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Multifactor Network Analysis: Exploring the Cross-Educational Impacts on the Effectiveness of Gamification in English Teaching

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Abstract

In the landscape of modern English education, gamification stands as one of the central transformative mediums. Despite existing findings, there is still a scarcity of research on gamified English teaching regarding the impacts of school support and personal factors. Current studies predominantly assessed the effectiveness of gamification through total scores, limiting insights into how teachers' perceptions at different levels of education are influenced. The objective was to examine how teacher-related factors and school support cross-educationally impact English teachers' satisfaction and their perceptions of gamification. A nationwide sample of 615 English teachers was used to conduct a series of network analyses to examine the effect strength of individual factors on the total score and item-level network relations. The estimated networks were then compared to discern any differences in effect strength across different educational levels. The analyses found no relation between gamification language learning outcomes and grade point averages, even after accounting for other factors. The results revealed moderate differences between levels of education concerning how frequency of use influences the teachers' perceptions of gamification and significant differences when controlling for teachers' age and teaching practice. However, no significant impact of school support was observed in both lower secondary and secondary education.

Introduction

For several decades, the modernization of English language education has become almost inseparably intertwined with the rapid technological advancements in digital content. One of the central components of this transformation has been the emergence of gamification. In broad terms, gamification refers to a methodological strategy that infuses gameful experience into the learning process, motivating and engaging the users (Hamari, 2019). At its core, gamification employs a vast range of gamification elements, including leaderboards, achievements, and in-game currency, to reward users for their efforts and provide continuous feedback about their progress (Flores, 2015; Kapp, 2012).

Nowadays, gamification usually does not stand on its own and is rather part of more complex learning systems encompassing a broad range of language learning strategies that aim to improve the effectiveness of foreign

language acquisition, such as mobile-assisted language learning and computer-assisted language learning, as well as various learning management systems. Prominent applications like Duolingo, Kahoot!, or Quizizz represent successful integrations of gamification into their core learning designs, attaining a spotlight in English language learning especially. One of the reasons why these learning systems became so popular among English teachers in particular might be their intrinsic adaptability and versatility to target all key language skills.

Over the years, a multitude of studies have already explored some of the main benefits of gamification in English language acquisition. The results revealed that gamification was found to have a positive effect on the development of key language skills and learners' academic performance (Fithriani, 2021; Hashim et al., 2019; Huseinović, 2024; Yildirim, 2017). In this regard, gamified mobile language learning was found to be particularly effective in learning key language skills (Burston, 2015; Golonka et al., 2014). Additionally, gamification has been found to be effective in motivating learners, improving overall class engagement, and promoting a positive language learning experience (Matsumoto, 2016; Roosta et al., 2016; Sun & Hsieh, 2018; Yildirim, 2017). Studies by Candan & Basaran (2023), Hong et al. (2022), Öden et al. (2021), and Zhang & Chen (2021) revealed that gamification effectively motivates learners and, in turn, reduces anxiety in language acquisition.

A similar positive effect on learning anxiety was observed in relation to gamification and how learners perceive and accept assessments. Research revealed that gamification improves learners' acceptance of the assessment and reduces the potential anxiety that is associated with it (Hawari et al., 2020; Pitoyo, 2019; Zainuddin et al., 2020). Nevertheless, there is still a significant scarcity of quality quantitative research assessing the effectiveness of gamification in English teaching with English teachers' perspectives in mind.

A recent systematic review by Helvich et al. (2023) found that only 11 quantitative or mixed studies exploring English teachers' perspectives across lower secondary, secondary, and higher education levels have been published thus far. This scarcity of quantitative studies addressing this topic was also observed in other literary and systematic reviews (Degirmenci, 2021; Lester et al., 2023; Lim & Yunus, 2021). Furthermore, a study quality assessment done in the same systematic review indicated a relatively low overall quality of contemporary published studies, posing significant challenges in interpreting their findings. This underscores the need for successive quantitative studies with more robust research methodologies.

Despite the promising results of concurrent studies, there is still a significant research gap regarding whether gamification-influenced language learning outcomes correlate with more objective metrics, such as end-of-term general point averages. This research gap is compounded by the limited examination of school- and teacher-related factors that may potentially impact their views on gamification in relation to its impact on learners' motivation and language learning outcomes across different levels of education. While some studies have identified some of the critical factors that limit gamification implementation (Boonmoh et al., 2021; Pham & Pham, 2022; Qing & Halim, 2021), little research has been conducted on personal factors that may shape teachers' perceptions of gamification in everyday use. In addition, none of the analyzed studies examined which institution-supportive measures are most effective in improving teachers' perceptions of gamification and encouraging their actual use in English lessons. So far, the existing studies predominantly analyzed the effectiveness of gamification

through measures' total scores, limiting the potential to gain a deeper cross-educational understanding of how personal factors and individual institutional supportive measures impact distinct facets of teachers' perceptions of gamification within the item-to-item scope. Addressing these gaps would substantially contribute to a better understanding of gamification, helping English teachers and school administration to make more informed decisions about implementation and institutional support.

The objective of this study is to explore how individual teacher-related and application-related factors such as teachers' age, length of English teaching practice, frequency of gamification application use, length of using gamification applications, or the school's support of gamification impact English teachers' perceptions of gamification in relation to its effectiveness on learners' motivation, language learning outcomes, and their association to end-of-term grade point averages in classes where gamification is used the most and longest. Additionally, the study aims to assess how these factors impact teachers' satisfaction with gamification applications and how often they use them. Subsequently, the impact of individual teacher-related factors and school support measures is compared across lower-secondary and secondary education levels.

Method

Data Collection and Participants

The study sample consists of Czech English teachers from lower secondary, secondary, and higher vocational educational levels, including both private and public institutions. Participants were recruited via the official registry of private and state institutions under The Ministry of Education, Youth and Sports of the Czech Republic. Teachers were contacted individually via email, and in cases where email contact was unavailable, headmasters were asked to relay the offer of participation to their English teachers instead. Employing mixed stratified, snowball, and convenience methods, the data collection was conducted through an online platform at Palacky University in Olomouc as part of a larger national data collection battery. The data collection spanned from March to June 2023 during the second half-year school term and from September to December 2023 during the first half-year school term. In total, 8941 English teachers and 1084 headmasters were contacted. Participation was entirely voluntary, and respondents could stop completing the survey at any point. Respondents had to provide informed consent before the survey started.

Data Exclusion

A quality control procedure was implemented, involving the exclusion of respondents with inconsistent answers regarding their height (±2 centimeters), weight (±2 kilograms), and age with the year of birth (±2 years). Additionally, completions lasting < 10 minutes were excluded. Outliers were identified using the Median Absolute Deviation method, revealing a total of n = 96 outlying values. However, visual inspection revealed that only n = 8 respondents exhibited a consistent response pattern. Following the exclusion of problematic respondents (n = 452), the sample comprised n = 615 respondents. For more detail regarding the quality control procedure, see Figure 1.

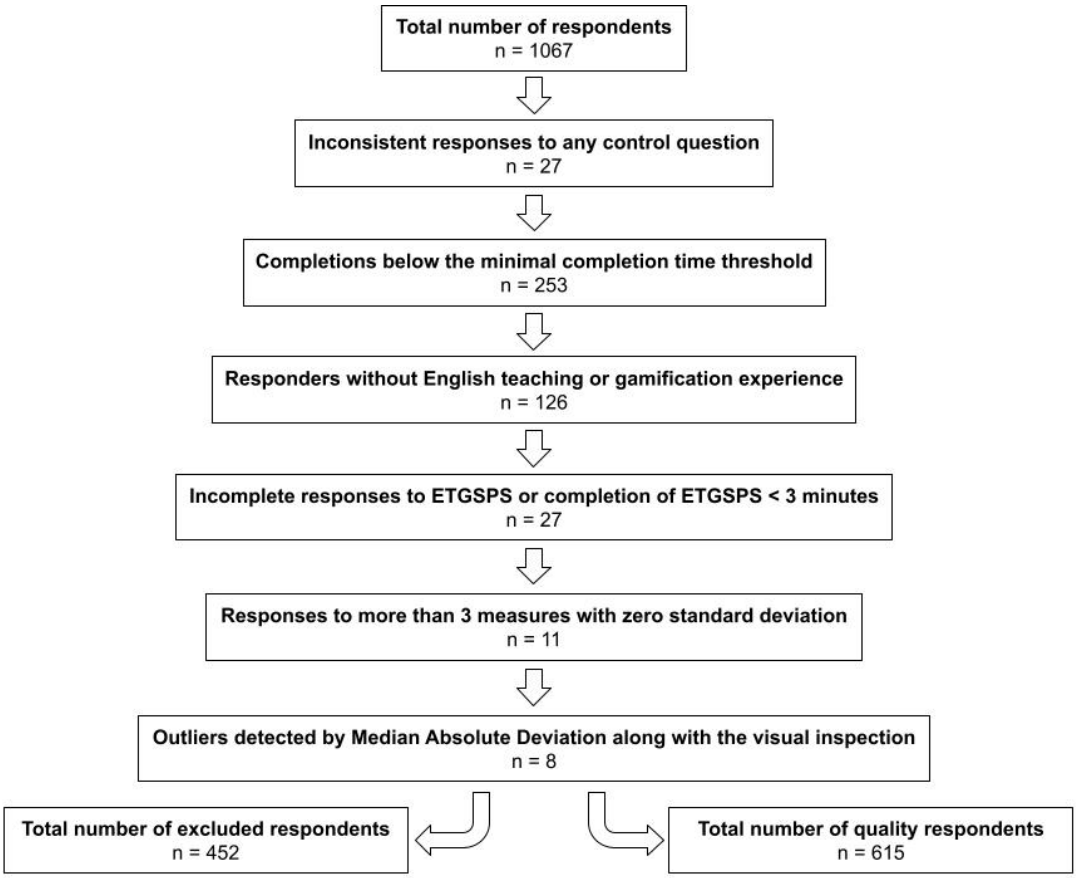

Figure 1: CONSORT diagram depicting the data exclusion process.

Measures

English Teachers' Gamification Satisfaction and Perception Scale (ETGSPS)

ETGSPS, a 29-item scale developed by Helvich et al., (2024), assesses English teachers' satisfaction with gamification applications and their perceived effect on learners' motivation and language learning outcomes. The scale was initially developed and validated in the Czech environment, so no translation was needed. The scale consists of motivation, learning outcomes of competence, learning outcomes of performance, and applicability subscales.

The scale also assesses the effectiveness of individual gamification applications in the English teaching context. Respondents answer each item on a 5-point Likert scale, ranging from 1 (strongly agree) to 5 (strongly disagree), where lower scores indicate greater perceived learners' motivation and learning outcomes and greater English teachers' satisfaction with the most used gamification application. The internal consistency of ETGSPS scale was: Cronbach's α: 0.91, 95% CI[0.9-0.92] and McDonald's ω: 0.93; Cronbach's α: 0.86, 95% CI[0.84-0.88] and McDonald's ω: 0.89 for motivation subscale; Cronbach's α: 0.88, 95% CI[0.86-0.89] and McDonald's ω: 0.91 for learning outcomes of performance subscale; Cronbach's α: 0.8, 95% CI[0.78-0.83] and McDonald's ω: 0.88 for learning outcomes of competence subscale, and Cronbach's α: 0.86, 95% CI[0.84-0.88] and McDonald's ω: 0.9 for applicability subscale.

Institutional Support

A 6-item self-report measure derived from the 5-item university support subscale included in the Teachers Mobile Learning Acceptance Questionnaire (TMLAQ) developed by Mittal & Alavi (2020). The adopted scale assesses the degree to which a school administration provides means of support for the integration of gamification in its formal educational framework. Initially, the original scale was reformulated and subsequently expanded to include supplementary forms of support for gamification. The additional items include the following statement: "Learners are adequately technologically equipped for "Learners are adequately equipped technologically for the implementation of gamification applications into lessons." Participants answer each item on a 5-point Likert scale, ranging from 1 (strongly agree) to 5 (strongly disagree), where higher scores indicate a greater perceived level of individual school support measures for the integration of gamification. The internal consistency of the scale was: Cronbach's α: 0.85, 95% CI[0.83-0.87] and McDonald's ω: 0.88.

Data Analysis

The Little MCAR test indicated no relationship among missing data points and that the data were missing at random. For this reason, missing data points were removed listwise. The multivariate normality of the data distribution was assessed using Mardia's test of skewness and kurtosis (skewness = 762.0537, p <.001, kurtosis = 5,147.6168, p <.001). Residual plots and significant values of the Breusch-Pagan test suggested heteroscedasticity of the data ($\chi 2$ = 59.08846, df = 1, p < .001). As the normality assumption was violated, Spearman's rank correlation and other non-parametric analytical methods were used during data analysis.

Network Analyses

Rather than explaining relationships between variables by an underlying latent construct, network analysis examines the mutual dynamics between individual variables while controlling for any potential effects of the surrounding nodes (Bell & O'Driscoll, 2018). To conduct network analysis, we employed Markov Random Fields (MRFs). In MRFs, variables are represented as nodes (circles), and their interrelations are depicted by edges (connections between circles). Our choice of MRFs was grounded in several key benefits over traditional statistical methods. Firstly, each edge in the network is estimated while accounting for all other variables in the network (Epskamp & Fried, 2018), offering a more nuanced understanding of potential causal relationships among variables. Secondly, MRFs enable the visualization of intricate relationships between variables, thereby aiding in the detection of reciprocal relationships such as feedback loops—whereby variable A influences variable B, which in turn influences variable A (Costantini et al., 2015). Thirdly, MRFs allow the examination of these complex relationships at the level of individual items, facilitating the identification of pivotal or influential elements within the network and how the relations are impacted when a new element is introduced into the network (Epskamp et al., 2018).

Therefore, to explore the dynamics between the individual variables, a large sequence of network analyses was conducted, and a bifurcation of the data sample into lower-secondary and secondary sub-samples was performed

for cross-educational comparison of factor effect strengths. The network analyses were conducted in two sequences. The first sequence examined the relations between subscales' total scores for both lower-secondary and secondary education levels, where individual school support measures and teacher-related factors were added into the network sequentially. Afterwards, all resulting networks were compared across education levels for any potential disparities in factor effect strengths between lower-secondary and secondary education. In the second sequence of analyses, the relations between individual subscale items were examined to obtain a better understanding of item-to-item dynamics when individual factors were introduced into a network. Subsequently, the same procedure of network examination and education level comparison as in total score-level analyses was conducted.

For both total score and item-level network analyses, the Pairwise Markov Random Field model and the Gaussian Graphical Model were estimated for the networks. The layout of the networks was created using the Fruchterman Reingold algorithm. To decrease the rate of false positive edges, we used Least Absolute Shrinkage and Selection Operator (LASSO) regularization techniques. The degree of penalty as imposed by LASSO is controlled using the tuning parameter γ, which was set conservatively to 0.5 in this study. It is suggested that if this cutoff is used, then the resulting network does not contain many false positive edges (Isvoranu & Epskamp, 2023; Liu et al., 2021). The node predictability was calculated to assess how well a single node can be predicted by the surrounding nodes. The bootstrapping procedure with 5000 bootstrapped samples was used to evaluate network estimates, including edge weights and confidence intervals. All statistical analyses were performed in R, using the following packages: psych (Revelle, 2023), lavaan (Rosseel et al., 2023), psychtoolbox (Novak, 2021), MissMech (Jamshidian et al., 2015), psychonetrics (Epskamp, 2023), mgm (Haslbeck, 2023), bootnet (Epskamp & Fried, 2023).

Results

Socio-Demographic Information

The data sample consists of primarily female English teachers (M = 42.5, SD = 9.37; 84.2% females), as expected in the lower-secondary and secondary education. See Table 1 for the socio-demographic information.

Table 1. Socio-Demographic Characteristics

Variables		N	Mean
Gender	Female	518	84.2
	Male	97	15.8
Age			M = 42.5
			SD = 9.37
Highest Education Attained	Secondary or higher vocational education	22	3.6
	Bachelor	49	8
	Master's or PhD	544	88.4
Teaching Level of Education	Lower-secondary education	321	52.2
	Secondary or higher vocational education	294	47.8

Variables	N	Mean
Total	615	100
Average Total Teaching Practice		M = 15.1
		SD = 9.65
Average English Teaching Practice		M = 14.5
		SD = 8.75
Average experience with		M = 4.52
gamification applications		SD = 2.70
Average monthly use of gamification		M = 11.5
applications		SD = 5.61

Network Analyses

Total Score-Level Network Analyses

In the first sequence of network analyses, the dynamics between subscales' total scores and how the strength of the total scores' relations change when controlling for individual school support measures were examined. Subsequently, the differences in impacts between individual educational levels were also analyzed. When controlling for no factors in the first step, the resulting networks for lower-secondary and secondary education showed only marginal differences between the relations of individual ETGSPS subscales; the largest detected was in the strength between the motivation subscale and the learning outcomes of competence subscale (see Supplementary materials 1 and 2). However, neither of them revealed any significant relation between language learning outcomes and end-of-term grade point averages. This also applies to GPA in a class where gamification is used the most and to GPA in a class where gamification has been used the longest. Nonetheless, no negative edges were detected in the networks.

In the next step, the school support total score was added to the networks, but no significant effect on the individual network relations was observed in both lower secondary and secondary education levels (see Supplementary materials 3 and 4).

Subsequently, individual teacher-related factors were sequentially incorporated into the networks. The resulting networks revealed that frequency of use, teachers' age, and length of English teaching practice had the strongest effect on the strength of relations between individual subscales. However, a moderate difference between lower secondary and secondary education levels was observed concerning how frequency of use impacts the relations between individual subscales. Specifically, a moderately higher negative effect was observed on subscale relations in lower secondary compared to secondary education when controlling for frequency of use (see Supplementary materials 5 and 6). Nevertheless, when controlling for frequency of use, the association between learning outcomes of competence and performance subscales became statistically insignificant. The same outcome was observed between the applicability and motivation subscales.

On the other hand, a significantly higher negative effect was observed on scale relations in secondary education

in comparison to lower secondary when controlling for both teachers' age and length of English teaching practice (see Supplementary materials 7 and 8). This effect difference was also detected in the relation between learning outcomes of competence and performance subscales, where in secondary education the relation became statistically insignificant, whereas in lower-secondary education the relation remained significant. However, no significant effect on the subscale relations was observed on both secondary and lower-secondary education levels when accounting for the length of use (see Supplementary materials 9 and 10). Furthermore, no significant effect was observed on the associations between frequency of use and other subscales when accounting for any of the other factors.

Item-level Network Analyses

In the second sequence of network analyses, the dynamics between individual subscale items were examined to obtain a deeper understanding of how the observed differences between lower-secondary and secondary education levels are reflected on the subscale item level and whether any significant effect of school support measures and other teacher-related factors can be detected on the item-to-item relations. As depicted in Figures 2 and 3, only a very small number of items, especially in secondary education, are associated with other items from different subscales. Additionally, a significant majority of these relations are very weak.

Moreover, in comparison to total score-level networks, no relation between learning outcomes of competence and performance items was detected in the item-level networks, even when other factors were not accounted for. On the other hand, in accordance with score-level networks, no association was found between any of the learning outcome items and end-of-term grade point averages. This also applies to GPA in a class where gamification is used the most and to GPA in a class where gamification has been used the longest. Nonetheless, no negative edges were detected in the networks.

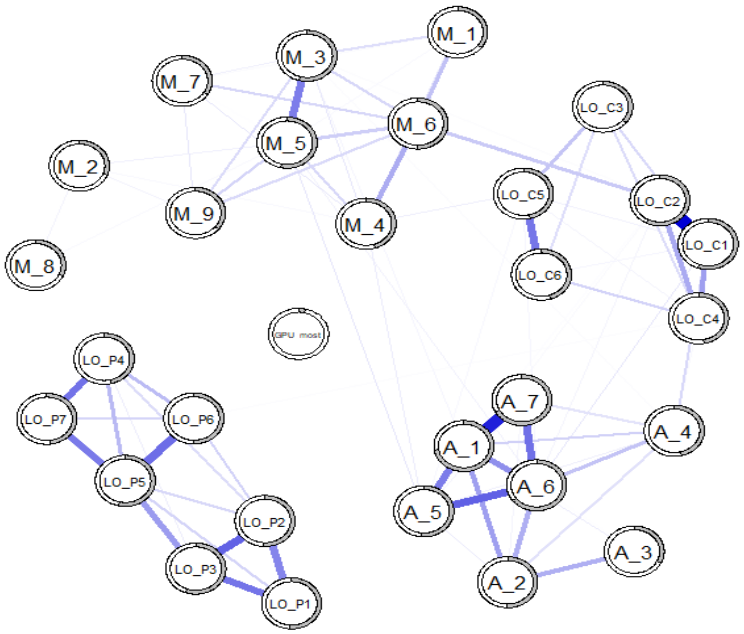

Figure 2. Network Depicting the Relations between ETGSPS Items at Lower-Secondary Education without Adjusting for Any Factors

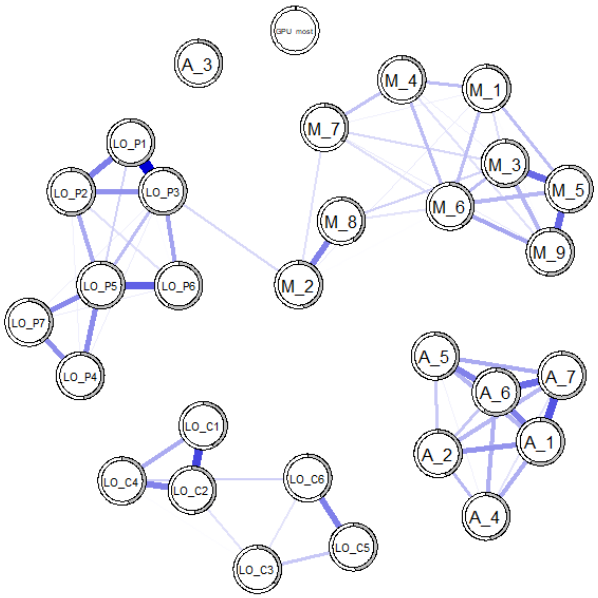

Figure 3. Network Depicting the Relations between ETGSPS Items at Secondary Education without Adjusting for Any Factors

Note. Figures 2 & 3 represent networks for lower-secondary (Fig. 2) and secondary (Fig. 3) education of ETGSPS items and end-of-term grade point average. Thicker edges represent stronger associations, while thin edges reflect weak associations. Blue edges reflect positive associations. Rings around the circles refer to node predictability. A higher degree of gray color inside these circles reflects higher node predictability, A = Applicability subscale, M = Motivation subscale, LO_C = Learning outcomes of competence subscale, LO_P = Learning outcomes of performance subscale, GPU = general point average in a class where gamification is used the most.

However, as in score-level network analyses, no significant impact was observed on the associations between frequency of use and other items as well as between individual subscale items when accounting for each and all school support measures or length of use (see Supplementary materials 11 and 12). In comparison to total score-level results, a similarly strong effect difference was found between educational levels when controlling for teachers' age and English teaching practice (see Figures 4 and 5). When controlling for both age and teaching practice in secondary education, the associations between most items got significantly weaker or completely disappeared, especially among motivation and performance items but also marginally among applicability and competence items. This difference in effect strength was also detected in the relations between frequency of use and motivation, as well as competence items, where all associations disappeared in secondary education, but no such effect was observed in lower-secondary education (see Figures 6 and 7).

In addition, when also controlling for frequency of use, a comparable moderate effect difference was detected between educational levels (see Figures 6 and 7). However, the item-level analyses revealed that in lower-secondary education, frequency of use mainly impacted relations between items of different subscales, which, in some cases, completely disappeared primarily between the applicability and learning outcomes of competence items as well as motivation items. In secondary education, on the other hand, frequency of use impacted relations mostly within subscales, especially within the applicability and learning outcomes of competence subscales.

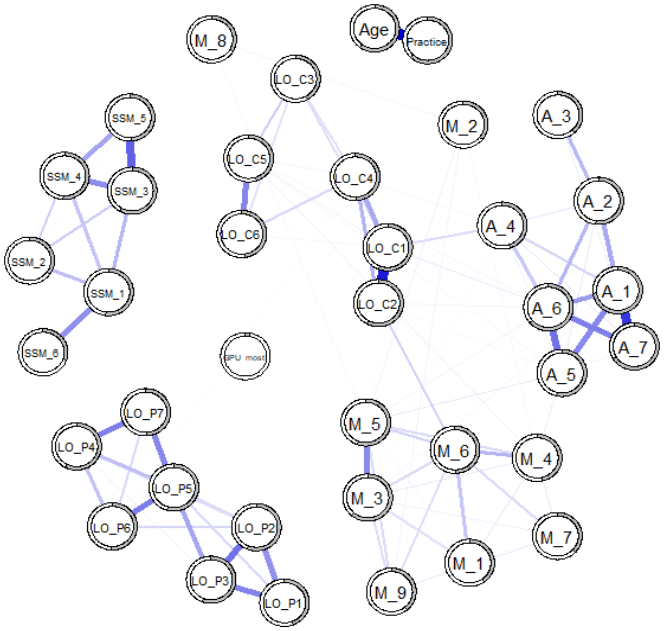

Figure 4. Network Depicting the Relations between ETGSPS Items at Lower-Secondary Education when Adjusting for Age and Length of English Teaching Practice

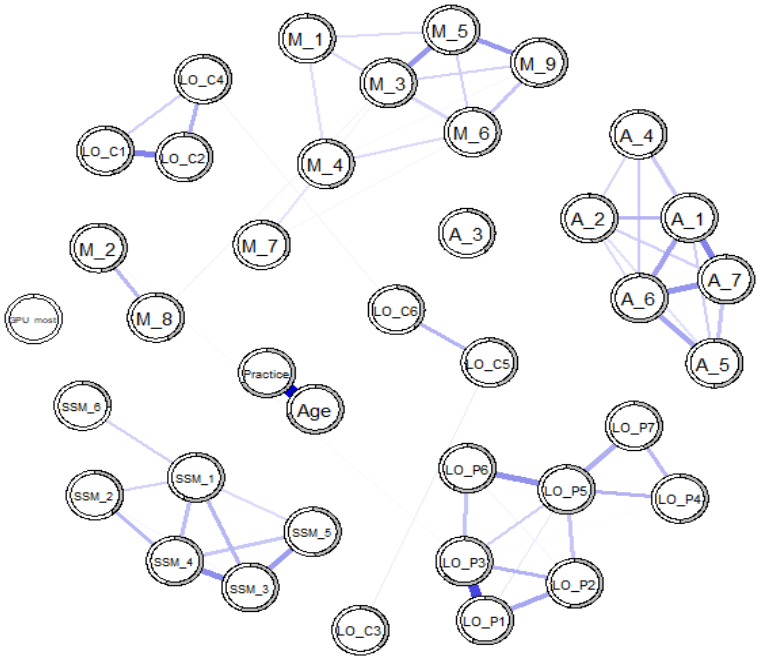

Figure 5. Network Depicting the Relations between ETGSPS Items at Secondary Education when Adjusting for Age and Length of English Teaching Practice

Note. Figures 4 & 5 represent networks for lower-secondary (Fig. 4) and secondary (Fig. 5) education of ETGSPS items and end-of-term grade point average when adjusting for Teachers' age and English teaching practice. Thicker edges represent stronger associations, while thin edges reflect weak associations. Blue edges reflect positive associations. Rings around the circles refer to node predictability. A higher degree of gray color inside

these circles reflects higher node predictability, A = Applicability subscale, M = Motivation subscale, LO_C = Learning outcomes of competence subscale, LO_P = Learning outcomes of performance subscale, GPU = general point average in a class where gamification is used the most, Age = Teachers' age, Practice = Length of English teaching practice, SSM = institutional support.

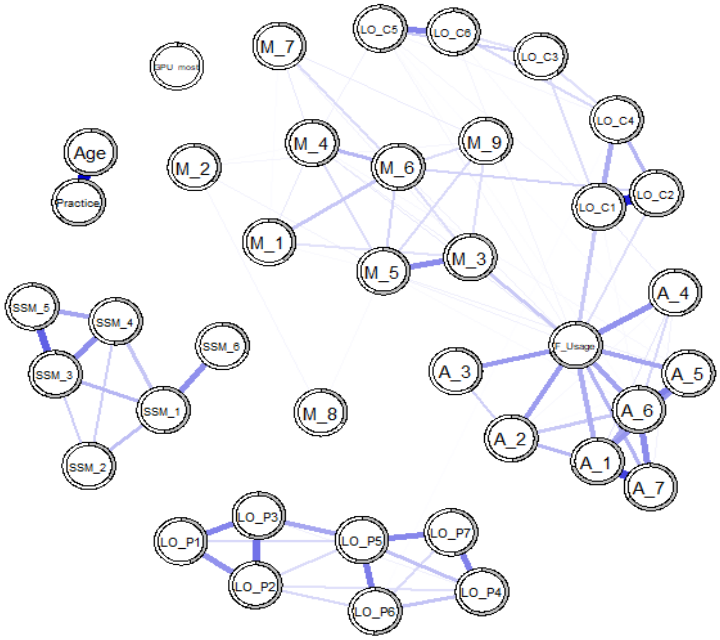

Figure 6. Network depicting the Relations between ETGSPS Items at Lower-Secondary Education when Additionally adjusting for Frequency of Use

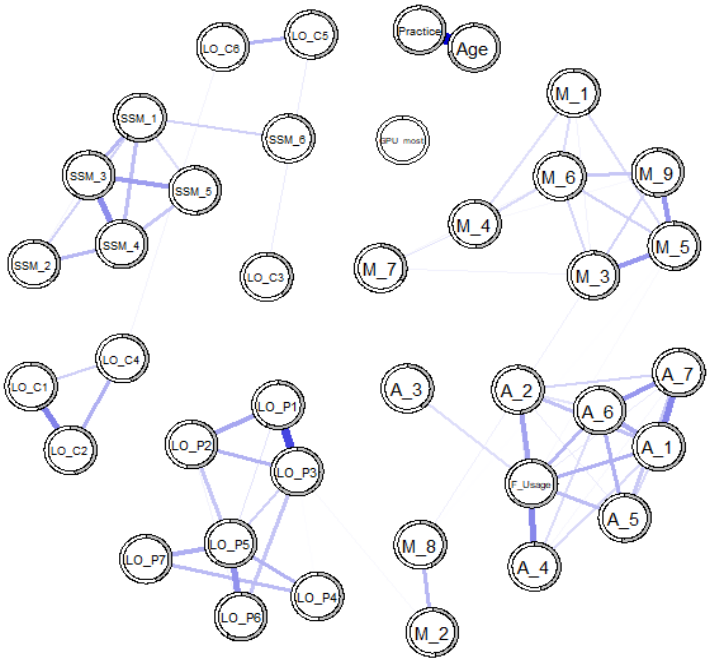

Figure 7. Network Depicting the Relations between ETGSPS Items at Secondary Education when Additionally Adjusting for Frequency of Use

Note. Figures 6 & 7 represent networks for lower-secondary (Fig. 6) and secondary (Fig. 7) education of ETGSPS items and end-of-term grade point average when adjusting for Teachers' age and English teaching practice and additionally for frequency of use. Thicker edges represent stronger associations, while thin edges reflect weak associations. Blue edges reflect positive associations. Rings around the circles refer to node predictability. A higher degree of gray color inside these circles reflects higher node predictability, A = Applicability subscale, M = Motivation subscale, LO_C = Learning outcomes of competence subscale, LO_P = Learning outcomes of performance subscale, GPU = general point average in a class where gamification is used the most, Age = Teachers' age, Practice = Length of English teaching practice, F_Usage = Frequency of use, SSM = institutional support.

For a detailed bootstrapping procedure summary of individual network estimates, including edge weights and confidence intervals, see Supplementary material 13. See Supplementary material 14 for individual total score-level and item-level networks.

Discussion

The study aimed to examine the influence of individual teacher-related factors such as age, frequency, and duration of gamification application use, length of English teaching practice, and school support for gamification on English teachers' perceptions of gamification in relation to its effectiveness on learners' motivation, learning outcomes, and their association to end-of-term GPAs. Furthermore, the study aimed to assess how these factors impact teachers' satisfaction with gamification applications and how often they use them. The study found no association between the perceived effectiveness of gamification on language learning outcomes and end-of-term GPAs at both total score and item levels. While competence and performance subscales showed a significant relation in total score-level network analyses, no relation was found between competence and performance subscale items in item-level analyses. Furthermore, the results revealed moderate to significant differences in how frequency of use, teachers' age, and length of English teaching practice impact the perceived effectiveness of gamification at lower secondary and secondary education levels. When controlling for frequency of use, the negative impact on item and total score relations is moderately higher for lower-secondary education than for secondary education. On the other hand, teachers' age and English teaching practice significantly influence the relations between items in secondary education, but only marginally in lower-secondary education. However, no significant impact on item relations was observed when controlling for any supportive measures or other teacher-related factors.

The study found no relation between gamification learning outcomes and end-of-term grade point averages in classes where gamification is used the most and longest. Furthermore, no relation was detected even after accounting for school support measures and other teacher-related factors. Nevertheless, this finding does not fundamentally oppose the conclusions drawn in other English teacher-centered studies, including some of the recent systematic reviews (Degirmenci, 2021; Helvich et al., 2023; Lester et al., 2023; Lim & Yunus, 2021). Despite the existing body of research examining the effectiveness of gamification on language learning outcomes, none of them investigated how language skill acquisition correlates with long-term objective metrics such as end-

of-term GPAs. This indicates that while gamification strategies may positively influence certain aspects of learners' language competence, as suggested by our findings, the effects might not be as significant in the long-term to be reflected in end-of-term GPAs, despite being perceived by English teachers as significant at one point in time. This might also indicate that shorter-term GPAs might show a stronger association with gamification language learning outcomes. Alternatively, the ETGSPS was originally developed to assess the perceived capabilities of gamification applications to influence various aspects of learners' language skills and motivation, not how exactly intensively impactful English teachers perceive them to be (Helvich et al., 2024). This fundamentally nuanced difference in how the scale was originally formulated might have also influenced our findings. Additionally, other factors, such as learner demographics and other contextual variables that were not controlled for in the present study, might have a significant impact on the observed outcomes.

Although competence and performance subscales showed a significant relation in total score-level network analyses, no such relation was found between the subscales' items in item-level analyses even before controlling for any factors. This applies to both lower secondary and secondary education levels. However, this relation becomes insignificant at the total score-level when controlling for other factors, particularly frequency of use, teachers' age, and English teaching practice. One possible explanation for the resulting discrepancy lies in the disposition inherent to the network estimation process, which automatically adjusts for all existing effects, whether they are robust or subtle, of surrounding nodes (Epskamp & Fried, 2018). In the context of item-level analysis, the network accounts not only for the direct effects of surrounding items within a subscale but also for the potential impacting effect of items across different subscales when estimating the relations between two nodes. Consequently, even if the impact of individual nodes on a particular relationship is minimal, the cumulative effect of numerous surrounding nodes could make the relationship appear insignificant in the estimated network. Moreover, the conservative γ value of 0.5 utilized in the analysis to reduce estimation errors, coupled with the chosen network estimation method, tends to diminish very weak relationships closer to zero, further contributing to the insignificance observed in item-level analyses (Isvoranu & Epskamp, 2023; Liu et al., 2021). Conversely, in total score-level network estimation, the network controls for the effects of other total score nodes, overlooking the dynamics among subscale items that are not present. Nevertheless, this finding also underscores the existing mutual interplay in individual item relations, presenting a potential for future research to examine the impact of surrounding gamification variables in an estimated network.

The results indicate a moderate difference between lower secondary and secondary education concerning how the frequency of use impacts the relations between individual subscales and subscale items. This difference was also observed in both total score-level as well as item-level analyses. Specifically, a higher negative impact was observed on subscale relations in lower secondary compared to secondary education when controlling for frequency of use. This discrepancy might be related to the significant variations in required teaching methodologies and curriculum emphasis between lower secondary and secondary education. Lower secondary education often focuses on building foundational language knowledge and skills, whereas secondary education tends to expand on the skills acquired in previous stages of education and focus on more sophisticated language skills connected to critical thinking and specialized subjects where alternative approaches might be more effective (Chen, 2014; DeKeyser, 2007; Denham & Lobeck, 2010). As a result, the frequency of use may have a more

pronounced effect in lower secondary education, where young language learners may rely heavily on repetition and practice to reinforce their understanding of language concepts (DeKeyser, 2007). Another possible reason might be the longevity of gamification effectiveness, as in lower-secondary education, the negative effect of diminishing effectiveness of gamification activities stemming from frequent usage might not be as prominent compared to secondary education, where a larger variety of teaching methods is required to maintain consistent language acquisition and classroom engagement (Tragant & Victori, 2012). This might be affected by other related factors, such as the difference in cognitive maturity, classroom dynamics, and learning strategies which typically vary at different stages of education (DeKeyser, 2007; Sepasdar & Soori, 2014; Zakaria et al., 2018). Language learners in lower-secondary education may exhibit greater susceptibility to peer influence and classroom dynamics (Butler & Liu, 2019; Steinberg & Monahan, 2007), which in turn underscores the need to use gamification activities more frequently to maintain more consistent engagement with educational materials. In contrast, learners in secondary education may demonstrate more autonomy and self-regulation in their learning behaviors (Duchatelet & Donche, 2019; Martinek et al., 2016), thereby influencing the impact of frequent usage of gamification applications.

A significant difference was detected between lower secondary and secondary education regarding the influence of teachers' age and English teaching practice on the relations between individual subscales and subscale items. This distinction was also detected in both total score-level as well as item-level analyses. Specifically, a significantly higher negative impact was observed on subscale relations in secondary compared to lower secondary education when controlling for teachers' age and English teaching practice. One of the explanations for the resulting discrepancy between education levels may lie in the inherent higher academic demands and cognitive complexities that are specific to secondary education. As language learners progress along the educational continuum, they encounter more advanced language concepts and skills that require different methodological approaches and higher expertise, which are tied to educators' overall teaching practice, and in proxy with teachers' age as well (Graham et al., 2017; Magogwe & Oliver, 2007; Pufahl & Rhodes, 2011). In addition, improvements are typically less rapid and not as easily observable compared to lower-secondary (Hartshorne et al., 2018; Muñoz, 2006) due to the longer duration required for mastering more complex skills, higher teaching expertise is often needed to discern the effect of certain teaching methods (Pufahl & Rhodes, 2011). Furthermore, secondary school teachers often need to utilize different and more sophisticated strategies to keep their learners motivated during the lessons. In general, learners at lower levels of education are motivated more easily and are more expressive, whereas assessing the level of motivation among secondary school learners may require higher teaching expertise often specific to secondary education (Hunt et al., 2008; Muñoz, 2006). Moreover, with the escalating language demands, gamification applications may no longer suffice for practicing some of the more demanding language skills and thus may require higher teaching experience to utilize these activities effectively. Altogether, due to the higher linguistic demands inherent to secondary education, higher teaching practice is required to utilize gamification applications effectively and observe how they impact learners' motivation and language learning outcomes.

However, when controlling for school support measures and other teacher-related factors, i.e., length of use, at total score-level and item-level analyses, no significant effect was observed across both lower secondary and

secondary education levels. Nevertheless, while the item and total score relations remained unaffected under this controlled factor framework, significant associations were detected in both score-level and item-level networks between frequency of use, applicability, and other subscales, particularly between learners' motivation and linguistic competence. This multi-encompassing combination of findings paints a crucial distinction, suggesting that the perceived effectiveness and use of gamification are not solely contingent upon institutional support but rather upon the intrinsic qualities of the gamification applications themselves and teachers' overall satisfaction with their applicability in English classes. This rationale aligns closely with the principles outlined in the Technology Acceptance Model (TAM) developed by Davis (1985), which posits a direct relationship between perceived usefulness, ease of use, and attitude, which collectively influence actual system use. Therefore, the responsibility falls not only on school administrators but mainly on developers to optimize their applications to meet the needs and preferences of educators. In addition, supportive strategies such as funding or professional development and training to facilitate the implementation of gamification may not yield the desired effect if the gamification application does not align with teachers' needs and preferences. Furthermore, our findings underscore the central role of teachers as mediators in shaping the effectiveness of gamification in their classrooms.

Conclusion

The objective of this study was to investigate the impact of various teacher-related factors on English teachers' perceptions of gamification. These factors included age, frequency, and duration of gamification application use, length of English teaching practice, and the level of school support for gamification. The study aimed to analyze how these teacher-related variables influenced perceptions regarding the effectiveness of gamification on learners' motivation, learning outcomes, and their correlation with end-of-term grade point averages. Additionally, the research aimed to assess the influence of these factors on teachers' satisfaction with gamification applications, along with their usage frequency. The study found no relation between the perceived effectiveness of gamification on learning outcomes and end-of-term GPAs at both total score and item levels. Although a significant relationship was found between competence and performance subscales in total score-level network analyses, no such relationship was found between competence and performance subscale items in item-level analyses. Additionally, moderate differences were identified in how the frequency of use, teachers' age, and English teaching practice length impact the perceived effectiveness of gamification in lower secondary and secondary education levels. Controlling for frequency of use revealed a significantly higher negative impact on item and total score relations in lower-secondary education compared to secondary education. On the other hand, teachers' age and English teaching practice significantly influenced item relations in secondary education but had only a marginal impact in lower-secondary education. Nevertheless, no significant impact on item relations was observed when controlling for any supportive measure or other teacher-related factors.

Recommendations

Recommendations for Research

Based on our findings, future research should encompass three key areas. Firstly, future studies should analyze other potential moderating factors impacting the effectiveness of gamification in the English teaching context,

such as prior digital experience, overall digital competence, the introduction of new technologies in educational settings, and the impact of innovative teaching methods traditionally combined with gamification. This would provide a more comprehensive understanding of factors that either hinder or enhance the effectiveness of gamification. Additionally, longitudinal studies are needed to track how the degree of influence of these moderating factors evolves over time and to understand the changes in teachers' perceptions of gamification effectiveness. Lastly, future research needs to verify the replicability of our findings in diverse socio-demographic contexts and compare outcomes across various subjects. Future studies should also compare how the perceptions of teachers differ from those of learners.

Recommendations for Practice

In practical terms, educators should be mindful of how specific factors can impact not only the observed outcomes associated with gamification but also influence their perceptions and decision-making. Recognizing the impact of these factors enables teachers to customize their gamification strategies, in turn improving their teaching performance. Moreover, school administrators should use the data to make informed decisions, fostering the adoption of gamification strategies in their institutions. Consequently, this may create a more effective learning environment that considers the needs of both teachers and learners, making more accurate adjustments based on the presence and degree of moderating factors. Finally, developers can benefit from these findings to enhance their applications by taking advantage of some of these factors, thus improving the overall design and functionality of their applications.

Limitations

However, this study is not without its limitations. The primary concern is the cross-sectional design, which prevents the derivation of causal conclusions. Another significant limitation pertains to potential information bias, as the data heavily relies on questionnaires and self-reports, susceptible to underlying factors like teachers' mood, recency biases, or preconstructed biases towards gamification. A third limitation is the limited sample sizes of bifurcated datasets that were used for the analyses; thus, subsequent studies with larger samples are needed to confirm the conclusions.

Notes

All supplementary materials, study code and other research data have been made publicly available on the Open Science Framework website: https://osf.io/aqbdh/

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