	3.96	1.65	0.15	4	1	6
	EE3	3.64	3.33	3.95	1.67	0.15	4	1	6
	CE1	3.79	3.51	4.08	1.58	0.15	4	1	6
	CE2	3.37	3.07	3.66	1.61	0.15	3	1	6
	CE3	3.09	2.80	3.39	1.61	0.15	3	1	6
	AE1	3.26	2.95	3.56	1.66	0.15	3	1	6
	AE2	3.30	3.00	3.60	1.63	0.15	3	1	6
	AE3	3.57	3.26	3.88	1.69	0.16	4	1	6
–Autonomous/ +Controlled (n = 137)	BE1	2.67	2.40	2.94	1.59	0.14	2	1	6
	BE2	2.98	2.70	3.26	1.66	0.14	3	1	6
	BE3	3.13	2.86	3.41	1.63	0.14	3	1	6
	EE1	2.69	2.45	2.94	1.43	0.12	2	1	6
	EE2	2.89	2.64	3.14	1.48	0.13	3	1	6
	EE3	2.88	2.63	3.12	1.43	0.12	3	1	6
	CE1	3.19	2.92	3.46	1.58	0.14	4	1	6
	CE2	2.83	2.58	3.09	1.50	0.13	3	1	6
	CE3	2.61	2.35	2.86	1.49	0.13	2	1	6
	AE1	2.65	2.39	2.90	1.51	0.13	2	1	6
	AE2	2.83	2.57	3.09	1.53	0.13	3	1	6
	AE3	2.91	2.65	3.18	1.57	0.13	3	1	6

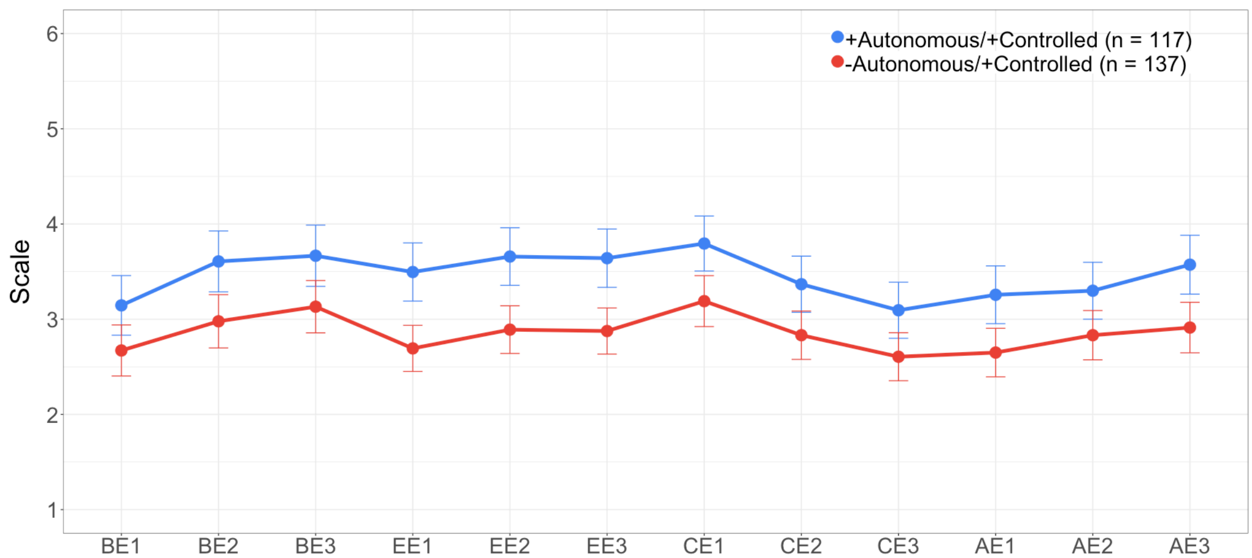


Figure 29 App engagement by L2 motivation group: means and 95% confidence intervals. The acronyms BE, EE, CE, and AE represent behavioral, emotional, cognitive, and agentic engagement, respectively.

Non-App English Learning Experiences and Perceived Opportunity Cost

Table 30 presents the mean scores for non-app English learning experiences out of class. Higher scores indicate greater and more intensive involvement in English skill sets. Among young beginners, listening emerged as the most frequently practiced activity beyond the classroom, while speaking, pronunciation and writing skills were the least practiced. Although the +Autonomous/+Controlled motivation group showed overall higher levels of learning activities, Panel A in Figure 30 reveals substantial overlap in 95% confidence intervals, suggesting no significant differences in non-app English learning patterns between the two L2 motivation groups.

Panel B in Figure 30 and Table 31 show the mean scores for perceived opportunity cost of app usage. Overall, both groups perceived a similar level of opportunity cost across all scale items, with mean values ranging between 3 and 4, further indicating a comparable proportion of learners who viewed app usage as involving a significant loss of valued alternatives and those who did not.

Table 30 Descriptive statistics of non-app English learning experiences by L2 motivation group

Group	Skill	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
			LL	*UL*					
+Autonomous/ +Controlled (*n* = 117)	R	19.68	14.16	25.19	30.10	2.78	9	0	189
	L	23.64	17.42	29.86	33.96	3.14	12	0	189
	W	13.93	8.88	18.99	27.61	2.55	0	0	189
	S	13.15	8.19	18.10	27.07	2.50	0	0	189
	G	13.79	8.81	18.78	27.21	2.52	0	0	189
	V	19.26	13.47	25.07	31.67	2.93	6	0	189
	P	11.74	6.62	16.85	27.95	2.58	0	0	189
–Autonomous/ +Controlled (*n* = 137)	R	12.93	9.49	16.37	20.36	1.74	0	0	127
	L	19.94	15.26	24.62	27.70	2.37	0	0	146
	W	9.60	6.67	12.52	17.31	1.48	0	0	114
	S	7.82	5.04	10.60	16.44	1.40	0	0	120
	G	12.58	8.53	16.64	24.00	2.05	0	0	142
	V	14.38	10.63	18.13	22.18	1.89	0	0	114
	P	9.18	5.94	12.42	19.17	1.64	0	0	114

Note. R = Reading; L = Listening; W = Writing; S = Speaking; G = Grammar; V = Vocabulary; P = Pronunciation.

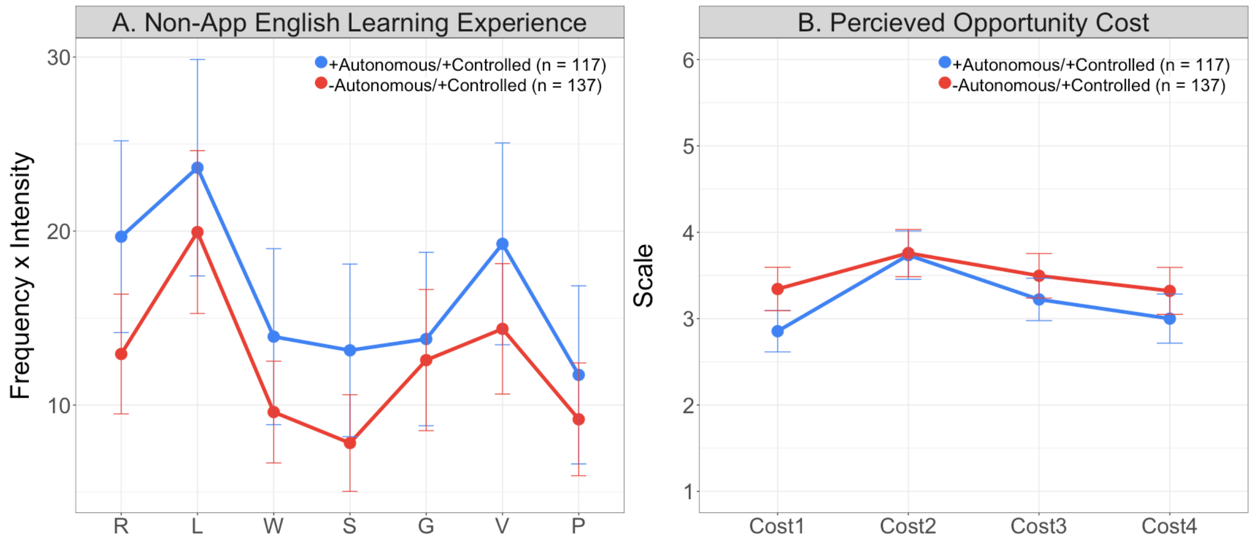


Figure 30 Non-app English learning experiences and perceived opportunity cost by L2 motivation group: means and 95% confidence intervals. R = Reading; L = Listening; W = Writing; S = Speaking; G = Grammar; V = Vocabulary; P = Pronunciation.

Table 31 Descriptive statistics of perceived opportunity cost by L2 motivation group

Group	Item	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
			LL	*UL*					
+Autonomous/ +Controlled (*n* = 117)	Cost1	2.85	2.62	3.09	1.31	0.12	3	1	6
	Cost2	3.74	3.46	4.01	1.53	0.14	4	1	6
	Cost3	3.22	2.98	3.47	1.34	0.12	3	1	6
	Cost4	3.00	2.72	3.28	1.55	0.14	3	1	6
–Autonomous/ +Controlled (*n* = 137)	Cost1	3.34	3.09	3.59	1.49	0.13	3	1	6
	Cost2	3.76	3.49	4.03	1.62	0.14	4	1	6
	Cost3	3.50	3.24	3.75	1.52	0.13	3	1	6
	Cost4	3.32	3.05	3.59	1.61	0.14	3	1	6

App Usage

As demonstrated in Figure 31, two L2 motivation groups showed similar repetitive fluctuations overall, with no significant differences in the patterns of app usage between them. The red trend line indicating the average cumulative app usage over time in Figure 32 also reveals similar patterns across the two L2 motivation groups.

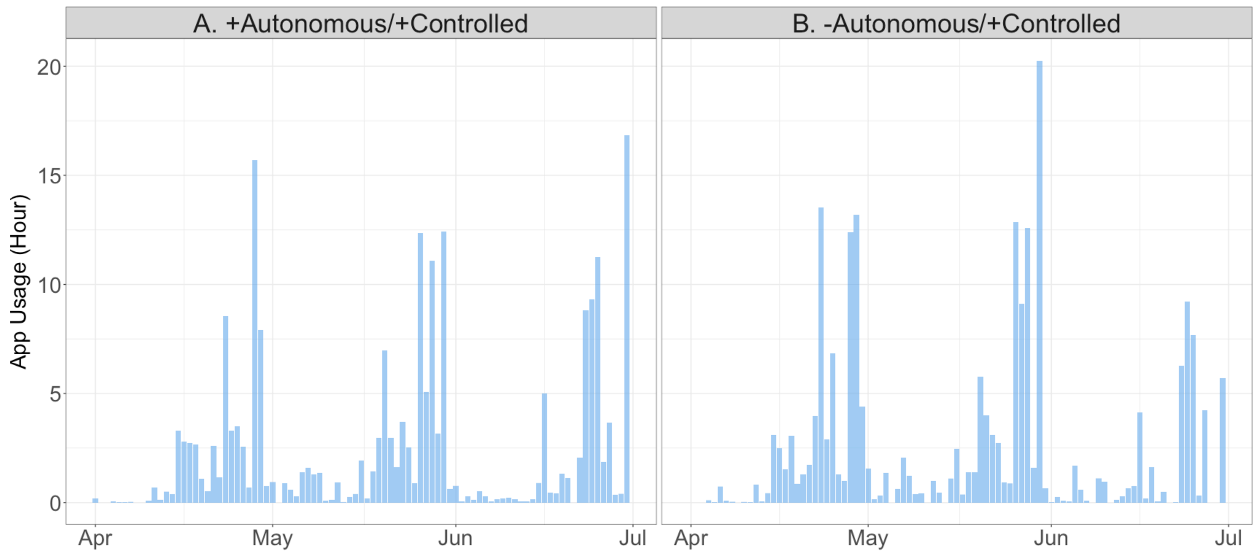


Figure 31 Daily total app usage by L2 motivation group.

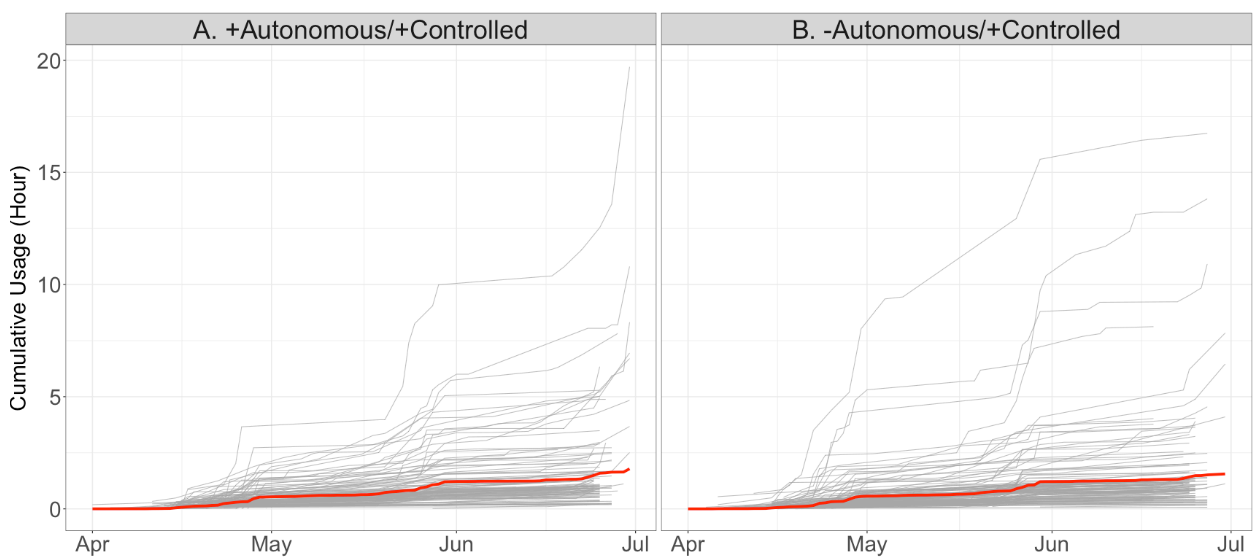


Figure 32 Individual cumulative app usage over time by L2 motivation group.

Table 32 presents the total app usage time by L2 motivation group. On average, the +Autonomous/+Controlled motivation group used the app for 1.76 hours (95% CI [1.32, 2.21]), while the –Autonomous/+Controlled motivation group used it for 1.55 hours (95% CI [1.16, 1.93]). However, the mean values of both groups were skewed toward the lower end due to a subset of learners with minimal app usage, as shown in Figure 33. Notably, on average, the top 10% of learners of each group used the app for 7.36 hours (95% CI [4.72, 10.00]) and 6.72 hours (95% CI [4.29, 9.15]) in the +Autonomous/+Controlled and –Autonomous/+Controlled motivation groups, respectively.

Table 32 Descriptive statistics of app usage by L2 motivation group

Group	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
		LL	*UL*					
A. +Autonomous/+Controlled motivation group								
All (n = 117)	1.76	1.32	2.21	2.41	0.22	1.01	0	19.70
Top 10% (n = 12)	7.36	4.72	10.00	4.16	1.20	5.94	4.51	19.70
B. –Autonomous/+Controlled motivation group								
All (n = 135)	1.55	1.16	1.93	2.27	0.19	0.98	0	16.74
Top 10% (n = 14)	6.72	4.29	9.15	4.21	1.12	4.65	3.63	16.74

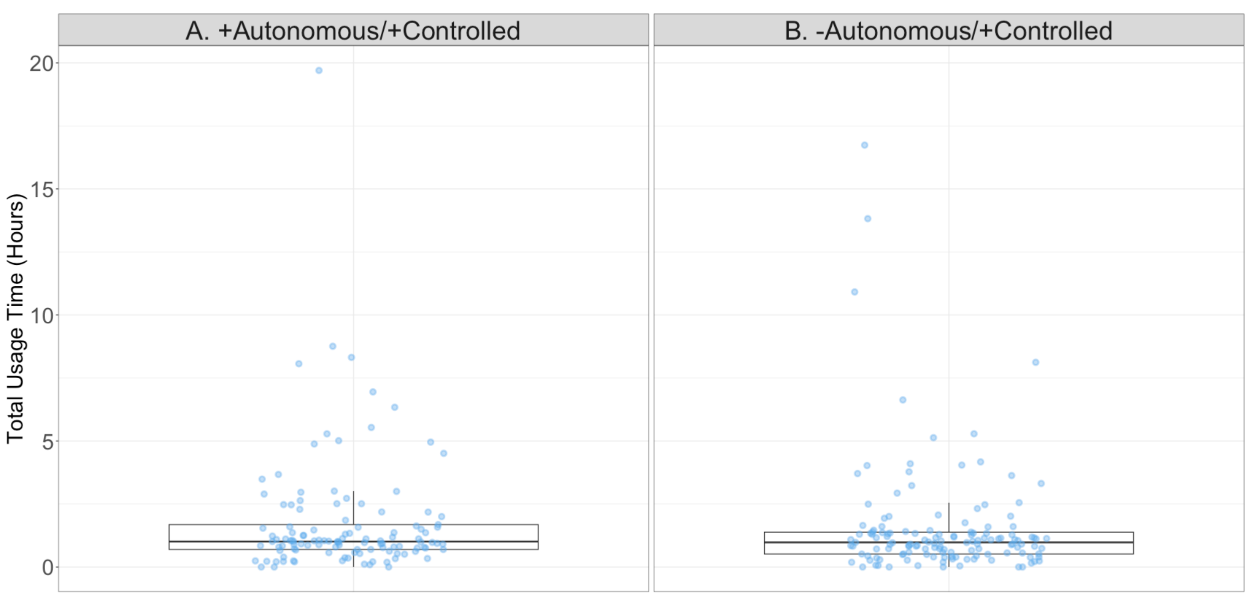


Figure 33 Distribution of app usage data by L2 motivation group.

Meaning Recall Test

Table 33 and Figure 34 present the results of the meaning recall test. While the +Autonomous/+Controlled motivation group showed a tendency to know more target words than the –Autonomous/+Controlled motivation group on the pretest, both groups demonstrated improvement on the posttest. The mean gain score for the +Autonomous/+Controlled motivation group was 4.90 (95% CI [4.05, 5.75]), which was higher than that of 2.99 (95% CI [2.30, 3.69]) for the –Autonomous/+Controlled motivation group.

Table 33 Descriptive statistics of meaning recall test by L2 motivation group

Group	Time	*Mean*	95% CI		*SD*	*SE*	*Median*	*Min.*	*Max.*
			LL	*UL*					
A. +Autonomous/+Controlled motivation group									
All	Pretest	6.88	5.91	7.85	5.31	0.49	7	0	23
(*n* = 117)	Posttest	11.78	10.40	13.20	7.54	0.70	11	0	28
Top 10%	Pretest	9.25	6.14	12.36	4.9	1.41	8.50	2	16
(*n* = 12)	Posttest	18.58	14.37	22.80	6.64	1.92	19	6	28
B. –Autonomous/+Controlled motivation group									
All	Pretest	4.53	3.71	5.35	4.85	0.41	3	0	19
(*n* = 137)	Posttest	7.53	6.40	8.65	6.68	0.57	6	0	25
Top 10%	Pretest	3.5	1.07	5.93	4.2	1.12	2.50	0	14
(*n* = 14)	Posttest	8.36	4.23	12.48	7.14	1.91	7	0	21

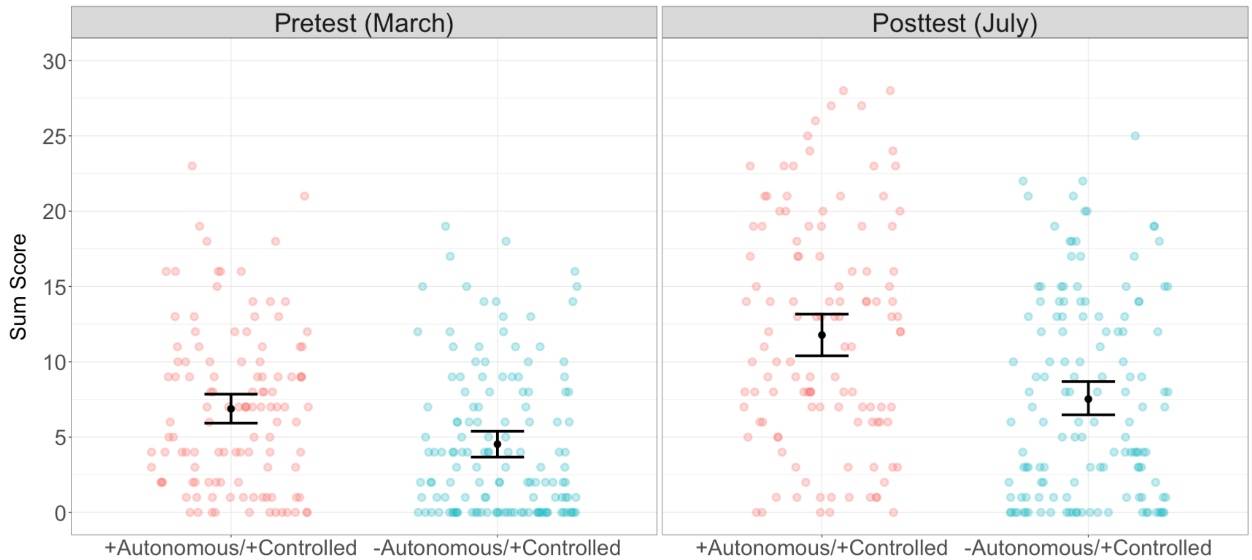


Figure 34 Meaning recall test scores by L2 motivation group: means and 95% confidence intervals.

Multi-Group Measurement Model

The four-factor multi-group measurement model, incorporating the two L2 motivation groups, demonstrated robust global fit (scaled $\chi^2(160) = 249.55$, $p < .001$; CFI = .96; TLI = .95; RMSEA = .07, 90% CI [.05, .09]; SRMR = .05). As for each L2 motivation group, local fit was supported with only four cases showing residuals exceeding ±2.0 (see Tables 34 and 35, respectively for each L2 motivation group). Additionally, all standardized factor loadings were significant ($p < .001$) and consistently high across items, with the lowest loading being .56 for Cost 1 in the +Autonomous/+Controlled motivation group (see Tables 36 and 37, respectively for each L2 motivation group).

Table 34 Normalized residuals for a measurement model: local fit of the +Autonomous/+Controlled motivation group

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Support1	0.00													
2. Support2	0.35	0.00												
3. Support3	–0.28	–0.72	0.00											
4. Support4	–0.13	0.01	0.22	0.00										
5. Autonomy1	–0.73	–0.27	0.82	0.27	0.00									
6. Autonomy2	–0.01	0.93	0.75	0.68	0.10	0.00								
7. Autonomy3	–0.33	–0.39	1.62	0.20	0.11	–0.53	0.00							
8. Engagement1	–0.14	–0.50	2.04	–0.53	–0.67	–0.52	0.06	0.00						
9. Engagement2	–0.07	–0.65	1.44	–0.32	–0.01	–0.10	0.05	0.17	0.00					
10. Engagement3	0.20	–0.13	1.65	–0.23	0.04	0.28	0.25	–0.04	–0.04	0.00				
11. Cost1	–0.99	–0.61	–1.48	–1.27	–1.18	–0.89	–0.81	–1.05	–0.83	–1.28	0.00			
12. Cost2	–1.17	–0.10	–0.77	0.03	0.72	–0.52	–0.22	–0.56	–0.26	–0.15	0.13	0.00		
13. Cost3	0.11	1.20	–1.09	0.35	0.53	0.63	0.36	0.03	0.50	0.22	–0.43	0.40	0.00	
14. Cost4	0.26	0.54	–0.05	0.05	–0.52	0.06	0.11	0.58	0.40	0.19	0.18	–0.41	0.09	0.00

Note. Residual values within the range of ±2.0 are acceptable.

Table 35 Normalized residuals for a measurement model: local fit of the –Autonomous/+Controlled motivation group

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Support1	0.00													
2. Support2	0.56	0.00												
3. Support3	–0.14	–0.75	0.00											
4. Support4	–0.44	–0.22	0.85	0.00										
5. Autonomy1	–0.69	–0.16	0.24	0.50	0.00									
6. Autonomy2	–0.61	0.12	–1.57	1.04	0.32	0.00								
7. Autonomy3	0.11	0.22	0.68	0.97	–0.21	–0.01	0.00							
8. Engagement1	–0.64	–0.86	1.81	–0.58	–0.20	–1.87	–0.08	0.00						
9. Engagement2	0.17	0.53	2.50	0.89	1.20	–0.73	0.46	–0.05	0.00					
10. Engagement3	–0.52	–0.80	1.77	0.21	0.41	–1.18	–0.20	0.09	–0.07	0.00				
11. Cost1	–0.34	0.74	–0.41	0.38	0.43	1.41	0.32	–0.13	–0.32	0.18	0.00			
12. Cost2	–0.13	0.04	–1.46	0.56	0.50	0.85	–0.15	0.16	–0.39	0.75	–0.12	0.00		
13. Cost3	1.13	0.01	–0.25	–0.20	–0.22	0.10	–1.17	–0.16	0.23	0.17	0.22	0.02	0.00	
14. Cost4	–0.22	–0.31	–1.27	0.56	–0.26	–0.02	–0.64	–0.52	–0.49	0.15	–0.02	0.14	–0.20	0.00

Note. Residual values within the range of ±2.0 are acceptable.

Table 36 Robust maximum likelihood estimates for a four-factor measurement model of the +Autonomous/+Controlled motivation group

Parameter	*b*	*SE*	*b**	*SE*	*z*
Factor Loadings					
Perceived Teacher Autonomy Support					
Support1	1.00		0.88	0.04	22.03
Support2	0.91	0.08	0.89	0.05	17.32
Support3	1.01	0.09	0.75	0.04	18.10
Support4	1.07	0.06	0.86	0.03	26.05
Autonomy Need Satisfaction					
Autonomy1	1.00		0.90	0.03	30.26
Autonomy2	0.60	0.10	0.66	0.08	8.33
Autonomy3	0.98	0.06	0.87	0.04	24.00
App Engagement					
Engagement1	1.00		0.89	0.03	31.96
Engagement2	1.04	0.05	0.93	0.02	39.78
Engagement3	1.08	0.05	0.96	0.02	57.10
Perceived Opportunity Cost					
Cost1	1.00		0.56	0.07	7.51
Cost2	1.30	0.32	0.62	0.10	6.27
Cost3	1.46	0.30	0.80	0.09	8.68
Cost4	1.65	0.29	0.77	0.06	13.54
Error (Unique) Variances					
Support1	4.27	0.14	2.84	0.23	12.15
Support2	4.41	0.13	3.26	0.30	10.82
Support3	3.50	0.17	1.97	0.11	17.35
Support4	4.21	0.15	2.56	0.20	12.64
Autonomy1	3.97	0.16	2.33	0.18	12.65
Autonomy2	4.56	0.13	3.24	0.34	9.67
Autonomy3	3.58	0.16	2.08	0.14	15.35

Table 36 (cont'd)

Engagement1	3.50	0.15	2.10	0.13	16.13
Engagement2	3.66	0.15	2.23	0.15	14.95
Engagement3	3.64	0.15	2.19	0.15	14.97
Cost1	2.86	0.12	2.19	0.13	17.08
Cost2	3.74	0.14	2.46	0.14	17.13
Cost3	3.22	0.12	2.42	0.13	18.06
Cost4	3.00	0.14	1.94	0.10	18.66
Factor Variances					
Perceived Teacher Autonomy Support	1.75	0.30	1.00	—	—
Autonomy Need Satisfaction	2.34	0.31	1.00	—	—
App Engagement	2.18	0.25	1.00	—	—
Perceived Opportunity Cost	0.53	0.18	1.00	—	—
Covariances					
Perceived Teacher Autonomy Support					
Autonomy Need Satisfaction	1.67	0.26	0.83	0.06	14.95
App Engagement	1.48	0.22	0.76	0.05	15.75
Perceived Opportunity Cost	–0.24	0.14	–0.25	0.12	–2.07
Autonomy Need Satisfaction					
App Engagement	1.79	0.25	0.79	0.06	12.31
Perceived Opportunity Cost	–0.43	0.17	–0.38	0.12	–3.34
App Engagement					
Perceived Opportunity Cost	–0.34	0.14	–0.32	0.11	–2.89

Table 37 Robust maximum likelihood estimates for a four-factor measurement model of the –Autonomous/+Controlled motivation group

Parameter	*b*	*SE*	*b**	*SE*	*z*
Factor Loadings					
Perceived Teacher Autonomy Support					
Support1	1.00		0.86	0.04	24.47
Support2	1.00	0.05	0.88	0.03	31.61
Support3	0.88	0.07	0.72	0.05	13.59
Support4	1.03	0.06	0.81	0.04	19.77
Autonomy Need Satisfaction					
Autonomy1	1.00		0.88	0.04	24.07
Autonomy2	0.71	0.10	0.69	0.07	9.54
Autonomy3	0.91	0.06	0.79	0.04	19.38
App Engagement					
Engagement1	1.00		0.94	0.02	54.73
Engagement2	1.01	0.05	0.92	0.03	35.51
Engagement3	1.01	0.04	0.95	0.02	43.33
Perceived Opportunity Cost					
Cost1	1.00		0.70	0.06	11.25
Cost2	1.20	0.15	0.77	0.06	12.60
Cost3	1.10	0.15	0.74	0.07	11.19
Cost4	1.26	0.16	0.81	0.06	12.97
Error (Unique) Variances					
Support1	3.69	0.13	2.42	0.16	15.13
Support2	3.85	0.13	2.56	0.18	14.00
Support3	3.21	0.14	1.98	0.11	18.62
Support4	3.65	0.14	2.17	0.13	16.42
Autonomy1	3.72	0.14	2.31	0.15	15.53
Autonomy2	4.04	0.13	2.72	0.20	13.91
Autonomy3	3.25	0.14	1.98	0.11	18.85

Table 37 (cont'd)

Engagement1	2.69	0.12	1.89	0.10	19.83
Engagement2	2.89	0.13	1.96	0.10	19.01
Engagement3	2.88	0.12	2.02	0.11	19.12
Cost1	3.34	0.13	2.26	0.12	19.28
Cost2	3.76	0.14	2.33	0.14	16.82
Cost3	3.50	0.13	2.30	0.13	18.26
Cost4	3.32	0.14	2.07	0.11	19.17
Factor Variances					
Perceived Teacher Autonomy Support	1.74	0.23	1.00	—	—
Autonomy Need Satisfaction	2.04	0.26	1.00	—	—
App Engagement	1.79	0.21	1.00	—	—
Perceived Opportunity Cost	1.06	0.22	1.00	—	—
Covariances					
Perceived Teacher Autonomy Support					
Autonomy Need Satisfaction	1.46	0.22	0.78	0.07	11.90
App Engagement	1.16	0.16	0.66	0.06	11.55
Perceived Opportunity Cost	–0.23	0.16	–0.17	0.11	–1.49
Autonomy Need Satisfaction					
App Engagement	1.24	0.19	0.65	0.07	9.35
Perceived Opportunity Cost	–0.42	0.16	–0.29	0.10	–2.86
App Engagement					
Perceived Opportunity Cost	–0.41	0.14	–0.30	0.09	–3.19

The findings in Table 38 also confirmed the strong reliability and validity of the four-factor measurement model for each L2 motivation group. The ω values exceeded the recommended threshold of .70 for all latent variables, indicating good construct reliability. Convergent validity was supported by AVE, which surpassed the .50 threshold for all constructs. Additionally, perceived teacher autonomy support, autonomy need satisfaction, and app engagement were positively correlated with one another, while all four latent variables showed negative correlations with perceived opportunity cost. The square roots of AVE were consistently higher than the correlations with other constructs, confirming discriminant validity. These results collectively provide robust evidence for the hypothesized factor structure and unidimensionality of the four latent variables for both L2 motivation groups.

Table 38 Reliability and validity of the measurement model by L2 motivation group

	ω	AVE	1	2	3	4
A. +Autonomous/–Controlled Motivation Group						
1. Perceived Teacher Autonomy Support	.90	.70	.84			
2. Autonomy Need Satisfaction	.87	.69	.83	.83		
3. App Engagement	.95	.86	.76	.79	.93	
4. Perceived Opportunity Cost	.79	.49	–.25	–.38	–.32	.70
B. –Autonomous/–Controlled Motivation Group						
1. Perceived Teacher Autonomy Support	.89	.67	.82			
2. Autonomy Need Satisfaction	.84	.63	.77	.80		
3. App Engagement	.95	.87	.66	.65	.93	
4. Perceived Opportunity Cost	.84	.58	–.16	–.28	–.30	.76

Note. The shaded values represent the square roots of the AVE for each latent variable. The correlations between latent variables are listed below the shaded diagonal.

Table 39 shows the results of measurement invariance tests across the two L2 motivation groups. It was found that only configural and weak invariance models were retained (i.e., $p > .05$), meaning that the relationships between the items and the latent construct were equivalent across two L2 motivation groups. However, strong invariance was not supported (i.e., $p = .03$), suggesting that item intercepts differed between the L2 motivation groups.

Consequently, while the +Autonomous/+Controlled motivation group descriptively showed higher mean scores for perceived teacher support and app engagement than the –Autonomous/+Controlled motivation group as shown Figures 25 and 26, such mean comparisons cannot be reliably interpreted as true differences due to the presence of potential group-specific response bias, which systematically affects observed scores in a particular group apart from respondents' true levels on the factor (Kline, 2023).

Therefore, I only compared path coefficients and the structural relationships between the two L2 motivation groups in the subsequent multi-group structural model.

Table 39 Invariance (multi–group) models across the L2 motivation groups

Model	χ^2	*df*	*p*	$\Delta\chi^2$	Δdf	*p*	CFI	TLI	RMSEA	RMSEA 90% CI		SRMR
										LB	UB	
Configural	275.41	142	< .001				0.97	0.96	0.07	0.05	0.09	0.06
Weak	283.87	152	< .001	9.09	10	.52	0.97	0.96	0.07	0.05	0.09	0.06
Strong	299.81	162	< .001	19.64	10	.03	0.96	0.96	0.07	0.05	0.09	0.06

Multi-Group Structural Model of Moderated Mediation for Research Question 6

In this multi-group structural model, the group variable, L2 motivation, was included as a moderator in the proposed mediation model shown in Figure 6. To examine differences in path coefficients between the +Autonomous/+Controlled and the –Autonomous/+Controlled motivation groups, I first built a constrained model in which the path coefficients were fixed to be equal across the two L2 motivation groups. Next, I also built an unconstrained model in which the path coefficients were allowed to vary freely between the groups.

Tables 40 and 41 present the result of the model comparison and its meaning. A chi-square difference test comparing these two models yielded non-significant results ($\Delta\chi^2 = 5.41$, $p = .862$), suggesting that constraining the path coefficients to be equal did not significantly worsen model fit (i.e., the strengths and directions of the effects were comparable between the L2 motivation groups). Therefore, Hypothesis 6 is rejected, indicating that teacher autonomy support functioned similarly regardless of learners' L2 motivation types existing prior to app-based language learning.

Table 40 Result of the constrained and unconstrained model comparison

Model	χ^2	*df*	AIC	BIC	$\Delta\chi^2$	Δdf	*p*
Constrained	392.94	234	16050	16410			
Unconstrained	387.55	224	16064	16460	5.41	10	0.86

Table 41 Summary of the finding

Hypothesis	Finding	Meaning
6	Rejected	Effect of initial L2 motivation on the structural relationships not found

DISCUSSION

In this study, I explored the effects of teacher autonomy support on young beginners' app-based language learning in a self-study context. Despite overall low app usage, I found that teacher autonomy support influenced out-of-class app usage in two main ways: (a) by enhancing autonomy need satisfaction for app usage and (b) by reducing perceived opportunity cost of app usage. Notably, the study found that these pathways were equally effective for learners with controlled L2 motivation. These findings are discussed through the lens of self-determination theory.

Enhancing a Positive Self-Reinforcing Loop by Supporting Intrinsic Motivation

As outlined in SDT (Ryan & Deci, 2017, 2020) and Noels et al.' (2019a) L2 motivation process model, I found a positive self-reinforcing loop, where teacher autonomy support initiates a series of interlinked instructional pathways for facilitating app-based language learning beyond the classroom: teacher autonomy support → autonomy need satisfaction → app engagement → app usage → L2 learning. That is, learners who perceived teachers' instructional behaviors as autonomy-supportive were more likely to experience greater volition and personal ownership in app usage. This, in turn, enhanced their app engagement and increased their actual app usage out of class, ultimately leading to improved learning gains. This finding provides empirical support for Noel et al.'s (2019) framework, highlighting its relevance and applicability to technology-mediated L2 learning beyond the classroom.

The effects of teacher autonomy support can be attributed to its emphasis on supporting intrinsic motivation for app-based language learning beyond the classroom (ASIB #2 Inviting students to pursue their interests, and ASIB #3 Presenting learning activities in need-satisfying ways, in Reeve & Cheon, 2021). In this study, the teachers supported learners using the app in ways that aligned with their personal interests in app-based language learning. Specifically, learners were encouraged to freely explore app features and activities that piqued their curiosity and interest (e.g., flashcards, automatic speech recognition, lesson topics) rather than strictly following predetermined learning paths and goals (e.g., completing all activities in one lesson before moving to the next). Through this process, learners could experiment with diverse ways of using the app (e.g., focusing on pronunciation practice with sound wave visualization, reading grammar notes) and might have felt that their behaviors and decisions were guided by their own interests, goals, and preferences, fostering a sense of volition and ownership in app-based language learning beyond the classroom. This sense of choice fuels intrinsic motivation for self-directed app usage, as learners can engage in in-app activities they find enjoyable and meaningful. Consequently, these types of teacher autonomy support, which provided learners with maximal flexibility to engage with the app based on their interest in it, enabled them to integrate app-based language learning into their intrinsic goal pursuit. This, in turn, may have created more frequent opportunities for sustained effort and meaningful progress in their learning through app usage (Reeve, 2022b). To summarize, teacher autonomy support in this study might have promoted learners' intrinsic motivation for app-based language learning by fostering a sense of volition and personal ownership, which in turn empowered them to personalize their app usage in ways that aligned with their interests in app-based language learning.

These findings may extend beyond the particular app used in this study, highlighting the critical role of classroom-based teacher autonomy support in facilitating the integration of a broader range of digital resources into L2 learning beyond the classroom. This is because L2 learning beyond the classroom "does not exclude the classroom but rather connects with it" (p. 563, Reinders & Benson, 2017). Indeed, while many self-study L2 learning tools are readily available, learners still expect teacher support for their out-of-class learning (Lai et al., 2016). Furthermore, to fully benefit from these resources, learners are required to have necessary skills and experiences to use them effectively (e.g., self-regulated learning in García Botero et al., 2021). However, since teachers do not directly guide out-of-class learning as they do in the classroom, this support and relevant training should begin in the classroom. Particularly, for most young beginner learners, classrooms may serve as the primary and, sometimes, the only place where they can receive proper need support (Oga-Baldwin, 2022). In the classroom, teachers can systematically implement diverse instructional strategies that promote students' intrinsic motivation for technology use—voluntarily engaging with technologies for L2 learning in ways that bring them inherent satisfactions and joys, rather than using it due to external pressure. This foundational classroom-based autonomy support may first empower learners to take personal ownership of their L2 learning with digital tools, further enabling them to benefit from autonomy need satisfaction through technology use (i.e., resource-based autonomy).

Reducing Perceived Opportunity Cost by Supporting Internalization

Aligned with the expectancy-value(-cost) model (e.g., Eccles & Wigfield, 2020), learners were less inclined to use the app if they felt that it was not worth the value lost from other important activities (Hypothesis 4a supported). In South Korea's high-pressure academic context, this might be particularly relevant to the heavy reliance on *hagwons*, which are seen as reliable investments for test success due to their emphasis on test-prep English learning activities. In contrast, language learning apps that focus on broader language skills may be perceived as less relevant for immediate test performance and, therefore, a less effective use of students' limited resources (e.g., time, energy). As emphasized in Noels et al.'s (2019a) L2 motivation model, which situates motivational dynamics in particular socio-structural and socio-cultural contexts (as in Figure 1), these findings highlight the importance of considering unique educational contexts when implementing app-based language learning, where apps must compete with well-established learning methods.

More importantly, higher levels of perceived teacher autonomy support were associated with reduced perceived trade-off of using the app (Hypothesis 1d supported). Moreover, the positive mediation effect of perceived opportunity cost (i.e., the product of two negative coefficients) suggests that teacher autonomy support may help learners evaluate app usage as less demanding, thereby making them more likely to use it (Hypothesis 4b supported). According to SDT, this effect may be due to the role of teacher autonomy support in facilitating internalization—helping learners discover the value and personal relevance of an activity (ASIB #4 Providing explanatory rationales, ASIB #5 Acknowledging negative feelings, ASIB #6 Relying on invitational language, and ASIB #7 Displaying patience, in Reeve & Cheon, 2021). Initially, app-based language learning may have perceived a high opportunity cost since the app was externally introduced by teachers, rather than emerging from learners' intrinsic interests. However, teachers mitigated this sense of opportunity cost by framing the app as a valuable self-study tool relevant to their English learning goals. Teachers also responded to learners' challenges during app usage (e.g., technical glitches) and praised their efforts to alleviate negative feelings (e.g., anxiety, frustration, confusion) that could potentially overwhelm their volitional motivation for app-based language learning. By lowering perceived opportunity cost, teachers might create internalization-enabling opportunities that prepare learners motivationally ready to accept app-based language learning as a self-endorsed practice, further enabling them to engage with and benefit from it.

These findings suggest a meaningful intersection between the expectancy-value(-cost) model and SDT, offering insights into why and how learners choose which technologies for their L2 learning in self-study settings. The findings also highlight the critical role teachers play in supporting this decision-making process in relation to the value (and cost) of technology use within the constraints of local educational contexts.

Controlled Type of L2 Motivation as a Primary Driver in a Test-Driven Context

Diverging from previous studies (e.g., Loewen et al., 2020; Sudina & Plonsky, 2024), this study did not find clear effects of initial L2 motivation on app-based language learning. This result might be attributed to different methodological approaches to conceptualizing motivation and engagement across studies. Specifically, this study adopted the view that motivation represents the initial desire or intention that energizes learning, whereas engagement is the goal-directed and purpose-driven enactment of this energy (i.e., the action component of motivation) (Hiver et al., 2021, 2024; Skinner & Raine, 2022). Engagement, in this framework, refers to the intensity and quality of what actively involved learners would do (behavioral), feel (affective), think (cognitive), and how they take an active role (agentic) during the learning process. In this regard, as posited in Noels et al.'s (2019a) L2 motivational process model, motivation serves as an antecedent to engagement (see Reschly & Christenson, 2022, for a comprehensive discussion on the relationship between motivation and engagement). In this context, the questionnaires used to measure L2 motivation in previous research focused on learning behavior (e.g., *I work hard at studying French/Spanish* in Sudina & Plonsky, 2024) or interest (e.g., *I am interested in learning Spanish* in Loewen et al., 2020), aligning more closely with the concept of engagement (behavior and affective engagement, respectively, in this study) rather than motivation itself. In contrast, the present study conceptualized L2 motivation within the framework of SDT as learners' willingness to take ownership—the initial desire or intention—distinct from learning in action. This approach conceptually distinguished motivation from engagement. Consequently, the different methodological approaches made it challenging to compare the possible effects of initial L2 motivation on app-based language learning in self-study contexts.

In this study's context, I identified two types of initial L2 motivation that learners carried into app-based language learning (i.e., +Autonomous/+Controlled and –Autonomous/+Controlled), both of which were driven by controlled types of motivation. Notably, it was initially hypothesized that learners with more autonomous L2 motivation would benefit more from teacher autonomy support due to its potential advantages in leading to the enactment of better learning behaviors and greater effort when learners are autonomously motivated (cf. Reeve, 2022b; Ryan & Deci, 2020). However, I found that teacher autonomy support was consistently effective regardless of L2 motivation type (Hypothesis 6 rejected). These findings may reflect unique socio-ecological contexts like South Korea, where English learning is a high-stakes activity tied to exams and future academic or career opportunities. In such contexts, controlled motivation often plays a prominent role in driving learning behaviors, not necessarily undermining the potential for autonomous motivation to co-exist or develop (e.g., Al-Hoorie, 2024). Especially for after-early-childhood learners, extrinsic motivation gradually becomes more prevalent as they progress through school grades, while their intrinsic motivation—the inherent desire to learn for interest and enjoyment—declines, potentially limiting the impact of autonomous types of motivation (Lepper et al., 2005; Ryan & Deci, 2017). Evidence of this observation can be seen in the strong influence of identified motivation—an autonomous extrinsic form of motivation—on English learning of both L2 motivation groups (Figure 27). Identified motivation, where learners engage in activities because they recognize and value their importance (e.g., *Because English helps my personal growth and development*), represents a transitional stage where externally imposed goals (e.g., social expectations, test scores) begin to align with a learner's internal values and sense of self. This form of motivation primarily drives English learning in the Korean context, attenuating the possible advantages of more autonomous types of motivation.

Nonetheless, the findings highlight the universal applicability and benefits of teacher autonomy support, even for young learners predominantly driven by controlled motivation—a group likely to represent a significant portion of learners in typical English classrooms. The positive impact of teacher autonomy support on students driven by controlled L2 motivation is particularly critical in facilitating technology-mediated L2 learning beyond the classroom. That is, teacher autonomy support can help learners consider digital tools as personally meaningful and relevant resources for effective self-directed L2 learning, fostering a sense of ownership and volition to use them beyond the classroom. Following that, learners with controlled motivation can self-create opportunities through technology use to support their autonomy need for L2 learning in general (i.e., resource-based autonomy). Over time, such experiences of autonomy need satisfaction can gradually shift their L2 motivational orientation, transforming externally regulated forms of motivation into more autonomous and self-determined types, facilitating a positive cycle of the L2 motivational process.

Pedagogical Implications

Persistence poses a considerable obstacle to successful app-based language learning in self-study contexts (e.g., García Botero et al., 2019; Hwang et al., 2024; Jeon, 2022). In this study, only a small group of learners meaningfully used the app beyond the classroom. This highlights the importance of understanding how real-world situations (e.g., holidays, school events, extracurricular activities) can affect app usage. In this regard, teachers are advised to set realistic expectations for app-based language learning and determine which learners are most likely to benefit from these tools.

However, as shown in Panel A in Figure 17, it is promising that the app usage pattern did not display a steep drop-out phase followed by a consistent decline over time. Instead, app usage among young beginners displayed more dynamic patterns, with peaks and valleys, indicating that they repetitively returned to the app after pauses, rather than failing to resume app usage once it was disrupted. The cyclical phases observed in this study align with the concept of persistence proposed by Hwang et al. (2024), who defined persistence as a multidimensional process involving engagement, disengagement, dormancy, and reengagement, not merely maintaining uninterrupted app usage sessions or days. In this regard, teacher autonomy support may have played a crucial role in developing learners' resilience against dropout, thereby enabling them to make consistent efforts to resume and sustain app usage.

For young learners who may not yet be ready for self-directed learning beyond the classroom, classroom-based teacher support is essential because simply providing access to apps does not ensure effective use. When providing such support, it is important that teacher support avoids taking the form of controlling behaviors that push learners toward specific ways or outcomes. Instead, teacher support should help learners take ownership of their learning and must be genuinely perceived and accepted by them. One effective approach is through autonomy-supportive instructional behaviors, which involve providing structured support (Ryan & Deci, 2020). Good structure can scaffold learning by setting clear expectations and goals, maintaining consistent rules and guidelines, and providing positive and efficacy-oriented feedback. With teacher autonomy support in structure, teachers can help learners gradually develop volition and ownership for effective app-based language learning beyond the classroom, leading to an enhancement of higher engagement (behavioral, affective, cognitive, and agentic)—both in quantity and quality. For instance, as in He and Loewen (2022), teachers can encourage learners to make key decisions about app usage, aligning in-app activities with their personal goals and interests in L2 learning. Engaging learners in meaningful decision-making processes (e.g., setting realistic app usage goals and schedules), combined with providing feedback on their goal progress, can lead to greater goal achievement. This process fosters self-endorsed accountability driven by intrinsic motivation for app-based language learning rather than externally imposed motives.

Additionally, reducing perceived opportunity cost is also vital for promoting app-based language learning beyond the classroom. Teachers can present language apps as tools that complement, rather than compete with or replace, existing learning methods to which learners are already committed. Instead of expecting learners to use every feature within an app, teachers can help them focus on specific functions that effectively address gaps in their L2 learning. For example, learners might use a sound recognition and pattern comparison feature to improve speaking and pronunciation skills, as these areas are often less practiced with non-app learning resources (Panel A in Figure 15). By demonstrating how targeted app use contributes to achieving broader L2 learning goals, teachers can help learners perceive apps as a valuable and worthwhile investment of their time.

To summarize, effective integration of language learning apps beyond the classroom requires structured classroom-based teacher autonomy support, including thoughtful planning and consideration of unique local contexts. More importantly, a single training session is inadequate and insufficient; instead, it is essential to create an autonomy-supportive learning climate where autonomy support can be delivered consistently and reliably throughout the semester.

Limitations and Future Directions

The findings of this study come with several limitations. First, while the study explored the role of teacher autonomy support, it did not directly examine its effect through a structured intervention design. In this study, two teachers provided the same types of autonomy support in a similar manner to minimize teacher-related differences for research purposes. However, in real-world settings, teachers might adopt varying approaches and attitudes toward autonomy support. Future research could compare the effects of autonomy-supportive teaching styles with controlling teaching styles. Such a comparison would provide a clearer understanding of the impact of autonomy-supportive practices on learner engagement and learning outcomes.

Second, despite the positive effects of teacher autonomy support observed in this study, app usage among learners remained limited overall. One possible explanation for this is that the participating teachers only received brief training sessions with the author prior to the study. As shown by Reeve and Cheon (2021), autonomy-supportive teaching is a malleable practice that can be enhanced through professional development. More intensive training could potentially increase the teachers' ability to create an autonomy-supportive climate, thereby boosting learners' app usage beyond the classroom to a greater extent. Future research should consider incorporating such intensive teacher training to explore whether it leads to greater and more sustained app usage.

Third, this study would benefit from the adoption of a longitudinal design in future research. While the current study provided valuable insights into the role of teacher autonomy support, it relied on a single-time measurement of variables, which limits the ability to observe changes over time. A longitudinal design, where variables are measured at multiple time points, could offer a deeper understanding of how the interactions among variables evolve and influence one another over time. This approach would allow researchers to capture the dynamic development of these relationships, providing a more comprehensive picture of the long-term impact of autonomy-supportive teaching on (technology-mediated) L2 learning beyond the classroom.

Fourth, I applied the Vocabulary Levels Test to include learners at or below the 1,000-word mastery level. While it is conceivable that including learners with higher proficiency or applying different inclusion criteria (e.g., using pretest scores as an alternative cutoff) might offer additional insights, my decision was primarily driven by the goal of maintaining a homogeneous sample of beginners to ensure that the study focused on true novice populations. Future research could further examine the relationship between broader ranges of initial proficiency and learning gains from app-based language learning (e.g., Loewen et al., 2020).

Fifth, future research should employ a broader range of measures to capture the multifaceted nature of language learning. In this study, learning gains were assessed solely through meaning-recall tests—a deliberate choice that reflected learners' agency in choosing how to engage with the app. Consequently, some participants may have focused solely on flashcard features while others emphasized pronunciation or listening tasks. To accommodate these diverse usage patterns, vocabulary knowledge was measured as a key outcome, given its capacity to cover a broad range of learning activities on the app and its role as a fundamental component of second language acquisition (Jeon & In'nami, 2022). However, since the focal app is designed for more than just vocabulary practice, evaluating its impact on comprehensive language skills—such as pronunciation, orthography, and speaking fluency—beyond mere vocabulary growth could provide deeper insights into its overall effectiveness. With additional resources, future studies could further investigate the app's influence on other language domains and compare its potential to enhance diverse competencies with that of more targeted applications.

Relatedly, in the present study, target words were selected based on the key concepts associated with each lesson's topic, ensuring a balanced representation of an average of 5 to 6 words per lesson. This decision was made on the assumption that lessons on the app are designed to repeatedly expose learners to target words through various examples and activities, as is typical in English classroom textbooks. Consequently, the lesson content on the app was expected to provide consistent exposure to and across target words, thereby reducing variability among learners regardless of individual differences in how they used the app.

However, while this selection method aligns with typical instructional practices and is ecologically justified, a more systematic approach could offer additional insights into the app's effectiveness for vocabulary learning. For instance, incorporating vocabulary-related factors—such as the frequency of target words in natural language and on the app, as well as their spatial distribution within the app—might better capture the influence of distinct characteristics of individual vocabulary items on learning outcomes. Furthermore, examining learning-related variables—such as the actual number of encounters for each target word and the patterns of user interaction with the app features and activities—could provide a more nuanced understanding of vocabulary learning processes and types (e.g., intentional versus incidental vocabulary learning) in the context of app-based language learning. Although the current study did not directly address these possibilities, future research incorporating detailed app usage log data could clarify how specific aspects of app curriculum design interact with learners' usage experiences to influence learning outcomes, thereby guiding the development of more adaptive and effective language learning apps.

Finally, due to logistical constraints, this study focused solely on learners' perceptions rather than directly examining how teacher autonomy support was implemented in the classroom or how learners responded to it. More direct in-class observations (e.g., Oga-Baldwin et al., 2017) and qualitative data—such as teacher logs, follow-up interviews, or focus groups with learners segmented by app usage and motivational profile—could provide a more nuanced understanding of these dynamics. While the current study focused on learners' perceived support, future research should also examine teachers' perceptions of autonomy support and how it can be more effectively implemented. For example, it would be useful to investigate whether incorporating external accountability (e.g., requiring, grading, or rewarding app usage)—which are common practices in typical classroom settings to ensure minimal engagement in learning activities—might undermine learners' autonomy need for technology use (e.g., Al-Hoorie, 2024). Insights from such studies could deepen our understanding of technology integration beyond the classroom, particularly in educational contexts where controlled motivation often drives L2 learning.

CONCLUSION

While language learning apps can facilitate self-directed L2 learning, high attrition rates challenge their effectiveness in self-study contexts. Grounded in self-determination theory, I investigated how teacher autonomy support influences app-based language learning beyond the classroom within South Korea's test-driven educational context.

Seventh-grade beginner learners used a language learning app for 13 weeks while their teachers provided various types of autonomy-supportive instructional behaviors to enhance out-of-class app usage. Mediation and moderated mediation analyses revealed three key findings: (1) greater app usage predicted vocabulary learning gains; (2) teacher autonomy support indirectly increased app usage by enhancing learners' autonomy need satisfaction and reducing perceived opportunity cost; and (3) teacher support benefited even learners with controlled L2 motivation. These findings highlight the importance of establishing an autonomy-supportive learning climate that promotes L2 learners' self-directed use of technology out of class.

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APPENDIX

Table A1 Perceived teacher autonomy support questionnaire (Korean translation)

Item	Question
Support1	선생님은 내가 스스로 망고 사용계획을 정할 수 있도록 도와 주신다.
Support2	선생님은 나의 망고 사용방식을 지지해 주신다.
Support3	선생님은 나에게 망고를 잘 사용하고 있다고 칭찬해 주신다.
Support4	선생님은 망고 사용 관련 나의 고민을 잘 들어 주신다.

Table A2 Autonomy need satisfaction questionnaire (Korean translation)

Item	Question
Autonomy1	나는 망고를 사용할지 여부를 자유롭게 결정할 수 있다고 생각한다.
Autonomy2	나는 망고 사용 계획을 자유롭게 결정할 수 있다고 생각한다.
Autonomy3	나는 내가 진정으로 원하는 방식으로 망고를 사용한다고 생각한다.

Table A3 App engagement questionnaire (Korean translation)

Item	Question
BE1	나는 망고를 부지런히 사용하였다.
BE2	나는 망고를 사용할 때 집중하였다.
BE3	나는 최선을 다해 망고를 하였다.
EE1	나는 망고가 재밌었다.
EE2	나는 망고에서 새로운 것을 배울 때 흥미로웠다.
EE3	나는 망고에서 하는 학습 활동들은 즐거웠다.
CE1	나는 망고에서 무엇을 어떻게 공부할지 잘 알고 있었다.
CE2	나는 망고를 언제 사용할지에 대한 계획이 있었다.
CE3	나는 망고에서 배운 내용을 복습하였다.
AE1	나는 정해진 목표 이상으로 망고를 사용하려고 노력하였다.
AE2	나는 망고를 사용하다가 어려움이 생기면, 주위 사람들에게 도움을 구하였다.
AE3	나는 망고로 공부를 하다가 궁금한 점이 생기면 해결하려고 노력하였다.

Table A4 Perceived opportunity cost questionnaire (Korean translation)

Item	Question
Cost1	망고는 현재 나의 상황에서 너무 많은 시간과 노력을 요구한다.
Cost2	현재 하고 있는 다른 영어 공부 때문에, 나는 망고에 투자할 시간이 없다.
Cost3	현재 망고를 꾸준히 사용하기 위한 별도의 시간과 노력을 들일 여유가 없다.
Cost4	망고를 열심히 하려면, 내가 사용할 수 있는 시간에서 너무 많은 것을 포기해야 한다.

Table A5 English learning orientation scale (Korean translation)

Scale	Question
Intrinsic Motivation	
Item1	영어를 좋아하기 때문이다.
Item2	영어 공부가 재밌기 때문이다.
Item3	영어를 사용하면 즐겁기 때문이다.
Integrated Motivation	
Item1	영어는 내가 어떤 사람인지 이해하는데 중요한 요소이기 때문이다.
Item2	영어는 내가 인생에서 중요하다고 여기는 것들(가치, 믿음)을 나타내기 때문이다.
Item3	영어는 자연스러운 나의 일부이기 때문이다.
Item4	영어를 할 수 있는 능력은 내가 어떤 사람인지 보여주기 때문이다.
Identified Motivation	
Item1	영어가 나의 성장과 발전에 도움이 되기 때문이다.
Item2	내가 이루고자 하는 목표를 달성하는데 영어가 도움이 되기 때문이다.
Item3	영어는 나에게 더 많은 미래의 가능성과 기회를 주기 때문이다.
Introjected Motivation	
Item1	주위 사람들이 내가 영어를 잘하기를 기대하고 있기 때문이다.
Item2	주위 사람들이 내가 영어를 잘하면 나를 긍정적으로 평가하기 때문이다.
Item3	주위 사람들이 내가 영어를 열심히 하기를 바라기 때문이다.
Item4	주위 사람들에게 내가 영어를 잘하는 사람으로 보이길 원하기 때문이다.

Table A5 (cont'd)

External Motivation	
Item1	영어 시험에서 좋은 점수를 받고 싶기 때문이다.
Item2	영어는 내가 선택할 수 없는 필수 과목이기 때문이다.
Item3	영어는 나의 선호와 상관 없이 의무적으로 공부해야 하기 때문이다.
Item4	영어를 잘하면 상위 학교에 진학하는데 도움이 되기 때문이다.
Amotivation	
Item1	나에게 영어 공부는 시간 낭비이다.
Item2	영어는 나에게 의미가 없다.
Item3	가능하다면 나는 영어를 배우고 싶지 않다.

Figure A1 Non-app English learning experiences beyond the classroom questionnaire.

Activities

이번 1학기(3월~6월)에 **학교 교실 밖에서** 어떤 영어 관련 활동을 하였나요? 해당되는 활동들을 **모두** 선택해 주세요 (단, **학교 영어 수업과 망고 사용은 제외합니다**).

- ☐ 영어가 나오는 글 읽기 (예: 단어/문법 학습지, 웹툰, 책, 신문, 잡지, SNS, 게임)
- ☐ 영어가 나오는 영상 보기 (예: 영화, 유튜브, 넷플릭스, SNS, 게임)
- ☐ 영어가 나오는 오디오 듣기 (예: 영어 듣기 학습지, 음악, 라디오, 오디오북, SNS, 게임)
- ☐ 영어로 (두 사람 이상이 말 또는 글을 주고 받는) 일상적인 의사소통 하기 (예: 비디오 채팅, 문자, 이메일, 대화하기)
- ☐ 관련 활동을 전혀 하지 않음

Reading

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 글 읽기 (예: 단어/문법 학습지, 웹툰, 책, 신문, 잡지, SNS, 게임)**를 한 **핵심 이유**는 무엇입니까? 여러 개에 해당하는 경우, 상대적으로 더 중요한 이유를 **하나만** 선택해주세요.

- ○ 영어 실력을 향상 시키기 위한 영어 공부 또는 연습을 하기 위해서
- ○ (영어 공부를 위해서가 아니라) 내가 궁금하거나 필요한 정보를 얻으려고
- ○ 나의 휴식 및 즐거운 여가 또는 취미 시간을 보내려고
- ○ 다른 사람들과의 상호작용 및 의사소통을 하려고

Figure A1 (cont'd)

이번 1학기(3월~6월)에 교실 밖에서 주로 어디에서 **영어가 나오는 글 읽기 (예: 단어/문법 학습지, 웹툰, 책, 신문, 잡지, SNS, 게임)**를 하였나요? 해당되는 장소를 모두 선택해주세요

- ☐ 학교 방과 후 프로그램
- ☐ 영어 시험 준비 과외/학원/인터넷 강의 (온라인/오프라인 모두 포함)
- ☐ 영어 시험과 관련이 없는 일반 영어 회화 과외/학원/인터넷 강의 (온라인/오프라인 모두 포함)
- ☐ (다른 사람 도움 없이) 내가 원하는 장소에서 나 스스로

이번 1학기(3월~6월)에 교실 밖에서 주로 언제 **영어가 나오는 글 읽기 (예: 단어/문법 학습지, 웹툰, 책, 신문, 잡지, SNS, 게임)**에 참여 하였습니까? 해당되는 요일을 **모두** 선택해주세요.

- ☐ 월요일
- ☐ 화요일
- ☐ 수요일
- ☐ 목요일
- ☐ 금요일
- ☐ 토요일
- ☐ 일요일

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 글 읽기 (예: 단어/문법 학습지, 웹툰, 책, 신문, 잡지, SNS, 게임)**에서 주로 어떤 종류의 **영어 세부 활동**이 있었습니까? 여러 개에 해당하는 경우, 해당되는 활동들을 특정 요일과 상관 없이 **모두** 선택해주세요.

- ☐ 영어 읽기
- ☐ 영어 문법
- ☐ 영어 듣기
- ☐ 영어 단어
- ☐ 영어 쓰기
- ☐ 영어 발음
- ☐ 영어 말하기

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 글 읽기 (예: 단어/문법 학습지, 웹툰, 책, 신문, 잡지, SNS, 게임)**에서 각 세부 활동이 얼마나 자주 있었는지 선택해주세요.

	거의 드물게 (10% 이하)	드물게 (10%-20%)	가끔 (20%-40%)	종종 (40%-60%)	자주 (60%-80%)	대부분 (80%-90%)	거의 대부분 (90% 이상)
영어 읽기	○	○	○	○	○	○	○
영어 문법	○	○	○	○	○	○	○
영어 듣기	○	○	○	○	○	○	○
영어 단어	○	○	○	○	○	○	○
영어 쓰기	○	○	○	○	○	○	○
영어 발음	○	○	○	○	○	○	○
영어 말하기	○	○	○	○	○	○	○

Figure A1 (cont'd)

Watching

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 영상 보기 (예: 영화, 유튜브, 넷플릭스, SNS, 게임)**를 한 **핵심 이유**는 무엇입니까? 여러 개에 해당하는 경우, 상대적으로 더 중요한 이유를 **하나만** 선택해주세요.

- ○ 영어 실력을 향상 시키기 위한 영어 공부 또는 연습을 하기 위해서
- ○ (영어 공부를 위해서가 아니라) 내가 궁금하거나 필요한 정보를 얻으려고
- ○ 나의 휴식 및 즐거운 여가 또는 취미 시간을 보내려고
- ○ 다른 사람들과의 상호작용 및 의사소통을 하려고

이번 1학기(3월~6월)에 교실 밖에서 주로 어디에서 **영어가 나오는 영상 보기 (예: 영화, 유튜브, 넷플릭스, SNS, 게임)**를 하였나요? 해당되는 장소를 모두 선택해주세요

- ☐ 학교 방과 후 프로그램
- ☐ 영어 시험 준비 과외/학원/인터넷 강의 (온라인/오프라인 모두 포함)
- ☐ 영어 시험과 관련이 없는 일반 영어 회화 과외/학원/인터넷 강의 (온라인/오프라인 모두 포함)
- ☐ (다른 사람 도움 없이) 내가 원하는 장소에서 나 스스로

이번 1학기(3월~6월)에 교실 밖에서 주로 언제 **영어가 나오는 영상 보기 (예: 영화, 유튜브, 넷플릭스, SNS, 게임)**에 참여 하였습니까? 해당되는 요일을 **모두** 선택해주세요.

- ☐ 월요일
- ☐ 화요일
- ☐ 수요일
- ☐ 목요일
- ☐ 금요일
- ☐ 토요일
- ☐ 일요일

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 영상 보기 (예: 영화, 유튜브, 넷플릭스, SNS, 게임)**에서 주로 어떤 종류의 **영어 세부 활동**이 있었습니까? 여러 개에 해당하는 경우, 해당되는 활동들을 특정 요일과 상관 없이 **모두** 선택해주세요.

- ☐ 영어 읽기
- ☐ 영어 문법
- ☐ 영어 듣기
- ☐ 영어 단어
- ☐ 영어 쓰기
- ☐ 영어 발음
- ☐ 영어 말하기

Figure A1 (cont'd)

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 영상 보기 (예: 영화, 유튜브, 넷플릭스, SNS, 게임)**에서 각 세부 활동이 얼마나 자주 있었는지 선택해주세요.

	거의 드물게 (10% 이하)	드물게 (10%-20%)	가끔 (20%-40%)	종종 (40%-60%)	자주 (60%-80%)	대부분 (80%-90%)	거의 대부분 (90% 이상)
영어 읽기	○	○	○	○	○	○	○
영어 문법	○	○	○	○	○	○	○
영어 듣기	○	○	○	○	○	○	○
영어 단어	○	○	○	○	○	○	○
영어 쓰기	○	○	○	○	○	○	○
영어 발음	○	○	○	○	○	○	○
영어 말하기	○	○	○	○	○	○	○

Listening

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 오디오 듣기 (예: 영어 듣기 학습지, 음악, 라디오, 오디오북, SNS, 게임)**를 한 **핵심 이유**는 무엇입니까? 여러 개에 해당하는 경우, 상대적으로 더 중요한 이유를 <u>하나만</u> 선택해주세요.

○ 영어 실력을 향상 시키기 위한 영어 공부 또는 연습을 하기 위해서
○ (영어 공부를 위해서가 아니라) 내가 궁금하거나 필요한 정보를 얻으려고
○ 나의 휴식 및 즐거운 여가 또는 취미 시간을 보내려고
○ 다른 사람들과의 상호작용 및 의사소통을 하려고

이번 1학기(3월~6월)에 교실 밖에서 주로 어디에서 **영어가 나오는 오디오 듣기 (예: 영어 듣기 학습지, 음악, 라디오, 오디오북, SNS, 게임)**를 하였나요? 해당되는 장소를 모두 선택해주세요

☐ 학교 방과 후 프로그램
☐ 영어 시험 준비 과외/학원/인터넷 강의 (온라인/오프라인 모두 포함)
☐ 영어 시험과 관련이 없는 일반 영어 회화 과외/학원/인터넷 강의 (온라인/오프라인 모두 포함)
☐ (다른 사람 도움 없이) 내가 원하는 장소에서 나 스스로

이번 1학기(3월~6월)에 교실 밖에서 주로 언제 **영어가 나오는 오디오 듣기 (예: 영어 듣기 학습지, 음악, 라디오, 오디오북, SNS, 게임)**에 참여 하였습니까? 해당되는 요일을 <u>모두</u> 선택해주세요.

☐ 월요일 ☐ 화요일
☐ 수요일 ☐ 목요일
☐ 금요일 ☐ 토요일
☐ 일요일

Figure A1 (cont'd)

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 오디오 듣기 (예: 영어 듣기 학습지, 음악, 라디오, 오디오북, SNS, 게임)**에서 주로 어떤 종류의 **영어 세부 활동**이 있었습니까? 여러 개에 해당하는 경우, 해당되는 활동들을 특정 요일과 상관 없이 **모두** 선택해주세요.

☐ 영어 읽기
☐ 영어 듣기
☐ 영어 쓰기
☐ 영어 말하기
☐ 영어 문법
☐ 영어 단어
☐ 영어 발음

이번 1학기(3월~6월)에 교실 밖에서 **영어가 나오는 오디오 듣기 (예: 영어 듣기 학습지, 음악, 라디오, 오디오북, SNS, 게임)**에서 각 세부 활동이 얼마나 자주 있었는지 선택해주세요.

	거의 드물게 (10% 이하)	드물게 (10%-20%)	가끔 (20%-40%)	종종 (40%-60%)	자주 (60%-80%)	대부분 (80%-90%)	거의 대부분 (90% 이상)
영어 읽기	○	○	○	○	○	○	○
영어 문법	○	○	○	○	○	○	○
영어 듣기	○	○	○	○	○	○	○
영어 단어	○	○	○	○	○	○	○
영어 쓰기	○	○	○	○	○	○	○
영어 발음	○	○	○	○	○	○	○
영어 말하기	○	○	○	○	○	○	○

Communication

이번 1학기(3월~6월)에 교실 밖에서 **영어로 일상 의사소통 하기 (예: 비디오 채팅, 문자, 이메일, 대화하기)**를 한 **핵심 이유**는 무엇입니까? 여러 개에 해당하는 경우, 상대적으로 더 중요한 이유를 **하나만** 선택해주세요.

○ 영어 실력을 향상 시키기 위한 영어 공부 또는 연습을 하기 위해서
○ (영어 공부를 위해서가 아니라) 내가 궁금하거나 필요한 정보를 얻으려고
○ 나의 휴식 및 즐거운 여가 또는 취미 시간을 보내려고
○ 다른 사람들과의 상호작용 및 의사소통을 하려고

이번 1학기(3월~6월)에 교실 밖에서 주로 어디에서 **영어로 일상 의사소통 하기 (예: 비디오 채팅, 문자, 이메일, 대화하기)**를 하였나요? 해당되는 장소를 모두 선택해주세요

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☐ 영어 시험 준비 과외/학원/인터넷 강의 (온라인/오프라인 모두 포함)
☐ 영어 시험과 관련이 없는 일반 영어 회화 과외/학원/인터넷 강의 (온라인/오프라인 모두 포함)
☐ (다른 사람 도움 없이) 내가 원하는 장소에서 나 스스로

Figure A1 (cont'd)

이번 1학기(3월~6월)에 교실 밖에서 주로 언제 **영어로 일상 의사소통 하기 (예: 비디오 채팅, 문자, 이메일, 대화하기)**에 참여 하였습니까? 해당되는 요일을 **모두** 선택해주세요.

- ☐ 월요일
- ☐ 화요일
- ☐ 수요일
- ☐ 목요일
- ☐ 금요일
- ☐ 토요일
- ☐ 일요일

이번 1학기(3월~6월)에 교실 밖에서 **영어로 일상 의사소통 하기 (예: 비디오 채팅, 문자, 이메일, 대화하기)**에서 주로 어떤 종류의 **영어 세부 활동**이 있었습니까? 여러 개에 해당하는 경우, 해당되는 활동들을 특정 요일과 상관 없이 **모두** 선택해주세요.

- ☐ 영어 읽기
- ☐ 영어 문법
- ☐ 영어 듣기
- ☐ 영어 단어
- ☐ 영어 쓰기
- ☐ 영어 발음
- ☐ 영어 말하기

이번 1학기(3월~6월)에 교실 밖에서 **영어로 일상 의사소통 하기 (예: 비디오 채팅, 문자, 이메일, 대화하기)**에서 각 세부 활동이 얼마나 자주 있었는지 선택해주세요.

	거의 드물게 (10% 이하)	드물게 (10%-20%)	가끔 (20%-40%)	종종 (40%-60%)	자주 (60%-80%)	대부분 (80%-90%)	거의 대부분 (90% 이상)
영어 읽기	○	○	○	○	○	○	○
영어 문법	○	○	○	○	○	○	○
영어 듣기	○	○	○	○	○	○	○
영어 단어	○	○	○	○	○	○	○
영어 쓰기	○	○	○	○	○	○	○
영어 발음	○	○	○	○	○	○	○
영어 말하기	○	○	○	○	○	○	○

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