GAME-BASED LEARNING APPROACH FOR PRACTICING MELODIC MUSICAL INTERVALS USING A MUSICAL INSTRUMENT

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ABSTRACT
Game-Based Learning (GBL) integrates games into teaching through repetition, failure, and the accomplishment of goals. GBL goes beyond fun; it is a strategy to motivate students to discover, immerse them in the study material playfully and dynamically, so they learn more effectively, and encourage them to learn from their mistakes. This approach has become increasingly popular as a way to engage students in learning and motivate them to perform educational activities. One of the contexts of application of GBL is in music education, where advances in technology reduce the complexity associated with the process of learning and mastering a musical instrument. This paper presents an experiment conducted to determine the effects on learning and motivation when students use GBL for practicing music intervals. Music students aged from 17 to 22 that took part in the experiment were divided into two groups. One group practiced using a digital tool, and the other group practiced utilizing a video game. No significant difference was found in terms of learning between the two groups. Nevertheless, students practicing with the video game were more motivated than students using the digital tool.

Keywords: Game-Based Learning, musical intervals, ear training, learning motivation.

1. INTRODUCTION

Ear training is an integral component of musical studies, responsible for the music student's aural skill development and to develop the inner ear, the ability to accurately hear and identify musical elements in the head while reading, listening to music or thinking about music. These skills allow the musician to connect music theory (notes, intervals, scales, melody, rhythm, and chords) with the sounds. A well-developed aural skill is an essential asset for a musician (Rizqyawan & Hermawan, 2015). This skill allows the musician to understand the sounds and be capable of writing down the music she hears, of having the ability to see a piece of music on a music score and perform it in her mind, and to be capable of detecting if there is a discrepancy between the music she hears and what she sees. Other benefits of the ear training are the improvement of the rhythmic, singing and intonation abilities. Improving aural skills, allows him/her to compose music faster, improve the ability to tune his/her instrument and, improve his/her musicality.
As mentioned above, ear training involves the study of intervals; a musical interval measures the distance in semitones between two notes. A harmonic interval befalls when two notes are played simultaneously, and a melodic interval befalls when two notes are played in sequence (Schellenberg & Trehub, 1996). Intervals are named to describe two properties, the quality (major, minor, perfect, augmented, diminished) and number (second to octave), which is the distance. Recognizing intervals is an essential skill for a professional musician (Cleland & Dobrea-Grindahl, 2010) that gives the ability to determine the notes in a melody and perform more complex pieces (Ponsatí et al., n.d.). Conservatoires and other higher-education institutions include in their programs the study of intervals for the first-year students through the ear training courses. In most cases, the study of music theory is disconnected from the study of the student's primary instrument (Krof, 2014), and the students must invest extra time to study intervals and to fill the gap between the theory and their instrument. On the other hand, there is a negative impact of the self-directed practice on a student's motivation. The time under teacher supervision is limited, so music students typically spend long periods of private study, which derives in a lack of motivation to practice (Maria et al., 2016). The goal of this study is to investigate the effects of using

video games on the skill for musical interval's construction, both theoretical and practical, as well as on student's motivation to practice.

Game-Based Learning (GBL) is a methodology that uses games in an educational environment to promote the learning process while the students are motivated. Motivation is a necessary condition for a successful learning process and is related to game design aspects; for example, the game experience can be boring if the task is very easy or frustrating if it is very tough to accomplish (Gower & McDowall, 2012).

In recent years, GBL has been implemented on different areas of knowledge, such as mathematics (Prendinger et al., 2005), science (Moreno & Mayer, 2005), history (Huizenga et al., 2009), computer science (Su & Cheng, 2013), among others. In a review of the effectiveness of educational games conducted by Vandercruysse et al. (Vandercruysse et al., 2012), they found positive effects on student's attitudes, behavior, engagement, and motivation, in other aspects such as self-perception and analysis skills, no differences were found. A major part of the studies were focused on the effects on learning outcomes with mixed results. Ke and Grabowski (Ke & Grabowski, 2007) and Moreno and Mayer (Moreno & Mayer, 2005) have found significant positive effects on learning outcomes. Other studies, however, have not found significant differences between experimental and control groups (Annetta et al., 2009; Beale et al., 2007; Ebner & Holzinger, 2007). According to Vandercruysse et al. (Vandercruysse et al., 2012), more research is necessary to generalize the positive effects on learning; this is aligned with (Hainey et al., 2016), who state that more empirical evidence is still needed to consider GBL as an effective approach.

Studies that use GBL in music, in particular, tend to have a shared focus on music theory, in subjects like rhythm (Gower & McDowall, 2012; Liang et al., 2016), pitch (Smith, Benjamin D. Thibeault, Matthew D. Jaworski, 2012) and ear training (Paule-Ruiz et al., 2017; Rizqyawan & Hermawan, 2015). The results showed that games could increase students' interest in learning music and can help to develop music skills on them. Other studies focused on supporting musical instrument learning (Nijs & leman, 2014; Yazdi & Sai Peck Lee, 2011), showing improvements in performance after using the games. Some studies, after analyzing musical games (Maria et al., 2016; Martin & Fares, 2007), aimed to reveal key findings and recommendations for designers and developers of game-based solutions.

Today's first-year students pursuing a musical career in a conservatoire or higher-education institutions are aged from 18 to 20 years old, on average. According to Prensky (Prensky, 2001), they are the digital native generation - students who were born in the 1900s and later- who have grown up surrounded by computers, cell phones, video games, and other technologies of the digital age. Their brains have been exposed to an excess of information and stimulation (Prensky, 2001). Therefore, they think and process the information differently, preferring images over text, feeling better when they are doing more than one task at the same time and developing well with immediate and frequent rewards. Another characteristic is that the new generation's learning process is based on practice and not as much on encyclopedic knowledge.

Digital natives have a particular interest in video games. According to (Games, 2018), people aged 13 and up will have had invested 8 hours a week playing video games; this is almost a quarter-time job. The invested time in playing video games is not just about entertainment, while the players are building civilizations, exploring a new world, killing monsters; on deeper levels they are developing other skills that allow them to make decisions quickly, to resolve complex problems, and work efficiently as teams (Prensky, 2001).

GBL is an alternative for the new generations that can help stimulate students to study content that has to be learned, but they are not motivated to study (Prensky, 2001). GBL also helps new generations to put abstract content into practice and make it easier to understand.

The document is organized as follows. Section 2 presents a background of the research topics and some of the previous related works. Section 3 presents the video game we used to investigate the effects of practicing musical intervals on interval construction skills, and student motivation to practice interval using their instrument. Section 4 presents the methodology of the study and describes the phases applied to carry out the experiment. Section 5 presents the threats of validity of our study. Section 6 describes the analysis of the experiment results. Finally, Section 7 concludes about the perspectives and limitations encountered, and some challenges for future work.

2. LITERATURE REVIEW

This section provides an overview of the use of Computer-Assisted Instruction (CAI) in music learning. Then some examples of Game-Based Learning (GBL) applied in music education are presented. Finally, a review of the existing frameworks to design educational games is presented.

Computer-Assisted Instruction (CAI)

A growing interest in using technology in music education is evident since the IBM 1500 instructional system appeared in 1966 (Deihl, 1971) until the most recent developments, such as motion sensors to support instrumental music learning (Nijs & leman, 2014; Perdana, 2014). A study with 398 professors of Advanced Placement Music Theory across the United States, revealed that 60% of the participants are encouraging students to use CAI to reinforce the aural skills development (Buonviri & Paney, 2015). The study also found that the most popular music software used for teachers to reinforce the aural skills development are Finale (MakeMusic, 2013), Auralia (Rising Software, 2013), and Practica Musica (Ars Nova Software, 2013), and the most popular websites are musictheory.net, gmajormusictheory.org, emusictheory.com, and teoria.com. Although it has been demonstrated that the use of CAI can be beneficial for music education (Lou et al., 2011), there is a lack of empirical evidence to conclude about the effectiveness of CAI on music education (Smith, 2009).

Game-Based Learning (GBL) in music education

The Music Paint Machine (Nijs & leman, 2014) focuses on supporting instrumental music learning in children aged 5-7 years, using a motion tracker system to create a digital painting based on the music and movement made by the user. A longitudinal nine-month study with 12 children was conducted aimed to test the effectiveness of the system to learn to play the clarinet. Students were divided into two groups, an experimental group that used the Music Paint Machine, and a control group who received traditional instruction. The study showed a difference between the two groups in music aptitude, while on the effectiveness of instruction with the system, the results do not show a significant difference.

SAMI (Paule-Ruiz et al., 2017) is a mobile-based music learning game for preschoolers aged 3-5 years. The application consisted of four games focused on teaching children how to identify the pitch of musical notes. In all four games, children interact with the pet SAMI to complete a series of activities. The study was conducted with 86 third-year children for five weeks in order to assess the impact of technology on music education. They divided the children into two groups. Children in the experimental group interacted with the games, and children in the control group followed a traditional method. Results showed significant differences between the groups regarding learning outcomes and children's motivation.

Rizqyawan and Herman (Rizqyawan & Hermawan, 2015) developed an adventure game focused on the relative pitch and musical interval. The game has five levels divided into three phases: Learning phase presents the theory, then the theoretical quiz phase asks the player a question related with the previous content, finally in the ear training phase, the game plays a musical interval, and the player has to guess the name of the interval. They conducted a pre-post-test study with 40 students aged 9-12 years from an elementary school in Indonesia. The study's purpose was to determine if the students improved their knowledge in musical intervals and relative pitch after using the game approach. The study showed an improvement in the theoretical test of 79.22%, and the relative pitch was 19.23%.

In summary, these examples show an interest in using video games to support the study of music theory and learning to play a musical instrument. Nevertheless, most of the studies are focused on primary and high school education. Also, there is a lack of tools that allow the student to learn theory while practicing with her emphasis instrument. Therefore, there is an opportunity to use GBL in music education for undergraduate musicians, linking the theory and the practical on an instrument.

Game design frameworks

Game design is the formal process of planning and specifying the game's content and features (Gunter et al., 2008). Adapting the learning goals to a game's elements is a key factor in the success of educational games (Arnab et al., 2014). Therefore the challenge for game designers is to keep the balance between amusing play and achieving learning outcomes (de Freitas, 2006).

Existing frameworks in educational games focus on providing guidelines and methods for design. The Mechanics, Dynamics, and Aesthetic (MDA) framework (Hunicke, R. and Leblanc, M. and Zubek, 2004) (Hunicke, R. and Leblanc, M. and Zubek, 2004), is a formal approach developed to help the game designers, developers, and other game researchers to understand the process of creating games. The mechanics define the game's rules, what the player is allowed to do. Dynamics results when the rules are implemented and describe how the mechanics run based on player input. Aesthetic is related to the player's feelings when she interacts with the game system.

The Four-Dimensional Framework (de Freitas & Oliver, 2006) was developed to support the evaluation of educational games as a response to a lack of frameworks to evaluate games that can support the learning in particular subject areas. The first dimension is the context where the learning will take place, considering factors such as resource availability and the tutor's background. The second dimension focuses on the student's attributes, *e.g.*, age and learning background. The third dimension is related to the virtual world and the interaction. The four dimension focuses on pedagogical considerations such as learning models.

The Relevance, Embedding, Transfer, Adaption, Immersion, Naturalisation (RETAIN) model (Gunter et al., 2008), aims to achieve a balance between learning content and gameplay; this model is based on three theories: (ARCS) Model, Gagne's Events of Instruction and Piaget's ideas on schema. The learning materials should be related to the student's current knowledge and should be relevant to them. The content must be effectively integrated with the game fantasy. The game provides a situation in which the learning content can be applied to similar or new circumstances. Adaptation implies that students build new concepts upon their existing cognitive structures, which means that new content must be presented following a sequenced structure. The model defines immersion as being fully engaged to an intellectual investment, balancing the player's skill and game challenge. Finally, naturalization happens when students automatically use the learned information and do not need to dedicate mental resources thinking about it.

3. SPYDERNOTE VIDEO GAME

This section presents SpyderNote, a video game that was built as part of the master's thesis of one of the authors. The overall objective of the game is to support the skill of musical interval's construction using a musical instrument as the input device. The features of the game are designed to help the accomplishment of this objective. The main features are as follows:

- The player uses his/her musical instrument as an input device to interact with the game; this supports the development of student skills with his/her musical instrument and the training of his/her muscle memory.
- The progress of the player in the game depends on his/her performance, the first level asks for second minor or second major intervals, once the player reaches a predetermined number of right answers the game goes to the next level and asks for third minor or third major intervals, there are six levels to complete for every scale.

In this game, the player must help a blind spider not to starve, guiding her to a mosquito. The spider has excellent aural skills, and with player guidance, she will find food. The player plays in his/her musical instrument the right interval note to tell the spider where the mosquito is.

The game incorporated other elements: a counter of the number of eaten mosquitos (points), immediate feedback, a health bar to represent the spider life. At the end of the game, the game displays the player's statistics; this encourages the player to replay and improve his/her performance.

In a systematic review of the literature on game-based learning, Vandercruysse et al. (Vandercruysse et al., 2012) identified four elements that have proven benefits in educational games. Table 1 shows these elements and how they were implemented in the SpyderNote game.

Game elements	**SpyderNote**
Interactivity	The player plays her musical instruments to interact with the game, and the game responds to the played sound.
Feedback	When the player plays the right note, the spider hunts the mosquito; otherwise, the mosquito flies away.
Competition	Players compete against themselves breaking their own time.
Content	Musical intervals.

Table 1. Game-elements with benefits on educational games.

The game design process for the SpyderNote was based on the RETAIN model (Gunter et al., 2008). The relevance of the learning content presented in the game is evident: recognizing musical intervals is an essential skill that a musician needs to develop (Rizqyawan & Hermawan, 2015). This learning content is embedded into the video game story to create an emotional connection with the player, which can enhance learning and increase intrinsic motivation (Hamari et al., 2016). Using a musical instrument to interact with the game requires the player to be involved physically and cognitively with the content, which derives in an immersive game experience. Encouraging the player to play again to beat her score, derives in retention, and enhances automaticity response.

Figure 1 shows screenshots from the video game. There is a welcome screen where the player can either access the game configuration screen or enter the game. After the player enters the game, she can select the level to start, which means: seconds, thirds, fourths, fifths, sixths o sevenths. Then the game starts, and the player must play on his/her instrument the correct interval note. When the spider life runs out, a stats screen is displayed and the player can review his/her performance and choose whether to play again or not.

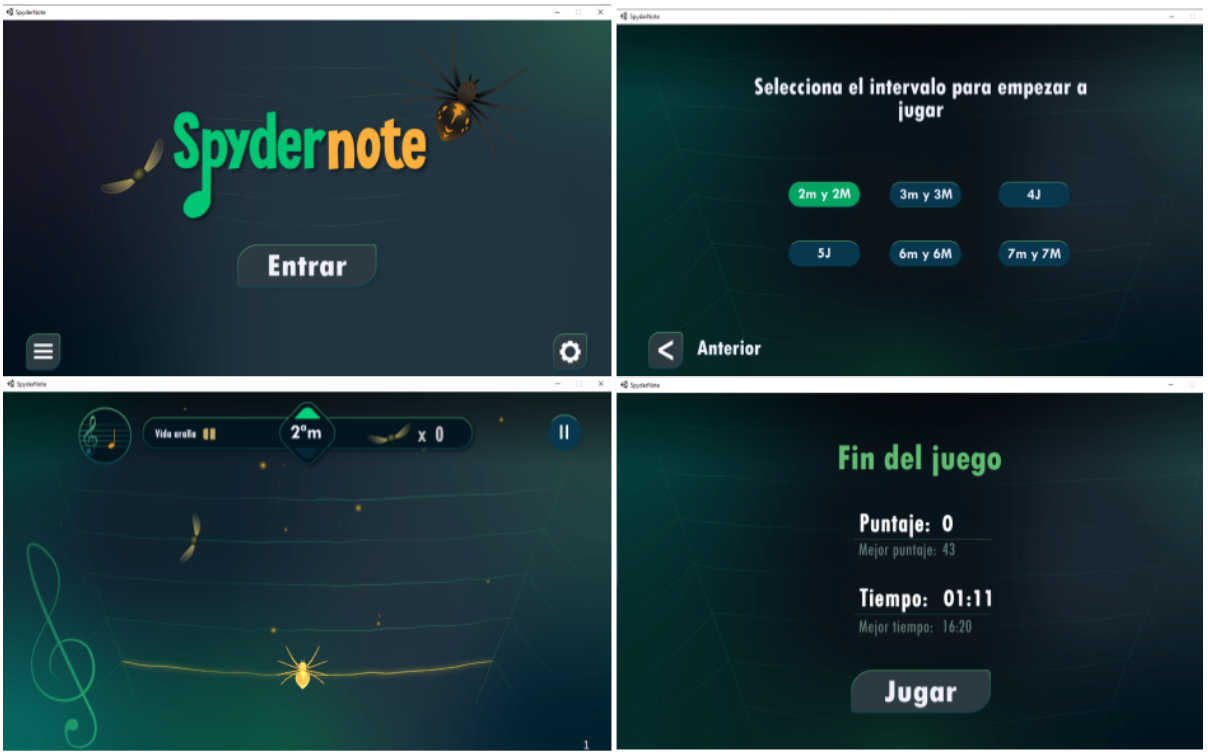

Figure 1. SpyderNote Screenshots

4. METHODOLOGY

A quasi-experimental design (Gay & Mills, 2016) was used in order to investigate the effects of practicing musical intervals through the video game on interval construction skills, and student motivation to practice interval using their instrument. We selected the SpyderNote video game because it meets the characteristics mentioned above.

The research questions that framed the current study were as follows:

- What is the effect of using the video game SpyderNote for practicing musical intervals on musical interval construction skills, both theoretical and practical?
- What is the effect of using the video game SpyderNote for practicing musical intervals on the student's motivation to practice?

Thus, the study hypotheses are as follows:

Ha1: The *theoretical* skills for musical interval's construction of the first-year musical students who use the video game SpyderNote to practice is significantly different from the skills of those who use the web application teoria.com.

Ha2: The *practical* skills for musical interval's construction of the first-year musical students who use the video game SpyderNote to practice is significantly different from the skills of those who use the web application teoria.com.

Ha3: The *motivation* to practice musical intervals of the first-year musical students who use the video game SpyderNote is significantly different from the motivation of those who use the web application teoria.com

Quasi-experiment execution

Before starting the study, an approval to conduct the experiment was granted by the Department of Music of the three higher education institutions participating in the study. Afterward, the quasi-experiment was divided into different stages, which are represented in Fig 2 and described thereafter.

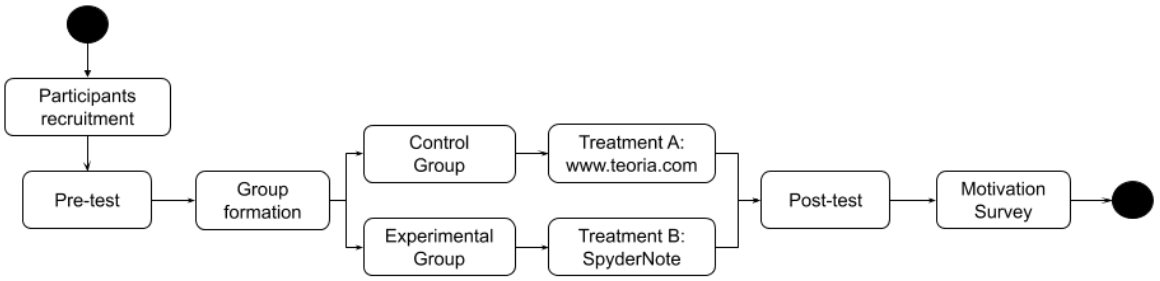

Figure 2. Quasi-experiment stages.

A. Participants' recruitment: Participation in the study was entirely voluntary. Participants were recruited from the music programs at three higher education institutions in Medellin: Universidad EAFIT, Escuela superior tecnologica de artes Débora Arango, and Instituto Tecnológico Metropolitano (ITM). A necessary condition to participate was that they must be enrolled in the ear training course, ensuring that they had a similar background in music theory. A desirable condition was that their emphasis instruments were violin, flute, or piano; otherwise, she could participate using the piano since each musicmajor must demonstrate basic keyboard proficiency (Young, 2013).

Interested students filled out a form with their name, contact phone, e-mail, emphasis instrument, and availability. A total of 50 students were cited for a pre-test via WhatsApp message, of which eleven first-year students attended. Participants were aged 17-22 years (six male and five female), nine of them participate with piano, one with the flute, and one with a violin.

B. Pre-test: Before the test began, all participants signed an informed consent document and were asked to fill out a form (see Appendix A) informing about the weekly time they invested in studying music theory, musical intervals, and playing video games. The questionnaire reveals that the average time invested in studying music theory was more than four hours a week, while only one hour or less studying musical intervals. For the time in playing video games, the average reported by the participants was 2 hours per week.
The pre-test aims to diagnose the initial ability in the construction of musical intervals, both theoretical and practical. Theoretical and practical skills in interval's construction were assessed using a 50 questions dictation (25 theoretical, 25 practical) where the students built the interval given a note, an interval name, and a direction. The test asked for intervals from seconds to sevenths, both minor and major. In theoretical dictation, students marked the answer from a multiple choice on their answer sheet (see Figure 3). In the practical dictation, they played the answer using their musical instruments.

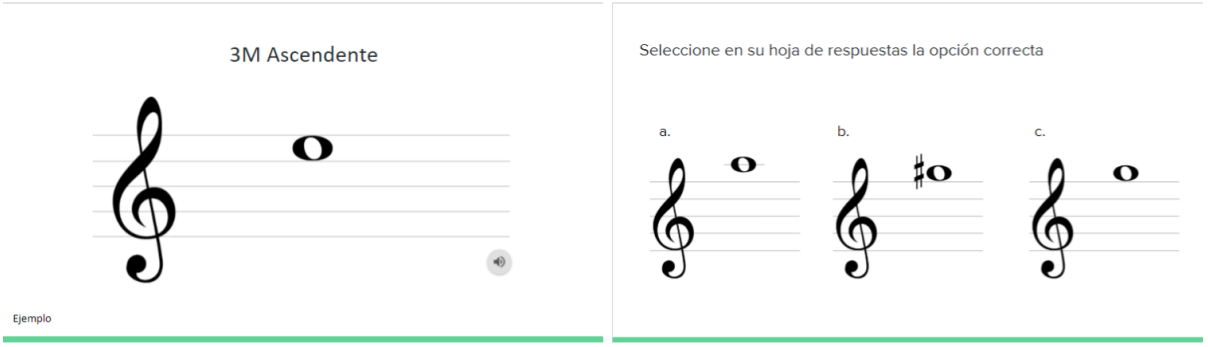

Figure 3. Pre-test question and answer format

C. Group formation: The participants were no-randomly assigned to the experimental and control groups, since for a quasi-experiments is necessary to assure that the participants are similar and that their base skills do not pose a significant threat to the validity of the results. Based on the results of the theoretical pre-test, the students were assigned to the groups, and an independent sample t-test was conducted to compare the average student's scores. Test results show that the difference between the experimental group (M=18.8, SD=0.84) and the control group (M=21, SD=1.73) was t=-1.964 (p>.05), which shows no significant difference between the participant's musical intervals construction skills before they start the practice.

D. Treatments: This stage consisted of two practice sessions. Each student, both control and experimental, was scheduled for a 30 minutes session per day. The two practice sessions took place in the same week. There was an instructor presenting every practice session in order to control the schedules, guaranteeing Internet access, and setting up the workstation before the practice began.

Treatment A: Treatment applied to the control group. Students assigned to this group practiced musical interval construction using the website www.teoria.com (see Figure 4), the selection of this site was based on the tool with the most similar exercise to the video game, and according to (Buonviri & Paney, 2015) is one of the common websites to study music theory. Each participant was provided a computer connected to the Internet and a headset.

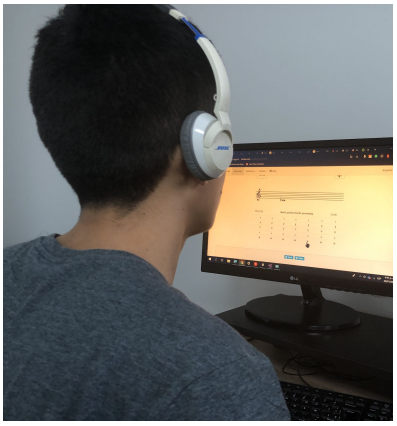

Figure 4. A student practicing with teoria.com

Treatment B: Treatment applied to the experimental group. Students assigned to this group practiced musical interval construction using the SpyderNote video game (see Figure 5), which was described in Section 3. Each participant was provided a computer running the game, a headset, and a microphone.

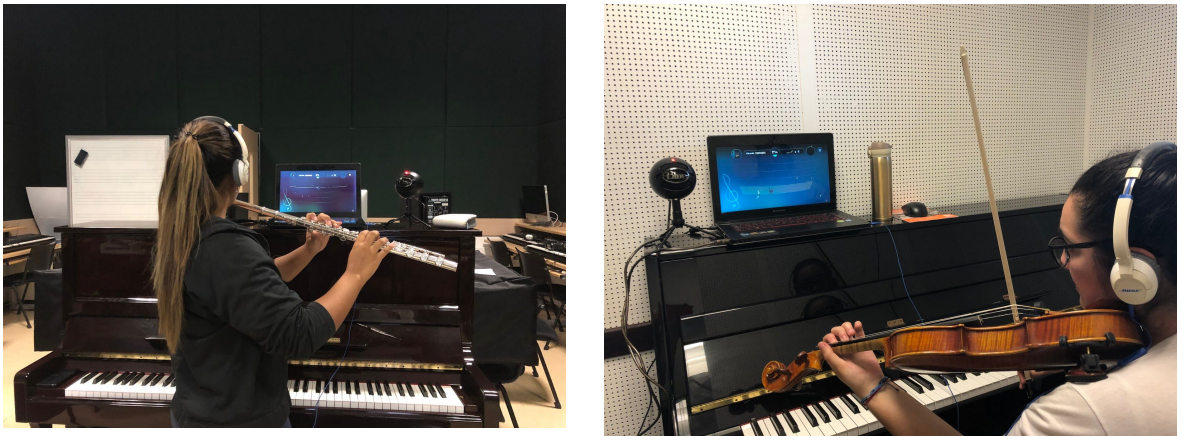

Figure 5. Students playing SpyderNote videogame

E. Post-test: At the end of the intervention, a post-test was conducted to determine the gain on learning outcomes, both theoretical and practical. The assessment allowed identifying whether participants improved musical interval's construction skills after using their assigned tool (SpyderNote or teoria.com). The post-test was similar to the pre-test, the same number of questions, and the same level of difficulty.

F. Motivation survey: The final stage of the quasi-experiment was to administer the Instructional Materials Motivation Survey (IMMS) in order to assess the participant's motivation to practice musical intervals. The IMMS encompasses four subscales: Attention, Relevance, Confidence, and Satisfaction, based on the ARCS Model of motivational design. According to (John M. Keller, 2009) those are the main dimensions of human motivation: Attention is related to the student's curiosity and the capacity to sustain it; Relevance is about the value of the content for the students, the Confidence created through the feedback that the student receives and self-control over the learning process; and Satisfaction with the results of the learning experience.
The IMMS is a 36 questions survey, divided into 12 questions related to Attention, 9 to Relevance, 6 to Satisfaction, and 9 to Confidence. Survey items were adapted to the study by changing the word ''this lesson'' to ''the application'' (*e.g.*, ''There was something interesting at the beginning of this lesson that got my attention.'' was changed to ''There was something interesting at the beginning of the application that got my

attention.’’). Recently, IMMS has been applied to and tested in computed-assisted instruction, and self-directed study with technology (Loorbach et al., 2015).

5. VALIDITY AND RELIABILITY

In this section, the reliability and validity of the quasi-experiment are presented, considering three types of threats to the validity of the experiment: external validity, internal validity, and conclusion validity (Gay & Mills, 2016).

External validity

The small number of participants can be a threat to external validity; nevertheless, the student participants came from three different higher education institutions, one private and two public, which is a diverse sample. The results would suggest trends rather than provide significant results; it implies that a generalization of the effectiveness of the video game SpyderNote to practicing musical intervals would not be possible.

Internal validity

The participant was accommodated in an empty classroom to assure similar ambient sound conditions; just one participant and the instructor were present during the practice time. To avoid the instructor's effect, she was not familiar with the participants and did not have a musical background. The quasi-experiment took place during one week; in this period, there were no relevant, academic, or personal factors that affected the results of the experiments.

Conclusion validity

The reliability of this study can be evidenced by the reliable procedures used throughout the study. In other words, the data collection methods were straightforward and well documented, and were collected and analyzed consistently without violating the assumptions of the statistical tests.

6. RESULTS

In order to assess the effectiveness of the SpyderNote video game to enhance the theoretical and practical construction’s skill of musical intervals, T-tests were conducted to determine the differences between the experimental and control groups. Later another t-test was conducted for the IMMS survey to assess the participant's attitude toward the self-directed practice tool. The significance level for all tests was set to 0.05. Table 4 and Table 5 show the descriptive statistics.

Group	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Experimental	6	21.0	1.73	21.67	1.51
Control	5	18.8	0.84	22.0	1.73

Table 4. Descriptive Statistics theoretical test

Group	N	Pre-test		Post-test	
		Mean	SD	Mean	SD
Experimental	6	15.33	2.94	17.33	3.14
Control	5	14.6	3.36	17.6	3.05

Table 5. Descriptive Statistics practical test

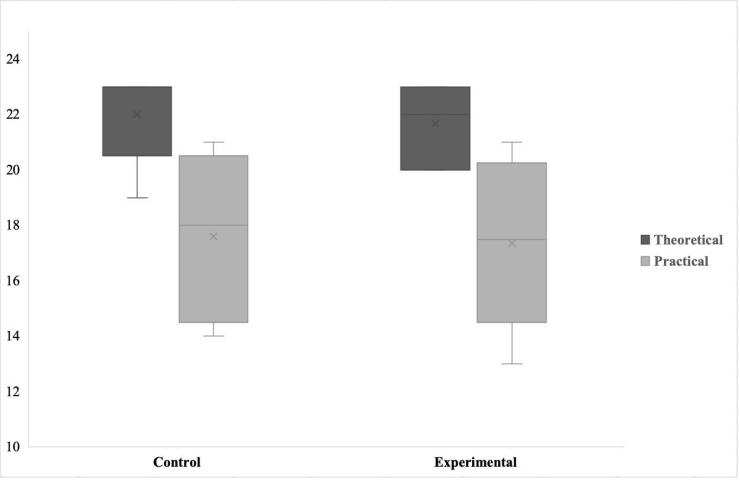

Figure 6. Boxplot for post-test scores, both theoretical and practical in experimental and control groups

Theoretical skill learning outcomes

A paired sample t-test was conducted to see the differences between the pre-test and post-test, both experimental and control groups. The difference between the pre- and post-tests of the experimental group is t=0.83 (p> .05); and the control group is t=3.719 (p<.05), only the control group have reached significant differences.

An independent t-test was conducted to examine whether the theoretical skills for musical intervals construction is different between experimental and control groups. The results presented in Table 6, shows no significant difference between the two groups as t = 0.740 (p>.05), therefore there is insufficient evidence at 5% significance to support the claim that the theoretical skills for musical interval's construction of the first-year musical students who use the video game SpyderNote to practice are significantly different from the skills of those who use the web application teoria.com.

Group	N	Post-test		t-test for Equality of Means		
		Mean	SD	t	df	Sig. (2-tailed)
Experimental	6	21.67	1.51	0.341	9	0.740
Control	5	22.0	1.73			

Table 6. Independent t-test of theoretical skill learning outcomes

Practical skill learning outcomes

In the case of practical learning outcomes, a paired sample t-test was conducted to see the differences between the pre-test and post-test, both experimental and control groups. The difference between the pre- and post-tests of the experimental group is t=0.189 (p> .05), and the control group is t=1.538 (p>.05); Although at first glance there is a difference between the means of the pre and post-test of the control and experimental groups, statistically there is no significant difference.

To see the difference between the experimental and control group in the practical skill to the construction of musical intervals, an independent t-test was conducted. Table 7 presents the results, which does not show a significant difference between the two groups, therefore there is insufficient evidence at 5% significance to support the claim that the practical skills for musical interval's construction of the first-year musical students who use the video game SpyderNote to practice is significantly different from the skills of those who use the web application teoria.com.

Group	N	Post-test		t-test for Equality of Means		
		Mean	SD	t	df	Sig. (2-tailed)
Experimental	6	17.33	3.14	0.142	9	0.890
Control	5	17.6	3.05			

Table 7. Independent t-test of theoretical skill learning outcomes

Learning motivation

The results of the four dimensions (Attention, Relevance, Confidence, and Satisfaction) considered in the IMMS questionnaire are shown in Table 8. The survey uses a Likert scale, which had a five-point format: (1) strongly disagree, (2) somewhat disagree, (3) neither agree nor disagree, (4) somewhat agree, and (5) strongly agree. According to (John M. Keller, 2009) the survey can be scored for each of the four subscales or the total scale score; thereby, in order to investigate in-depth the four dimensions, a t-test was conducted to examine the differences between the two groups.

Group	Attention		Relevance		Confidence		Satisfaction		Overall Score
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean
Experimental	4.59	0.30	4.44	0.21	4.31	0.39	4.64	0.32	4.50
Control	3.90	0.28	3.88	0.63	4.33	0.25	4.13	0.32	4.06

Table 8. Average of IMMS Survey

The t-test results showed a significant difference between the two groups as $t=-3.91$ ($p<.05$) in the Attention dimension. Participants in the experimental group were more interested when they used the video game than the group who used the web site. During the practice time, participants in the control group always asked to finish the practice before the time, while the participants who used the video game were asking for more time to practice. In contrast, no significant difference was found between control and experimental groups in the relevance dimension as $t=-2.042$ ($p>.05$); all participants recognize the importance of the study of the musical intervals as part of their ear training practice. The t-test result for the Confidence dimension is $t=0.074$ ($p>.05$), again, no significant difference was found between control and experimental groups. It shows that participants can obtain learning confidence in both tools. Finally, the results for the Satisfaction dimension showed a significant difference between control and experimental groups as $t=-2.58$ ($p<.05$). The participants favor the video game SpyderNote over the website teoria.com. The reinforcement theory of motivation (Isai Amutan, 2014) states that people would be more motivated if the task and the reward are defined. The video game has a specific objective, feed the spider, and do not let her die. Participants who used the video game gave more positive feedback, such as asking for more time to play or where they can download the game.

7. CONCLUSIONS

This study investigated the effects of using video games on the skill for musical intervals construction, both theoretical and practical, and on students' motivation to study. The video game SpyderNote was developed following the RETAIN framework to educational games and was used to assess the student's learning achievements in the construction of musical intervals. Regarding the students' motivation to study musical intervals, the IMMS survey was used at the end of the intervention.

The results show no significant difference between using the video game SpyderNote and the web application teoria.com in terms of learning outcomes, both theoretical and practical, but for motivation, the Attention and Satisfaction dimensions of the ARCS model presents a significant difference.

Although there is no significant difference between the control and experimental group, there is a difference in the control group on the theoretical pre and post-test, this difference obeys to the familiarity the participants had with the teoria.com interface, the practice they had during the experiment was on the intervals construction, and they do not need to invest time or cognitive resources on the learning of a new interface.

Regarding the performance in the practical test, as the video game was designed only for violin, flute, and piano; participants with other major instruments (65%) used the piano to execute the pre and post-test, this may be one of the reasons for the results as (Maria et al., 2016) states that is necessary long hours of repetitive practice to acquire technical skills with a musical instrument.

Another interesting result is that the two groups' average scores, both theoretical and practical tests, show improvement. It can be explained because, during the experiment, the students truly practiced for one hour, in contrast with the one hour or less weekly practice time they reported in the form at the beginning of the experiment.

Despite the results in learning outcomes, the experimental group shows a significant difference in the motivation to practice musical interval's construction using the video game. The video game was more effective in attracting the participant's attention than the website. A common comment was the fact you have to play in silence; this favors the concentration. They valued the use of the instrument to practice, a participant using the flute says: "better to study intervals than with the piano," and finally, they stated they were studying musical intervals, but also the technical skills.

Although the pre and post-tests had improvements, the study results were still not significant. This might be due to the limited gaming time participants had to interact with the game. For future research, longer playing time with the game might be necessary. Another factor to consider is the number of participants, even though there was a great interest to participate in the study, it was difficult to coordinate the schedules of the participants. Therefore, in order to assure a number of participants, in the future, the study could be integrated into an ear training class curriculum.

REFERENCES

Annetta, L., Minogue, J., Holmes, S., & Cheng, M.-T. (2009). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers & Education*, *53*, 74–85.

Arnab, S., Lim, T., Carvalho, M., Bellotti, F., de Freitas, S., Louchart, S., Suttie, N., Berta, R., & De Gloria, A. (2014). Mapping learning and game mechanics for serious games analysis: Mapping learning and game mechanics. *British Journal of Educational Technology*. https://doi.org/10.1111/bjet.12113

Ars Nova Software. (2013). *Practica musica*. http://www .ars-nova.com/practica6.html

Beale, I. L., Kato, P. M., Marin-Bowling, V. M., Guthrie, N., & Cole, S. W. (2007). Improvement in Cancer-Related Knowledge Following Use of a Psychoeducational Video Game for Adolescents and Young Adults with Cancer. *Journal of Adolescent Health*, *41*(3), 263–270. https://doi.org/10.1016/j.jadohealth.2007.04.006

Buonviri, N. O., & Paney, A. S. (2015). Melodic Dictation Instruction: A Survey of Advanced Placement Music Theory Teachers. *Journal of Research in Music Education*, *63*(2), 224–237. https://doi.org/10.1177/0022429415584141

Cleland, K., & Dobrea-Grindahl, M. (2010). *Developing Musicianship through Aural Skills: A Holistic Approach to Sight Singing and Ear Training* (First). Routledge.

de Freitas, S. (2006). *Learning in immersive worlds: A review of game-based learning* [WorkingPaper].

de Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers & Education*, *46*, 249–264. https://doi.org/10.1016/j.compedu.2005.11.007

Deihl, N. C. (1971). Computer-Assisted Instruction and Instrumental Music: Implications for Teaching and Research. *Journal of Research in Music Education*, *19*(3), 299–306. https://doi.org/10.2307/3343765

Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: An example from civil engineering. *Computers & Education*, *49*(3), 873–890. https://doi.org/10.1016/J.COMPEDU.2005.11.026

Games, N. (2018). *Games 360 U.S Report* (No. 9; p. 44). NIELSEN GAMES. https://www.nielsen.com/us/en/insights/report/2018/us-games-360-report-2018/

Gay, L. R., & Mills, G. E. (2016). *Educational research: Competencies for analysis and applications* (11 Global Edition). Pearson.

Gower, L., & McDowall, J. (2012). Interactive music video games and children's musical development. *British Journal of Music Education*, *29*(01), 91–105. https://doi.org/10.1017/S0265051711000398

Gunter, G. A., Kenny, R. F., & Vick, E. H. (2008). Taking educational games seriously: Using the RETAIN model to design endogenous fantasy into standalone educational games. *Educational Technology Research and Development*, *56*(5), 511–537. https://doi.org/10.1007/s11423-007-9073-2

Hainey, T., Connolly, T. M., Boyle, E. A., Wilson, A., & Razak, A. (2016). A systematic literature review of games-based learning empirical evidence in primary education. *Computers & Education*, *102*, 202–223. https://doi.org/10.1016/j.compedu.2016.09.001

Hamari, J., Shernoff, D., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2015.07.045

Huizenga, J., Admiraal, W., Akkerman, S., & Dam, G. (2009). Mobile game-based learning in secondary education: Engagement, motivation and learning in a mobile city game. *J. Comp. Assisted Learning*, *25*, 332–344.

Hunicke,R. and Leblanc,M. and Zubek, R. (2004). MDA: A formal approach to game design and game research. *AAAI Workshop - Technical Report*, 1–5.

Isai Amutan, K. (2014). ☂ A Review of B. F. Skinner's 'Reinforcement Theory of Motivation. *Journal of Research in Education Methodology*, *5*.

John M. Keller. (2009). *Motivational Design for Learning and Performance* (1st ed.). Springer US.

Ke, F., & Grabowski, B. (2007). Gameplaying for maths learning: Cooperative or not? *British Journal of Educational Technology*, *38*(2), 249–259.

Krof, T. (2014). *The Process of Musicking: An Alternative to Melodic Dictation and Other Activities Involved in the Undergraduate Music Program.* [University of Nebraska]. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1071&context=musicstudent

Liang, Y.-C., Shiue, Y.-M., Huang, Y.-M., & Liu, C.-G. (2016). *Development of a digital game-based learning system in music learning*. 241–244. https://doi.org/10.1109/ICAMSE.2016.7840298

Loorbach, N., Peters, O., Karreman, J., & Steehouder, M. (2015). Validation of the Instructional Materials Motivation Survey (IMMS) in a self-directed instructional setting aimed at working with technology: Validation of the IMMS. *British Journal of Educational Technology*, *46*(1), 204–218. https://doi.org/10.1111/bjet.12138

Lou, S.-J., Guo, Y.-C., Shih, R.-C., & Dzan, W.-Y. (2011). Applying computer-assissted musical instruction to music appreciation course: An example with chinese musical instruments. *Turkish Online Journal of Educational Technology*, *10*.

MakeMusic. (2013). *Finale* [Computer Software]. http://www.finalemusic.com

Maria, M., de Oliveira, M., & Waddell, G. (2016). *Game-Based Learning of Musical Instruments: A Review and Recommendations*.

Martin, P., & Fares, K. (2007, September). Levels of Sound: On the Principles of Interactivity in Music Video Games. *DiGRA &#3907 - Proceedings of the 2007 DiGRA International Conference: Situated Play*. http://www.digra.org/wp-content/uploads/digital-library/07311.14286.pdf

Moreno, R., & Mayer, R. (2005). Role of Guidance, Reflection, and Interactivity in an Agent-Based Multimedia Game. *Journal of Educational Psychology*, *97*, 117–128.

Nijs, L., & leman, marc. (2014). Interactive technologies in the instrumental music classroom: A longitudinal study with the Music Paint Machine. *Computers & Education*, *73*, 40–59. https://doi.org/10.1016/j.compedu.2013.11.008

Paule-Ruiz, Mp., Álvarez-García, V., Pérez-Pérez, J. R., Álvarez-Sierra, M., & Trespalacios-Menéndez, F.

(2017). Music learning in preschool with mobile devices. *Behaviour & Information Technology*, *36*(1), 95–111. https://doi.org/10.1080/0144929X.2016.1198421

Perdana, I. (2014). Teaching elementary school students new method of music performance with Leap Motion. *2014 International Conference on Virtual Systems Multimedia (VSMM)*, 273–277. https://doi.org/10.1109/VSMM.2014.7136655

Ponsatí, I., Miranda, J., Amador, M., & Godall, P. (n.d.). Aural identification of harmonic intervals: An observational study at the Girona Music Conservatory (Catalonia, Spain). *Psychology of Music*, *0*(0), 0305735618809868. https://doi.org/10.1177/0305735618809868

Prendinger, H., Mori, J., & Ishizuka, M. (2005). *Using human physiology to evaluate subtle expressivity of a virtual quizmaster in a mathematical game* (Vol. 62). https://doi.org/10.1016/j.ijhcs.2004.11.009

Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon*, *9*(5), 1–6. https://doi.org/10.1108/10748120110424816

Rising Software. (2013). *Auralia* [Compueter Sofware]. http://www.risingsoft ware.com/auralia/

Rizqyawan, M. I., & Hermawan, G. (2015). Adventure game as learning media for introducing music interval and ear training to kids. *2015 International Conference on Automation, Cognitive Science, Optics, Micro Electro-Mechanical System, and Information Technology (ICACOMIT)*, 172–175. https://doi.org/10.1109/ICACOMIT.2015.7440200

Schellenberg, E., & Trehub, S. (1996). Children's discrimination of melodic intervals. *Developmental Psychology*, *32*, 1039–1050. https://doi.org/10.1037//0012-1649.32.6.1039

Smith, Benjamin D. Thibeault, Matthew D. Jaworski, N. (2012). Developing games that can create real heroes on real guitars: Using acoustic musical instruments and the human voice as controllers. *Proceedings GLS 8.0: Games + Learning + Society Conference*, 269–274.

Smith, K. H. (2009). The effect of computer-assisted instruction and field independence on the development of rhythm sight-reading skills of middle school instrumental students. *International Journal of Music Education*, *27*(1), 59–68. https://doi.org/10.1177/0255761408099064

Su, C.-H., & Cheng, C.-H. (2013). 3D game-based learning system for improving learning achievement in software engineering curriculum. *Turkish Online Journal of Educational Technology*, *12*, 1–12.

Vandercruysse, S., Vandewaetere, M., & Clarebout, G. (2012). *Game-Based Learning: A Review on the Effectiveness of Educational Games* (Vol. 1).

Yazdi, K. M., & Sai Peck Lee. (2011). E-Santur: A customizable tool for learning Santur music instrument using game-based learning approach. *2011 International Conference on Research and Innovation in Information Systems*, 1–6. https://doi.org/10.1109/ICRIIS.2011.6125707

Young, M. (2013). Authentic Assessments in Group Piano Classes: The Effect on Performance Skills and Attitudes. *MTNA E-Journal*.

APPENDICES

Appendix A: Participants study habits questionnaire
https://docs.google.com/document/d/1U_RRH0gTHgJo0QmErVt71H-mYPMUgIpBq-g9lFiR7GA/edit?usp=sharing

Appendix B: Pre-test presentation
https://docs.google.com/presentation/d/1cIh5pEldOuMEGuplWgQw2IhGRHiV1VB1adt1E98de28/edit?usp=sharing

Appendix C: Pre-test response sheet
https://docs.google.com/document/d/1u1wMeQ8vXlk-puTSnEGNOJMYdlUYUCOeZrZeGg-HYIo/edit?usp=sharing

Appendix D: Post-test presentation
https://docs.google.com/presentation/d/17SDd1USkGalQ079PJhsSaOK4fsSrDSZDskVLBInVHlw/edit?usp=sharing

Appendix E: Post-test response sheet
https://docs.google.com/document/d/1S4PAxQK1pP6m_F-EonhnhWIMRxM0kbzp7EwPa8dojCg/edit?usp=sharing

Appendix F: IMMS questionnaire form
https://forms.gle/aHUGy7tLbmCDYfeM8