Research Article

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Investigating the effect of a game-based learning application on students' grammar learning in a Singapore university

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ABSTRACT

Good grammar is essential for university students to communicate effectively; however, students often find learning and applying grammar rules boring and challenging. This study aims to investigate the effect of game-based learning to support undergraduate students' grammar learning in a Singapore university. This study involved two hundred and twenty students who played a web-based grammar game application from January to April 2024. The researchers found a significant correlation between the highest level achieved in the game and the grammar test. This suggests that the more effort the students put into playing the game to attain higher levels, the more likely their English grammar will improve. Our findings support using a grammar game-based learning, which is situated in a business context, to facilitate students' learning of grammar in context. As grammar is an important aspect of good writing, it is hoped that students can develop good grammar to support their writing assignments. The implications of how educational technologies can be utilized in writing classes, along with practical ideas for implementing a game-based app to support students' grammar learning, will be proposed.

Keywords: educational technology, higher education, game-based application, grammar

INTRODUCTION

The prevalence of educational technologies worldwide has influenced teaching and learning in tertiary institutions. UNESCO (2023) reported that digital technology has resulted in changes to education and learning, especially in higher education. Increasingly, educational institutions had placed more emphasis on technology to increase learning interest and motivation (Castillo-Cuesta, 2020). Types of technologies, which were mentioned in systematic review papers from 2009 to 2018, included online games, mobile games, blended learning and virtual reality (Lai & Bower, 2020; Pérez-Sanagustín et al., 2017).

Good grammar is one of the essential skills necessary for English language mastery and effective communication. University students, in particular, should facilitate communication orally and in written form in professional contexts (Rossiter, 2021). Conversely, if university students' grasp of grammar is weak, their ability to communicate effectively with academic and professional audiences in a variety of communicative situations can be impeded. Scholars and educators had acknowledged that good grammar training could improve one's language skills and communication skills (Cook, 2016). Hence, having a good knowledge of grammar can facilitate effective communication. However, grammar learning could pose challenges for students due to the rules they encounter and the difficulty in teaching grammar by teachers (Cook, 2016; Ellis, 2006).

Researchers had investigated ways to enhance grammar learning in university students by understanding the challenges faced by learners (Halim et al., 2021; Zabolotskikh et al., 2021). One way to support students' grammar learning is to tap into education technology, such as game-based learning. Increasingly, game-based learning has been used in different contexts to enhance students' learning, such as developing students' 21st century skills (Boyle et al., 2014) and increasing engagement and motivation (Glover, 2013; Pesare et al., 2016). In English language learning, studies had proven that game-based learning has the potential to enhance students' English language learning (Chen, 2023; Mulder et al., 2021) and, more specifically, grammar (Mulder et al., 2021; Purgina et al., 2020). Few research studies on game-based learning have focused on learning grammar in context, apart from Lin et al.'s (2020) study.

Recognizing that game-based learning had been useful in promoting learning experience and developing students' skill acquisition and training for all ages across various fields, the first researcher in this study and a team developed a grammar application, which was launched in August 2024 for students. The team consisting of three lecturers from the English Communication Center, together with a manager from the Teaching Centre and an external vendor, earlier developed this in-house grammar application from February 2022 to September 2023 based on game-based elements. The team was motivated to create and use the application to complement students' learning as a blended learning tool, which is aligned with the university's recommendation to develop students' self-directed learning at their own pace and improve their learning outcomes. Furthermore, learners were given the flexibility to learn during out-of-class time and to decide the play duration and how much of the game they want to play (e.g., in terms of the game levels). With the funding received from the university's Technology-Enhanced Learning grant, the team worked on creating the application that possessed game elements (e.g., levels, rules and leaderboard) to harness the benefits of game-based learning, which included enhanced motivation and increased cognitive development (Adipat et al., 2021; Krath et al., 2021; Plass et al., 2015).

Given that few studies focused on applications that teach grammar in context, our study hopes to fill this gap by providing and assessing the effectiveness of a contextualized game-based learning application in supporting undergraduate students from a writing course in attaining higher grammar test scores. Furthermore, as teachers' pedagogical beliefs are closely linked to technology use (Richardson, 1996; Tondeur et al., 2008), recommendations (content scaffolding and technical assistance during the game-play stage and debrief sessions to connect the game play to learning outcomes at the post-game play stage) will be proposed on how teachers can integrate applications into teaching and learning (Bado, 2022).

LITERATURE REVIEW

Grammar Learning

Bo et al. (2023) and Harmer (2007) contended the importance of grammar in language courses, where grammar serves as a language's framework to provide the necessary structure and rules to convey meaning accurately. With the mastery of grammar, students are well-equipped to communicate orally and in written form in professional workplaces (Rossiter, 2021). These oral and written forms include team meetings and presentations, proposal writing, minute-taking and email writing. The inability to master these oral and written forms could put an individual at a disadvantage because of their incoherent speech and poor grammar, respectively (Rossiter, 2021).

The term grammar was polysemic because of the different meanings it conveyed (Lance, 1977). Larsen-Freeman (2009, p. 518) showed the different meanings by giving examples: prescriptive grammar is "a set of prescriptions and proscriptions about language forms and their use for a particular language"; descriptive grammar which is "a description of language behavior by proficient users of a language" and pedagogical grammar which uses "the structures and rules compiled for instructional and assessment purposes". Modern linguists argued that teaching contextualized grammar, which took a descriptive view of grammar, could be a solution to developing better writing instead of traditional ways of teaching grammar, which adopted a prescriptive view of grammar. Teaching grammar in a contextualized way meant grammar "is taught with the particular writing context in mind, [and] it will help the learners have a better understanding of language, leading to improved writing" (Chatterjee & Halder, 2022, p. 972). According to Chatterjee and Halder (2022, p. 972), learning grammar in a contextualized way arose to overcome learning grammar in isolation, where learners are usually given isolated sentences involving "repletion, manipulation, and grammatical transformation". As a result of this way of learning, students' grammar knowledge was not transferred to their writing, as seen in many grammar instruction studies and reviews from the 1980s to the early 2000s (Andrews et al., 2004; Hillocks, 1986; Wyse, 2001). Traditional grammar instruction normally involved drilling and grilling rules which involved teaching irregular verbs, verb tenses, sentence structures, and word order without putting them in a practical context; it is unsurprising that learners would find grammar learning challenging (Chatterjee & Halder, 2022; Richards & Reppen, 2014). In contrast, learning grammar in context enabled learners to connect grammar to writing. The benefits of contextualized grammar instruction were reported by Jones et al.'s (2013) mixed study, where students in the intervention group received positive writing performance. To overcome these challenges, researchers (Halliday, 1993; Myhill et al., 2020; Schleppegrell, 2007) had put forth a contextualized grammar teaching approach to support students' writing by ensuring a direct connection between the "grammar under focus and the learning focus for the writing" (Jones et al., 2013, p. 1243). When grammar was taught with the writing context in mind, the outcomes enable learners to better understand writing and, in turn, improve their writing (Chatterjee & Halder, 2022).

Within the scope of education, English teachers should be familiar with the term pedagogical grammar, which would impact how teachers would perceive grammar (e.g., prescriptive and descriptive) and influence the approaches (e.g., present, practice, and produce or commonly known as PPP, explicit grammar teaching or implicit grammar teaching) which would be implemented in their classrooms (Chatterjee & Halder, 2022).

Game-Based Learning

The utilization of game-based learning had become increasingly popular across various domains, including workplace training (Passalacqua et al., 2020) and education (Martín-Hernández et al., 2021). Game-based learning involved incorporating elements from gaming principles into real-life settings with the purpose to educate rather than to entertain (Camacho-Sánchez et al., 2022; Krath et al., 2021). These principles often involved the use of points, badges, leader boards and feedback loops to effect positive cognitive outcomes such as critical thinking (Qian & Clark, 2016),

engagement (Plass et al., 2015), and academic outcomes (Yu et al., 2020).

Game-based learning offered advantages in terms of acquiring knowledge and skills (Qian & Clark, 2016), improving learners' motivation and self-efficacy, which referred to the belief in achieving their goals across diverse disciplines (Bandura, 1982). Recent technological advancements facilitated the development and deployment of educational computer games for students at various academic levels and in different fields. For example, Chen (2023) investigated the motivation of Taiwanese undergraduate students using a digital game-based application to learn English-to-Chinese translation. The findings revealed that the students had positive attitudes towards the application because it supported their learning experiences. When students felt supported in their learning, they were motivated to learn further (Dörnyei, 2001). Another research on game-based learning for manufacturing education showed that students' learning and motivation improved (Perini et al., 2018). The authors added that the application was useful to complement teachers' teaching by providing a supporting activity to frontal lecturing; hence, students' learning could be made more engaging. Both studies demonstrated the versatility and efficacy of game-based learning in their fields to enhance students' learning outcomes and engagement.

Specifically, in English language learning, games had been created to facilitate the acquisition of different skills (e.g., reading, writing, speaking, listening, grammar and vocabulary). These include games that mainly support writing development (Hwang et al., 2023), translation practice (Chen, 2023), vocabulary performance (Yang et al., 2022) and grammar (Lin et al., 2020; Mulder et al., 2021; Purgina et al., 2020). Reynolds and Kao's (2019) study of 45 Taiwanese university students found that targeted language errors, when accompanied by instruction (from teachers or digital games), were more effective in assisting learners to gain grammatical accuracy of English articles than learners who did not receive instruction. Additionally, the "just-in-time grammar feedback provided during game play afforded learners with opportunities to engage in awareness-raising language related episodes" (Reynolds & Kao, 2019, p. 1) was a significant factor in the program's success. Lin et al.'s (2020) study was one of the few that examined a contextualized grammar game-based learning system together with learning activities like task-based learning or direct instruction. More particularly, they reported how contextual learning through a game has benefitted students' grammar learning, evident in the decreased context error rates for grammar. As few studies are found at the nexus of contextualized grammar learning and game-based grammar learning, our study hopes to fill this gap by investigating whether an application like Grammar Expert (pseudonym given) will impact grammar test scores among undergraduate students in a writing course.

CONTEXT OF STUDY

The study's context was situated in a first-year writing course during the university's academic semester from January to April 2024. The student cohort consisted of approximately

Figure 1. Grammar Expert interface (Source: Second author)

900 students in a business management university, and they were mainly English as first language learners. This writing course had been developed based on constructivist theory which underscored using a Problem-Based Learning approach to teach students.

The course syllabus focused on developing writing and thinking skills, and students had to exhibit their grammar and language skills through their writing. Students were also tested on grammar items in a grammar test, which made up for students to use 10% of the course score. The grammar quiz was a multiple-choice test administered on the university's e-learning system. The test consisted of 30 questions and was conducted in class with a lockdown browser and the teacher as an invigilator. To discourage cheating, each student was randomly assigned both the questions and the question options. Further support for the students' grammar learning was available as they could access the e-learning system for online blended learning resources and a mock grammar quiz at their own time. The mock grammar quiz was similar to the grammar quiz as it provided the students with an idea of the types of questions that would appear in the actual grammar quiz. Lessons were conducted over two sessions of one and a half hours each, across twelve weeks. As the instructors must go through about eight problems and three assignments in the twelve weeks, they had limited time to go through grammar skills in class. A problem in the course was defined as a writing scenario that was given to the students to solve, e.g., writing an email to a targeted audience to fulfil a purpose.

The Grammar Expert application was launched in the previous semester (August to November 2023) for students to use after receiving the university's technology-enhanced learning grant. The application, contextualized in the office environment, includes features such as achievements, hints and a leaderboard. **Figure 1** shows an image of the game interface, which was set in an office environment.

Students had to complete a diagnostic test before they could proceed to play the rest of the eight levels of the game. The eight levels included junior and senior intern, junior and senior management trainee, junior and senior middle management and junior and senior director. The diagnostic test in the Grammar Expert application consisted of 30 sentence-correction questions related to grammar categories such as subject-verb agreement, article, punctuation, preposition and verb tense. Players would obtain a score between 0 to 100% after they played the ten-minute diagnostic test. The primary objective of the diagnostic test was to assess
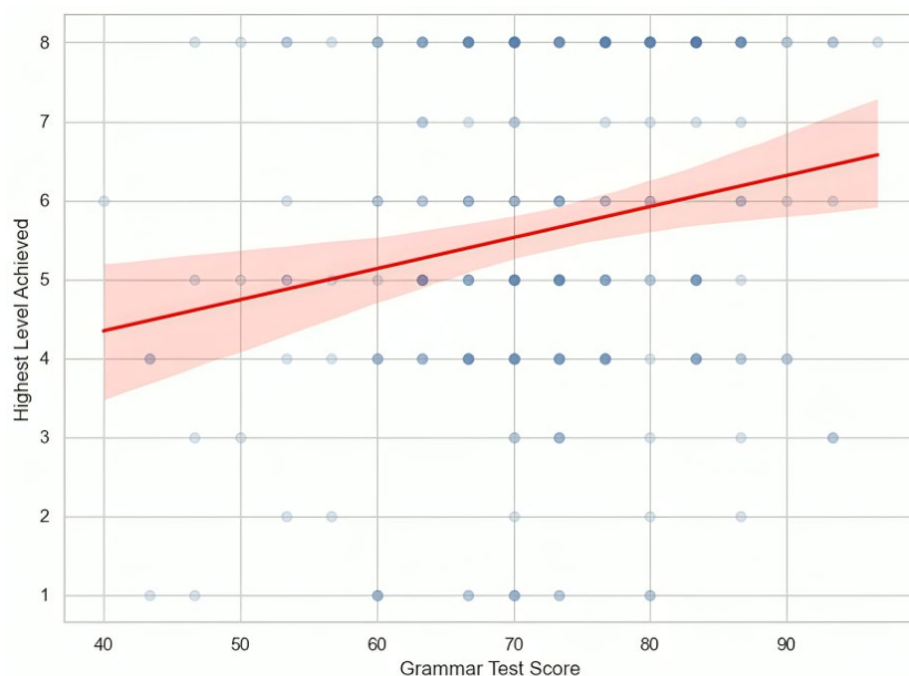
Figure 2. Correlation between grammar test scores and the highest levels achieved (Source: Authors)

the students' grammar proficiency before the game would assign them to either level 1 (junior intern) or level 2 (senior intern) to start playing.

The research team publicized the study to 32 classes and recruited 231 first-year students from the writing module to participate in the study after obtaining approval from the university's Institutional Review Board. Each class had a member of the research team explain and invite the students to participate in the study. The students volunteered to join the study by indicating their interest through a survey link. Students who chose to take part in the study were informed that participation in the research was entirely voluntary and were assured that their involvement would not affect their grades. To protect the students' confidentiality, the class instructors were unaware of the students who were involved in the research project, as they were requested to step out of class before the researchers spoke with the students. Students who were taught by the research team were not invited to join the study to avoid being coerced into joining the study.

During the recruitment, students were informed of the study's purpose and the information that would be collected from them, e.g., diagnostic test scores from Grammar Expert, the highest level attained in Grammar Expert and the grammar test scores. If any student chose to withdraw from the study, he/she would not be penalized in any way. Additionally, the students were informed that their involvement would not affect their grades as their instructors were unaware of their participation. To protect participants' anonymity, once all relevant data from participants' diagnostic test scores, game levels and the grammar quiz scores had been collected, the research team immediately replaced all identifying information with anonymous labels, such as student 001, before storing and analyzing the data.

Out of the two hundred and thirty-one students who initially participated in the study, two students completed the diagnostic test but did not continue playing the game to reach the levels, and nine students did not participate in the diagnostic test at all. After excluding these eleven students from the analysis, the final sample consisted of two hundred and twenty students who completed the diagnostic test, played at least one level in Grammar Expert, and took the grammar test.

METHODOLOGY

A correlational design was adopted for this study. The research team focused on the following data points for their analysis and tried to assess the correlation between the two variables:

- The highest level achieved in Grammar Expert
- The grammar test scores

The highest level achieved in Grammar Expert referred to the highest level a participant had played in the game. All the students on the writing course were encouraged to complete at least level four (senior management trainee level), and they had the option to play up to the highest level.

To assess the correlation between the two variables, we initially employed the Pearson's correlation coefficient, which is a statistical measure that assesses the strength and direction of a linear relationship between two continuous variables (Benesty et al., 2009). However, preliminary checks indicated that the data were not suitable for Pearson's correlation since the assumptions for a Pearson's relationship were not met. When we employed the Shapiro-Wilk test (Shapiro & Wilk, 1965), the findings showed significant deviations from normality for both variables, and the scatter plot (**Figure 2**) revealed a non-linear pattern with visible outliers. As a result, Spearman's rank-order correlation (Zar, 2010) was used. The formula for Spearman's rank-order correlation is $\rho = 1 - \frac{6 \sum d_i^2}{n(n^2-1)}$, ρ is the Spearman's rank correlation coefficient, d_i is

Table 1. Descriptive statistics of the two variables

Variable	N	Mean	Standard deviation	Minimum	Maximum
Grammar test score	220	72	11	40	96.67
Grammar Expert	220	5.60	2.15	1	8

the difference between the two ranks of each observation and n is the number of observations.

Table 1 shows the descriptive statistics that were calculated for the student grammar test score and Grammar Expert. The mean student grammar test score was 72 (standard deviation [SD] = 11), with scores ranging from 40 to 96.67. Grammar Expert had a mean of 5.6 (SD = 2.15), with a range of 1 to 8.

FINDINGS

The significance level α was set at 0.05 to determine if the observed correlations were statistically significant. The Spearman's rank-order correlation analysis demonstrated a significant correlation (ρ = 0.18, p =0.007, 95% confidence interval [0.05, 0.31]) between the highest level achieved in Grammar Expert and the grammar test score. This suggested a weak but meaningful monotonic relationship between the two variables. This finding indicated that Grammar Expert was effective, as there was a positive relationship between the students' progress in the game and their grammar test scores. Notably, students who invested more effort in advancing through the game's levels tended to achieve higher scores on the grammar test.

It is worth mentioning that as the game's levels increased, the questions generally became more challenging. Therefore, the positive correlation observed suggested that the higher level a student played, the higher the student's English language proficiency.

We noted that although the effect size of 0.18 was small, it showed a weak positive relationship between the two variables –Grammar test score and Grammar Expert. In the field of education, it is common to find small correlations (Cheung & Slavin, 2016; Evans & Yuen, 2022) because learning could be influenced by many different factors, such as prior knowledge, motivation and socio-economic background (Tobler, 2024). As a result, while the correlation value of 0.18 was not strong, it was valid, especially when the result was statistically significant.

Although the analysis revealed a statistically significant correlation between Grammar test score and Grammar Expert, it is important to consider potential limitations which could have influenced the results. As mentioned, the students' prior grammar ability, the amount of learning time spent by the students, and intrinsic student motivation could affect academic performance independently or interact with the variables that were studied. These factors were not controlled in the current analysis, which could have limited the causal relationships. Future research should include these variables to better understand their impact and to clarify the complex interplay between motivation, prior knowledge, and learning outcomes.

DISCUSSION

The findings demonstrated that the grammar application had the potential to support grammar learning in university students. Educational technology, such as online applications, promotes students' independent learning by offering them the flexibility of learning at their own pace and at their preferred time. For students to improve in their language learning, Nation (2013) stressed the need to practice and apply language use to improve learning. More specifically, students benefited from game-based learning by being able to apply the targeted language context in one context to another context (Reynold & Kao, 2019).

This study's findings have provided some practical recommendations on how grammar applications can be used to support students' learning. Firstly, the curriculum team can refine the writing curriculum to integrate multiple online resources (e.g., grammar application, online grammar resources, and mock grammar quizzes) at appropriate junctures during the 12-week writing course. Secondly, instructors can direct their students to these same online resources when giving grammar-related feedback on their assignments. In doing so, the students' learning experiences can be enhanced through the use of various resources from the internet and technology (Richards & Reppen, 2014). With autonomy to practice grammar in a relatively stress-free environment, students can benefit from this learning experience by determining the duration of their practice. At the same time, the instructors benefit as they would have more valuable class time for writing activities because the "location of grammar-focused instruction has shifted from the classroom to the multimedia-learning center" (Richards & Reppen, 2014, p. 22). Thirdly, instructors' professional development workshops can be hands-on avenues for instructors to familiarize themselves with the use of the grammar application and other online resources.

Furthermore, instructors should be exposed to game-based learning pedagogy that provides insights into how both pedagogical practices and games can be integrated into the classroom. Bado's (2022) review study of instructional activities implemented at each stage (i.e., pre-game, game and post-game) of the game-based learning process provides a clear and organized way for instructors. For instance, instructor development workshops can be conducted to introduce the rationale of these instructional activities and to view educational technologies as support and to scaffold learning rather than being the object of learning (Jonassen, 1991). Given that constructivism underscores our curriculum and teaching practices where knowledge is co-constructed with others (Vygotsky, 1978) in group discussions, instructors can use educational technology such as game applications, Kahoot quizzes, and online learning resources to enhance their learning (Churcher et al., 2014). For instance, game-based pedagogy can be applied by getting instructors to introduce

the purpose and overview of the game at the pre-game stage; to scaffold group activities for students to discuss the common grammar errors students faced in writing by getting students to refer to additional online resources, and finally, at the post-game stage, to reflect and share about their learning experiences, i.e., connections with grammar to their writing. As a result, because of the three stages, grammar learning for the students can be more systematic and well-supported.

CONCLUSION

This study investigated Grammar Expert's effectiveness in helping year 1 undergraduate students in a university's writing course attain higher grammar test scores. In the analysis, a significant correlation was observed between the highest level attained in the game and the grammar quiz score, indicating that increased effort spent on Grammar Expert has led to improvements in English grammar proficiency. These results demonstrated that Grammar Expert was a suitable tool for students to enhance their grammar skills. This, in turn, could improve their use of English in their daily communication tasks in a business setting.

The present study has several limitations. First, this study focused only on the application's impact on a grammar test score. A future study can focus on the application's impact on students' writing, which is measured based on summative assessments implemented in the course. Second, this study focused on the students' performance in terms of the highest level played; however, gathering qualitative player feedback on their experience could add more in-depth perspectives. To overcome this limitation, a concurrent qualitative study was carried out to provide in-depth insights into student user feedback.

Future studies can explore other variables, such as the daily time spent on the game, the time allocated for each question and the frequency of hint usage, which could impact students' grammar test scores. These variables can be drawn out with a potentially improved version of the Grammar Expert game-based application with added elements. Furthermore, future studies can focus on writing instructors' teaching practices by integrating grammar game-based applications and examining other factors such as grammar teaching approaches (e.g., teaching grammar in context) and blended learning considerations which include the IT resources, pedagogical and financial support from the management of institutions (Bokolo et al., 2022). As the current study is conducted with undergraduates, subsequent studies can focus on the effect of the application on postgraduate students.

The study adhered to established guidelines for data storage, data collection, and analysis to maintain confidentiality and anonymity where required. All data was stored in Singapore Management University's secure SharePoint, which was only accessible to the research team. For Figure 1 in this paper, The Head of the Department had given his consent for the image to be used in the article.

Declaration of interest: The authors declare that they have no competing interests.

Availability of data and materials: All data generated or analyzed during this study are available for sharing when appropriate request is directed to the corresponding author.

REFERENCES

Adipat, S., Laksana, K., Busayanon, K., Asawasowan, A., & Adipat, B. (2021). Engaging students in the learning process with game-based learning: The fundamental concepts. *International Journal of Technology in Education, 4*(3), 542-552. https://doi.org/10.46328/ijte.169

Andrews, R., Torgerson, C., Beverton, S., Locke, T., Low, G., Robinson, A., & Zhu, D. (2004). The effect of grammar teaching (syntax) in English on 5 to 16 year olds' accuracy and quality in written composition. *EPPI-Center.* https://eppi.ioe.ac.uk/cms/Portals/0/PDF%20reviews%20and%20summaries/eng_rv7.pdf?ver=2006-03-02-124853-077

Bado, N. (2022). Game-based learning pedagogy: A review of the literature. *Interactive Learning Environments, 30*(5), 936-948, https://doi.org/10.1080/10494820.2019.1683587

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*(2), 122-147. https://doi.org/10.1037/0003-066X.37.2.122

Benesty, J. C., Chen, J., Huang, Y., & Cohen I. (2009). Pearson correlation coefficient. In J. C. Benesty, & W. K. Erlangen (Eds.), *Noise reduction in speech processing* (pp. 1-4). Spinger. https://doi.org/10.1007/978-3-642-00296-0_5

Bo, W. V., Fu, M., & Lim, W. Y. (2023). Revisiting English language proficiency and its impact on the academic performance of domestic university students in Singapore. *Language Testing, 40*(1), 133-152. https://doi.org/10.1177/02655322211064629

Bokolo, A., Kamaludin, A., Romli, A., Raffei, A. F. M., Phon, D. N. A. L. E., Abdullah, A., & Ming, G. L. (2022). Blended learning adoption and implementation in higher education: A theoretical and systematic review. *Technology, Knowledge and Learning, 27*(2), 531-578. https://doi.org/10.1007/s10758-020-09477-z

Boyle, E. A., MacArthur, E. W., Connolly, T. M., Hainey, T., Manea, M., Kärki, A., & van Rosmalen, P. (2014). A narrative literature review of games, animations and simulations to teach research methods and statistics. *Computers and Education, 74*, 1-14. https://doi.org/10.1016/j.compedu.2014.01.004

Camacho-Sánchez, R., Rillo-Albert, A., & Lavega-Burgués, P. (2022). Gamified digital game-based learning as a pedagogical strategy: Student academic performance and motivation. *Applied Sciences, 12*(21), Article 11214. https://doi.org/10.3390/app122111214

Castillo-Cuesta, L. (2020). Using digital games for enhancing EFL grammar and vocabulary in higher education. *International Journal of Emerging Technologies in Learning, 15*(20), 116-129. https://doi.org/10.3991/ijet.v15i20.16159

Chatterjee, A., & Halder, S. (2022). Teaching grammar in the context of writing: A critical review. *Journal of Education, 203*(4), 971-983. https://doi.org/10.1177/00220574221074308

Chen, Y. (2023). Using a game-based translation learning app and google apps to enhance translation skills: Amplification and omission. *International Journal of Human-Computer Interaction, 39*(20), 3894-3908. https://doi.org/10.1080/10447318.2022.2108591

Cheung, A. C. K., & Slavin, R.E. (2016). How methodological features affect effect sizes in education. *Educational Researcher, 45*(5), 283-292. https://doi.org/10.3102/0013189x16656615

Churcher, K., Downs, E., & Tewksbury, D. (2014). "Friending" Vygotsky: A social constructivist pedagogy of knowledge building through classroom social media use. *Journal of Effective Teaching, 14*(1), 33-50.

Cook, V. (2016). *Second language learning and language teaching*. Routledge. https://doi.org/10.4324/9781315883113

Dörnyei, Z. (2001). *Teaching and researching motivation*. Pearson. https://doi.org/10.1075/hop.5.mot1

Ellis, R. (2006). Current issues in the teaching of grammar: An SLA perspective. *TESOL Quarterly, 40*(1), 83-107. https://doi.org/10.2307/40264512

Evans, D. K., & Yuan, F. (2022). How big are effect sizes in international education studies? *Educational Evaluation and Policy Analysis, 44*(3), 532-540. https://doi.org/10.3102/01623737221079646

Glover, I. (2013). Play as you learn: Gamification as a technique for motivating learners. In J. Herrington, A. Couros, & V. Irvine (Eds.), *Proceedings of the World Conference on Educational Multimedia, Hypermedia and Telecommunications 2013* (pp. 1999-2008). AACE.

Halim, T., Wahid, R., & Halim, S. (2021). Challenges of teaching and learning grammar in online classes at the tertiary level. *ELT Forum: Journal of English Language Teaching, 10*(3), 212-221. https://doi.org/10.15294/elt.v10i3.47970

Halliday, M. A. K. (1993). Towards a language-based theory of learning. *Linguistics and Education, 5*(2), 93-116. https://doi.org/10.1016/0898-5898(93)90026-7

Harmer, J. (2007). *The practice of English language teaching* (4th ed.). Pearson.

Hillocks, G. (1986). Research on written composition: New directions for teaching. In *Proceedings of the National Conference on Research in English*.

Hwang, W.-Y., Nurtantyana, R., Purba, S. W. D., Hariyanti, U., Indrihapsari, Y., & Surjono, H. D. (2023). AI and recognition technologies to facilitate English as foreign language writing for supporting personalization and contextualization in authentic contexts. *Journal of Educational Computing Research, 61*(5), 1008-1035. https://doi.org/10.1177/07356331221137253

Jonassen, D. H. (1991). Objectivism versus constructivism: Do we need a new philosophical paradigm? *Educational Technology Research and Development, 39*(3), 5-14. https://doi.org/10.1007/bf02296434

Jones, S., Myhill, D., & Bailey, T. (2013). Grammar for writing? An investigation of the effects of contextualised grammar teaching on students' writing. *Reading & Writing, 26*(8), 1241-1263. https://doi.org/10.1007/s11145-012-9416-1

Krath, J., Schürmann, L., & von Korflesch, H. F. O. (2021). Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. *Computers in Human Behavior, 125*, Article 106963. https://doi.org/10.1016/j.chb.2021.106963

Lai, J. W. M., & Bower, M. (2020). Evaluation of technology use in education: Findings from a critical analysis of systematic literature reviews. *Journal of Computer Assisted Learning, 36*(3), 241-259. https://doi.org/10.1111/jcal.12412

Lance, D. M. (1977). What is "grammar"? *English Education, 9*(1), 43-49. https://doi.org/10.58680/ee197719427

Larsen-Freeman, D. (2009). Teaching and testing grammar. In M. H. Long, & C. Doughty (Eds.), *The handbook of language teaching* (pp. 518-542). Blackwell Publishing Ltd. https://doi.org/10.1002/9781444315783.ch27

Lin, C.-J., Hwang, G.-J., Fu, Q.-K., & Cao, Y.-H. (2020). Facilitating EFL students' English grammar learning performance and behaviors: A contextual gaming approach. *Computers and Education, 152*, Article 103876. https://doi.org/10.1016/j.compedu.2020.103876

Martín-Hernández, P., Gil-Lacruz, M., Gil-Lacruz, A. I., Azkue-Beteta, J. L., Lira, E. M., & Cantarero, L. (2021). Fostering university students' engagement in teamwork and innovation behaviors through game-based learning (GBL). *Sustainability, 13*(24), Article 13573. https://doi.org/10.3390/su132413573

Mulder, E., van de Ven, M., Segers, E., Krepel, A., de Bree, E. H., van der Maas, H., de Jong, P. F., & Verhoeven, L. (2021). Serious game-based word-to-text integration intervention effects in English as a second language. *Contemporary Educational Psychology, 65*, Article 101972. https://doi.org/10.1016/j.cedpsych.2021.101972

Myhill, D., Newman, R., & Watson, A. (2020). Going meta: Dialogic talk in the writing classroom. *The Australian Journal of Language and Literacy, 43*(1), 5-16. https://doi.org/10.1007/BF03652040

Nation, I. S. P. (2013). *What should every EFL teacher know?* Compass Publishing.

Passalacqua, M., Léger, P.-M., Nacke, L. E., Fredette, M., Labonté-Lemoyne, É., Lin, X., Caprioli, T., & Sénécal, S. (2020). Playing in the backstore: Interface gamification increases warehousing workforce engagement. *Industrial Management + Data Systems, 120*(7), 1309-1330. https://doi.org/10.1108/IMDS-08-2019-0458

Pérez-Sanagustín, M., Nussbaum, M., Hilliger, I., Alario-Hoyos, C., Heller, R. S., Twining, P., & Tsai, C.-C. (2017). Research on ICT in K-12 schools–A review of experimental and survey-based studies in computers & education 2011 to 2015. *Computers and Education, 104*, A1-A15. https://doi.org/10.1016/j.compedu.2016.09.006

Perini, S., Luglietti, R., Margoudi, M., Oliveira, M., & Taisch, M. (2018). Learning and motivational effects of digital game-based learning (DGBL) for manufacturing education –The life cycle assessment (LCA) game. *Computers in Industry, 102*, 40-49. https://doi.org/10.1016/j.compind.2018.08.005

Pesare, E., Roselli, T., Corriero, N., & Rossano, V. (2016). Game-based learning and gamification to promote engagement and motivation in medical learning contexts. *Smart Learning Environments, 3*(1), Article 5. https://doi.org/10.1186/s40561-016-0028-0

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist, 50*(4), 258-283. https://doi.org/10.1080/00461520.2015.1122533

Purgina, M., Mozgovoy, M., & Blake, J. (2020). WordBricks: Mobile technology and visual grammar formalism for gamification of natural language grammar acquisition. *Journal of Educational Computing Research, 58*(1), 126-159. https://doi.org/10.1177/0735633119833010

Qian, M., & Clark, K. R. (2016). Game-based learning and 21st century skills: A review of recent research. *Computers in Human Behavior, 63*, 50-58. https://doi.org/10.1016/j.chb.2016.05.023

Reynolds, B. L., & Kao, C.-W. (2019). The effects of digital game-based instruction, teacher instruction, and direct focused written corrective feedback on the grammatical accuracy of English articles. *Computer Assisted Language Learning, 34*(4), 462-482. https://doi.org/10.1080/09588221.2019.1617747

Richards, J. C., & Reppen, R. (2014). Towards a pedagogy of grammar instruction. *RELC Journal, 45*(1), 5-25. https://doi.org/10.1177/0033688214522622

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula (Ed.), *Handbook of research on teacher education* (pp. 102-119). Macmillan.

Rossiter, A. (2021). The importance of grammar. *ERIC*. https://eric.ed.gov/?id=ED613321

Schleppegrell, M. J. (2007). The linguistic challenges of mathematics teaching and learning: A research review. *Reading & Writing Quarterly, 23*(2), 139-159. https://doi.org/10.1080/10573560601158461

Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika, 52*(3-4), 591-611. https://doi.org/10.1093/biomet/52.3-4.591

Tobler, S. (2024). Context matters: Interpreting effect sizes in education meaningfully. *MethodsX, 13*, Article 103023. https://doi.org/10.1016/j.mex.2024.103023

Tondeur, J., Hermans, R., van Braak, J., & Valcke, M. (2008). Exploring the link between teachers' educational belief profiles and different types of computer use in the classroom. *Computers in Human Behavior, 24*(6), 2541-2553. https://doi.org/10.1016/j.chb.2008.02.020

UNESCO (2023). Technology in education. *UNESCO*. https://www.unesco.org/gem-report/en/technology

Vygotsky, L. S. (1978). *Mind in society*. Harvard University Press.

Wyse, D. (2001). Grammar for writing? A critical review of empirical evidence. *British Journal of Educational Studies, 49*(4), 411-427. https://doi.org/10.1111/1467-8527.t01-1-00185

Yang, J. C., Chung, C., & Chen, M. (2022). Effects of performance goal orientations on learning performance and in-game performance in digital game-based learning. *Journal of Computer Assisted Learning, 38*(2), 422-439. https://doi.org/10.1111/jcal.12622

Yu, Z., Gao, M., & Wang, L. (2020). The effect of educational games on learning outcomes, student motivation, engagement and satisfaction. *Journal of Educational Computing Research, 59*(3), 522-546. https://doi.org/10.1177/0735633120969214

Zabolotskikh, A., Zabolotskikh, A., Dugina, T., & Tavberidze, D. (2021). Creating individual learning paths in the Moodle plugin for undergraduate students to study English grammar. *Education and Information Technologies, 26*(1), 617-637. https://doi.org/10.1007/s10639-020-10278-1

Zar, J. H. (2010). *Biostatistical analysis* (5th ed.). Prentice-Hall/Pearson.