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Technical exercise practice: Can piano students be motivated through gamification?

ABSTRACT

Gamification is a process whereby game design and game mechanics are applied in non-game contexts to influence behaviour. This research study explores the effects of gamification on young piano students' practice of technical elements such as scales, chords and arpeggios in the context of independent practice between private lessons. A control and a treatment group of ten piano students each were formed across two different private piano studios. A game-like environment was introduced for the treatment group, in which the players experienced game elements such as avatars and rewards, including points, badges and level achievements. Gamification was found to have a positive effect on the number of technical elements students mastered and a modest effect on their attitude towards practicing technical elements. The educational implications for these findings are discussed.

KEYWORDS

music education
piano
gamification
technique private
music lessons

INTRODUCTION

Training to be a piano player is a process not unlike training to be an athlete (Martin 2008). Physical skills must be developed in order to execute piano pieces, in the same way that physical skill development is necessary to succeed in athletic endeavours. The time that a piano student spends with a teacher in weekly lessons, often ranging between 30 and 60 minutes, is not enough time for those students to develop the physical skills necessary to become accomplished players. Practice is defined as the process of systematically engaging in experiences or exercises in order to learn; it is defined as fundamental for achieving musical success on an instrument (Schatt 2011; Austin and Berg 2006). While a piano teacher can employ strategies and techniques to increase student engagement within the piano lesson, what happens outside of lessons is crucial and more difficult for the teacher to influence.

This study was undertaken to explore how children might be motivated to practise more between weekly piano lessons. As researchers, we were aware of the importance of student practice (McPherson and Williamon 2006; Bloom and Sosniak 1985; Ericsson et al. 1993) and of the challenges commonly faced by students when practising between weekly lessons (Bonneville-Roussy and Bouffard 2015; Jorgensen 2009; Jorgensen 2000; McPherson and Renwick 2001). One of us (Heather), as a piano teacher, saw firsthand how students found it difficult to practise regularly and consistently between lessons. This is corroborated by other studio music teachers who report that students routinely do not practise as much as expected or do not use effective practice techniques (McPherson and Renwick 2001; Oare 2012). In response to these factors, we designed a set of game elements which would operate in coordination with student practice. Our hypothesis was that these game elements, functioning as a type of 'game layer' over top of the students' music learning experience, would provide motivation which would result in increased student practice and thereby increase musical achievement.

The importance of technical exercises

Technical exercises, such as scales, chords and arpeggios, are an important part of regular practice which teachers often assign for students to practise between lessons. These exercises are important for warming up the fingers so they will be at maximum flexibility before tackling intricate, complex pieces. The exercises consist of patterns that develop a musician's ability to control the interaction between their physical self and their instrument (Green 2006). Practicing technical exercises provides opportunities to develop fingering techniques such as learning to quickly tuck fingers under, stretch fingers, reach to distant notes and play many notes at a time using the correct fingers – techniques that lead to an easy dexterity and command over the piano keyboard (Bastien 1977). Since music is often based on scale, chord and arpeggio patterns, practicing technical exercises provides opportunities for student success when a student tackles a piece which contains one of the patterns.

Even though technical exercises are important, students often do not enjoy practising them. According to a study by Cooper (2001), 564 piano players who had taken lessons at many different ages consistently rated technical exercises as their least favourite part of piano study. During graded examinations in which students are asked to perform ear tests, pieces and technical requirements, the technical requirements are often the weakest of the three and cause great frustration for students (McCormick and McPherson 2006).

Technical exercises were chosen as a focus of this research study due to their importance for music learning, as well as the unique obstacles they present for students as they practise. In addition, a standardized set of technical exercises can be defined and counted in order to assess student achievement.

Gamification proposed as a motivator

The current research study was inspired by the importance of technical exercise practice, and the hope that a strategy could be devised and implemented to increase student motivation to practise technical exercises, as well as improve student attitudes towards this type of practice. The chosen strategy is gamification, which is defined as 'the use of game design elements in non-game contexts' (Deterding et al. 2011: 9). The game design elements which were implemented in this study to test for an effect on student motivation included awarding points and virtual trophies for beating levels, the use of avatars and the sharing of student progress online. It was anticipated that gamification could, in fact, motivate students to practise technical exercises, which would result in increased practice time, and therefore be indicated by improved student achievement. Researches in many learning domains, including music, have shown that both quality and quantity of practice positively correlate with achievement (Ericsson et al. 1993; Williamon and Valentine 2000; Bonneville-Roussy and Bouffard 2015; Barry and Hallam 2002). This study does not distinguish between practice quality and quantity as factors which are influenced by motivation. Notably, Sloboda et al. (1996) demonstrated that in the case of 8- to 18-year-old students, practice quantity on its own is a predictor of musical achievement.

This research study was designed to address the question of whether the game elements of narrative, replayability, recognition, social sharing and player agency have the potential to influence students' practice of technical exercises within the private piano lesson environment. First, a search for existing digital tools for motivating technical exercise practice was conducted. At the time, no websites or apps were found which specifically facilitated the practice of technical exercises and included the gamified environment we were interested in exploring with the students. Keeping in mind that not all the participants in the research study had personal devices, and wanting to move ahead with the research study in a timely manner, the decision was made to develop a website; using web design allowed us to promptly create and implement a set of game elements for use in the context of piano lessons with students ages 10 through 17. Our vision for the gamified environment was that it would provide students with additional motivation to practise technical exercises such that, instead of practicing technical exercises from a written-out list, students would practise technical exercises as a means of moving through a narrative. This narrative involved a journey to the top of 'Technique Tower'. As students mastered technical exercises and earned points, they would level up, and figuratively move to the next floor of the tower, until they finally reached the summit. Reaching the top of the tower was held out as a motivational goal for students to strive towards, in addition to learning to play a series of exercises.

LITERATURE REVIEW

In the context of private music studios, students commonly learn in one-on-one weekly lessons with a teacher. The importance of independent practice is heightened, since most of the musical learning takes place outside of the

lesson (Ericsson et al. 1993; Pitts and Davidson 2000). This study conducts research in the context music learning within the private music studio and is informed by the literature about motivation, self-regulation and gamification.

Motivation

Intrinsic and extrinsic motivation

Reinforcement theory (Skinner 1965; Kimble 1956) was a type of behaviourism which considered extrinsic motivation to be a powerful motivator for predicting and controlling behaviour. This theory viewed motivation as an integrated construct which varies only in quantity (Ryan and Deci 2000). Bruner (1966) acknowledged that a decision either to act or not to act was much more complex than that which could be explained by the result a positive or negative stimulus. A more accurate picture of motivation acknowledges it as a complex phenomenon; not only do learners experience either more or less motivation, they also experience different types of motivation; these types of motivation are determined by the root causes that lead a learner to act (Ryan and Deci 2000).

Intrinsic motivation

Lepper (1988) defines intrinsic motivation as leading to 'behavior undertaken for its own sake, for the enjoyment it provides, the learning it permits, or the feelings of accomplishment it evokes' (292). This type of motivation leads to the pursuit of a genuine interest, a desire to learn or a desire to be challenged (Alderman 2008). Intrinsic motivation can cause learners to focus on the degree of fun and pleasure they experience when doing something (Barry 2007). McPherson and McCormick (1999) reported that among piano students, those with greater amounts of reported practice tended to express more intrinsic interest in learning an instrument.

Extrinsic motivation

Extrinsic motivation leads learners to action based on reasons external to themselves (Alderman 2008: 252). It compels students to focus on future goals such as awards and good marks (Barry 2007) and can cause students to act based on opportunities to demonstrate their skills, in order to gain recognition from their peers, teachers or parents. Acting based on extrinsic motivators has been shown to weaken intrinsic motivation, thus reducing opportunities for learners to be curious and pursue tasks for interest's sake (Deci et al. 1999). However, not all extrinsic motivators are created equal, and it is too simplistic to say that all must be avoided (Deci 1971). As Lehman, Sloboda and Woody (2007) contend, during any specific music making session, a music learner is likely acting as a result of more than one source of motivation, some sources being intrinsic and others, extrinsic.

Motivation and achievement

Motivation can also be described in terms of mastery orientation and performance orientation. As described by Elliot and McGregor (2001), the mastery approach refers to learners who are motivated to track their own personal improvement and achievement of goals in order to continue moving forward and avoid moving backward. The performance approach describes learners

who compare their own growth and accomplishment with others to demonstrate success or avoid appearing incapable. Both mastery and performance orientations motivate learners to take on musical challenges and persevere during difficulty (Dweck 2000; Elliot and McGregor 2001), while mastery orientation has been shown to result in greater levels of learning success.

Motivational learning theories

Self-regulation

Self-regulation theory, as a way of understanding how a person undertakes the learning of music, was first identified by McPherson and McCormick (1999) and Zimmerman (2000). Self-regulated learning is described as a set of cyclical steps including deciding to take action, defining goals, attaining goals, engaging in self-reflection and adapting (Zimmerman and Campillo 2003). While a learner is engaged in making decisions about goals and actions to take, known as the forethought phase, motivation has a particularly distinct influence (Zimmerman and Campillo, 2003). Motivation is one of the factors that inspires learners to set out on a path towards learning, based on their personal belief that the learning goal is achievable, that they have the skills needed to achieve the learning goal, and that they have a certain autonomy in progressing towards achievement of the learning goal (Zimmerman 1986).

Gamification

The idea of gamification as a pervasive phenomenon was first predicted by Jesse Schell at the February 2010 DICE (Design Innovate Communicate Entertain) conference. In his presentation called 'The Future of Games', Schell (2010) shared his vision that game elements will gradually encroach upon more aspects of our daily lives until they are ubiquitous. Gamification, in educational contexts, has the goal of increasing student motivation and student learning. While the term 'gamification' is sometimes used to refer to online or mobile games that teachers invite students to play in order to develop skills, gamification is more commonly described as occurring outside the context of an actual game (Di Serio et al. 2014). Gamification asks the question of how non-game contexts can be made more game-like, in order to motivate learners. Game elements are added to a learning environment in an effort to increase engagement and increase behaviour which leads to learning.

Gaming elements

Gaming elements which have the potential to increase motivation and learning, as defined by Kapp (2012) include story, characters, recognition, chance, replayability, aesthetics, time and continual feedback. In the context of this research study, some of these specific elements were chosen as potential motivators and applied to the experience of learning piano in the form of a game-like experience known as 'Technique Tower'. As students practised the piano, they had opportunities to experience game elements including story, replayability, recognition, social sharing and player agency. These elements will briefly be described here, to highlight their motivational potential within proper games, and suggest their potential application as motivational factors in the non-game context of music learning.

Story comprises the elements of characters, plot, tension, resolution and conclusion (Kapp 2012). Learning in the context of story comes naturally,

since the human brain is wired to resonate with narratives (Green and Brock 2000). Learners recall facts more accurately and are prompted to think more deeply when those facts are presented in a story, as opposed to presented in a list (Kapp 2012); these capabilities of story give learners increased opportunities for success (Green and Brock 2000).

Replayability is inherent in video games, thus making failing and trying repeatedly not only commonplace, but expected. Mastery is developed as each game level is repeated and eventually beaten, allowing the player to move on to the next level. This is in contrast to learning environments which are characterized by a finite number of opportunities to acquire skills and demonstrate understanding before moving on to the next unit. For example, if a student receives a mark of 62 per cent on a music test, there is often not time in a structured course to provide opportunities for the student to learn and demonstrate their understanding of the other 38 per cent of the material before moving on to cover the next important topic. Getting it wrong in a videogame is often thought of as exploration and discovery; this reduces players' fear of making a mistake while engaged in a task (Gee 2003).

Recognition is definitely an element of most games, although Kapp (2012) is hesitant to include points, badges and rewards in his list of game mechanics. He is wary of the view that gamification consists only of the awarding of points and badges and maintains that these rewards are actually the least important element of gamification. Kapp (2012) defends these types of rewards, suggesting that in an educational context, awarding points to learners, while allowing them to progress through levels with increasingly prestigious titles such as novice, apprentice and expert, can motivate learners make them feel safe, and result in powerful learning. Points, badges and leaderboards are among the most commonly used game elements (Dicheva et al. 2015; Hamari et al. 2014).

Social sharing has been described as integral to the experience of games. Online games often feature this type of relational experience, and as Gee (2008: 33) explains, 'people find great pleasure, excitement, and fun in organizing themselves into cross-functional teams'. While social competition has been shown to decrease opportunities for student learning (Nebel et al. 2016), social collaboration and sharing can facilitate student engagement and learning (De-Marcos et al. 2016).

Player agency is crucial for enjoyable game experiences; within a game, there are rules and conventions, but within videogames in particular, players often have several choices about where to go next, and in what order to attempt challenges. Agency has been defined by Bandura (2001). This gives players a sense of ownership. As Gee (2003: 34) explains, 'In good games, players feel that their actions and decisions [...] co-create the world they are in and shape the experiences they are having. Their choices matter. What they do matters'. Snow et al. (2015) showed how agency is important for motivation in learning contexts.

These gaming elements, story, replayability, recognition, social sharing and player agency, having been identified as effective means for engaging players, were chosen to comprise the gamification environment in the current study in order to test their effect on student motivation to practise technical exercises.

METHODOLOGY

This research study took place over a nine-week period and involved quantitative inquiries into how a gamified environment might affect students' practice and mastery of technical exercises. A control group of students did not

experience the game elements, while an experimental group did; a comparison of the two groups provided the opportunity to consider the effect of gamification on music learning.

The participants for this quasi-experimental study were recruited from two piano studios in a small community in Ontario, Canada. One studio was my own (Heather), while the other studio was run by one of our colleagues, who will be known as Trudy. Trudy and I, the teacher-researcher, both place a high priority on technique as an integral part of learning to play the piano. When asked to describe her feelings about students practising technical exercises such as scales, chords and arpeggios, the participating teacher's answer echoed the perspective described in the Introduction section:

> It's a necessity; it's part of taking lessons that gives you the skills, tools and ability to play the pieces you want to play. If you want to play Für Élise, you'll have to know how to play all the arpeggios and chords in e minor. [My students] don't have an option. I don't present [technique] as a negative or a positive thing. I just present it as: this is how you learn to play.

Another similarity between Trudy and I is that we both make use of the Royal Conservatory of Music (RCM) graded curriculum in our piano teaching. The RCM is a widespread, highly respected instructional program which represents a levelled approach to music learning. This type of approach is ideal for the context of this research study since it provides an indication of a student's progress as a music learner and specifies a sequential order in which technical exercises should be learned, detailing which keys and exercises should be mastered at each grade level. The student participants in this study, aged ten through seventeen, were organized into categories according to their level of experience playing the piano. In the Beginner Category (RCM Preparatory – Level 1), there were eight participants, while the Early Intermediate (RCM Levels 2–4) and Advanced Category (RCM Levels 5–9) each had six participants. These categories were defined based on the time commitment necessary for mastering technical exercises at different RCM levels.

The student participants were cross-assigned randomly to either the control or the experimental group. Group 1 (Control group) practised technical exercises in a non-gamified environment, while Group 2 (Treatment group) had gaming techniques implemented in relation to their practice of technical exercises. Throughout the duration of the research study, data were collected about the participants' mastery of technical exercises on the piano. In order to determine whether mastery had been achieved, the teachers in the study used a performance measure rubric (see Appendix). This rubric was designed in consultation with three additional music teachers in order to help establish content validity. Ideas were pooled in order to come up with a comprehensive list of characteristics which would comprise mastery of technical exercises such as scales and triads. The rubric provided clear direction for students who needed to know how to achieve mastery, as well as a common reference point for teachers to assess mastery. In addition to counting the number of technical exercises that were mastered by students, the attitudes of participants were also measured in order to provide a broader picture of student motivation in the context of the study. The primary independent variable was *type of instruction*, with participants being divided into two groups of ten students each.

Procedure

Group 1 (Control)

Participants in Group 1 were assigned one key at each lesson, for example, C major or F minor, and were expected to spend one week practicing all the technical exercises related to that key that are specified in the RCM curriculum for their particular level. At the following week's lesson, the student was asked to play those technical exercises for the teacher, who used a performance measure rubric to determine whether mastery was achieved for each exercise. If students achieved mastery in any or all of the technical exercises they had practised throughout the week, the teacher provided positive verbal feedback and recorded the results; the teacher then asked the student to move on to another key for the next week. If the student did not achieve mastery in all the exercises, that same key was assigned for another week. After two weeks, whether full mastery was achieved or not, a new key was assigned.

Group 2 (Experimental)

Group 2 received the experimental version of technical exercise instruction, that is, gamification. During Week 1, participants were introduced to the gamified environment, which was known as Technique Tower. Figure 1 illustrates a screenshot of a student's webpage and depicts an image of a tower with seven rows of windows. The purpose of the webpage is to depict the figurative climb up the tower which the student accomplishes through receiving points, and levelling up, indicated by the 'lights' turning on at each level, along with a virtual trophy appearing. Bonus stars, another type of achievement, were surprises awarded by teachers for other impressive musical achievements.

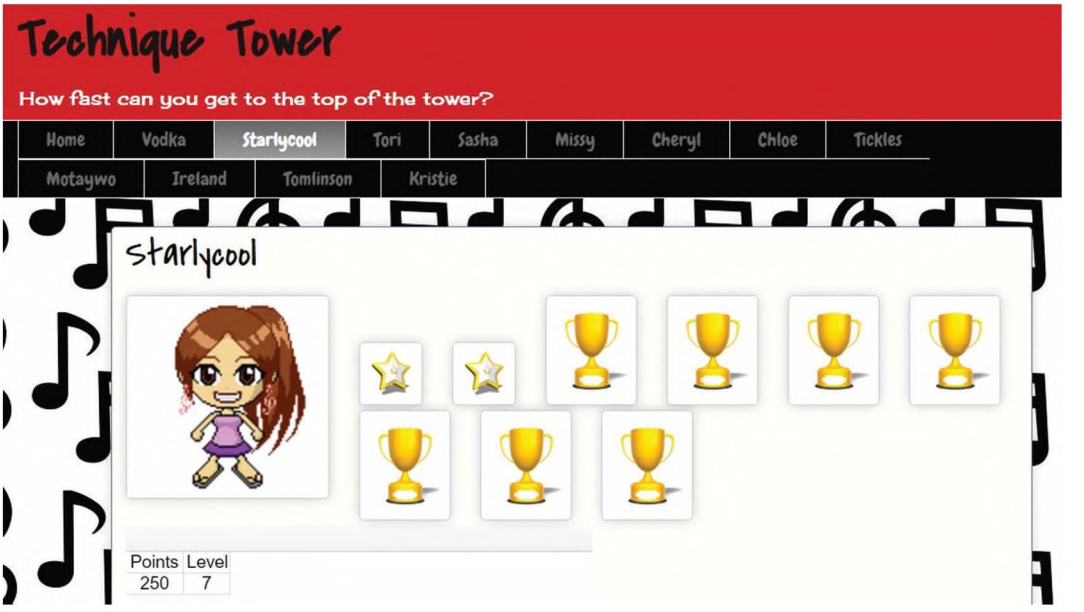

Figure 1: Screenshot of a Technique Tower webpage – Alias 'Starlycool', http://technique-tower.blogspot.ca/p/starlycool.html.

Points, trophies and stars were earned as the result of mastering designated technical exercises and are the way in which the game element of recognition becomes part of the experience of music learning. Starting at the bottom of the tower and gradually moving towards the top represent the game element of narrative; this gives students a story to be part of as they learn to play technical exercises, in contrast with achieving mastery over exercises as they move through a list of tasks to practise. In addition, each student's webpage featured an avatar and an alias which represented them, suggesting the narrative element of character.

Game players were given a comprehensive chart detailing all of the specific technical requirements for their grade level, and players were encouraged to choose any technical exercise to work on at any time, in any order. This chart was provided as a way to maximize student agency with regard to technical exercise practice, mimicking the game element of player agency.

Once participants mastered a technical exercise, an audio recording of that exercise was created using a mobile application called SoundCloud and uploaded to the player's web page for parents, other students, teachers and members of the public to listen to and comment on (see Figure 2). This design element of the webpage was intended to provide students with opportunities to share their success with others, as would happen readily within a game context.

Data collection

The teachers in this research study kept track of the progress of students in both the control and experimental groups by documenting information on a record sheet designated for each music learner. This record sheet indicated the student's assigned ID number, gender, age, Royal Conservatory grade level and e-mail address. Throughout the research study, teachers logged which technical exercises students played, along with a rating indicating whether each exercise was mastered. Subsequently, the weekly point total for Group

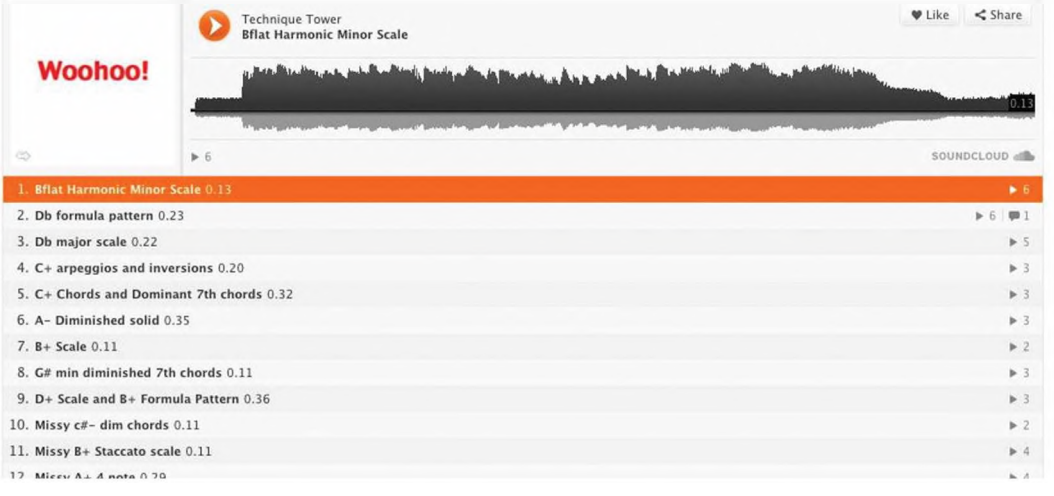

Figure 2: Playlist of technical exercises a player has mastered embedded on her webpage, http://technique-tower.blogspot.ca/p/missy.html.

2 participants was entered into an online spreadsheet which automatically updated each player's webpage to reflect their achievements.

The attitudinal measure consisted of an online questionnaire which was administered at the end of the study and featured ten statements which participants responded to by choosing from five-point Likert scales. The statements were developed by the researcher, who invited feedback from three other music teachers regarding their potential to effectively gauge students' attitudes towards practicing technique. A consensus was reached concerning the questions on the scale and their ability to provide insight into student attitudes.

During the final week of the study, participants in the treatment group were invited to fill out an additional survey which featured ten questions designed to elicit information about the nature of gamified environment experience. Not all participants chose to fill out the survey, but those who did were asked to describe the range of feelings they experienced throughout the playing of the game, and then to rate the game in the areas of fun, fairness and effectiveness. They were also asked to comment on their perception of experiencing technique flower.

RESULTS

Mastery of technical exercises

The hypothesis that the participants in the experimental group, as a result of the gamification environment, would master more technical exercises in a nine-week period than the participants in the control group was tested. The Mann–Whitney U-test was chosen to compare the difference in the achievement scores between the groups, since it is well-suited for use with small sample sizes, that is, five to twenty participants (Nadim 2008). Proportional achievement scores for the experimental group ($Mdn = 0.99$) were higher than for the control group ($Mdn = 0.32$). A significant effect of group was found, with the mean rank of the Control Group being 6.4 and the mean rank of the experimental group being 14.6; $U = 9.0$, $p = 0.002$. Figure 3 illustrates the total number of exercises mastered by each group, showing that according to these results, gamification does have a positive effect. While the number of students in this research study limits the generalizability of the results, this specific case suggests that over the short term, piano students who learn technical exercises in a gamified environment master more technical exercises than those who are not in a gamified environment.

Effects on attitude

At the end of the study, to determine whether gamification had an effect on attitudes towards practicing technique, Likert scale data were collected and summed to represent each participant's attitude (ATT) score. Again due to small sample size, the non-parametric Wilcoxon signed-rank test was performed to compare the ATT scores of the control and treatment group, assuming that if gamification had an effect, a significant difference would be detected. However, the test did not show a statistically significant difference between the ATT scores of the control and experimental groups. A marginal effect was indicated, with the mean rank for the Control Group being 7.9 and the mean rank for the Experimental Group being 11.1, $z = -1.29$, $p = 0.198$.

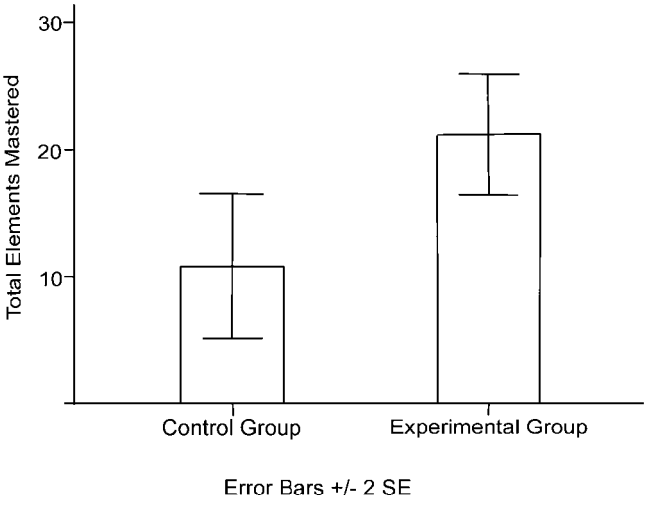

Figure 3: Achievement scores showing the number of technical exercises mastered.

Student experiences

To assess whether the experience of playing the game Technique Tower was perceived to be enjoyable and effective by the players, an online survey was conducted. This survey was optional for the ten participants in the treatment group, of whom eight chose to participate. Positive comments about the game written by players included, 'We LOVE teqnice [sic] tower!!!!!:)', and 'This game is really fun We like it'.

One of the survey questions invited participants to rate the Technique Tower game by assigning various scores out of 10. The mean fun score was 7.67, *SD* = 2.29, the mean fairness score was 8.00, *SD* = 2.06 and the mean effectiveness score was 7.75, *SD* = 1.83. Participants were also asked to select which of the following emotions, if any, they felt when they received points, beat a level or earned a trophy in the game: happy, powerful, safe, selfish, strong, confident, greedy, sad, confused, competitive, excited or angry. Happy was mentioned seventeen times, followed by excited, ten times; confident, eight times; competitive, five times and strong, four times. Proud and powerful were also mentioned once each.

DISCUSSION

The main purpose of this study was to discover the effect of gamification on piano students' motivation to practise technical exercises, and on their attitude towards this type of practice. As described above, student motivation was measured by tracking achievement, since motivation to practise a musical instrument is closely linked with achievement levels (Schmidt 2005). In this particular study, gamification was found to have a significant positive effect on the number of technical exercises students mastered, while students' attitudes towards practicing technique showed a modest positive effect. Students' experiences in the gamified environment were largely positive, although not all of their descriptions were favourable.

Increased mastery of technical exercises

Gamification had a positive effect, with students in the experimental group attaining mastery of significantly more scales, chords and arpeggios than those in the experimental group. This research suggests that, in order to motivate piano students to practice technique, using gamification might be an effective motivator. These findings concur with studies in other learning contexts about the ability of game elements in non-game context to influence student motivation and student learning (Burguillo 2010; Shin et al. 2012). The Technique Tower website was designed as an online environment that tracked students' mastery of technical exercises and shared their accomplishments with them and their families. Each game webpage displayed a player's username and avatar, along with their current point total, level and earned bonus stars and trophies. In addition, the webpage functioned as a hub for collecting artefacts that represented players' progress. Some of the game elements which were part of Technique Tower that may have contributed to increased achievement levels in players include story, replayability, recognition, social sharing and player agency.

Story

Admittedly, the game used in this study did not feature any tension and resolution, two crucial ingredients of story. However, it did feature characters, a simple plot and a conclusion. Each game player was represented online by a character which they named and designed using an avatar creation website (AbiStudio.com). Some of the avatars designed by the players in this game appear in Figure 4. Each of these game characters began at the bottom of Technique Tower and gradually climbed up by earning points and levelling up. Figure 5 shows Technique Tower with varying degrees of achievement depicted; the ultimate goal was to beat all seven levels and reach the top of the tower.

Replayability

Technique Tower players spent time practicing technical exercises; they worked towards earning points by playing exercises for their piano teacher during the first five minutes of each lesson and having the teacher rate them as mastered. Realistically, this short time period was not long enough for a player to repeat a scale an unlimited number of times. However, if players did not demonstrate mastery on the first try, they could continue practicing it at home and play it for the teacher each week until they achieved mastery and earned points.

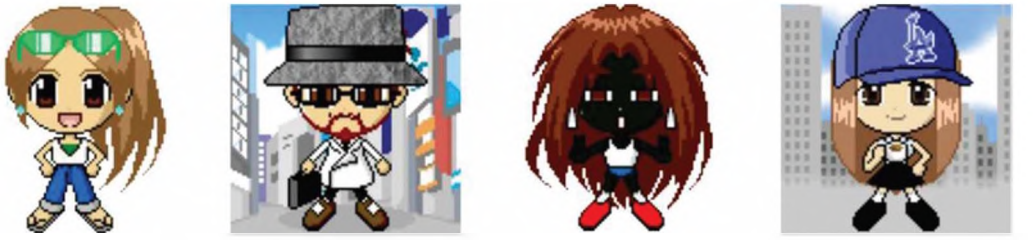

Figure 4: Selection of avatars designed using Otaku Avatar Maker, © AbiStudio.com.

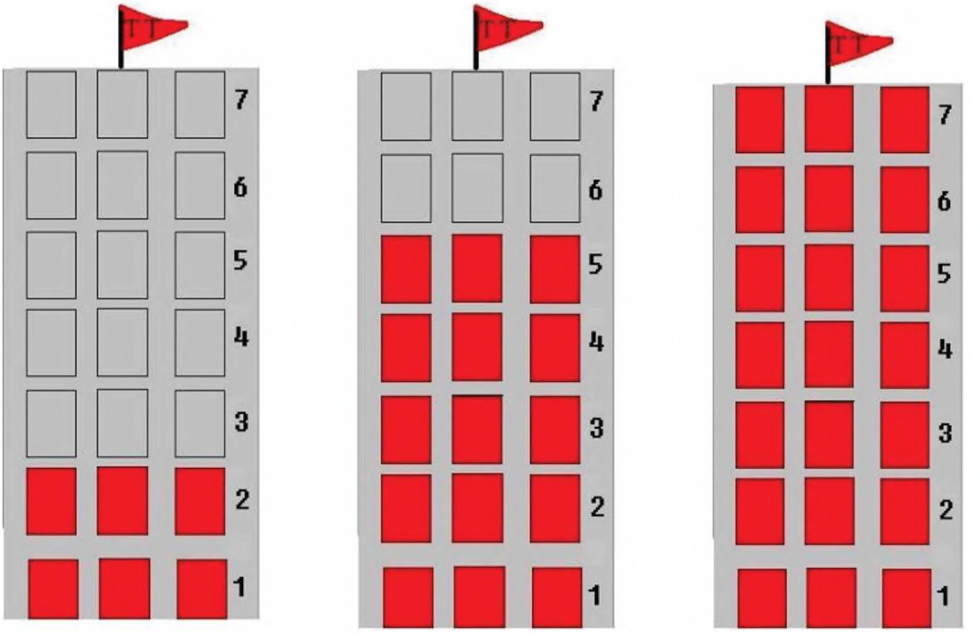

Figure 5: Three iterations of technique tower depicting various levels achieved.

Recognition

Technique Tower rewarded players with ten points for each technical exercise they mastered, and a certain number of points resulted in the earning of a virtual trophy. The point score and number of trophies for any player could be viewed on their webpage which tracked their progress in the game. Weekly e-mail updates about players' progress were sent as notifications and reinforcements of the rewards given. While players could compare their personal progress with others' in the game, all players had the opportunity to 'win' the game or to complete the game by achieving the maximum number of points and reaching the top of the tower.

Social sharing

The social context of Technique Tower was provided by the online webpages which tracked players' progress and provided opportunities for visitors to leave audio and text comments. This online context was designed to shift the students' achievements from the confined environment of a one-on-one piano lesson to an open platform, accessible by anyone, but in particular by the students' family and other students in the studio. While crossing paths between piano lessons, game players were heard discussing their progress with fellow students, and eagerly showed their webpages to one another, using their phone or iPod.

Player agency

Technique Tower supported autonomy and student agency over choices by encouraging players to learn to play technical exercises in any order. While a non-gamified approach to learning technical exercises may be sequential,

with direction by the piano teacher, the gamification environment in this study gave control to the student in an effort to encourage ownership and decision-making.

Marginal attitudinal effects

Attitude was marginally affected by gamification. Over the course of the study, levels of the participants did increase within the experimental group which received the gamified condition. Perhaps the limited length of the study was a factor which inhibited gamification from effecting a significant influence. Extended exposure to music learning, and a series of successful achievements over years of piano study, might reveal more robust attitude changes. Then again, perhaps an extended experience within the gamified environment might also negatively influence music learners' attitudes towards practicing. Nonetheless, on the basis of this research study with a small sample size, a difference in attitude towards practicing technique can cautiously be accounted for by gamification. If gaming elements can indeed positively affect even some piano students' attitude towards technical exercises, this is a powerful finding. The positive attitude a student has towards technique has the potential to stay with them long after the game is over, throughout months or even years of piano study. While achievement levels may only be affected while the gamification environment is present, positive attitudes may be a lasting legacy. Further research is needed to test this hypothesis.

Mixed student experiences

Student participants rated Technique Tower fairly high on fun, fairness and effectiveness. Several positive comments were heard as students excitedly shared their progress with their colleagues, sometimes with reference to how many technical exercises they had mastered, and other times with mentions of how far up the tower they had travelled. Positive comments about Technique Tower which were written by students on the final survey included, 'I think this game is fun and educational for people to practice and achieve our goal/level. I hope this game will last forever!!' (Kristie, age 10), 'I am proud' (Sasha, age 9) and 'When I get to the top of Technique Tower, I will say I'm king of the tower!!!!!!!!:)' (Motaywo, age 14).

However, not all of the reactions to Technique Tower were so affirmative. One participant, Cheryl, indicated that she felt happy, excited and powerful when she earned points, but when asked about the effectiveness of the game for getting students to practise technique, she wrote, 'It's sort of not a good way to get them to practice because you don't actually get the real trophies'. A follow-up question about whether she would practise more if she got real trophies elicited a bold 'Yes!' Another scenario which revealed a mixed reaction to Technique Tower occurred when Chloe successfully reached the top of Technique Tower. After practicing a lot to master each technical element required for her grade level, she was invited to play again to help motivate her to practise the technical requirements for the following grade level. She declined and said she would rather just practise the next grade-level technique in the regular way, instead of playing Technique Tower. When asked why, she said she was not sure.

Missy, age 17, reported feeling happy, confident and excited when she received points in the game. Yet, she also expressed frustration that in order to climb the tower, she had to master longer and more difficult technical exercises than some other students in her studio who were in less advanced levels. In addition, Missy, as well as other participants, expressed either confusion or resentment when the points on their webpage did not immediately update to reflect their achievements.

The piano teachers in this research study found that while the motivational benefits to practicing may have been valuable for students in the experimental group, the extra time commitment required to keep track of students' points and update individual webpages was difficult to maintain. After the nine-week study, an invitation was extended to continue facilitating Technique Tower; however, the participating piano teacher, Trudy, was not inclined to do so. The teacher–researcher (Heather) also felt that the manual labour required was onerous, and even at times, threatened the teacher's ability to remain absolutely focused on students' playing and student learning within the weekly lesson. Increased achievement levels in the context of the gamified environment definitely suggest the potential for this type of initiative in the context of piano practice; however, automated solutions are more realistically useful to teachers for long-term use.

CONCLUSION

The findings from this study are applicable to private piano teachers who seek to motivate their students to practise technical exercises more often and more regularly. They may benefit from the use of gamification to increase student motivation to practise technique. Parents of private piano students may also be interested in how elements of gamification can influence their child's piano practice time and experience. Ultimately, students can benefit from a gamified environment if their playing improves based on their increased practice of technical exercises. As Starlycool, age 12, described, 'As soon as you've got the chords and the scales you can play songs a lot easier'. While this study represents data collected from private piano studios, it is likely that the results could be used as a model for studios which provide lessons for other instruments such as guitar, violin or flute. It may also provide a model for other scenarios in which student learners must spend time outside of class to consistently practise skills to gain mastery, such as home reading programs designed to develop reading fluency and numeracy programs designed to increase accuracy and speed of math facts recall.

Overall, this study has shown that gamification can be successfully implemented in an educational context. Further study is necessary to determine the long-term effects of gamification on students' piano practice and to isolate and identify specific gaming elements which may maximize student motivation and achievement. If a web or mobile application can be developed which automates the process of gamifying technical exercise practice, this will more easily be adopted and enjoyed by both piano teachers and students.

APPENDIX PERFORMANCE MEASURE RUBRIC

Group 1	Learning	Almost there	Got it
Group 2	Recruit	Veteran	Master
Posture and Hand Position	Slumps back, tension in fingers, hands or forearms, flattens fingers	Tension or incorrect hand position may arise at times during the exercise; elbow, wrist and hand may not consistently rotate freely as needed	Sitting up straight, forearms straight, curved fingers, moves fingers up higher on the keys when needed to facilitate natural hand shape, hands and forearms are relaxed; elbow, wrist and hand rotate freely as needed
Notes	Some incorrect notes	Correct notes are known but not always reached on the first try	Notes are correct
Fingering	Problematic fingering causes errors, unnatural hand position, accuracy or rhythmic compromises	Recommended fingering is known but not always used on the first try; challenging finger stretches or tucks cause slight hesitation	Recommended fingering is used; challenging finger stretches or tucks are done seamlessly
Tempo	Minimum tempo is not yet reached	Tempo is close to the required speed	Minimum tempo (or faster) is played evenly
Rhythm	Rhythmic inconsistency, or rhythmic pulse is not evident	Rhythm is mostly even with slight inconsistencies, or rhythmic pulse is not consistent	Rhythm is even, with a good musical pulse
Tone	Tone is uneven or fuzzy (notes overlap)	Tone is mostly even, or tone is rigid	Tone is balanced, clear and even; the exercise is shaped with a slight crescendo on the way up and diminuendo on the way down
Articulation	Legato or staccato touch is not evident	Legato or staccato touch is not consistent	Legato or staccato touch is effective

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