The application of gamification in developing an innovative mobile app for music tuition

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ABSTRACT
The ascent of technology as well as the use of computer based learning in the teaching and learning environment plays an important role in the consideration of the use of technology as an aid in music tuition. My development of an interactive application for music tuition (PianoBoost), is the result of a need to address the issue of learners not knowing the basic concepts of music notation. Concepts such as identifying single notes and note patterns as well as the transition of written music to the performance thereof are challenging for beginner learners of any age. Research was done on important aspects in the designing of an app, and terms such as gamification, computer based learning and blended learning stood out as central to this investigation. The Four Pillars of learning of Hirsh-Pasek and his colleagues, and the game mechanics of Lee and Hammer were used as guide lines to develop this app to use as an aid to traditional music tuition. Innovative aspects of the PianoBoost app that distinguishes it from other existing music apps are that it has instant note recognition, the learner gets real-time feedback, a real piano is used as well as the indication of the correct notes. This app can help students learn music notation on their own so that precious time in the teaching environment can be utilized for other pedagogical purposes. The app was launched on Google Play in January 2017 with positive feedback from pedagogues and students alike.

Author Keywords
Gamification, blended learning, app development, technology and education, threshold concept

INTRODUCTION
Many piano teachers know the frustration of having a learner come to a lesson not having mastered their notes. Not only is the recognition of note patterns a problem but also the transition of the written music to the performance thereof. Teachers try to overcome this problem by writing in finger numbers or demonstrating what it must sound like. This, however, exacerbates the problem and causes children to not make an effort to learn their notes, which results in frustration as a result of not being able to play any music they want, and a waste of lesson time, because the actual goal of making beautiful music is seldom reached.

Two groups of learners are in question, namely piano learners of any age, as well as prospective university students with limited knowledge of the rudiments of music. The latter include talented, previously disadvantaged learners\(^1\) from rural areas, who did not have the opportunity to attend music lessons, nor the luxury of having instruments to practice on. Devroop (2009, p. 7) blames the school system, because there are no instruments to practise on. Music programs have been abolished in favor of mathematics and science since 1994\(^2\) and ‘lack of facilities, curriculum constraints, lack of suitably qualified teachers and little to no financial resources to support music programs’ have been a given (Devroop, 2012, p. 3).

Learners are used to the use of technology and electronics (Corr, 2006), as well as being relatively over-stimulated all the time. In this article I propose a possible solution in the form of the incorporation of a new interactive app, PianoBoost, that can aid piano learners in the process of learning notes. I developed this app based on core elements that are discussed in this article. I have situated my research in a few contexts, namely the identification of a threshold concept that forms the core off the functionality of the app, computer based learning, blended learning, gamification, as well as the characteristics

\(^1\) Due to the Apartheid regime in South Africa a term was coined, namely previously disadvantaged people. This refers to people and their descendants who were part of the struggle and did not have all the opportunities that white South Africans had.

\(^2\) 1994 is seen as a water shed date in South Africa, since this is the year that Nelson Mandela was elected as President, and Apartheid was finally abolished.
and game mechanics of a good app. What I want to establish is that the use of technology and applications\(^3\) in the music lesson, can add value to good teaching.

**THRESHOLD CONCEPT**

In 2003 Jan Meyer and Ray Land published the paper, *Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practising within the disciplines*, which enriched the literature of higher music education. In their own words:

> A threshold concept can be considered as akin to a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. (Meyer & Land, 2003, p. 1)

In layman’s terms, this means that when a concept, previously incomprehensible, is understood in terms of a person’s own frame of reference, it can improve the meaning of the concept, as well as the way he/she thinks about it. A threshold concept is therefore a core concept/building block that is important in order to help understand the content at hand. It is also important to define concepts which are essential in understanding how a discipline sees the world and construct knowledge. This is essential to my argument that knowing the music notation is essential in mastering the discipline of music.

A threshold concept has certain characteristics, namely transformative, irreversible, integrative, bounded, and potentially troublesome (Meyer & Land, 2003, p. 4). *Transformative* implies that ‘…once understood, its potential effect on student learning and behavior is to occasion a significant shift in the perception of the subject or part thereof’ (Meyer & Land, 2003, pp. 4-5). What is meant by *irreversible*, is that once someone’s perspective has been changed, the threshold concept is unlikely to be forgotten, and *integrative* encompasses the exposition of the ‘previously hidden interrelatedness of something’ (Meyer & Land, 2003, pp. 4-5). *Bounded* refers to the sense that any ‘conceptual space will have terminal frontiers’ that may border on other threshold concepts. *Potentially troublesome* refers to the fact that concepts may be troublesome and ‘students may have to wrestle with a concept in order to grasp it’ (Tucker, Weedman, Bruce, & Edwards, 2014, pp. 153-154).

In the field of music a few threshold concepts can be identified, such as rhythm, music terms, metre or phrasing. However, one concept stands out that fits Meyer and Land’s definition of a threshold concept of ‘understanding, or interpreting, or viewing something without which the learner cannot progress’ (Meyer & Land, 2003, p. 1) This concept is music notation which is the central building block of any instrumentalist’s music tuition.

The five characteristics of a threshold concept mentioned by Meyer and Land, can be applied to music notation in the following manner. In terms of *transformative*, once one understands music notation, it causes a shift in the perception of reading music and one reads and plays almost any piece of music within one’s reach and technical capacity. When we look at *irreversible*, it can be said that once one knows the names and positions of the notes, one will not forget them again. Music notation stands in a close relationship with other music concepts that will be grasped and *integrated* once one knows one’s notes. In the same sense the concept of music notation bordering on other threshold concepts such as rhythm and metre – hence we can say that it is *bounded*. The only way in which music notation is *potentially troublesome*, is in the difficulty to initially grasp the concept of abstract symbols.

In the initial planning stages of the *PianoBoost* app, it was important to first identify the threshold concept before continuing with the process of developing the app. Computer based learning was identified as being a core element in planning and developing the app.

**COMPUTER BASED LEARNING**

The year 2008 can be seen as the beginning of a new era when the Apple app store launched its first 500 apps (Hamburger, 2011). In 2016\(^4\), 155 countries had access to an app store and 342 000 apps were downloaded per minute (Harney, 2016). Statistics in January 2017 revealed that Apple App store has 2.2 million apps (Israel, 2017) and Google Play store 2.8 million\(^5\). Android users installed 65 billion apps in 2016 alone (Slatt, 2016). One cannot imagine a time when one did not have an app for almost anything in daily life: from ordering food from the local chain store to doing bank transactions from the comfort of one’s living room.

**Blended learning**

An outcome of computer based learning is blended learning – also known as hybrid or mixed-mode learning (Mayadas & Picciano, 2006, p. 4; Graham & Dziuban, 2007, p. 270). Graham (2006) describes blended learning as a ‘…convergence

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\(^3\) From here on further the word *app* will be used, since this abbreviated term is generally in use.

\(^4\) Unfortunately I could not secure statistics for 2018.

between face-to-face and technology mediated learning environments.’ Dwaik, Jweiles, & Shrouf (2016, p. 1270) goes a step further by saying that the blended learning approach creates an ‘…innovative teaching-learning methodology that increased the effectiveness of the teaching-learning situation and offered new opportunities for the creation of an interactive learning environment’.

Blended learning does not require the teacher and learner to be in the same space at the same time (Graham, 2006, p. 270). Dwaik et al. (2016, p. 126.127) remind us of the fact that, traditionally, the teacher was the most important figure in the classroom due to him/her imparting knowledge, and the learner passively received all the facts. However, e-learning6 and blended learning started to change that and gives the learner the role of participator and researcher, embracing their diverse learning styles and enable them to work in their own time and at any location.

Applying blended learning to the music lesson situation, it makes sense to use apps such as PianoBoost so that one may use the app at home and not necessarily be at a place where one needs the teacher to acquire knowledge.

Gamification
Another concept that forms part of computer based learning is gamification – a fairly new term that was coined to describe the process where game mechanics are being applied to non-game activities in the education situation (Gomes, Figueiredo, Bidarra, & Gomes, 2014, pp. 257-258). Some of the core aspects of gamification are solving problems (Zichermann & Cunningham, 2011), ‘sense of engagement, immediate feedback, feeling of accomplishment, and success of striving against a challenge and overcoming it’ (Kapp, 2012, p. xxii). In the United States more and more instructors at universities are engaged in the exploration of gamification as an aid to teaching (Armier, Shepherd, & Skrabut, 2016).

When applying gamification to the teaching and learning environment it means that game mechanics are being integrated with learning activities and that apps are not only for entertainment value anymore, but can be used as a powerful aid in interactive learning activities and ‘foster creativity and long term knowledge’ (Gomes et al., 2014, p. 259). Sturgis (2016, p. 1) confirms this by saying, ‘As technology that supports gamification becomes more accessible many universities are infusing their courses with game mechanics and alternate reward structures to enhance learning among the generation of digital natives’.

This is what I wanted to accomplish with PianoBoost. It works like a game and if the learners can have fun while playing it, they will not even know that they are learning, hereby ensuring that the gaming element fits with the music element. The concept of learning brings us to the next section, namely computer based learning in the education situation.

Computer based learning in education
Smith (2015, p. 1) is of the opinion that the divide between games and the classroom has been narrowing in recent years. Technological approaches do equally well or better than more conventional teaching. According to Lam, Yau and Cheung (2010, p. 306) universities are now more likely to accept technology as part of the curriculum in an attempt to ‘improve learning outcomes’. Voogt, Erstad, Dede and Mishra (2013, p. 406) add that technology has the potential to change pedagogy and improve student learning. Schrand (2008, p. 84) suggests that we have to involve learners by letting ‘…them work with well-designed ‘games’ instead, where they can experience the sense of discovery and play that often accompanies meaningful learning’. There is a notion to move away from laptops and desktop computers to handheld devices such as smart phones and tablets for the use of technology and student centred activities in the classroom. In Zhang and Liao’s (2015, p. 64) words: ‘People enjoy the life on fingertips’.

Advantages of using technology
The advantages of computer based learning are well documented. Rochelle, Pea, Hoadley, Gordin and Means (2001, pp. 4-5) are of the opinion that computer based applications can ‘enhance learning for students at various achievement levels’. From the teachers’ perspective technology saves time that can be used to focus on other aspects. The use of technology can also accelerate the rate of learning, and reduces costs associated with instructional materials. Seen from the students’ perspective, it can enhance abilities, make learning meaningful, and let them work at their own pace, as well as assist them to ‘achieve higher learning outcomes and form a more positive attitude toward learning’ (Volman & Van Eck, 2001).

Independent learning
Zhang and Liao (2015, pp. 62-63) confirm the fact that apps can help one to improve one’s learning ability, because one can study anywhere and any place. Hirsh-Pasek, Zosh, Golinkoff, Gray, Bobb and Kaufman (2015, p. 4) add to this by stating that ‘Apps present a significant opportunity for out-of-school, informal learning when designed in educationally

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6 eLearning is the use of electronic technology to deliver, support and enhance teaching and learning or the use of multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services, as well as remote exchanges and collaboration (Mobbs, 2007).
appropriate ways’. Rochelle et al. (2001, pp. 6-7) came to the conclusion that children must be more actively involved in the learning process, and this can be accomplished through the use of technology.

**Immediate feedback**

The advantages of immediate feedback cannot be emphasised enough (Ritshaupt & Kealy, 2015, p. 525; Stuart, 2004). Not only does this give the learner immediate satisfaction, but the learning process is accelerated. Roschelle et al. (2001, p. 7) corroborate this by stating that ‘…learning proceeds most rapidly … when feedback on the success or failure of an idea comes almost immediately’. Using technology can accomplish this in three ways; computers and handheld devices can encourage rapid feedback, learners can work on computers for extended periods, and computer programmes can be programmed to immediately analyse the learners’ performance (Roschelle et al., 2001, pp. 10-11). Phillips and Popović (2012, 27) also comment on the immediacy of feedback when saying, ‘Gaming technology can enable personalized learning by immediately showing students where they’ve gone wrong and repeating levels as necessary’.

From the literature study I have established the fact that apps are beneficial for the mastering of a concept. The question is how to develop such an app and what must form part of it to be described as functional and effective.

**DEVELOPMENT OF AN APP**

Triantafyllakos, Palaigeorgiou and Tsoukalas (2008, p. 125) call the process of app development ‘challenging and complex’. The needs of the consumer are regarded as the most important aspects in designing an app. Triantafyllakos et al. (2015, p. 126) describe it as a twofold process of ‘…identifying the users’ needs and finding an optimal way of fulfilling them’.

Hirsh-Pasek, Zosh, Golinkoff, Gray, Bobb and Kaufman (2015, p. 4) state that app developers are influenced by ‘current trends in technology and design, their own interactions with technology, and their experiences and intuitive sense of how learning happens or what children will find enjoyable’. They also have ‘clear learning goals’ in mind when developing a new educational app (Hirsh-Pasek et al., 2015, p. 7). According to Lee and Hammer (2011, pp. 2-3) the following are some of the most common game mechanics that must be included in apps: a point system that can serve as motivation, levels, challenges/achievements, and leader boards.

Hirsh-Pasek et al. (2015, p. 7) believe that there are four ‘pillars of learning’ or core concepts that need to be part of the development of any good educational app. These are that learners need to be actively involved and engaged, that they must have meaningful experiences, and that the app should be socially interactive. ‘Active learning’ means that learners do not merely listen or observe, but actively engage in a situation. ‘For cognitively active learning to occur, there must be more than mindless, stimulus–response reactions to on-screen actions’ (Hirsh-Pasek et al., 2015, p. 10). When applying this to the development of an app it means that the learner must be able to interact with content on the screen either by means of selecting options or consciously making decisions that will influence a next step. ‘Engagement’ entails that the learner will stay on the task at hand (Hirsh-Pasek et al., 2015, p. 11). This means that the app must be interesting and challenging so that the learner’s mind will not wander off, but stay engaged. The term ‘meaningful learning’ is described as ‘…learning with a purpose, learning new material that is personally relevant, and linking new learning to pre-existing knowledge’ (Hirsh-Pasek et al., 2015, p. 13). When applying this knowledge to app development one needs to think about the core concepts that need to be learned and the connection of those concepts with everyday experiences. The last pillar, namely ‘social interaction’ can be accomplished by playing on-line, putting results of the game on social media and competing against each other.

**THE PROCESS OF DEVELOPING Pianoboost**

The project of developing my own app commenced around three years ago. I was frustrated with my piano learners who did not know their notes and I wanted to find an alternative to traditional piano methods. Computer based learning was my point of departure. I started conducting research regarding technology and music, development of apps, teaching strategies, and available apps on the app stores. I could not find anything similar to my idea of an interactive app with immediate feedback. I came to the conclusion that it is possible and plausible to develop my own app to address the threshold concept (as suggested by Meyer & Land, 2003) of learning music notation. The learning objectives of the app would not only be to let learners acquire sufficient knowledge about recognising and playing all the different music notations, but also to let them have fun while doing it, as suggested by Isikoglu (2003, p. 27) and Yelland (2011).

The actual process of getting this done, was extremely more intricate than coming up with the idea. Since I am a music teacher and clueless regarding coding, I contacted a developer of an existing, well-functioning music app. They were situated in London, and after receiving the quote I came to the realisation that the exchange rate linked to the poor

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7 [https://info.dynatrace.com/rs/compuware/images/Mobile_App_Survey_Report.pdf](https://info.dynatrace.com/rs/compuware/images/Mobile_App_Survey_Report.pdf)

8 Adding levels to an app can add educational value. In the words of Phillips and Popović (2012: 27), ‘By requiring students to demonstrate mastery before moving to the next level, games cultivate student persistence, an essential component of learning’.
performance of the South African rand as well as the distance and a lack of possible physical contact, does not make this a viable option.

I got hold of a local technology expert, but his workload as a full-time lecturer, did not give him the opportunity to live out his hobby/dream of developing apps. I did however get valuable information from him regarding note detection which was my main concern and biggest problem to solve. Not only did the app pick up any background noise, it was also a problem if the piano was not hundred percent in tune. I was however adamant that an acoustic piano must be used and not a keyboard to expand the possible app users. (Note detection on a plug-in keyboard is easy because of the fixed tuning.)

I did some research and got hold of a company in Cape Town. They promised positive results, but after losing a lot of money I realized that they only used me as a monthly income and was not dedicated to finish the job any time soon. After a visit to them, and seeing their feeble attempt to satisfy my needs, I kindly terminated our working agreement. I was really disillusioned and weary of any company that promised to deliver the goods.

I was introduced to an amazing team with excellent work ethics by a friend. They were open and honest and told me that if they could not perfect note detection we will abort the project before I spend too much money. This gave me hope and I felt that I could trust them. Note detection was indeed established (perfected to each octave on the keyboard) and they built in a variant to compensate for a piano that was slightly out of tune. From here the detailed work began. I had to plot out a road map as well as content for every screen and any possible pathways from and to that specific screen. We included a page regarding functioning of the app as well as tutoring pages for those who did not now music at all. I had to think about every single detail like the color scheme, duration of the appearance of the note on the screen, amount of levels and information to be included on the score board.

More gravitated decisions include developing it for Android or iOS. The choice felt on Android because it was a bit less difficult to develop, and at that stage research suggested that more people own Android than iOS devices, and it was less expensive to put it on the Google Play store. The app was completed and we had a test run with several users to look for any glitches. After we were satisfied with the results, the app PianoBoost was launched on the Google Play store in January 2017. It was one of the best feelings I ever had. We also had to decide on the pricing structure: will it be a free download; a fully paid app with all levels included or will it be an initial free app with in-app purchases. The decision was made to make it a free download because, amongst other reasons, 81% of existing apps are free downloads. The market is, therefore, very competitive and my main idea was to help learners and add value to the music lesson and not to make a profit. Another reason is that I first needed to establish a name for myself and for the ‘Boost’ domain. If people download this app and they like it, they will be more likely to download a next app developed by me. I still want to develop similar apps for other instruments like GuitarBoost or ViolinBoost. Preliminary market research also identified the need for apps helping learners with rhythm and aural training. Therefore, apps such as RhythmBoost and AuralBoost are still part of future endeavours.

Functionality of the app
PianoBoost\(^9\) helps any learner to learn music notation. It works like a game and is divided into different levels. A note is shown on the tablet or cell phone, and the learner has to play it on a piano or a keyboard. The app will give immediate feedback by indicating whether the execution by the learner was correct or not. If incorrect, the correct position on the piano is displayed. Prompt feedback is advocated by Roschelle et al. (2001); Ritzhaupt and Kealy (2015), as well as Phillips and Popović (2012). Although this app was developed for piano, it can also be used for other instruments.

Appearance
The interface has colourful imagery, because research shows that colour and concrete images can have a positive influence on the learning experience (Carney & Levin, 2002; Ritzhaupt & Kealy, 2015). The notes are written on a complete staff with a treble and bass clef, as well as bar lines, in order for the learners to get used to what sheet music look like.

Tutorial and instructions
Instructions are included following a question mark link on the introductory page of the app. When this page opens the learner will see what is needed for full functionality of the app. Further instructions include how to play the game, what the different levels will consist of, as well as the fact that there is a tutorial. The tutorial is included to show the learner the most important rudiments of music. This adds to the educational value of the app.

Different levels
The app consists of different levels of difficulty. This is in line with, amongst others, Phillips and Popović’s (2012) suggestion that the adding of levels can enhance the educational value of the app. The learner must first accomplish a level before he/she can progress to the next one. The levels increase in difficulty and notes are randomized to make it unpredictable for the learner. The app is user friendly in the sense that it is easy to operate, instructions are clear, and each level is indicated by an explanatory icon.

\(^9\) www.pianoboostapp.com
**Reward system**

In accordance to what Sturgis (2016) and Phillips and Popović (2012) suggest, a reward system is built in. At the completion of a level the learner will receive a score and when the level is completed with a full score, the learner can progress to the next level. The learner also competes against him/herself. There is a timer built in to encourage faster completion of the levels. This encourages better proficiency at a given level, when one can obtain a full score in a faster time. The score board will help the learner to validate him/herself and it can add to the enjoyment of the application. This is grounded in the theory that when people enjoy what they are doing, this enjoyment can have a positive influence on the learning experience (Gomes et al., 2014; Herrmann, 1995; Jensen, 1995).

**Innovation**

The innovative components that distinguish this app from other existing music apps are instant note recognition, the fact that a real piano is used, the indication of the correct notes, and real-time feedback. Other music apps use plug-in keyboards and microphones, on screen representations of the piano, only tapping on the screen and not using a real piano, or backtracks accompanying the exercise, and at completion it will show one that it was not correct by either indicating this non-specifically, or without showing one where the correct note is.

**Educational value**

The educational value of this app is that it works like a game, which means that learners learn while having fun. Other educational benefits are that the learner competes against him/herself, a scoreboard is included where the time and score are allocated, and, lastly, that time can be saved in the class if the lecturer does not have to present this aspect of the learning process.

**Linking the considerations in the design of the app with the literature**

Core elements that were considered during the initial designing stages of the *PianoBoost* app were the literature discussed earlier on.

First, I regarded the Four Pillars of learning suggested by Hirsh-Pasek et al. (2015) that need to be part of the development of an app:

- Actively involved: Involvement with the app means that they have to do the exercises and not only observe or listen to tutorials. Physical involvement is in the form of playing the note on the piano and mental involvement requires them to think what the answers are.
- Engaged: They are engaged, as they cannot lose focus, because all the levels are timed.
- Meaningful experiences: According to Hirsh-Pasek (2015) meaningful experiences involve learning with a purpose. The purpose of the app is to learn one’s notes, so that this knowledge can be linked to other key concepts regarding piano playing.
- Socially interactive: When the app is used in a music school environment, learners can compete against each other and thus be socially interactive.

When comparing the features of *PianoBoost* with Lee and Hammer’s (2011) mechanics that need to be included in the development of an app namely points, levels, challenges/achievements/goals, and a high-score table, *PianoBoost* fits all the criteria. The app is also interactive, providing fun, enhancing learning and cognitive development, building skill, promoting social interactions as well as involving physical activity as suggested by the afore-mentioned literature.

**CONCLUSION**

We live in a society where everything is ruled and influenced by technology. Children grow up with computers and the latest technology at arm’s length. This must be taken advantage of and taken into consideration, especially in the teaching and learning environment. Music teaching is no exception. We must come to the understanding that perhaps it is not enough anymore to just rely on ‘old’ and trusted methods alone. The development and use of a cell phone application such as *PianoBoost* to learn music notation, as suggested in this article, can help to combine the best of teaching methods with computer based learning, blended learning and gamification. Such an app can be used in the school environment or private studios, and especially in the safe environment of the learner’s home. The universal language of music, along with the availability and accessibility of handheld devices, can make this a fun way for learners of different ages to learn music notation.

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