

Will Trippas

2019909

Development Element 2b - Essay

The Role Of Video Games In Music Education

3884 words

Major educational advancements are rare, however the advent and democratisation of video game technology is an opportunity for a revolution in music teaching. The relative pace of development of technology has left education in a place whereby it needs to compete with the technology in the forms of games (and social media) for attention. What if there was a way to harness this very competition to both educate and stimulate young minds?

Surely the holy grail of music educators everywhere is a game that kids would want to play more than other games, but contributes to the half hour to an hour of practice required each day to reach a state of instrument proficiency.

In this essay we will look at the conception and development of MIDI Invaders, a musical education game that takes the idea of rhythm games, and also develops skills in music theory, note-matching, chords, intervals and keyboard technique.

Initially we'll discuss the potential role that computer games can play in early education, the instrument development process led to the product, and what future development will look like.

What role can video games play in education?

Given the maturing of the video game industry, there are some techniques we can borrow from what is arguably a much more engaging endeavour than a classroom, that we can use to promote educational outcomes.

We know that games have the power to command people's attention in a way that education can not do as they have fundamentally different aims. Games are purposefully engineered and refined to induce dopamine hits in the user, which renders them to be thought of as addictive as alcohol, drugs and even social media! (Montag et al, 2019)

There are parallels between the learning process and progress through a game, Bereiter et al (1993) called it the "cycle of expertise." In fact they consider a good game as a learning machine. Take, for instance, the level design of a Mario game. Mark Brown talks about the 4 steps of a Mario level, as establishing the concept, develop the consequences of that concept, hit you with a twist to test your mastery and then concluding. There is a parallel here with a good lesson design in a classroom, Hiebert (2003) talks about lesson design as an experiment.

Birch (2013) found that "Gamification was found to have a positive effect on the number of technical elements students mastered, and on their attitude toward practicing technical elements, while self-efficacy levels were not affected." Paney (2015) ran experiments that showed that singing video games can develop pitch-matching skills, while Carter (2017) argues that as long as the "curriculum is driving the choice of technology" then gaming technology can be used to the teacher's advantage in the class room.

From Gee (2005) "So the question is: How do good game designers manage to get new players to learn long, complex, and difficult games? The answer, I believe, is this: the designers of many good games have hit on profoundly good methods of getting people to learn and to enjoy learning." Can we incorporate this passion for learning how to master a computer game onto more transferable skills, such as playing keys? Through

mastery of the game, familiarity with the piano keyboard, and the notes that are produced with key presses is taught by stealth.

Gee (2005) concludes his article with “When we think of games, we think of fun. When we think of learning we think of work.” Thus setting up what I will call the edutainment spectrum. Getting kids to learn without realising it is an achievable goal, more achievable than chocolate-flavoured spinach.

Gee (2003) states “Games allow players to be producers and not just consumers” which ties into the idea of musicians, more than other fields of education, as makers. From a personal point of view, I lost interest in learning instruments at a young age due to the rote nature of much of the learning and the lack of creativity during that learning phase - there was no focus on creation throughout 99% of my musical education. The aim here is to supplement the learning phase of an instrument with video game dopamine to reach the desired learning outcomes more easily, and by stealth.

Proficiency in any endeavour, particularly an instrument or a game, is reliant on reaching a state of flow, described by Mihalyi Csikszentmihalyi (1990) as “a feeling of total immersion, creativity and involvement where the challenges of the activity and a person’s skills to meet them are balanced and high. Flow is a peak experience that often occurs when a persons doing an activity with no external reward, such as rock climbing or playing music for pleasure.” Or playing a computer game. Since this peak experience is shared between the two endeavours, we can use flow state to challenge a gamer slash student to acquire new music skills.

Another important aspect of music education as preparation for a musical career, is that familiarity with computers for music is integral to the modern music production process. DAW literacy is vital for all but a very narrow range of music creator career paths these days, so an introduction to the concepts and ideas behind DAWs at an early age would put students in good stead for future musical creation. (King, 2016) Given the importance of computers to music creation, the MIDI keyboard seems the obvious choice for education as it is the primary interface with any DAW regardless of genre.

The Approach

There were some key considerations that went into the conception, design and subsequent implementation of this instrument. The instrument needed to be fun, intuitive and commercially-viable.

The most intuitive way to interact with an instrument is without having an instrument at all. Initially I had considered using the Leap Motion controller from Ultra Leap. Ultra Leap boasts the “World’s most advanced hand-tracking,” which would have been good to integrate with a MaxMSP instruments, parsing the variables from the Leap Motion API to parameters to create a controllable synth and a sequencer. Unfortunately the user-base for the Leap Motion is very small, which would have rendered the project as, at best a niche product, or worse, a fun demo. Consideration was also given to the discontinued Xbox Kinect, using a full body to control the parameters but this has a footprint of similar magnitude.

Apple's Vision Framework can achieve full-body, hand and facial recognition and movement tracking, however given Swift's relatively steep learning curve, and the time constraints for this assignment, a simpler input method was sought.

Unity Games has partnered with Lego to create a micro game - giving budding 10-year-old programmers and 43-year-old Master's students alike the joy of being completely frustrated by lines of incomprehensible code. While the environment for making the game was akin to building Lego, the actual gameplay was not, and the fundamental mechanic for the idea of a Lego synth/sequencer which relied on placing blocks onto to other blocks to create sounds was not supported by the software. Given the time constraints, future licensing and that the focus of the assignment is more on music than designing collision detection systems, this approach was revised. It was certainly an intriguing idea that although Lego is focused on fun and play, there is almost nothing, except for Vidiyo, in it's line-up that is musical in nature.

The plan for the instrument was to use FMOD as the audio middleware, however there is no native MIDI implementation (and none of the plug-in solutions seemed simple enough) which could limit the future sonic possibilities, not to mention limit further development of the instrument commercially. The solution was to learn Audiokinetic's Wwise which has a native MIDI synth - Synth One. In-game status, such as how many notes in a row have been hit, can be fed to Wwise's Unity to, for example, open the filter on the Synth One, or increase and effect such as reverb or distortion, making the musical experience much more interactive.

While the instrument can be played with a regular computer keyboard, the ideal way to play from an educational perspective is with a MIDI keyboard, increasing the player's familiarity with how a piano keyboard is played out, and how it feels.

In his 2016 video, Mark Brown (Brown, 2021) argues that "the design of the traditional console controller [limits] the sorts of experiences designers can offer." He goes on to argue that the types of games that are made are informed by the controller - hence the proliferation of first person shooters on consoles. It would seem that given the relative ubiquity of MIDI keyboards, that there could be demand for a games based not on gamepad input, or keyboard and mouse, or touch, but on MIDI input. The subsequent design of these games, because they're designed with MIDI in mind, can be novel.

In 2018 the global market for MIDI controllers was \$99.8 million (about £72 million) so there is a not inconsiderable cache of MIDI controllers that can be used with computers, tablets and phones (Global MIDI Controller Market Analysis, Trends | Forecast (2019-2028), 2021) not to mention the global synth market, forecast to be \$1.9 billion a year in 2026 (Markets, 2021).

Once the idea catches on, a hardware partner would be sought to produce MIDI Invaders keyboards for play - and as a first MIDI keyboard for students that could also be used for conventional lessons and DAWs.

The core concept of the instrument is to teach piano keyboard skills by stealth (although if it's fun, then it doesn't have to be stealthy), by associating notes with key presses, but hiding the learning behind a game mechanic. The goal with the game is to teach the association of the sound of each note to where the note is on the keyboard - the first

stages of ear-training, however further development will incorporate more musical concepts such as playing chords and tunes.

Given the abundance of MIDI keyboards in classrooms, it would be an obvious choice to use in an educational setting as the only extra expense would be the cost of the software, however to develop the product to the point where it could be considered as a “proper” educational tool would require enlistment of a music educator to help with the MIDI Invaders “syllabus” and a software development team.

Principles of the Instrument

The instrument has been built in the game-engine Unity. There are a number of advantages for using Unity in this instance, such as simplicity of implementation, ease of deployment to multiple platforms, including augmented reality (Chow, 2013) and virtual reality, and the broad range of assets available for use within projects.

There are two plugins used to augment Unity’s capabilities. Keijiro Takahashi’s Minis plugin gives Unity the ability to parse MIDI signals from OSX and Windows into in-game events. This event can then trigger an event in Wwise’s Synth One - effectively a key press - and also trigger the appearance of the Laser layer and it’s collision box. Using Unity’s Input Manager I was also able to program a normal computer keyboard to be used for the MIDI-impaired, with the Z row acting as the white keys from C3 to C4 and the A row as the black keys accordingly.

The Wwise plugin then takes the event, passes it to Synth One, which plays a note and passes the audio to the Unity Audio Engine. Wwise is also responsible for playing the accompaniments, with drum sounds held in a different Soundbank.

The game's design is based on the classic Space Invaders. In the original game rows of enemy space ships slowly descend on the player's planet while shooting projectiles. In MIDI Invaders, rather than having a spaceship that can move in 1 dimension on the side of the screen, each key in the octave of a MIDI keyboard is assigned a spaceship that can shoot a laser to destroy enemy crafts.

The incidence of the crafts can be controlled by a MIDI file and when the correct key is pressed when the enemy crafts hit a visible forcefield line, this is considered a hit, which can be measured for accuracy to ascertain the player's score.

The cues for which MIDI key to press - the enemy spaceships to be destroyed by the player - will be contained in a simple MIDI file, and further development will incorporate the ability to import MIDI files that can be read for both notes and tempo. To manage the learning curve of the game, at least initially, these MIDI files - the levels - will be supplied with the game and graded, gating levels until proficiency is achieved in earlier ones. The levels will be a combination of drills, incorporating such musical ideas as chords, scales and intervals, and public domain musical pieces. MIDI Player Toolkit would be a viable option to implement both MIDI file reading, and also turning MIDI signals from the keyboard into notes and in game events, however the Pro version required to properly implement these actions was beyond the budget for this project.

Different levels can be grouped together as worlds (lessons), and the worlds can be put together to create a syllabus that can map the development of required learning outcomes, and the advancement of the player's motor skills. As the association between pressing a singular key, killing an enemy, and hearing a sound is further developed, more advanced concepts such as chords and melodies can be introduced. More advanced worlds will include 2-handed exercises, and implementation of these levels should prove relatively trivial once the MIDI file import system is functional.

Compare and contrast with existing commercial instruments

The current selection of quality games that incorporate MIDI input is quite small. The three leading current competitors in this space are Synesthesia, Melodics and Ambrose Piano Tabs. All three sit much further to the educational end of the edutainment spectrum than MIDI Invaders - providing extended educational value without the gamification found in MIDI Invaders. Synesthesia probably offers the most advanced vision for further development of MIDI Invaders, given it's ability to load any MIDI file in for playing (not to mention its presence on YouTube.)

In fact, to find a product arguably in the same niche as MIDI Invaders, we would have to go back to 1990, with the release of The Miracle Piano Teaching System for NES, Super Nintendo, Sega, Mac, Amiga, Sega Genesis and PC. This software was bundled with a MIDI keyboard that produced sounds, while the computer system listened for MIDI via a proprietary plug, and generated the visual elements of the game. The whole package cost \$500 when it was first released - about £650 in today's money.

(www.poundsterlinglive.com, 2021) Despite a \$6 million dollar advertising budget, it was a failure (Barczak and Wesley, 2010).

There are a number of games that use MIDI controls, however do not use them in a useful musical way. Games such as the entertainingly-titled *Bachs Baroque Brawl*. While the implementation of the keys and key-combinations is a bit iffy, there is a solid idea in there that could be explored in *MIDI Invaders* and subsequent games for the platform - combining the traditional idea of fighting games having button combinations for different moves with chords and motifs from music. Developing a full suite of games around the concept of using a MIDI controller as a game controller would certainly broaden the appeal, thus increasing the game's marketability.

Resynth (*Resynth on Steam*, 2021) was an informative game to compare with. It's a puzzle game that looks and sounds like a sequencer, building the music as you progress through the puzzle. It teaches the visual language of a DAW while entertaining as a puzzle game - another angle for the educational element of the game and one that is often overlooked by traditional music education.

Possible improvements

Ideally *MIDI Invaders* has a number of areas where further iteration would help the final product.

Graphically, a more modern, cartoonish style would certainly help engage the target audience. The 16-bit graphics appeal to a generation of gamers weened on the heyday of 90s consoles, and this would also be the group of consumers who have MIDI controllers lying about. Ideally the approach taken by 2017's *Wonder Boy: The Dragon's Trap* - giving

the option of 2 different graphics skins - could be implemented here so as to appeal to both the target demographic of current MIDI keyboard owners, and their children.

A songs feature, as seen in Synthesia and Melodics, would be a good way to push the educational value of the product. There are a few of challenges here. Firstly, getting the number of keys on the keyboard to match the range of the songs. Synthesia confronts the issue by suggesting a minimum of a 61-key keyboard. Synthesia lets you import any MIDI file to play, neatly circumventing any copyright issues, however the educational value of the product is compromised by the lack of a compelling syllabus with increasing and measured difficulty. Synthesia pitches itself as a tool that educators and content creators can use for teaching, as opposed to providing the lessons itself.

Melodics will work for much smaller configurations, however the content is custom, and more drill-oriented rather than whole songs. The songs that are included are written by a selection of their in-house producers, providing a different approach to music rights.

Notably a similar approach was taken by the largest VR game in history, Beat Sabre, which is inevitably going to be a smaller upfront cost than, say The Beatles: Rock Band which was \$10 million up front, and up to \$40 million after sales (Kohler, 2009).

Interestingly, Viacom made the decision “The marketing material for the *Beatles: Rock Band* urges consumers to use *Guitar Hero* controllers, enabling Viacom to piggyback on its more successful rival,” “Let [Activision] take on the burden of getting those super-tight margin instruments out there,” said MTV Games senior VP Paul DeGooyer. A lesson for The Miracle Piano Teaching System, certainly, but also an indication that the concept of using existing controllers that are not traditional gamepads is a viable one.

There is a known issue with Minis that key presses that register a MIDI value less than 63 will not register. This would require rectification through building a custom solution as it would not be acceptable in the final product to tell the player to “press harder.” Again MIDI Player Toolkit should prove a viable solution.

A scoring system is a necessity to make this a “proper game.” Features will include an online leaderboard and some social sharing features. The scoring system will be similar to rhythm games, with the possibility of multipliers for continued streaks of successful note hits. This would tie in with the levelling system - a player would not be able to reach the next level without achieving a certain score - ie reaching a certain level of proficiency.

Reflection on the results of the instrument.

The instrument clearly isn't finished... or functional. While a lot of time was spent learning how to implement even basic features in Unity, most of this effort was on discarded ideas. These initial forays were instructional with regards to what could and couldn't be achieved, particularly with the looming deadline, so more focus was put into the research for the final product and this essay. The concept as laid out in this essay is achievable and ultimately marketable to a parents, teachers, educational institutions should be greedily consumed by the core demographic - music students.

Personally, I'm quite disappointed I didn't get further than I have, but on reflection I feel it's because at the start of the process I didn't know what I didn't know, and didn't have a realistic idea of game development times. The creators of rhythm-violence game Thumper said they worked on it for 7 years, - putting the 7 weeks of novice development into

perspective. I do believe, however, that the fundamentals of the idea are sound and worth pursuing beyond the competing of this assignment.

Although the actual results are limited, the results of the research have proved invaluable for formulating a plan of how to develop and market this product.

References

2021. [online] Available at: <<https://www.poundsterlinglive.com/bank-of-england-spot/historical-spot-exchange-rates/usd/USD-to-GBP-1990.>> [Accessed 15 July 2021].
- Barczak, G. and Wesley, D., 2010. *Innovation and Marketing in the Video Game Industry: Avoiding the Performance Trap*. Ashgate Publishing Group.
- BEREITER, C. AND SCARDAMALIA, M. 1993. *Surpassing Ourselves: An Inquiry into the Nature and Implications of Expertise*. Open Court, Chicago:
- Brown, M., 2021. *Controllers Control Everything*. [online] Youtube.com. Available at: <https://www.youtube.com/watch?v=VJGKDyrR8qc&ab_channel=GameMaker%27sToolkit> [Accessed 12 July 2021].
- Birch, H. (2013). *Motivational effects of gamification of piano instruction and practice* (MA Thesis) Retrieved from <https://tspace.library.utoronto.ca/handle/1807/35576>
- Carter, Daniel (2017) *Can video games technology be used for educational purposes?* Masters thesis, University of Huddersfield.
- CHOW, J., FENG, H., AMOR, R. and WUNSCH, B., 2013. Music Education using Augmented Reality with a Head Mounted Display.
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York: Harper and Row.

Gee, James. (2003). *What Video Games Have to Teach Us About Learning and Literacy*. Computers in Entertainment. 1. 20. 10.1145/950566.950595.

GitHub. 2021. *keijiro/Minis*. [online] Available at: <<https://github.com/keijiro/Minis>> [Accessed 15 July 2021].

KING, A. and HIMONIDES, E., 2016. *Music, Technology, and Education: Critical Perspectives*.

Kohler, C., 2009. *Report: Beatles' Rock Band Royalties Could Reach \$40 Million (UPDATE)*. [online] Wired. Available at: <<https://www.wired.com/2009/09/beatles-rock-band-royalties/>> [Accessed 15 July 2021].

Hiebert, J., Morris, A.K. & Glass, B. Learning to Learn to Teach: An "Experiment" Model for Teaching and Teacher Preparation in Mathematics. *Journal of Mathematics Teacher Education* 6, 201–222 (2003). <https://doi.org/10.1023/A:1025162108648>

Market.us. 2021. *Global MIDI Controller Market Analysis, Trends | Forecast (2019-2028)*. [online] Available at: <<https://market.us/report/midi-controller-market>> [Accessed 15 July 2021].

Markets, R., 2021. *Global Frequency Synthesizer Market (2021 to 2026) - by Type, Application and Geography*. [online] Prnewswire.com. Available at: <<https://www.prnewswire.com/news-releases/global-frequency-synthesizer-market-2021-to-2026---by-type-application-and-geography-301306005.html>> [Accessed 15 July 2021].

Micheloni, E., Tramarin, M., Rodà, A. *et al.* Playing to play: a piano-based user interface for music education video-games. *Multimed Tools Appl* 78, 13713–13730 (2019). <https://doi.org/10.1007/s11042-018-6917-1>

Montag C, Lachmann B, Herrlich M, Zweig K. Addictive Features of Social Media/Messenger Platforms and Freemium Games against the Background of Psychological and Economic Theories. *International Journal of Environmental Research and Public Health*. 2019; 16(14):2612. <https://doi.org/10.3390/ijerph16142612>

Paney, Andrew S. (2015) *Singing video games may help improve pitch-matching accuracy*, *Music Education Research*, 17:1, 48-56, DOI: [10.1080/14613808.2014.969218](https://doi.org/10.1080/14613808.2014.969218)

Store.steampowered.com. 2021. *Resynth on Steam*. [online] Available at: <<https://store.steampowered.com/app/819960/Resynth/>> [Accessed 15 July 2021].