## Grit as the predictor of flow and buoyancy among Duolingo multiple language learners: the mediating roles of perceived competence and competitiveness

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**Abstract**

This study investigates the relationship between grit and psychological flow and academic buoyancy among Duolingo users, with perceived competence and competitiveness as mediating factors. A sample of 191 Duolingo multiple language learners, selected through convenience sampling, participated in the study by completing self-report questionnaires measuring their grit, psychological flow, academic buoyancy, perceived competence, and competitiveness. Path analysis results revealed that persistence of effort directly and positively predicted both psychological flow and academic buoyancy, whereas consistency of interest was only a positive predictor of psychological flow. Additionally, the findings demonstrated that persistence of effort predicted both psychological flow and academic buoyancy through the mediation of perceived competence and predicted psychological flow through the mediation of competitiveness. In contrast, consistency of interest did not predict either psychological flow or academic buoyancy through the mediating effects of perceived competence or competitiveness. These findings underscore the importance of grit as a crucial determinant of user engagement in Duolingo's language learning activities and their ability to navigate the challenges inherent in acquisition through this platform.

*Keywords*: Duolingo, grit, psychological flow, academic buoyancy, competitiveness, perceived language competence

## Introduction

Apart from their commercial success in entertainment and leisure markets, game-based technologies have been used with increasing regularity in various fields, including language acquisition (Reinders, 2012). Over the past decade, digital games have become ubiquitous, diverse, and widely accessible to a growing number of language users worldwide (Reinhardt & Sykes, 2012). More recently, Digital Game-Based Language Learning (DGBLL) has emerged in affiliation with mobile-assisted language learning (MALL) and represents a promising area of language learning (Hung et al., 2018; Reinders, 2012). The popularity of DGBLL apps attests to the potential benefits they offer to language learners. These benefits include boundless opportunities for authentic exposure, meaningful language use, low-pressure language production, out-of-class language learning and practice, and instant feedback; they also feature elements that incorporate challenge, competition, collaboration, and fun, among others (e.g., Peterson & Jabbari, 2022; Reinders, 2012). The affordances of mobile gamification apps (e.g., Duolingo) have been affirmed to enhance learners' motivation (Zhang et al., 2020), and learning outcomes among players (Berns et al., 2016).

With more than 300 million active users and approximately 95 languages offered, the Duolingo app caters to the interests of a wide global audience, including language learners and researchers (Shortt et al., 2023). Duolingo has been broadly praised by language learners for its interactive gamified design, structured language lessons, ease of use, and free-of-charge access (Leowen et al., 2019; Shortt et al., 2023). Prior research on Duolingo users' experiences has primarily focused on a limited set of variables, including enjoyment and satisfaction, engagement and performance (Shortt et al., 2023), willingness to communicate (Zhao et al., 2024), and motivation and grit (Sudina & Plonsky, 2024). In addition, much of the research conducted so far has been descriptive in nature, overlooking the potential interactions among these variables. The concepts of competition, academic buoyancy, grit,

and psychological flow are gaining traction in the literature on language learning. However, these constructs remain relatively unexplored within the specific context of language learning via Duolingo. To cast some light on the socio-affective and emotional aspects of DGBLL, we investigated the extent to which perseverance of effort and consistency of interest (i.e., grit) demonstrated by language learners using the Duolingo gamification app can predict their sense of flow, academic buoyancy, perceived competence, and competitiveness. We also explored whether language learners' perceived competence and competitiveness could mediate the relationship between their grit on the one hand and their academic buoyancy and flow on the other hand.

The authors believe that investigating flow and buoyancy among Duolingo language learners is important because these variables reflect learners' deep engagement and resilience in a gamified, self-directed environment. Flow shows immersive, motivated learning, while buoyancy reveals how learners cope with setbacks like lost streaks. Understanding these outcomes can improve platform design and support sustained use. This study also clarifies how traits like grit interact with gamified features, promoting better language learning and satisfaction.

## Literature Review

### *Digitally gamified language learning*

Deterding (2019) defined gamification as using video game elements (rather than full-fledged games) to enhance users' experience and engagement in non-game applications and services. Gamified learning environments, incorporate game-design elements such as competition, rewards, rules, and leaderboards – as external motivators – into non-game environments (both digital and non-digital) to increase learners' engagement and motivation (Huang et al., 2020). Researchers have indicated that gamified learning environments can

boost motivation, engagement, autonomy, competence, and persistence in language learning (e.g., Hellin et al., 2023). Moreover, there is a growing interest in understanding learners' emotional experiences (e.g., Loewen et al., 2019). Positive emotions, such as enjoyment, pride, and satisfaction, are frequently linked to increased motivation and sustained use of language in digital gamification platforms (Dehganzadeh & Dehghanzadeh, 2020).

Duolingo is a prominent gamified digital language-learning application classified as a mobile-assisted language learning (MALL) tool. Although the core activities consist of traditional exercises, quizzes, and educational content, Duolingo employs game-like features to enhance engagement and sustain learner interest, increase their persistence and willingness to continue learning and help develop their academic self-efficacy (Rachels & Rockinson-Szapkiw, 2018). Past research has shown that using Duolingo is closely related to user's psychological characteristics. James and Mayer (2019) reported that the competitive aspect of Duolingo's design introduced a social dimension to learning that could further enhance motivation and engagement. Research has also revealed that certain gamification designs such as Duolingo may lead to anxiety or frustration in learners who struggle with competitive features like leaderboards (Hanus & Fox, 2015), as well as in those who experience limited task variation and few authentic interactions in language learning apps (Loewen et al., 2019). Despite these efforts to investigate the potential outcomes of digital gamification, both positive and negative, for language learning, the existing literature still requires investigation of the socio-affective and emotional factors (e.g., psychological flow, grit, and academic buoyancy) among language learners within such contexts. Likewise, there is a lack of research addressing how competition, as the inherent element of games, can relate to the motivational and affective aspects of gamified language learning. To fill this gap, the present study examined how these variables may interact and influence learning dynamics within, Duolingo.

### *Grit*

The concept of grit, as introduced by Duckworth and her colleagues (2007), refers to the non-cognitive attribute of high-achieving individuals, characterized by "perseverance and passion for long-term goals" (p. 1087). Drawing on this definition, grit is a higher-order construct with two underlying dimensions: perseverance of effort and consistency of interest (Duckworth et al., 2007). The former involves the ability to invest energy and sustain effort over an extended period, whereas the latter pertains to maintenance of passion and commitment to goals despite challenges and setbacks (Duckworth et al., 2007). More specifically, grit is the personality trait of assiduous individuals who are willing to work strenuously towards demanding yet irreplaceable goals; therefore, grit serves as a distinguishing factor in the success or failure of those with equal talent and opportunities (Duckworth & Gross, 2014). That is why grit is specified as a salient indicator of students' academic productivity and engagement (Hodge et al., 2018).

Given the significant contribution of persistence and passion to the language learning process (e.g., Dörnyei, 2014), grit has become the subject of recent inquiries among second language acquisition (SLA) scholars (e.g., Teimouri et al., 2022; Yang et al., 2022). Utilizing domain-general scales (i.e., Duckworth et al., 2007; Duckworth & Quinn, 2009), early research on grit has linked the construct to academic achievement and language emotions (Khajavy & Aghaee, 2022; Li & Dewaele, 2021), self-perceived competence (Li & Yang, 2023), and language learning mindsets and motivation (Liu, 2022). Following inconsistencies found in results employing domain-general measures of grit, researchers developed new instruments specifically for gauging grit within the context of language learning (Sudina & Plonsky, 2024; Teimouri et al., 2021). In their quest to validate the language-specific grit scale, Teimouri et al. (2022) observed that gritty learners were more cognitively engaged in language learning and displayed higher willingness to communicate, greater joy, and lower

anxiety in English-as-a-foreign language (EFL) classrooms. In a similar vein, grit was reported to be inextricably and positively interwoven with a host of different psychological factors, including academic engagement (Jin, 2024), emotion regulation (Solhi et al., 2023), motivated behavior (Pawlak et al., 2022), and perceived teacher support (Hejazi & Sadoughi, 2022).

Some efforts have also been made to investigate grit within the context of technology-assisted language teaching and learning. Previous empirical evidence suggests that grit is effective in enhancing the quality and satisfaction of e-learning (Aparicio et al., 2017) and positively predicts attitudes towards computer-assisted language instruction (Zarrinabadi et al. 2024). As noted by Liu et al. (2021), grit is negatively associated with learning anxiety and academic inefficacy within the context of MALL. In a related study, Sudina and Plonsky (2024) found that learners with higher motivation and grit demonstrated greater duration, frequency, and intensity of Duolingo app usage.

***Buoyancy***

With the advent of positive psychology in the field of SLA (MacIntyre & Gregersen, 2012), the concepts of motivation and resilience have gained significant scholarly attention in recent years. While crucial for success in language learning, motivation alone proves insufficient to maintain effort and sustain academic gains amidst the inherent ups and downs of the language learning process (Yun et al., 2018). To address this concern, Martin and Marsh (2008) introduced the concept of academic buoyancy and defined it as "students' ability to successfully deal with academic setbacks and challenges that are typical of the ordinary course of school life" (p. 54). Therefore, academic buoyancy represents a form of everyday resilience; that is, taking a proactive rather than a reactive stand. In this sense, traditional resilience differs from academic buoyancy; traditional resilience involves managing chronic or acute educational adversities, while academic buoyancy pertains to

effectively coping with stress, self-doubt, and disengagement, which are often triggered by isolated poor grades and negative feedback (Martin & Marsh, 2009). Further research in educational psychology suggests that academic buoyancy is concerned with reducing minor undesirable outcomes such as "anxiety, failure avoidance, and uncertain control" (Martin, 2013, p. 490). In addition, academically buoyant students are apt to display more positive affective, cognitive, and behavioral orientations toward their educational pursuits (Martin & Marsh, 2009).

Research on buoyancy in language teaching and learning is limited (e.g., Yang et al., 2022; Yun et al., 2018; Zheng et al., 2023). As the first to study language learning buoyancy, Yun et al. (2018) identified key factors contributing to this construct, including the ideal self, self-regulation, self-efficacy, and the teacher-student relationship. Their findings also uncovered that buoyancy is a significant predictor of performance and overall academic achievement among EFL students. Moreover, subsequent research revealed a positive correlation between buoyancy and mindfulness (Mohammad-Hosseini et al., 2023), classroom social support (Fu, 2024), and grit (Yang et al., 2022). In contrast, students with lower levels of buoyancy were found to be more prone to language learning boredom (Mohammad-Hosseini et al., 2023) and academic burnout (Fu, 2024). In a closely related study, Zheng et al. (2023) examined the impact of the Telegram application on the students' academic buoyancy, academic emotion regulation, foreign language anxiety, and English achievement. They concluded that Telegram-based instruction enhanced learners' buoyancy and emotion regulation.

***Psychological flow***

At the core of positive psychology lies an emphasis on the sense of flow commonly described as a "subjective state that people report when they are completely involved in something to the point of forgetting time, fatigue, and everything else but the activity itself"

(Csikszentmihalyi & Rathunde, 1993, p. 59). In this sense, flow is a multifaceted construct, defined by three main experiential dimensions (Norsworthy et al., 2023): absorption (i.e., a full immersion in a task, rested in undistracted attention and merging of action and awareness), effortless control (i.e., a heightened sense of control over one's performance, making a task feel less effortful and more fluid than usual), and intrinsic reward (i.e., an intrinsic motivation and enjoyment derived from a task which is an end in itself). Central to various flow models is the optimal balance between the learner's skills and the challenges of the task at hand (Nakamura & Csikszentmihalyi, 2009). This balance motivates students to engage in progressively more challenging activities commensurate with improving skills, thereby maintaining enjoyment and intrinsically fostering learning (Piniel & Albert, 2019). There is also a consensus that flow contributes to positive development, improved performance, higher engagement (Norsworthy et al., 2021), and positive affect (Esteban-Millat et al., 2014).

The concept of flow is increasingly being explored within the expanding body of SLA literature (e.g., Dewaele & MacIntyre, 2024). Empirical studies have consistently demonstrated that flow is positively correlated with enjoyment (Dewaele et al., 2023), and willingness to communicate (Lu, 2024). Conversely, it has been found to be negatively associated with boredom (Dewaele et al., 2023) and anxiety (Dewaele & MacIntyre, 2024). Flow theory in language learning research has been applied to gamified and digital contexts. Li et al. (2019), for example, modeled the relationship between Chinese EFL learners' flow experiences (e.g., concentration, motivation, enjoyment) and their antecedents and outcomes. They found that challenge-skill balance, clear goals, and playability predicted higher perceived learning and satisfaction. Similarly, Liu and Song (2021) reported a strong link between enjoyment and focused attention during immersion, which correlated with satisfaction, achievement, and attitudinal change. In a blended context, Wang and Huang

(2022) conceptualized flow as a three-dimensional construct: enjoyment, anxiety, and boredom, capturing both flow and anti-flow emotions.

***Competitiveness***

Competition is inseparable from almost every facet of our social and academic life (Deutsch, 1949; Garcia et al., 2024). Brown et al. (1998) identified three distinct terms to conceptualize competition: structural competition, defined as an actual situation where individuals vie for outcomes; trait competitiveness, described as a personal disposition to compete in real-world scenarios; and perceived environmental competitiveness, which refers to the subjective perception of a situation as competitive. The primary focus of this research is on perceived environmental competitiveness. Perceived competitiveness, conceptualized as the assessment of the learning environment's competitiveness and the competitiveness of the individuals within it (Elliot et al., 2018), influences how individuals think, feel, and behave (Deutsch, 1949). This perception also significantly affects their goal-setting behavior and performance (Elliot, 2020).

Research in educational psychology shows that competition provides a sense of challenge and excitement (Ryan & Reeve, 2024), enhances motivation, attention, and effort (Cheng et al., 2009), and stimulates interest, interaction, and active participation (Burguillo, 2010). For students with lower abilities, however, competition is likely to impair performance (Johnson & Johnson, 2013) and contribute to increased levels of depression and anxiety (Cheng et al., 2009), diminished confidence, and elevated rates of suspension and hostility (Coleman & Deutsch, 2015). In other words, perceived competitiveness is a double-edged sword, with both facilitating and debilitating effects (e.g., Bailey et al., 2024; Elliot, 2020; Murayama & Elliot, 2012). Murayama and Elliot (2012) conceptualized two types of achievement goals— "performance-approach goals" and "performance-avoidance goals" (p. 1041)—as mediating variables in the relationship between competition and performance.

They proposed that in competitive contexts, the adoption of performance-approach goals, which are defined as striving to outperform others, can enhance performance. Conversely, the adoption of performance-avoidance goals, which involve attempting to avoid performing poorly relative to others, can lead to decreased performance. These findings are further corroborated by recent SLA research, which identifies competitiveness as having dual effects: it can either enhance perceived learning or nurture anxiety (Bailey et al., 2024).

As arguably "the most recognizable form of play" (Reinhardt, 2019, p. 55), competition is an integral component of gameplay and, consequently, of game-based language learning (e.g., Chen et al., 2020; Li & O'Rourke, 2022; Vandercruysse et al., 2013). In a meta-analysis aimed at examining the effects of competition in digital game-based learning (DGBL), Chen et al. (2020) discovered that competition in DGBL significantly enhances learning outcomes in language, mathematics, and science. Also, Vandercruysse et al. (2013) showed that integrating competition into a 3D computer-based language learning environment positively impacts students' motivation, attention, and perceived competence. In a similar vein, Chen and Chen (2014) investigated the effects of competitive educational agents and found that competitive educational agents enabled young students to perceive clear goals, face greater challenges, and experience increased enjoyment. More recently, Li and O'Rourke (2022) reported that the leaderboard element of the Duolingo triggered a sense of competitiveness, thereby promoting motivation and persistence among users. Finally, Acquah and Katz (2020) reported that competition could distract learners or even diminish their motivation and enjoyment.

***Perceived competence***

Perceived competence, defined as the self-assessment of one's abilities in the target language, significantly influences learners' engagement and interaction in language learning contexts (Clement, 1980). Previous studies have shown that critical decisions regarding

language communication are predominantly based on individuals' perceptions of their competence rather than their actual language performance (McCroskey & McCroskey, 1988). According to Mercer (2011), perceived competence is closely related to but distinct from key self-belief constructs: self-concept and self-efficacy. Specifically, perceived competence, along with a lack of anxiety, can contribute to students' self-confidence in language learning (Clement, 1980).

The self-determination theory of motivation (Ryan & Deci, 2017) considers competence as one of the basic psychological needs of language learners, the fulfilment of which enhances self-regulation and well-being, ultimately contributing to optimal functioning. Empirical evidence indicates a positive correlation between students' actual achievements and their perceived competence, both overall and in specific domains (Dewaele & Li, 2022). Furthermore, language learners with higher perceived proficiency are more likely to invest more effort (Author et al., 2022) and experience greater enjoyment and lower levels of anxiety in their language learning endeavours (Botes et al., 2020).

Given the above review of the literature, the present study aimed to address the following research questions.

1. Is there a significant difference between single and multiple foreign language learners in terms of their grit, perceived competence, competitiveness, academic buoyancy, and flow?
2. Does persistency of effort predict psychological flow and buoyancy in Duolingo users?
3. Does consistency of interest predict psychological flow and buoyancy in Duolingo users?
4. Does persistency of effort predict psychological flow and buoyancy in Duolingo users through the mediation of perceived competence?

5. Does consistency of interest predict psychological flow and buoyancy in Duolingo users through the mediation of perceived competence?
6. Does persistency of effort predict psychological flow and buoyancy in Duolingo users through the mediation of competitiveness?
7. Does consistency of interest predict psychological flow and buoyancy in Duolingo users through the mediation of competitiveness?

## Method

### *Participants*

Participants were recruited via convenience sampling and through multiple channels, including posting an invitation letter on one of the author's Facebook pages, utilizing the British Association of Applied Linguistics' mailing list, and contacting friends and students who were Duolingo users or had connections with Duolingo users (learning languages such as Arabic, Italian, German, French, Korean, Japanese, Spanish, Russian). A total of 191 Duolingo multiple language learners participated in the study: 57 males (29.8%), 130 females (68.1%), and 4 participants (2.1%) who did not disclose their gender. From the sample 103 (54%) were learning a single and 88 (46%) were learning multiple foreign languages. Among the multiple language learners, 58 (30%) were learning two foreign languages, 21 (11%) were learning three foreign languages, 5 (3%) were learning four foreign languages, and 4 (2%) were learning five multiple languages (the percentages are in proportion to the whole sample). The age of participants ranged from 18 to 75 years, with a mean age of 26.55 years (SD = 9.69). With respect to their experience with Duolingo, 95 participants (49.7%) had less than one year of experience, 76 participants (39.8%) had between one and three years, 9 participants (4.7%) had between three and five years, and 11 participants (5.8%) had more

than five years of experience. Additionally, 103 (53.9%) participants were learning only one language on Duolingo, while 88 (46.1%) were learning more than one language.

Participants were provided with an information sheet and a consent form at the beginning of the survey designed using Google Forms. They confirmed their informed consent before answering to the items.

### *Instruments*

Data were gathered via a survey that was part of a broader research project. The survey was divided into two sections. The first section collected demographic data, including age, gender, years of experience with Duolingo, and the languages being learned. The second section comprised 85 questions rated on a five-point Likert-type scale from 1 ("completely disagree") to 5 ("completely agree"). These questions were adapted from various validated and reliable scales to assess ten variables: psychological flow, autonomy, mindsets, grit, perceived competitiveness, self-perceived competence, beliefs about competition, academic buoyancy, cooperative and competitive orientation, and engagement. In this study, the analysis concentrated on data from five selected variables: psychological flow, grit, perceived competitiveness, self-perceived competence, and academic buoyancy.

#### *Psychological flow*

Norsworthy et al.'s (2023) Psychological Flow Scale (PFS) was used to measure the participants' flow in language learning through Duolingo. This scale comprises nine items across three related dimensions: "absorption" (3 items, e.g., "I was highly focused on the task/activity."), "effortless control" (3 items, e.g., "I felt like I could easily control what I was doing."), and "intrinsic reward" (3 items, e.g., "The experience felt satisfying."). These dimensions are proposed to characterise the psychological flow experience across different activities including gaming. The global flow score is obtained by averaging the nine scores for the three dimensions.

*Grit*

To measure the participants' grit, we adapted the L2-Grit scale developed by Teimouri et al. (2022). This scale comprises nine items divided into two related but distinct sub-components: "perseverance of effort" and "consistency of interest". The "perseverance of effort" subscale, consisting of five items, evaluates the persistence of language learners in achieving their language learning goals. An example item is: "I will not allow anything to stop me from my progress in learning this language". The consistency of interest subscale, consisting of four items, measures variations in language learners' interest levels during the language learning process. An example item is: "My interests in learning this language change from year to year."

*Perceived competitiveness*

Murayama and Elliot's (2012) 5-item Perceived Competitiveness scale was slightly adapted to measure the participants' perception of competitiveness in the context of Duolingo. An example item is: "Learners seem to value competition in this learning environment." Higher scores on this scale indicate higher perceived competitiveness.

*Perceived competence*

The participants' self-perceived competence was measured using four items (e.g., "I am good at reading in the language I am learning with Duolingo.") adapted from the scale developed by Clark (1981). These items ask the participants to rate their competence in using the four language skills, i.e., reading, writing, speaking and listening. Higher scores on the scale indicate higher perceived language competence.

*Academic buoyancy*

The learners' academic buoyancy was measured by adapting the scale developed by Martin & Marsh (2008). An example item is "I am good at dealing with setbacks in game-based learning". This scale measures students' everyday academic resilience, i.e., their ability

to effectively deal with academic setbacks and challenges such as poor grades, negative feedback, exam pressure, and challenging schoolwork.

***Data analysis***

The data were analyzed using SPSS (Version 23) and AMOS (Version 24). To ensure the reliability of the model estimation outcomes, fundamental assumptions of Structural Equation Modeling (SEM), including multivariate normality, linearity, and homoscedasticity, were evaluated. An assessment for missing values and outliers was also conducted.

Descriptive statistics were computed for all variables encompassed in the study. These statistics provided a comprehensive overview of the central tendency, dispersion, and distribution of the data. Pearson correlation coefficients were then calculated to investigate the bivariate relationships among the variables of interest. This analysis served to identify potential associations between grit, psychological flow, perceived competitiveness, self-perceived competence, and academic buoyancy. Also, SEM utilizing AMOS was employed to assess the hypothesized relationships among the variables within a proposed mediational model. This model elucidated the direct effects of grit on academic buoyancy and psychological flow, as well as the indirect effects mediated by perceived competence and perceived competitiveness. Observable variables were included for grit (i.e., perseverance of effort and consistency of interest) and psychological flow (i.e., absorption, effortless control, and intrinsic reward), while latent variables were used to represent grit, psychological flow, self-perceived competence, perceived competitiveness, and academic buoyancy. The goodness of fit of the model was evaluated using established indices (Gaskin & Lim, 2016; Hu & Bentler, 1999), including the chi-square statistic ($\chi^2$/df = between 1 and 3), comparative fit index (CFI > .90), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA < .06; PClose < .05) and standardized root mean square residual (SRMR < .08).

To investigate the mediating role of perceived competence and perceived competitiveness in the relationship between grit and academic buoyancy and psychological flow, a mediated path analysis was conducted within the SEM framework. This analysis provided insights into the indirect effects of grit on academic buoyancy and psychological flow through the proposed mediators. Model modification indices were scrutinized to pinpoint potential areas for model enhancement. Subsequent adjustments were made based on theoretical justifications and statistical recommendations. Additionally, fit indices were re-evaluated following each modification to ensure the optimal fit of the final model to the data.

**Results**

The descriptive statistics including mean, standard deviation (SD), skewness and kurtosis and Cronbach's alpha as well as the intercorrelations between the variables of the study are presented in Table 1. The results indicated that the kurtosis and skewness indices for all variables were between -2 and +2, which is an acceptable range (Kim, 2013). Moreover, the reliability coefficients for all variables were more than 0.70, which is an acceptable level in the field (Dörnyei, 2007). Additionally, the assumption of normality was ensured by calculating Shapiro-Wilk and Kolmogorov-Simonov tests. Also, the results showed that there were no differences between male and female participants with respect to their flow ($t$ = -1.98, $p$ = 0.055), perceived competitiveness ($t$ = .751, $p$ = 0.453), perceived competence ($t$ = -1.154, $p$ = 0.089), effort-less control ($t$ = -1.678, $p$ = 0.095), intrinsic reward ($t$ = -1.563, $p$ = 0.120), absorption ($t$ = -1.60, $p$ = 0.106), persistence of effort ($t$ = -0.640, $p$ = 0.523), buoyancy ($t$ = 0.564, $p$ = 0.574), and consistency of interest ($t$ = 0.537, $p$ = 0.592).

An independent-samples t-test was conducted to compare the psychological traits of learners who study a single foreign language versus those who study multiple foreign languages. The results indicated that there were no significant differences between the two

groups in perceived competence (t(189) = -1.055, p = .293), consistency of interest (t(189) = -1.678, p = .095), perseverance of effort (t(189) = 1.062, p = .290), competitiveness (t(189) = -0.503, p = .615), buoyancy (t(189) = -0.339, p = .735), absorption (t(189) = 0.437, p = .662), and intrinsic motivation (t(189) = 0.907, p = .366). However, a statistically significant difference was found in effortless control (t(189) = -2.416, p = .017, Cohen's d = .26, small to medium effect size), suggesting that learners of multiple foreign languages reported higher levels of effortless control compared to those who study only one language. Overall, the findings indicate that while most psychological traits were similar between the two groups.

**Table 1.** Descriptive statistics and bivariate correlations.

| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
|---|---|---|---|---|---|---|---|---|
| **1. Persistence of Effort** | | | | | | | | |
| **2. Consistency of Interest** | .276** | | | | | | | |
| **3. Competence** | .418** | .112 | | | | | | |
| **4. Competitiveness** | .306** | -.084 | .294** | | | | | |
| **5. Buoyancy** | .292** | .123 | .276** | .057 | | | | |
| **6. Absorption** | .413 | .240** | .423** | .244** | .296** | | | |
| **7. Effort-less Control** | .274** | .127 | .365** | .153* | .400** | .392** | | |
| **8. Intrinsic Motivation** | .379** | .221** | .358** | .276** | .401** | .512** | .411** | |
| **Cronbach's α** | 0.86 | 0.84 | 0.70 | 0.82 | 0.77 | 0.76 | 0.70 | 0.85 |
| **Mean** | 3.55 | 3.50 | 3.39 | 3.42 | 3.53 | 3.61 | 3.69 | 4.10 |
| **SD** | 0.86 | 1.05 | 0.78 | 0.83 | 0.81 | 0.83 | 0.71 | 0.83 |
| **Skewness** | -.263 | -.490 | -.293 | -.355 | -.321 | -.328 | -.281 | -1.17 |
| **Kurtosis** | -.562 | -.689 | .343 | -.212 | -.094 | -.011 | .176 | 1.71 |

*Note.* $^{*}p < .0$; $^{**}p < .01$

The preliminary model of the study was evaluated using Amos (version 24) with maximum likelihood estimation. This initial hypothesized model included all potential pathways among the variables, as illustrated in Figure 1. The results showed that the model fit the data poorly. The goodness of fit indices included: $\chi^2 = 37.209$, df =10.000, $\chi^2/df =$ 3.721, CFI = 0.910, PClose = 0.003, RMSEA = 0.120.

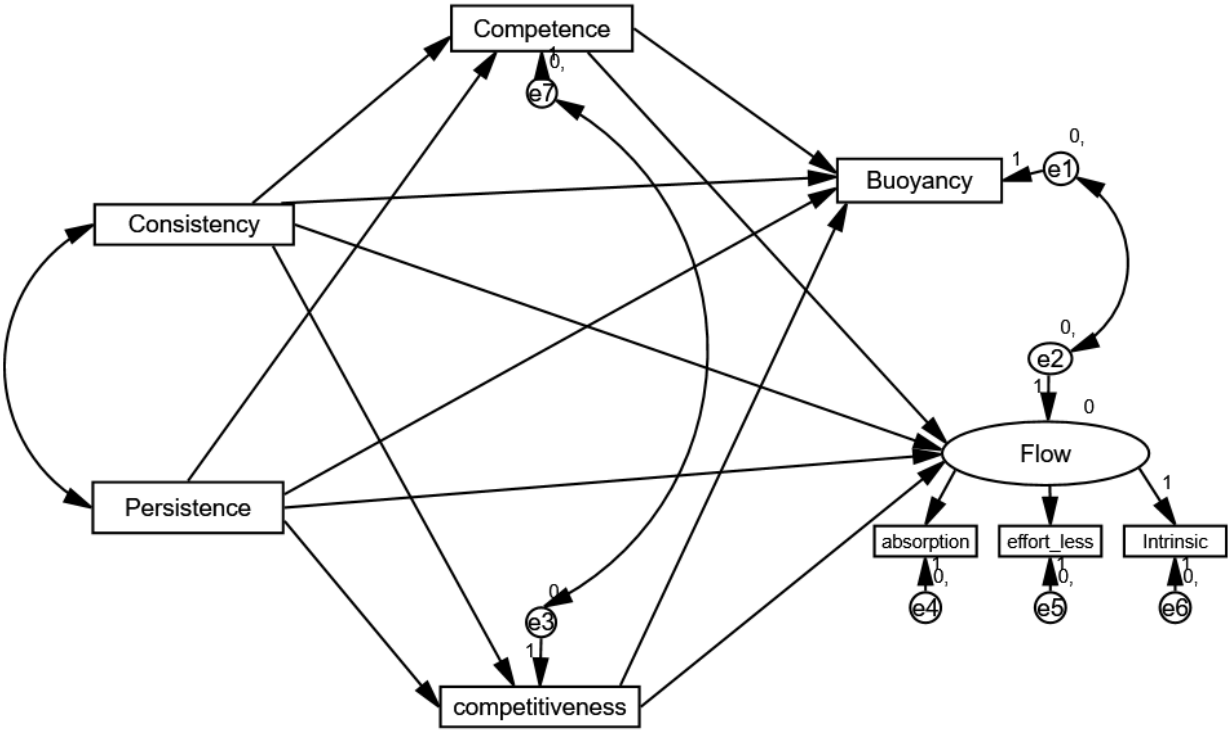


**Figure 1.** The initial hypothesised model.

Therefore, non-significant paths were removed from the model, and the revised model was tested again. The results showed that the revised model fit the data well. The goodness of fit indices for the corrected model were: $\chi^2 = 20.413$, $df$ =14, $\chi^2/df$ = 1.458, CFI = 0.979, PClose = 0.468, RMSEA = 0.049. Figure 2 depicts the corrected model with significant paths.

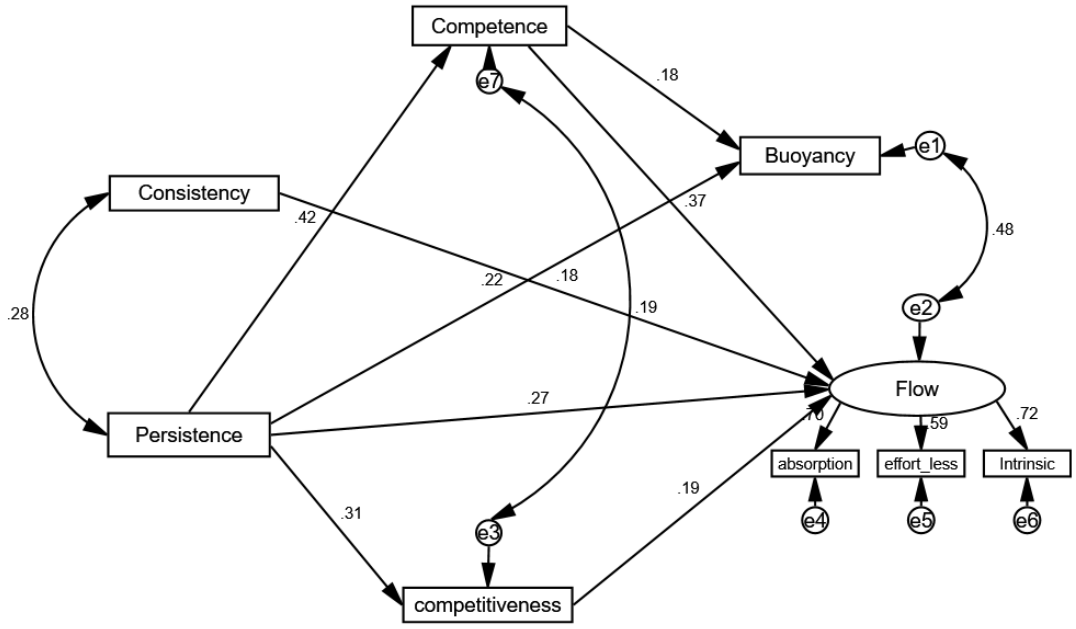


**Figure 2.** The model with significant paths.

The results of the direct effect are presented in Table 2. The results showed that persistence of effort positively and significantly predicted perceived competitiveness ($\beta$ = .295, $p$ < .001, small effect size, Cohen, 1988), perceived competence ($\beta$ = .379, $p$ < .001, medium effect size), flow ($\beta$ = .191, $p$ < .001, small effect size) and academic buoyancy ($\beta$ = .206, $p$ < .004, small effect size). On the other hand, consistency of interest only predicted flow ($\beta$ = .106, $p$ < .007, small effect size) directly but did not predict other variables. The results also showed that perceived competence predicted both flow ($\beta$ = .282, $p$ < .001, small effect size) and buoyancy ($\beta$ = .182, $p$ < .020, small effect size). Furthermore, perceived competitiveness positively predicted flow ($\beta$ = .182, $p$ < .007, small effect size) but did not predict buoyancy.

**Table 2.** Estimates for the direct effects.

| **Path** | $\beta$ | *B* | ***CR*** | ***p-value*** | $f^2$ |
|---|---|---|---|---|---|
| Persistence → Competitiveness | .295 | .067 | 4.42 | .000 | .095 |
| Persistence → Competence | .379 | .060 | 6.33 | .000 | .168 |
| Persistence → Flow | .191 | .057 | 3.34 | .000 | .038 |
| Persistence → Buoyancy | .206 | .071 | 2.89 | .004 | .044 |
| Consistency → Flow | .106 | .039 | 2.71 | .007 | .011 |
| Competence → Flow | .286 | .062 | 4.60 | .000 | .089 |
| Competence → Buoyancy | .182 | .078 | 2.33 | .020 | .034 |
| Competitiveness → Flow | .138 | .051 | 2.70 | .007 | .019 |

The subsequent step in the analysis involved examining the mediation model and the indirect pathways. To examine the indirect effect of persistence of effort on flow and buoyancy through the mediation of perceived competitiveness and competence, 5000 bootstrap resamples were employed. The results of standardized and unstandardized estimates together with the effect sizes are given in Table 3. The results of the indirect effects showed that persistence of effort predicted flow through the mediation of both perceived competitiveness ($\beta = .058$, $p < .008$, small effect size) and perceived competence ($\beta = .155$, $p < .001$, small effect size). In addition, persistence of effort predicted buoyancy through the mediation of perceived competence ($\beta = .073$, $p < .022$, small effect size).

**Table 3.** Estimates for the indirect effects.

| Indirect path | $\beta$ | *B* | Lower | Upper | *P value* | $f^2$ |
|---|---|---|---|---|---|---|
| Persistence → Competitiveness → Flow | .058 | .041 | .014 | .081 | .008 | .003 |
| Persistence → Competence → Flow | .155 | .109 | .062 | .176 | .001 | .034 |
| Persistence → Competence → Buoyancy | .073 | .069 | .017 | .133 | .022 | .005 |

*Note.* A 95% biased-corrected CI (with 5000 bootstrap samples) not including zero indicates significant indirect effects

## Discussion

The findings of this study revealed that persistence of effort, a key component of grit, directly and positively influenced psychological flow and academic buoyancy among Duolingo language learners. As defined by Csikszentmihalyi (1990), psychological flow refers to a state of deep immersion and absorption in an activity. Persistence of effort, as characterized by Teimouri et al. (2022), denotes sustained determination and commitment to language learning despite encountering challenges and setbacks. This unwavering determination enables Duolingo users to maintain a consistent focus on language learning activities, which facilitates achieving a balance between the inherent challenges of Duolingo's language tasks and their developing language proficiency. Learners who exhibit such persistent effort are more likely to experience heightened levels of immersion, concentration, and engagement in their daily Duolingo activities, thereby increasing the likelihood of experiencing psychological flow. Furthermore, the ongoing practice and incremental improvements resulting from persistent effort contribute to a growing sense of mastery among Duolingo users. This sense of mastery, in turn, creates the optimal conditions for the emergence of psychological flow. Consequently, high levels of persistence in effort are likely to lead Duolingo users to frequent flow states, which enhance their engagement and satisfaction with the language learning process. These findings are consistent with those of Smith et al. (2023) who identified robust relationships between grit and flow in other domains, such as music.

Academic buoyancy, defined as learners' capacity to navigate and cope with daily academic challenges, is critical in language learning contexts (Yun et al., 2018). Learners

with high levels of persistence of effort are likely to maintain their dedication and commitment despite the difficulties encountered during language acquisition (Teimouri et al., 2022). This steadfast commitment contributes to the development of resilience, enabling learners to recover from frustrations arising from challenging Duolingo tasks and resume their language learning without prolonged disappointment. Within a learning context characterized by such psychological dynamics, learners will likely develop effective coping strategies and enhance their problem-solving skills through the consistent effort required to complete Duolingo tasks. Consequently, individuals with high persistence of effort are better equipped to manage the fluctuating demands of Duolingo's learning activities. This finding is consistent with Alazemi et al. (2023), who also reported positive correlations between persistence of effort and academic buoyancy.

In addressing research question two, the data further demonstrated that consistency of interest directly and positively predicts psychological flow among Duolingo users but not academic buoyancy. A plausible explanation for this finding is that learners with high levels of consistency of interest have cultivated long-term dedication, sustained passion, and interest in language learning, which help them remain focused and motivated over time (Teimouri et al., 2022). By maintaining a consistent interest in language learning, Duolingo users are likely to engage regularly with the platform and explore its diverse features and challenges with enthusiasm and passion. This ongoing engagement enables them to achieve an optimal balance between their target language competencies and the demands posed by Duolingo's learning tasks, a balance that is essential for experiencing psychological flow (Norsworthy et al., 2023). When learners immerse themselves in learning activities with genuine passion, enthusiasm, and interest, they are more likely to experience heightened concentration, joy, and control—hallmarks of psychological flow (Csikszentmihalyi, 1997). These findings align

with the results of Alazemi et al. (2023), which also show positive relationships between different dimensions of grit and flow.

In response to research question three, the findings suggest that persistence of effort predicts both flow and buoyancy through the mediation of perceived competence. A possible explanation is that learners who consistently engage in Duolingo lessons gradually develop language skills, which in turn enhance their perceived competence. As learners feel more competent in the target language, they are more likely to achieve a state of psychological flow and fully immerse themselves in language learning activities (Csikszentmihalyi, 1990). Enhanced perceived competence also positively contributes to the development of academic resilience, helping learners manage setbacks and challenges encountered during their language learning experience on Duolingo.

Conversely, as for research question four, the findings suggest that consistency of interest does not predict flow or buoyancy when mediated by perceived competence. Duolingo's brief, game-based learning activities may effectively sustain learners' interest primarily through external motivators such as streaks, experience points, and badges (Loewen et al., 2020). While these extrinsic rewards encourage consistent platform use, they may not foster the intrinsic motivation necessary to develop a genuine sense of competence. This intrinsic competence is critical for achieving psychological flow and academic buoyancy (Deci & Ryan, 2000). Furthermore, while consistent interest reflects ongoing engagement, if this engagement does not translate into meaningful skill acquisition or a robust sense of perceived competence, it may fail to contribute to the development of flow or buoyancy. Consequently, learners may maintain interest in using Duolingo but still perceive themselves as inadequate in their language abilities—a perception that can undermine their academic resilience and impede their ability to achieve flow (Ryan et al., 2006).

Regarding research question five, evidence indicates that persistence of effort positively influences psychological flow, but not buoyancy, through the mediation of perceived competitiveness. Duolingo's design, which includes regular progress notifications and comparative standings, enhances learners' desire to outperform peers and achieve higher success levels. This competitive aspect likely strengthens users' commitment to their learning goals, fostering a focus on surpassing previous achievements and excelling relative to others. The competitive drive inherent in Duolingo's gamified structure enhances users' motivation to excel, leading to more frequent and concentrated engagement with the platform's learning activities. As users persistently engage with a competitive spirit, they are more likely to challenge themselves with increasingly difficult tasks—an essential factor in achieving psychological flow (Csikszentmihalyi, 1990). Moreover, heightened competition intensifies users' determination and focus on learning games, creating optimal conditions for experiencing psychological flow (Nakamura & Csikszentmihalyi, 2009).

Finally, in response to research question six, findings indicate that consistency of interest fails to predict flow and buoyancy through the mediation of perceived competitiveness within Duolingo's learning environment—a pattern similar to that observed with perceived competence as the mediator. While consistent interest may sustain learners' participation in Duolingo's activities, it alone may not be sufficient to foster the competitive edge required to engage fully with the platform's gamified elements, which typically enhance flow and buoyancy. While consistency of interest is crucial for maintaining motivation and engagement (Duckworth et al., 2007), it may not significantly influence intermediary factors such as perceived competitiveness, driven by a desire to outperform others, and perceived competence, typically shaped by consistent effort and tangible skill improvements rather than interest alone. Hence, although consistency of interest can promote long-term engagement

(Duckworth et al., 2007; Teimouri et al., 2022), it may not necessarily translate into immediate boosts in users' competitiveness and perceived competence.

*Limitations of the study*

This study also has several limitations. The results are specific to the characteristics of the sample, which may limit the generalizability of the findings. Additionally, the study relied solely on self-report data to assess users' psychological characteristics, which can be subject to biases such as social desirability. Moreover, data were collected at a single time point, limiting the study to the constraints of a cross-sectional design. To address these limitations, future research should consider using different samples across various game-based language learning platforms and employing a triangulation of data sources. This approach would allow for more robust and generalizable findings.

## Conclusion

This study provides evidence that grit is positively associated with psychological flow and academic buoyancy among Duolingo users. The findings highlight the critical role of persistence of effort in fostering positive psychological outcomes, such as increased buoyancy and flow. This sustained effort is shown to be vital for deep engagement and the development of academic resilience among language learners using Duolingo. Moreover, the results suggest that learners' belief in their language ability and a competitive mindset—enhanced by persistent effort in language learning—can significantly improve their engagement and focus, thereby increasing the likelihood of experiencing psychological flow while using the Duolingo app. Interestingly, while consistency of interest and sustained passion are essential for experiencing flow, they do not appear to significantly impact learners' perceived competence and competitiveness within the Duolingo learning environment.

These findings have important implications for language learners and researchers focused on game-based language learning. Specifically, they suggest that enhancing learners' grit can positively influence their flow and buoyancy in language learning through platforms like Duolingo. Additionally, fostering a strong sense of perceived competence and promoting a healthy competitive spirit can further support the development of academic resilience and psychological flow. Future research is recommended to explore the relationship between grit and other positive psychological constructs (e.g., enjoyment, happiness, hope, pride, and well-being), as well as negative ones (e.g., anxiety, anger, and boredom). It is also advisable to investigate whether various emotional states mediate or moderate the relationship between grit, psychological flow, and academic buoyancy. Furthermore, comparing outcomes across different game-based language learning platforms could reveal whether platform-specific features influence the mediational roles of perceived competence and competitiveness in the relationship between the two components of grit and flow and buoyancy. Lastly, future research should delve deeper into the role of competitiveness in learning, exploring different forms of competition—such as individual vs. group competition—to understand how these dynamics impact learners' flow, buoyancy, and overall success in game-based language learning contexts.

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