Effects of Duolingo on Taiwanese 10th Graders Leanring English Grammar

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ABSTRACT

This qusi-experimental study aimed to investigate the effects of game-based instruction (GI) on 10th graders. In addition, the present study wanted to explore the relative impacts of GI on students' learning motivation and learning anxiety. The participants were 80 first-year senior high school students enrolled in a remedial program. One class (*n*= 40) was assigned to the experimental group who received game-based instruction, called Duolingo while the other (*n*= 40) to the control group who received traditional instruction, embedded with lecturing and note-taking. A grammar test, learning motivation, and learning anxiety questionnaires were administered before and after the treatment. The treatment lasted for eight weeks, which covered the grammar competences corresponding to GEPT elementary level. The results showed that both groups made improvements in their learning performance after the treatments. In addition, Duolingo had significant impact on enhancing GI group's learning motivation and lowering the learning anxiety. It was concluded that Duolingo could be an alternative when English was taught. In the end, pedagogical implications, limitations of the study, and suggestions for future research were provided.

Keywords: Duolingo**,** Game-based instruction, Learning motivation, Learning anxiety

1. Introduction

As the mobile devices continue to advance, smartphones have become ubiquitous and omnipotent (Lin, 2016). As a result, the utilization of digital learning games in educational environment has tremendously developed (Brick & Cervi-Wilson, 2019; Hense & Heinz, 2014), having the advent of game-based instruction recognized as a significant research field (Hung et al., 2018). Hitherto, several studies have been done, and they all contributed critical parts into several fields, including vocabulary learning (Chen, et al., 2019; DeHaan, et al., 2010; Lu, 2008; Zhou, 2016), listening comprehension (Liu, 2009; Liu & Chu, 2010; Rahimi &

Elham, 2015), reading comprehension (Jacovina, et al., 2016; Mioduser, et al, 2001; Mpofu, 2016) and grammar learning (Danowska-Florczyk & Piotr, 2012; Wichadee & Fasawang, 2018).

Nonetheless, the positive and consistent results yielded from the recent studies are to some extent restricted since a myriad of state-of-the-art mobile learning techniques are constantly springing out. Furthermore, despite the fact that the affordances of increasing learners' learning motivation and decreasing learners' learning anxiety have been reported, the relative effects deserve a close examination. Hence, the present study focused on one of the prevalent learning APP to investigate its fundamental effects.

2. Literature Review

2.1 Game-based instruction

In 2008, Terill firstly used the term "Gamification" in a blog post. He described the term as "taking game mechanics and apply them to other web properties to increase engagement." Nowadays, it has been widely recognized as game-based instruction, consisting of audiovisual features, animations, videos, and games that interactively stimulate learning processes (Chen, 2010). In this current day and age, games have occupied an important place in adolescents' lives (Hong et al., 2009); thus, game-based instruction has been reported to better encourage learners' engagement in the academic field (Hlodan, 2008; Tsai & Chen., 2008). Chen et al (2019) further supported that text and course contents are simplified and presented via simulations, which a sense of achievement can be fulfilled especially when levels in games are completed.

Liu et al. (2011) proposed that the learning motivation can be elicited by saturating in gamified learning experiences which contain challenges and feedback mechanisms. With iterative trial and error, imitation ensues after problem-solving techniques are prompted in the low anxiety learning environment. Accordingly, game-based instruction can serve as a powerful medium to enhance motivation, cognitive competence and creativity (Chen et al., 2019). In the same vein, Deterding et al (2011) perceived game-based instruction as "the use of game design elements in non-game contexts." To embed learning contexts in games, Lee and Hammer (2011) proposed that three influential areas in motivating players' engagement, including cognitive, emotional, and social areas, should be the focuses whenever game-based learning is implemented.

Specifically, in the cognitive area, an intricate system of rules along with series of tasks would be presented, and the players would be guided through a process to

master rules. In the learning process, players would be assured to know what to deal with the following tasks. Those tasks were designed to be a cycle, consisting of the repeatedly try-and-fail process to make sure the players acquire the necessary knowledge (Gee, 2003). In the emotional area, a close relationship with players' success and failure was found. With the help of award systems, immediate recognition of players' success was presented by awarding them with points or items on task completion; nonetheless, a little anxiety was hoped to be aroused because of low-level penalties to promote experimentation and task repetition when players fail (Csikszentmihalyi, 2008). According to Lee and Hoadley (2007), the designed nature of multiplayer interaction mechanisms had a great influence on players' social area. Those mechanisms make players engage in team works to achieve a goal by discussing, which triggers the meaningful interaction and help players build up the meaningful identities during the game worlds.

Based on the criteria proposed by Lee and Hammer (2011), one particular game-based learning APP – Duolingo, has prosperously expanded in recent years. According to Nushi and Mohamad (2017), Duolingo was perceived as an effective language application that can provide learners of different ages and cultures with practical and systematic steps to learn a new language on their own. Cook (2010) further supported that Duolingo promotes noticing and metalinguistic awareness and encourages peer-to-peer collaboration by using translation as pedagogical techniques. Statistically, Duolingo is the most popular category in the education field in Google Play. As a result, several studies have been done on its effectiveness.

2.2 Reviews of previous studies

In the Czech Republic, Jašková (2014) administered a questionnaire survey to discover the awareness and the effectiveness of Duolingo. The participants were 118 Czech people who already used it. The instrument was a self-designed questionnaire, consisted of fifteen questions. Among them, question item one to fourteen was designed as multiple choices questions; while the last one was an open ended question. The complete questionnaire was put online, and the data collection period was a month. The results were presented with percentage. According to the results of data analysis, only 33.9% of Czech people used electronic devices to learn foreign languages. Besides, only 4.2% of Czech people had heard of Duolingo. Moreover, only 20.3% of Czech people were persuaded to create accounts. In the end, the open-ended question revealed that there were flaws to be improved, including the inaccuracy of translation and the unauthentic sentences applied in this APP.

For another instance, conducted by Finardi, et al (2016), the study aimed to explore the possible effects of mobile assisted language learning (MALL) on second or foreign language learning. Duolingo was the focus of this study. Participants were 80 people in a Brazil university, including 45 L2 leaners, 25 MALL users, and 10

teachers. A mixed method was used to collect the data. For quantitative data, a total number of 45 L2 learners completed an online questionnaire used to reveal the participants' perceptions. For qualitative data, 25 MALL users answered the open-ended questions online; while, 10 L2 teachers were interviewed. Three major results were shown. First of all, 77.7% of participants still preferred to have face-to-face interactions with their teachers; while 8.3% participants chose the online learning. Secondly, most participants claimed that the effects of learning through Duolingo varied from person to person. Motivation, personal discipline, and dedication were the three major factors that greatly affected the learning effects through Duolingo. Thirdly, teachers revealed that Duolingo was effective in helping participants learn languages under the teachers' instructions and guidance. Most importantly, Duolingo was suggested to be utilized as a supporting tool not the only source to make learners acquire a foreign or second language. The conclusion was made that a hybrid approach was recommended in the teaching environment.

Still another, Rachels and Amanda (2018) conducted a quasi-experimental study to inspect the effects of Duolingo on third and fourth graders learning Spanish. The participants were students from a private school in South America, consisted of five third-grade classes and six fourth-grade classes. Specifically, a total number of 164 participants were included in the study; 79 were in the treatment group, and 88 were in the control group. The instrumentation included a self-designed Spanish achievement test served as pretest and posttest. Besides, a questionnaire was used to assess participants' perceptions of their confidence to do the class works. For the instructional packages, the experimental group received instructions with Duolingo and the teachers' guidance; while the control group received traditional instruction. After twelve weeks session, the results showed significant differences found within two groups; in other words, both groups made improvements due to different treatments provided in the experimental sessions. The result of the questionnaire indicated that Duolingo had positive effects building learners' confidence. The conclusion was made that Duolingo was suggested as an alternative teaching approach because it was equally effective.

Furthermore, Brick and Cervi-Wilson (2019) investigated the effectiveness of Duolingo on students' learning European languages. The participants were 182 students studying French, German, Spanish, and Italian at CEFR A1 level. The instrumentation included a virtual classroom set up in Duolingo School, and the students were expected to monitor their own learning processes outside the classroom. Besides, a total number of eleven tutors were recruited so as to analyze the collected data from the virtual classroom. Both quantitative and qualitative data were collected to explore the effectiveness of Duolingo. The result showed that 80% of the participants achieved the goal. In addition, most of the participants revealed positive attitude toward using Duolingo as a learning tool. Finally, the conclusion was made that Duolingo could be used most effectively as a supplementary language

learning tool to consolidate and deepen knowledge acquired in the classroom setting rather than as a sole source.

In Taiwan, Tsai (2016) investigated the effectiveness of Duolingo on promoting college students' learning autonomy. Both qualitative and quantitative tools were applied to collect the data. To collect quantitative data, a questionnaire with self-initiated and self-regulated questions was used. In addition, a semi-structured interview was designed to obtain in-depth information. The participants were ten college students of different ages using Duolingo to learn various kinds of foreign languages. The results showed that Duolingo regulated all the participants to learn languages on daily bases, and they found the answers to the questions themselves. In other words, the role of teacher's instruction was decreased. In addition, Duolingo's instant feedback and daily reminder were considered as the two most significant features to promote learners' learning autonomy. To conclude, Duolingo was effective in making learners maintain the familiarity with the target language, and the learning autonomy was promoted as well.

However, the studies reviewed above all shows limited results in the effect of game-based learning technique. In addition, the studies related to instructional effects of English grammar learning and specific attentions on grammar learning motivation and anxiety tend to be rare in Taiwan. Because effective methods to teach grammar are essential to be developed, game-based teaching is suggested to be especially effective when the instruction is combined with chances for interactive and communicative circumstances to galvanize their learning motivations and diminish their learning anxieties (Danaher et al., 2009). Hence, the relevant topic of the game-based instruction and English grammar deserves a further investigation.

2.3 Purpose of the study and research questions

This study aims to investigate the effects of game-based instruction (GI) on Senior High school students learning English grammar in eight-week treatments, which included two-hour lessons in every week. The current study attempts to answer the following questions:

1. What are the impacts of game-based instruction on students' English learning performances?
2. What are the effects of game-based instruction on students' learning motivation?
3. What are the effects of game-based instruction on students' learning anxiety?

3. Method

This current study, based on a qusi-experiment design, focused on the results of

remedial instruction administered to students who failed to meet the standard scores required for the English units. A pretest and a posttest were used to obtain data. Therefore, three pretests which included a grammar test and a motivation and an anxiety tests were administered to 80 participants, who were selected by nonrandom cluster sampling. The students were divided into a control group and an experimental group. Both groups received the different instruction but with the same learning content.

Students in the control group received traditional instruction about English grammar, such as explicit rule explanation, note-taking process, and error corrections. On the other hand, students in the experimental group received game-based instruction with the same learning content. In addition, two questionnaires were adopted to explore students' grammar learning motivation and anxiety.

3.1 Participants

Nonrandom cluster sampling was employed to select participants from first-year senior high school students in northern Taiwan. There were eighty students from two intact classes, including 24 male and 56 female students. The control group consisted of 14 males and 26 females while the experimental group included 10 males and 30 females. One of the classes was assigned to the game-based instruction (GI) group while the other to the control group. The participants had started learning English in elementary school and they had at least six years' experiences in learning English as a foreign language. In terms of their English proficiency level, they were all low-achievers because they all received C level in their English scores of Comprehensive Assessment Program for Junior High School Students. Besides, none of them ever participated and passed any sorts of English certificates.

3.2 An Instructional Package for Game-Based Teaching

An English grammar learning APP, Duolingo, was used as the instructional material for this group. In the very beginning, several set-up steps (see Figure 1) were needed to be done. The first step was to choose the learning mode, and the app would send notices to the participants to do the learning they needed to; while they chose to every day. There are four modes, including leisure (five minutes everyday), normal (ten minutes everyday), industrious (fifteen minutes everyday), and curve-wrecker (twenty minutes everyday) mode. To better control the study, all the participants in this group were asked to choose industrious mode. For the second step, the first learning lesson in the first topic will start up automatically. In this learning app, fifty-five topics related to English grammar are included. Within each topic, there are three lessons for the participants to learn. After finishing all the lessons in one topic, the participants can take a test. During the learning and testing sections, there are several kinds of tasks, including matching, translation, listening, dictation

and speaking needed to be completed. Examples were given below.

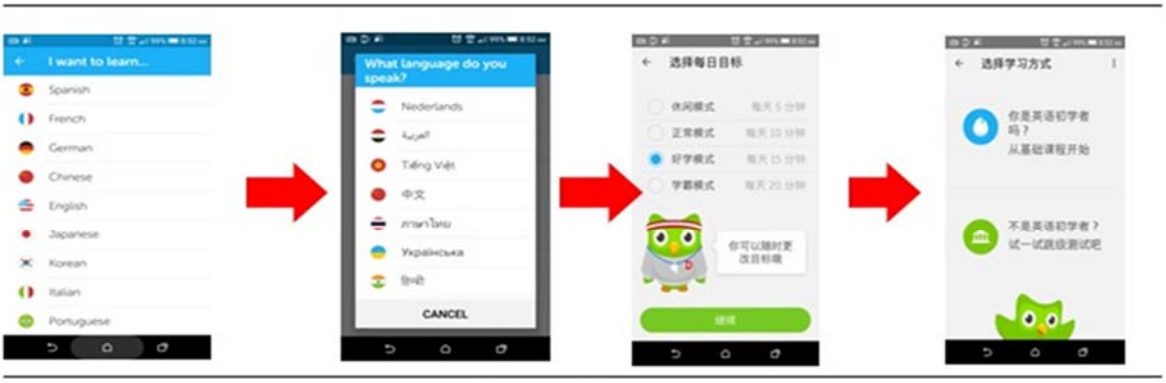

Figure 1

Setup Steps of Duolingo

The matching task, shown in Figure 2, requires the learners to select the correct English words corresponding to the Chinese words given on top of the screen. Every time the learners tap the options, and English words will be pronounced. As the learners decide to send out their answers after they select a desired option, all they have to do is to press "check" on the bottom of the screen. If the answers are correct, the correct buttons will show up, and then, the learners can go on to the next questions. To be specific, a sample was shown in Figure 3.

Figure 2 Choosing Task

Figure 3 Correct Answer

Take the simple present tense as an example, Figures 4, 5, and 6 present the sample tasks students in the GI group would encounter.

Figure 4 English to Chinese Translation

Figure 5 Chinese to English Translation

Figure 6 Dictation

Figure 7 presents a task that requires the learners to select the correct Chinese translation based on the English words or sentences given on the top of the screen. Every selected word can be removed and reconstructed if the learners want to change their answers. If the learners have decided their answers, they can press “check” to see whether they get this task right or not. If those answers are correct, they can move on to the next test item.

Figure 7 English to Chinese Translation

The dictation task (see Figure 8) requires learners to listen first, and then they have to type the content of what they just hear. In this part of the task, the listening content could be a word, a phrase, or even a complete sentence. The level of the content difficulty would change as the learners achieve higher level of the task.

Figure 8 Dictation

In the speaking task, as shown in Figure 9, learners have to repeat the exact words presenting on the screen. In this speaking task, learners' voices will be recorded immediately after they repeat the task items. The system will then compare the learners' recording voices with the correct answers so as to decide whether they can pass or not. Because it is a recording-comparison system, learners have to pronounce words clearly to pass this type of the task.

Figure 9 Speaking Test

After the learners finish each unit, Figure 10 will show up on the screen. In this phase, the learners can go on another chapter or take a rest. In addition, it shows that if the learners constantly pass certain amount of the units, there will be extra rewards. Those rewards can be used to buy some tools to facilitate learners during the tasks' phase or after the completion of the unit.

Figure 10 Goal Achieving

For the GI treatment process, the teacher was a facilitator, leading learners to use the APP or dealing with some minor techological problems. The atmosphere of the classroom was made to be easy and comofrtable, and learners could form into groups to discuss the problems they faced naturally.

3.3 Instructional package for control group

For the control group, the instructional package consisted of a series of rule explanations and note-taking activities. The note, constructed by the researcher, was presented the moment the teaching session began. The participants in the control group were asked to copy down whatever the researcher put down on the blackboard after they received the lecturing section of every English grammar concept corresponded to the GEPT elementary level. To fulfill that goal, specific details, including the meaning of the tense, the verb forms, the formula, and the examples were taught. In addition, a chart of frequent use regular and irregular verb transformation will be given to the students (see Table 1). This met the fundamental basis of verb forms in the past tense and perfect aspect.

Table 1 An Example Chart of Regular and Irregular Verb Transformation

Chinese	Root Verb	Past tense	Past Participle
是	be	was/were	been
帶來	bring	brought	brought
選擇	choose	chose	chosen

Moreover, based on an output-based teaching methodology, the error correction exercises were contained within examples (see Example 1).

Example 3.1 *An Example for Error Correction Exercise*
The teacher have has taught for ten years ago.

For the treatment process of the control group, the teacher was a controler. The teacher strictly asked leaners to follow the steps, take notes, and do drills. The atmosphere of the classroom was made to be stressed.

3.4 English grammar tests

To assess how well the participants learn those grammar concepts, the participants were given tests which served as the pretest and the posttest. Tests' items were developed by the researcher. For both pretest and posttest, there were fifty items in each and the two tests were designed in parallel. The content of the tests covered the teaching content in both groups. The total scores were one hundred, meaning that each test item was worth two points. In addition, the number of the test items in the two parallel tests was the same. The test items were all multiple choice questions so as to fit the testing type in the GEPT elementary level. Example 1 showed one of those questions that the participants were given.

Example 1: (B) Taking the MRT is a very convenient way for people _____ in Kaohsiung.

(A)for travel (B)to travel (C)in traveling (D)of traveling

To ensure the validity of the assessment tasks, the researcher examined the questions carefully to see whether the test items were correspondent to the learning objectives and able to test the participants' learning effects. The test items were validated by an experienced English teaching professor. In addition, to confirm its reliability, the researcher completed test–retest reliability tests for all the instruments before the study. The researcher administered the test twice with an interval of three weeks. The participants were 36 first-year vocational senior high school students in central Taiwan. The collected scores were analyzed by using *Pearson Product Moment Correlation Coefficient* to establish a test-retest reliability. The results indicated that the test-retest reliability was acceptable (r = .89).

3.5 Motivation and Anxiety Questionnaires

Two questionnaires, including learning motivation and learning anxiety questionnaires were included. Adapted from Noels, et all (2003), a learning motivation questionnaire was constructed. Specifically, it consisted of five dimensions, including amotivation (n=3, items 1,2,3), external regulation (n=3, items 4,5,6), introjected regulation (n=3, items 7,8,9), intrinsic motivation in terms of knowledge (n=3, items 10,11,12), and intrinsic motivation in terms of accomplishment (n=3, items 13,14,15). Along with grammar test, two questionnaires were administered, and the participants were expected to complete all these three things in a fifty-minute class period.

For learning anxiety questionnaire, adapted from Horwitz, et al (1986), fifteen items were also designed. Even though three dimensions were proposed to construct the questionnaire, no specific classifications were found in the analysis of the questionnaire. Among the items, the concept of anxiety was put into different

situations to explore deeper on the change of students' mental statuses. Four points Likert scales were used so as to be further analyzed. Garland (1991) supported the idea with the conclusion that "social desirability bias, arising from respondents' desires to please the interviewer or appear helpful or not to be seen to give what they perceive to be a socially unacceptable answer, can be minimized by eliminating the mid-point category from Likert scales" (p. 1). Most importantly, testing results of pretests and posttests were not informed to the students in both groups. To examine their reliabilities, test-retest measures were carried out in a vocational high school in central Taiwan. The results indicated that the test-retest scores were highly correlated: (a) grammar learning motivation questionnaire (r = .84) and (b) grammar learning anxiety questionnaire (r = .82).

4. Results

The purpose of the present study aimed to examine the effects of GI on senior high school students' learning English grammar. Three research questions were addressed. First, the present study wanted to discover the impacts of GI on students' learning performance. Second, the present study wanted to discover the impacts of GI on students' learning motivation. Third, the present study wanted to discover the impacts of GI on students' learning anxiety.

4.1 Results of Research Question One

In the first part, the results are presented by comparing pretest scores and posttest scores within and between the two groups. Next, the results of their performances on the grammar learning motivation questionnaire are explored by comparing within and between the two groups. Finally, the results of the grammar learning anxiety questionnaires are shown by comparing within and between the two groups.

The first research question aimed to find out the impact of GI on students' learning performance. To make sure that the experimental group and the control group did not acquire the target grammar concepts before the study, the pretests were administered and analyzed via the independent samples *t*-test. Table 2 showed that there was no significant difference between two groups ($t(78)= 1.134$, $p > .05$). The results indicated that the two groups were homogeneous on their prior knowledge of the target grammar concepts.

Table 2 Results of The Independent Samples T-Test on Pretest Score of the GI and Control Group

Group	n	*M*	*SD*	*t*	*p*

GI	40	38.75	14.07	1.134	.26
Control	40	42.45	15.1		

Note. The total score was 100.

To explore the differences of the participants' performances before and after the treatments, the paired samples *t*-test was applied. In Table 3, statistically significant improvements were shown for both experimental ($t(38)= -6.976$, $p < .001$) and control groups ($t(38)= -4.584$, $p < .001$) made after the instructions.

Table 3 Results of The Paired-Samples T-Test on Pretest and Posttest Scores of the GI and Control Group

Group	n	Test	*M*	*SD*	*t*	*p*
GI	40	Pretest	38.75	14.07	-6.976	.000***
		Posttest	54.45	11.92		
Control	40	Pretest	42.45	15.1	-4.584	.000***
		Posttest	49.05	14.09		

Note. The total score was 100. ***$p < .001$

To further explore whether there was a significant differences between two different instructions, an independent t-test was applied to analyze their posttests' scores. Table 4 showed that there was significant difference between the two in their posttests ($t(78)= -1.849$, $p < .05$) in one-tailed tests.

Table 4 Results of The Independent Samples T-Test on Posttest Scores of the GI and Control Group

Group	n	*M*	*SD*	*t*	*p*
GI	40	54.45	11.92	-1.849	.034*
Control	40	49.05	14.09		

Note. The total score was 100. *$p < .05$

4.2 Results of Research Question Two

The second research question aimed to discover the impact of GI on students' learning motivation. To find out the participants' initial states of their learning motivations, a learning motivation questionnaire was administered along with the pretest. An independent *t*-test was performed to examine whether the two groups were different or not. In Table 5, the results showed that there was no significant difference between two groups ($t(78)= -0.38$, $p > .05$).

Table 5 Results of The Independent Samples T-Test on the Learning Motivation

Questionnaire Pretest of the GI and Control Group

Group	n	*M*	*SD*	*t*	*p*
GI	40	2.25	0.63	-0.38	.69
Control	40	2.20	0.51		

To understand whether the participants' motivations toward grammar learning change or not after the instructions, the learning motivation questionnaire was administered again along with the posttest. Therefore, the paired samples *t*-test was applied. Table 6 revealed that the GI group reached a significant difference ($t(38)=-7.12$, $p < .001$); nonetheless, there was no significant difference found in the TI group ($t(38)=-0.19$, $p > .05$).

Table 6 Results of The Paired-Samples T-Test on Learning Motivation Questionnaire Pretest and Posttest of the GI and Control Group

Group	n	Test	*M*	*SD*	*t*	*p*
GI	40	Pretest	2.08	0.47	-7.12	.000***
		Posttest	3.01	0.58		
Control	40	Pretest	2.36	0.69	-0.19	.85
		Posttest	2.38	0.56		

Note. *** $p < .001$

To explore whether different instructions affect the participants' learning motivation, an independent *t*-test was applied to analyze the collected data. In Table 7, the results revealed that there was a significant difference between the two groups' learning motivation scales after applying the instructions ($t(78)= 4.89$, $p < .001$).

Table 7 Results of The Independent Samples T-Test on the Learning Motivation Questionnaire Posttest of the GI and Control Group

Group	n	*M*	*SD*	*t*	*p*
GI	40	3.01	0.58	4.89	.000***
Control	40	2.39	0.56		

Note. ***$p < .001$

Specifically, five constructs were included in the grammar learning motivation questionnaire. For question items one to three, it belonged to the construct of amotivation. Table 10 compared the results of GI group's performances before and after the treatment in details. According to Table 8, item 1 ($t(38)= -2.15$, $p < .05$) and item 2 ($t(38)= -2.72$, $p < .05$) reached significant differences; while other items were not. In other words, the participants in the GI group still did not like learning English grammar.

Table 8 Results of The Paired-Samples T-Test on Amotivation's Pretest and Posttest of the GI Group

N	Statement	Test	*M*	*SD*	*t*	*p*
1.	I don't know why I have to learn English grammar, and in fact, I don't even care.	Pretest	2.63	0.89	-2.15	.037*
		Posttest	3.03	0.86		
2.	I feel like it is a waste of time learning English grammar.	Pretest	3.08	0.73	-2.72	.010*
		Posttest	3.48	0.75		
3.	I don't understand what the point is to study English grammar.	Pretest	3.43	0.63	0.21	.830
		Posttest	3.40	0.84		
Overall		Pretest	3.02	0.49	-1.92	.062
		Posttest	3.21	0.54		

Note. * $p < .05$

For items four to six, it belonged to construct of external regulation. Table 9 showed the results in details. Significant differences were found in item five ($t(38)= -3.12$, $p < .01$), six ($t(38)= -2.65$, $p < .05$) and the overall point ($t(38)= -2.57$, $p < .05$); while the results of item four and the overall were not significant. That is to say, the participants in the GI group did not think that grammar competences would bring better impressions for them. However, they did believe that with great grammar competences, they would possibly get better jobs.

Table 9 Results of The Paired-Samples T-Test on External Regulation's Pretest and Posttest of the GI Group

N	Statement	Test	*M*	*SD*	*t*	*p*
4.	I get my brownie points according to my English grammar competence.	Pretest	1.93	0.82	-1.35	.185
		Posttest	2.18	0.98		
5.	The better my English grammar competence is, the better job I will get.	Pretest	1.95	0.98	-3.12	.003**
		Posttest	2.43	1.10		
6.	The better my English grammar competence is, the higher salary I will get.	Pretest	1.88	0.64	-2.65	.011*
		Posttest	2.35	0.86		
Overall		Pretest	1.90	0.46	-2.57	.014*
		Posttest	2.26	0.62		

Note. * $p < .05$, ** $p < .01$

The third construct included the questionnaire items 7 to 9. It covered the idea of introjected regulation. Table 10 presented the results of the paired-samples t-test. Only item nine did not reach a significant difference ($t(38)= -1.09$, $p > .05$), which tried to discover whether the participants in the GI group felt guilty if they knew nothing about English grammar.

Table 10 Results of The Paired-Samples T-Test on Introjected Regulation's Pretest and Posttest of the GI Group

N	Statement	Test	*M*	*SD*	*t*	*p*
7.	The English grammar competence equals to the English proficiency.	Pretest	1.88	0.33	-3.44	.001**
		Posttest	2.30	0.82		
8.	It's going to be embarrassed if my foreign friends know that my English grammar competence is poor.	Pretest	1.80	0.40	-2.96	.005**
		Posttest	2.28	0.96		
9.	I will feel guilty if I don't know anything about English grammar.	Pretest	2.03	0.66	-1.09	.279
		Posttest	2.18	0.93		
Overall		Pretest	1.95	0.37	-2.80	.008**
		Posttest	2.23	0.68		

Note. ** $p < .01$

Items 10 to 12 was were included in the fourth construct. The fourth construct explored the concept of intrinsic motivation knowledge. Table 11 showed the results of the analysis. All the items reached significant differences, especially item 11 ($t(38)= -2.81$, $p < .01$) and the overall points ($t(38)= -2.92$, $p < .01$).

Table 11 Results of The Paired-Samples T-Test on Intrinsic Motivation of Knowledge's Pretest and Posttest of the GI Group

N	Statement	Test	*M*	*SD*	*t*	*p*
10.	I feel happy to be able to learn a lot about English grammar.	Pretest	1.68	0.91	-2.34	.024*
		Posttest	2.25	1.14		
11.	I feel satisfied to be able to learn many new concepts about English grammar.	Pretest	2.05	0.74	-2.81	.008**
		Posttest	2.45	0.93		
12.	I enjoy learning English grammar.	Pretest	1.78	0.69	-2.29	.028*
		Posttest	2.18	0.84		

Overall	Pretest	1.72	0.64	-2.92	.006**
	Posttest	2.21	0.62		

Note. * $p < .05$, ** $p < .01$

For the fifth construct, it included question items 13 to 15. It covered the concept of intrinsic motivation in terms of accomplishment. Table 12 showed the details of the analysis. There were two items that reached statistically significant, including item 15 with the t value of t(38)= -7.95, p < .001 and the overall points with the t value of t(38)= -6.03, p < .001.

Table 12 Results of The Paired-Samples T-Test on Intrinsic Motivation of Accomplishment's Pretest and Posttest of the GI Group

N	Statement	Test	*M*	*SD*	*t*	*p*
13.	I feel pleasant when I make progresses in my English grammar competence.	Pretest	1.68	0.73	-1.80	.079
		Posttest	2	1.06		
14.	I enjoy comprehending a tough English grammar concept.	Pretest	1.95	0.90	-1.81	.078
		Posttest	2.23	1.09		
15.	I feel satisfied when I undergo a tough process of learning English grammar.	Pretest	1.55	0.59	-7.95	.000***
		Posttest	3	0.96		
Overall		Pretest	1.61	0.56	-5.94	.000***
		Posttest	2.50	0.75		

Note. * $p < .05$, *** $p < .001$

Additionally, five constructs applied in the learning motivation questionnaire were further analyzed to examine the differences between GI group and the control group. An independent *t*-test was performed, and the results were summarized in Table 13. All the constructs reached significant differences, meaning that GI group's learning motivation was enhanced and surpassed the control group.

Table 13 Results of The Independent Samples T-Test on Five Constructs in Learning Motivation Questionnaire Posttest of the GI and Control Group

Constructs	Group	*M*	*SD*	*t*	*p*
Amotivation	GI	3.21	0.54	12.88	.000***
	Control	1.68	0.52		
External Regulation	GI	2.26	0.62	4.17	.000***
	Control	1.65	0.69		
Introjected	GI	2.24	0.68	5.64	.000***

Regulation	Control	1.45	0.55		
Intrinsic Motivation of Knowledge	GI	2.16	0.64	5.50	.000***
	Control	1.43	0.54		
Intrinsic Motivation of Accomplishment	GI	2.50	0.75	7.40	.000***
	Control	1.45	0.49		

Note. *** $p < .001$

4.3 Results of Research Question Three

The third research question revealed the effects of GI on students' learning anxiety. To discover the participants' learning anxiety toward learning before the instructions, the grammar learning anxiety questionnaire was administered. An independent *t*-test was performed to examine whether the two groups varied from each other or not. In Table 14, there was no significant difference found between the two groups before the teaching instructions ($t(78)= 0.861$, $p > .05$).

Table 14 Results of The Independent Samples T-Test on the Learning Anxiety Questionnaire Pretest of the GI and Control Group

Group	n	*M*	*SD*	*t*	*p*
GI	40	2.88	0.35	0.861	.392
Control	40	2.81	0.29		

To further discover whether the two groups' learning anxieties change after the instructions, the identical learning anxiety questionnaire was administered again. The paired samples *t*-test was utilized to analyze the collected data. Table 15 illustrated that the GI group reached a significant difference ($t(38)= 18.951$, $p < .001$); however, there was no significant difference found in the control group ($t(38)= 1$, $p > .05$).

Table 15 Results of The Paired-Samples T-Test on Learning Anxiety Questionnaire Pretest and Posttest of the GI and Control Group

Group	n	Test	*M*	*SD*	*t*	*p*
GI	40	Pretest	2.88	0.35	18.951	.000***
		Posttest	1.30	0.40		
Control	40	Pretest	2.81	0.29	1.000	.472
		Posttest	2.79	0.31		

Note. *** $p < .001$

To inspect whether there was a difference between two groups' learning anxiety

after applying different instructions, an independent *t*-test was performed to analyze the collected data. Table 16 revealed that there was a significant difference between the two groups' learning anxiety after applying the instructions ($t(78)= -18.268$, $p < .001$).

Table 16 Results of The Independent Samples T-Test on the Learning Anxiety Questionnaire Posttest of the GI and Control Group

Group	n	*M*	*SD*	*t*	*p*
GI	40	1.30	0.40	-18.268	.000***
Control	40	2.79	0.31		

Note. ***$p < .001$

Even though there were no specific domains distinguished in the learning anxiety questionnaire, paired-samples *t*-tests were performed on each questionnaire statements to further explore which items had significant differences after the GI group received the treatment. Table 17 summarized the results of the first five items. All the five items reached statistically significant differences. In other words, after using Duolingo, participants in the GI group felt less uncertain and less nervous when they were called to answer grammar questions. In addition, they could concentrate on grammar learning and understood grammar concepts much better than before. In the end, they became more confident in themselves in terms of their grammar competences.

Table 17 Results of The Paired-Samples T-Test on Learning Anxiety from Item One to Five Pretest and Posttest of the GI Group

N	Statement	Test	*M*	*SD*	*t*	*p*
1.	When I self-check my English grammar, I always feel uncertain.	Pretest	2.85	0.62	12.09	.000***
		Posttest	1.35	0.53		
2.	When I am asked to answer the question of English grammar, I always feel nervous.	Pretest	2.95	0.50	15.65	.000***
		Posttest	1.20	0.40		
3.	When I don't understand the English grammar concepts the teacher is teaching, I always feel frightened.	Pretest	3.03	0.57	15.65	.000***
		Posttest	1.15	0.42		
4.	When the teacher is teaching English grammar, I am always absent-minded.	Pretest	2.90	0.49	15.35	.000***
		Posttest	1.35	0.53		
5.	I always believe that other	Pretest	2.83	0.54	9.94	.000***

students' English grammar competences are stronger.	Posttest	1.65	0.53	

Note. ***$p < .001$

For questionnaire items 6 to 10, Table 18 summarized the results. All the items had statistically significant differences. Specifically, the participants in the GI group were not afraid if they did not review grammar concepts before presenting. Besides, they became more confident while they were taking grammar exams in the class. In the end, questionnaire item nine revealed that Duolingo might have effects on long-term memories.

Table 18 Results of The Paired-Samples T-Test on Learning Anxiety from Item Six to Ten Pretest and Posttest of the GI Group

N	Statement	Test	*M*	*SD*	*t*	*p*
6.	If I don't review the concept I am going to explain on stage in advance, I will feel nervous.	Pretest	2.88	0.51	10.38	.000***
		Posttest	1.50	0.59		
7.	I am always worried that my English grammar competence is the worst in the class.	Pretest	2.98	0.27	16.76	.000***
		Posttest	1.40	0.49		
8.	I am always worried that my English grammar test is going to fail.	Pretest	3.00	0.39	12.09	.000***
		Posttest	1.50	0.59		
9.	In an English grammar class, I am always worried that I will definitely forget what my teacher has taught me.	Pretest	2.85	0.48	9.88	.000***
		Posttest	1.58	0.78		
10.	Even if I am well-prepared for the English grammar, I am still very anxious.	Pretest	2.80	0.51	9.88	.000***
		Posttest	1.45	0.71		

Note. ***$p < .001$

Table 19 summarized the results of the last five items. All the items had statistically significant differences. Specifically, the participants in the GI group were more willing to accept grammar learning and teaching. They felt less anxious and pressure. Most importantly, they were getting to understand the grammar concepts much better than before.

Table 19 Results of The Paired-Samples T-Test on Learning Anxiety from Item 11 to 15 Pretest and Posttest of the GI Group

N	Statement	Test	*M*	*SD*	*t*	*p*
11.	I always hope that the teacher does not teach English grammar.	Pretest	2.90	0.84	9.06	.000***
		Posttest	1.45	0.55		
12.	When I am called to answer the English grammar questions by my teacher, I can feel my heart beats fast.	Pretest	2.88	0.40	10.67	.000***
		Posttest	1.45	0.63		
13..	The more diligently I study English grammar, the more doubts I will have.	Pretest	2.80	0.46	13.18	.000***
		Posttest	1.40	0.59		
14.	In comparison with other classes, English grammar class makes me feel more anxious.	Pretest	2.75	0.63	9.56	.000***
		Posttest	1.40	0.49		
15.	I am afraid that other classmates will tease me if my English grammar competence is poor.	Pretest	2.90	0.37	15.76	.000***
		Posttest	1.25	0.58		

Note. ***$p < .001$

In addition, every five items were grouped, and the mean scores were computed. To examine whether there were differences between GI and the control group, an independent *t*-test was performed. Table 20 summarized the results. Three groups all reached significant differences, indicating that GI group's learning anxiety was greatly lowered.

Table 20 Results of The Independent Samples T-Test in Learning Motivation Questionnaire Posttest of the GI and Control Group

Items	Group	*M*	*SD*	*t*	*p*
Item 1 - 5	GI	1.50	0.39	-13.306	.000***
	Control	2.74	0.43		
Item 6 - 10	GI	1.48	0.48	-13.856	.000***
	Control	2.76	0.33		
Item 11 - 15	GI	1.35	0.32	-16.385	.000***

	Control	2.76	0.43

Note. ***$p < .001$

5. Discussion and Conclusion

Nowadays, many highly advanced information and communication technologies are almost omnipresent (Jašková, 2014). The purpose of the present study was to explore a comparably effective method to teach and support students' English grammar learning. The researcher paid attention to one special grammar learning APP – Duolingo, and investigated its effects. As far as the results of the present study were concerned, three discrete points for the pedagogical implications after the discussion are proposed as follows.

Firstly, the results showed that the GI group benefited moderately from the selected English grammar learning APP – Duolingo. Therefore, the results can be utilized as the indication that such APP can be effective in promoting remedial students' English grammar learning in senior high school EFL classroom in Taiwan. Despite the fact that the GI group did not outmatch the control group, it can also be concluded that students' grammar learning performances will not be hampered under the instructional packages of Duolingo.

Secondly, the GI group's grammar learning motivation increased after the treatment. In the view of this, Duolingo has a positive effect on students' grammar learning motivation in comparison to the control group, which there is no noteworthy improvement found after the treatment. Based on Gardner's (2001) proposal of critical elements for composing the motivation, the effort to learn the language, the desire to achieve certain goals, and the positive effects that result from the enjoyment the learning tasks have brought are all can be obtained from Duolingo. It can be noted that instead of making students cram things they do not like into the heads, making them learn the language actively is a better idea.

Thirdly, the results presented that Duolingo meritoriously lower the grammar learning anxiety of the GI group. In other words, Duolingo helps remedial students feel less stressful and more comfortable in the English grammar learning environment. In addition, the juxtaposition of the GI group's result with the control group clearly showed up the difference, indicating that Duolingo can be a better approach for teachers to teach remedial students. In fact, students are hoped to learn better, and the input of the targeted language will not be hindered for the reason that their affective filters are low (Krashen, 1985). As a result, traditional instructions may not do more harms to cause students' learning anxiety, but students can still learn well under less pressure by using Duolingo.

All in all, the results revealed in the present research all line up with the previosly-reviewed studies. In other words, although the effects of the English grammar learning APP were not completely justified according to the analysis of the tests results, the questionnaires' results of the grammar learning motivation and anxiety suggest that mobile learning can still play a major part in students' grammar learning.

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