Saved by the Dell: A Study of Technology Based Music Classes

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Jacob Holton

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

Kathryn A. Neeley, Associate Professor of STS, Department of Engineering and Society

Technology Can Either Facilitate or Hinder a Students' Academic Success

School systems in local and global communities struggle to provide their students with better opportunities and to inspire creativity and success in the Classroom. More times than not, educators think the answer lies in technology. This may be true in some cases but technology does not serve as a panacea for all economic barriers in the classroom. Reviewing the One Laptop per Child (OLPC) program and Technology-based music classes (TBMCs) has shed light on when technology fails and succeeds in the classroom respectively. Using Actor Network Theory (ANT), the OLPC program was organized in a hierarchy that limited student and teacher power. On the other hand, TBMCs emphasized training teachers in the new technologies and received student feedback as a check on students' engagement. The scope of the OLPC program was too broad. Teachers were tasked to fit new laptops into their general curriculum with little aid from the program other than weekly tech support. TBMCs used their music scope to engage students in a relatable and creative way, while effectively training teachers in three-day workshops. The aspects leading to a successful tech implementation in schools include a well-defined scope for the technology and a feedback network between the students, teachers and engineers.

In the words of journalist Sydney J. Harris, "The whole purpose of education is to turn mirrors into windows" (Harris, 1985, n.p.). A student's education is about broadening their perspectives from a mirror, looking closely at their own lives, to a window where they can endless opportunity. When technology works, it can be life changing to a student. Music education proves this by engaging students with music production tailored to their interests. With the right scope and student-oriented design, technology has a vibrant place in the classroom. However, the haphazard approach to technology integration can become a burden to teachers and expensive for schools. In this paper, I argue that technology-based music classes are successful due to a successful actor network structure and engaging scope. Case studies and reviews on TBMCs and the OLPC program will provide the context for the Actor Network Theory framework. These two actor networks will shed light on why some implementations of technology in the classroom succeed and why others fail.

Technology Based Education Works Well in the Right Context

Traditional music education in western education includes concert band, marching band, orchestra, chorus, and even guitar classes. Each of these classes offer valuable life skills and engage students in ways that differ from Math, Science, English and History classes. A study conducted on adults with and without musical backgrounds discovers that, "Musical training may promote the development and maintenance of certain [Executive Function] skills, which could mediate the previously reported links between musical training and enhanced cognitive skills and academic achievement" (Zuk, 2014, p.1). The author of the former study, Benjamin Zuk, explains further that executive functions are the brain's ability to operate independently spanning traits like inhibition, problem solving, cognitive flexibility, and a working memory (Zuk, 2014, p.1). Glenn Schellenberg of the University of Toronto has shown in his research that playing a musical instrument often results in positive cognitive behaviors including goal setting, self-motivation, and even a higher IQ (Schellenberg, 2011, p.297). This means that learning and playing a musical instrument in school can provide students with lasting cognitive benefits. The issue lies in that over 80% of students are not engaged in music education (Williams, 2012, p.134).

A majority of students ignore or cannot afford the opportunity to grow as a student through music education. Some of the lack in music participation is in the hands of the school board. Long time athlete and musician John Gerdy explains, “When program cuts are necessary, priorities must be set and difficult choices made. Traditionally, one choice has been between fielding elite athletics programs and maintaining enriching programs in the arts—with the arts usually being the first to suffer” (Gerdy, 2015, n.p.). Due to a lack of funding, kids face economic barriers in accessing music education. Furthermore, Vincent Bates of the National Association of Music Educators says that there is a disparity between creative opportunities for wealthy students and lower income students (Bates, 2018, p.73). Economic boundaries prevent students from pursuing creative outlets at school while increasing the opportunity gap between rich and power.

Along with time and economic constraints, students show a general apathy towards participating in music education. Popular musicians do not usually rely on standard music notation, so students are less inclined to want to participate in classical or marching bands (Williams, 2012, p.132). Students enrolled in technology-based music programs took surveys regarding their involvement in music in Williams’ study. The data suggests that students are interested in music, but may not be interested in participating in traditional music education. Plenty of students know how to play and instrument or sing, but only 28% of students participate in ensembles. Moreover, students involved in TBMCs appear to be uneducated about music as 78% of students cannot read music notation, while a majority of the students are interested in music. Figure 1 below shows the musical backgrounds of surveyed students enrolled in nontraditional music classes.

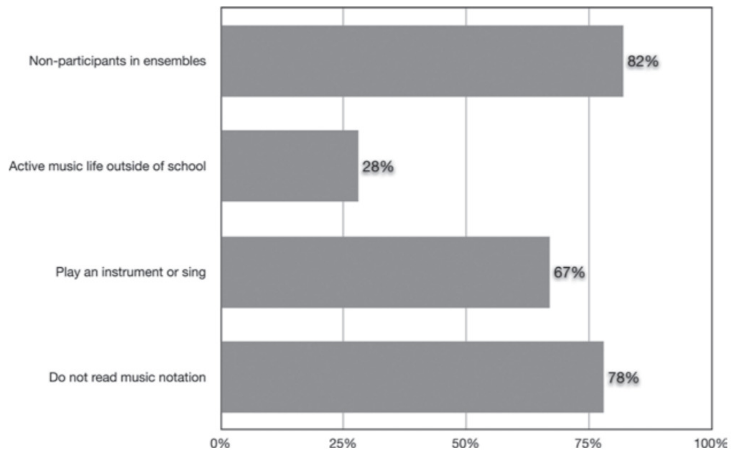

Figure 1: Survey data taken by students who participate in technology-based music classes. 82% of students do not participate in a musical ensemble. This suggests that TBMC's are successful in engaging students who do not participate in traditional music classes. (Williams, 2012, p.138)

Nontraditional methods of music education pose an exciting, cost-effective, and modern alternative to traditional music education. Nontraditional methods include digital music production programs like GarageBand, Logic, or EarSketch. These TBMCs aim to teach students music theory and inspire creativity with cutting edge music production applications. Specifically, EarSketch serves a compelling dual purpose as a music production application and a computer science education tool. Jason Freeman's review of Earschetch explains, "students learn elements of computing and sample-based music composition (that is, composition using musical beats, samples, and effects)" (Freeman, 2019, p.78). Figure 2 displays the Earsketch terminal where students code and display their music. This application includes a search bar for references, multiple sound libraries, a code editor, and a digital audio workstation. A music production application like this offers students the opportunity to understand the concepts of computer science and IT through the lens of music production.

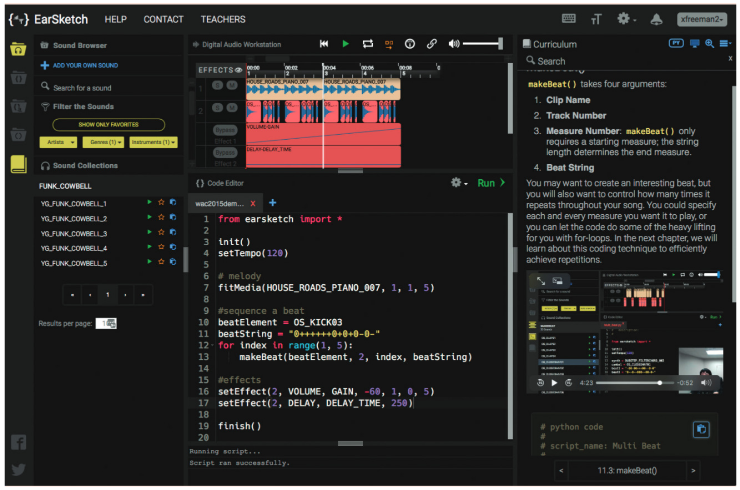

Figure 2: The Earsketch terminal. This window snip is what a student would see when coding and producing with Earsketch. There is a digital audio workstation as well as a coding editor where the music is produced. The code students write will direct the sound type, volume, delay, and tempo. (Freeman, 2019, p.81)

Later in his review, Freeman states, “Computer science is a core skill not only in a growing high-tech sector, but also for careers across many other domains; yet, computing is often seen by students as uncool and approaches to teaching it may be uninspiring” (Freeman, 2019, p.79). Both traditional music classes and computing are seen as uncool in the eyes of students, but technology-based classes seem to break through this social barrier. As music changes, music education should change with it. Students who show apathy towards traditional music classes may find nontraditional music classes, that appeal to their music tastes, more attractive. Williams’ study suggests, “students who are academically unmotivated or prone to creating discipline problems in other classes find TBMCs [Technology Based Music Classes] rewarding” (Williams, 2012, 142). His research suggests that TBMCs have made music education more appealing to unmotivated and quarrelsome students. At the same time, TBMCs give these students confidence and affirmation that they may not receive in other classes or at home. It is notable that 82% of students enrolled in TBMC’s do not participate in ensembles

(Williams, 2012, p.138). It is apparent that TBMCs appeal to a demographic of students that otherwise do not participate in traditional music education.

TBMCs attempt to engage students that are unreached in many aspects of education. Past efforts using technology to engage unreachable students are seen in the OLPC program. The OLPC program looked to grant discounted laptops to students in impoverished conditions such as in rural Peru and Costa Rica. The program hoped to give children better opportunities and to see students to excel with new technology in their hands.OLPC was meant to be a way to "'provide means for learning, self-expression, and exploration.'" (Meza-Cordero, 2016, p.4). The program also provided teachers with lesson plans and would check back with the schools every week for repairs. As seen in Figure 3, Engineers designed the XO laptops with students in mind, with a waterproof and shockproof design (Meza-Cordero, 2016, p.9). For this reason, technicians only made repairs on a yearly basis on average (Meza-Cordero, 2016, p.9).

Figure 3: The XO Laptop. This is the laptop OLPC provides the participating schools. Built with students in mind, this laptop is waterproof and shock resistant. (Meza-Cordero, 2016, p.9)

Despite the thought put into this program, critics of the OLPC say that, "the program is expensive, disrupts the educational process and imposes additional burdens on the teachers, and that students mostly use the computers to play games" (Meza-Cordero, 2016, p.4-5). The OLPC program treats technology as more of a Band-Aid for social inequalities than an impetus for long term change. Another study shows that despite giving these children laptops, they perform just as well on aptitude tests as before having the laptop (Cristia, 2017, p.295).

Actors with Agency and Division of Power Produce Successful Sociotechnical Networks

Carolyne Stanforth develops a model for ANT in her research of E-government implementation that will serve well in developing an ANT model for technology implementation in the classroom. ANT is the sociotechnical process of observing conflicts, design, and failures of disruptive technologies in society. Technologies which significantly alter an industry or human interactions. The actors in ANT cover every human and non-human involved in an innovation (Latour, 1992, n.p.). Sociologists study the interactions of actors within multiple networks to discover insights about how technology and society interact. Stanforth suggests that "technologies do not evolve under the impetus of scientific logic…technologies mirror society as they are shaped and reshaped by interactions between actors in social networks" (Stanforth, 2007, p.38). Bruno Latour, one of the pioneers of ANT, stresses the role of technology as an actor in ANT in his work, "Where are the Missing Masses". Latour goes into detail about an automatic door closing mechanism. He describes the door closer as being an actor in ANT, as it influences how human actors interact with doors. Latour introduces mechanisms as actors through the concept of prescription. "Prescription is the moral and ethical dimension of mechanisms" (Latour, 1992, p. 157). New technologies have both moral and ethical aspects, and prescription will differ between technologies. For example, a Yo-yo has a much less important prescription than that of the atomic bomb. Under ANT framework, society drives technological innovation, and following the actors involved with a technology will uncover the nature of a new technology. These actors interact and shape the context of a new technology creating a network.

The ANT framework introduces several abstract concepts which serve to contextualize a disruptive technology. Stanforth describes power in the ANT framework. Power belongs to the actors that can shaped the network (Stanforth, 2007, p.39). The ones who define the network are powerful as a result. This creates an implicit hierarchy between the actors in a network. Powerful actors play a larger role in a network than those without power. The aspect of agency goes hand and hand with power in ANT. Agency describes an actor's ability to establish itself in a network for a distinct period of time (Stanforth, 2007, p.39). Another concept in the ANT framework is translation. Translation is the driving force behind the creation of a network (Stanforth, 2007, p.39). This explains how some actors exercise power and others do not during network formation. The translation of power during the formation of a network is a crucial aspect of ANT. The final important aspect of the ANT framework is empirical story telling. ANT authors use specific examples and case studies to develop their arguments and problem frameworks (Stanforth, 2007, p.39). Drawing from empirical evidence, ANT authors map out the networks of actors involved. This is not a frivolous task but one of great detail and scrutiny. Piecing together fragments of actors surrounding a technology, an ANT author gives depth and meaning to new technologies.

For this reason, ANT will be a great tool to analyze the role of technology in the classroom; Namely with respect to the OLPC program and TBMCs. Two networks arose in education technologies. The first is the successful implementation of digital technologies in music education. The second network consists of the actors involved in the less successful efforts of the One Laptop per Child Program in third world countries. Comparing these two implementations with the ANT framework will aid engineers and educators in developing and implementing technology successfully into the classroom. Empirical evidence will define the actors which shape the two networks. Drawing from various case studies will make for a great ANT study. Understanding which actors hold the network shaping power will have profound effects on how to implement the technology. If student actors dominate networks, then education technology should prioritize student engagement. On the other hand, if teachers pose profound power in networks, greater effort will be placed on technical training and design with instructors in mind. The aspect of agency should be an important concept in the classroom context where teachers instruct students who have little agency in their learning. The ANT approach will consider if education technology inspires students, inhibit classical knowledge, or be a distraction from curriculum.

Actor networks for sociotechnical systems come in various organizational structures. It is the job of an STS researcher to understand these structures and understand if this structure is beneficial or detrimental to the system. Understanding a complex sociotechnical system may seem like a herculean task, but ANT provides methods for understanding and analyzing these complex systems. First, define the major actors in the problem frame and remember to include all human and non-human factors in the system. In defining each actor, it is important to discuss the agency each actor imposes on the other actors. Understanding these interactions will shape what type of networks the sociotechnical system belongs to. A positive network would be one where each actor has agency despite discrepancies in power throughout the system. A negative network will have actors who have all of the power. This leaves the smaller actors in the network to bend to the will and direction of the powerful. Figure 4 below shows the model for both positive and negative actor networks.

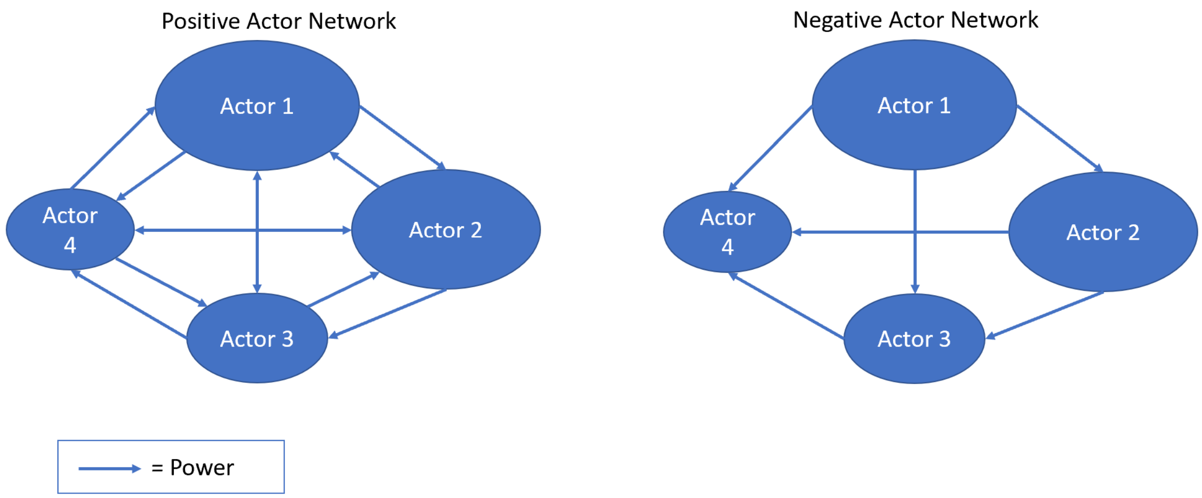

Figure 4: Two forms of the ANT framework represented as a flowchart. In the positive network, each actor has network shaping power and can impose that power on any of the other actors despite the size of the actor. The negative network displays a hierarchical framework where stronger actors hold more power than smaller actors. (Created by Author)

A network may take form anywhere between positive and negative networks showing traits of both models. No two networks are the same in sociotechnical systems. Networks that exhibit positive traits, such as agency and division of power, will prove to be a more successful system than those lacking said traits. The next step is to understand and consider the role the technology has is its system. Determine the technology's prescription in society. Then, evaluate the moral significance this technology has in its network. Lastly, given the prescription and network type, determine if the network is successful and where its weaknesses lie. This analysis will provide future steps for the actors to make.

TBMCs Draw Their Success from Scope and Actor Network Structure

A vast network of musicians, engineers, educators, and students support the development of arising technologies in music education. TBMC applications directly affect the way teachers can teach. A large part of teaching is developing lesson plans and implementing a music production application like GarageBand or Earsketch require teachers to flip traditional lesson plans upside down. TBMCs require teachers to develop a full understanding of the applications they are teaching students to use. To illustrate, teachers in Atlanta who began to use Earsketch, were required to attend a Three-day training workshops about the application before adopting the program in the classroom (Freeman, 2015, p.2). Furthermore, developers are working on an online teacher workshop for increased accessibility (Freeman, 2015, p.2). The Earsketch developers understood the importance of agency in sociotechnical systems, so they made sure teachers had a full understanding of the Earsketch program and curriculum. This helps students learn the material and troubleshoot when things go wrong. In other, smaller TBMCs, teachers seek to inspire music creativity and emphasize a love for music over technological proficency (Williams, 2012, p.137). David Williams describes this group as grass roots group of band directors who took interest in digital music production and formed these classes on their own (Williams, 2012, p.137-138). Earsketch presents a top down model of music and STEM education, but Williams study dealt with a small group of passionate instructors. It appears that teachers in this context, whether self-taught or taught corporately, are passionate and willing to put extra time in to inspire unengaged learners.

The student's role in the network is to learn and provide feedback to the teachers and developers on how the programs function. Students provide feedback to teachers and developers with their enrollment in TBMCs, and by voicing their opinions. Feedback is a student's form of agency in a network. When a student brings feedback to their teachers, the network shaping power translates from the teachers to the students. To illustrate, some students gave their teachers feedback on how TBMCs have changed their outlook on life and school. Students of Earsketch began to consider a career in STEM based on their experience with this music production software (Freeman, 2019, p.78). Other students, who grew tired of learning an instrument, rediscovered a love for music with TBMCs (Williams, 2012, p.142).

The final large actor in this network is the developers and the software that they create. Developers designed Earsketch carefully so that students would feel as though they are both doing authentic coding and music production (Freeman, 2019, p.79-80). GarageBand and other music production applications are made for new learners thus, TBMC students does not need any traditional training before enrolling. In the word of David Williams, “your ear could simply be your guide” (Williams, 2012, p.136). These applications, as actors, inspire students to be creative in school and teach students fundamental music theory concepts. This network functions well due to student-teacher communication and user-oriented design.

The second network is a failed implementation of technology in the classroom. The OLPC program consists of actors including teachers, students, OLPC program, and the laptops given to students. The OLPC program arose to alleviate the digital divide in school systems in predominantly rural communities in lower income countries. The OLPC organizers are one of the main actors that shapes the network of this failed attempt to implement technology. This group includes the OLPC program staff and the local authorities in participating communities. The local authorities exercise total network power by choosing which schools are deserving of OLPC. Criteria include medium school size, a need for computers, and distance from a major city (Meza-Cordero, 2016, p.10). The OLPC program in Peru chose similar criteria with the additional exclusion of schools with limited access to electricity (Cristia, 2017, p.299). The authorities then chose schools at random from those that fit the criteria. OLPC has negative prescription in participant countries where the program chooses schools at random and excludes certain schools that do not fit their criteria. The result is One Laptop per Child, but only if said child fits the programs criteria chosen at random.

Between the two programs, the teachers have different roles. In Costa Rica, teachers are given training and have access to laptop repairs (Meza-Cordero, 2016, p.9). In Costa Rica, the OLCP program helps teachers understand and teach with the new laptops. In Peru, the teachers had limited clear instruction on adopting the OLPC curriculum into the classroom (Cristia, 2017, p.297). Teachers have varied levels of agency based on their training. In Costa Rica, teachers had the resources to teach students and help with baseline troubleshooting. However, Peruvian teachers lack the agency to make any difference in the classroom due to deficient program resources. Furthermore, the overwhelming curriculum change inhibited teachers' instruction and the level of learning the students could receive (Cristia, 2017, p.318).

The student's actors in these programs received their first computers thanks to OLPC. In Costa Rica, the students had the ability to repair the laptops so they were more likely to bring them home. In Peru, students had limited access to repairs, so they had to be cautious and often left their laptops in school (Cristia, 2017, p.310). The student actors in OLPC programs interacted with the new laptop devices in various ways. Student used the laptops to play games, read, and do classwork (Meza-Cordero, 2016, p.6). Students lacked agency in these networks because they were not given a structure to provide feedback about their experience. The only information students provided was screen use data and results from standardized testing. This negative network structure prevents the main users of the XO Laptops from letting the OLPC program know what they like and dislike about the program. Instead, the students were treated as test subjects testing the hypothesis of whether or not laptops make children smarter.

The OLPC program controlled most of the power in its network. Their power in the network comes from the amount of resources they provide to their communities. Teacher resources gave teachers better capability to teach and helps students learn. When technical resources were scarce, as it was in Peru, teachers could not employ the OLPC curriculum as well as it was implemented in other countries. This constricted student's laptop usage outside of school. Students had limited power in the network and were treated as test subjects for the OLPC program. Teachers' technical competences directly affected students learning capabilities. OLPC displays a dictatorial, top down approach to technology implementation where power resided with the OLPC program organizers.

Based on the two introductions of technology in the classroom, the TBMCs were more successful than the OLPC programs. The division of power and agency of the Actors in TBMCs led to a successful network. TBMCs' feedback system between teachers, students, and developers allowed each of the actors to benefit from the implemented technology. In the OLPC program, students and teachers did not benefit from the technology due to its negative power structure. The teachers that implement their respective programs were better trained in programs that were easier to adopt. In the OLPC program, teachers had to teach general education while implementing the laptops for a whole new curriculum. The student actors were different primarily because the OLPC students were young, elementary age while the music programs targeted high school student. Moreover, the music programs inspired and engaged students with something they were familiar with: Music. While Laptops are a general tool used for both education and entertainment, and students often chose the latter. The scope of music gave students a creative outlet whereas the OLPC programs did not serve to inspire. The result of the OLPC program was not high academic achievement. On the contrary, the same students achieved the same test score with laptops. The OLPC program was lacking a specific scope and vision for the students. Scope proves to be an important factor to the success of technological implementation based on the comparative ANT models.

Conclusion

The main factor that can make or break a sociotechnical system are its actor network characteristics that lead to a positive or negative network. Positive networks provide the ideal environment for a sociotechnical system because it is structured to give a voice to actors at all levels of engagement with the technology. Anywhere down the network, valuable feedback can be offered to enhance the system in any way. Negative networks will always ignore the smaller voices. This leads to the larger actors ignoring the technology's prescription which negatively affects those who engage with the technology. Other factors that could have led to the failure of the OLPC program is the lack of resources and infrastructure in these rural areas to support the program. While the American TBMCs were held in large urban and suburban communities where there are students from low income families, but a much better infrastructure for teaching with technology.

Moving forward, actors in sociotechnical systems should be aware of the type of network they are contributing to and work towards a more positive network. Before implementing a technology into the classroom, understand that student teacher feedback must be valued and the technology must be made adaptable to its users needs. Furthermore, the scope of the technology cannot be too broad for the sake of the teachers who use it and must be engaging for the sake of the students who eventually need to be interested in the product. The TBMC's structure lays out a near perfect example of the positive network with correct scope. Music production applications make music teachable and engages with students' interest in popular music. Music stands to be one of the most influential aspects of modern education providing students with opportunities no other class can provide. With new music production technologies, the longstanding tradition of music education lives on.

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