Cheating or Learning? A Vygotskian Perspective on the Use of Modern Technologies by Novices, Drawn from a Study of Informal Music-Theory Learning

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Abstract

Many self-directed music learners turn to YouTube for free instruction that uses familiar contexts to discuss theory concepts. A grounded-theory analysis of videos that ranked highly in searches for music theory for guitar or digital audio workstation (DAW) revealed "cheating" on theory to be the most prominent emergent theme. In particular, videos that offered DAW-based methods for staying in key, without understanding the relevant concepts, appeared to be as popular and warmly received as videos that explained the concepts. A Vygotskian perspective suggests that the DAWs are being used as mediating tools that allow novices to work in their zones of proximal development while undertaking desirable sociocultural activities such as music composition. However, while some of the tools may help users eventually grasp and internalize the concepts, others hide theory concepts from view. Formal theory instruction may benefit from adopting DAW-based techniques that provide learners with access to early success in composition while also scaffolding conceptual understanding.

Keywords: *music theory education, self-motivated music learning, self-directed online learning, digital audio workstation, YouTube, Vygotsky*

Introduction

Theoretical models offer simplified, orderly structures that can be useful for making sense of complex real-world phenomena such as music or learning. Multiple theories may be relevant to a single instance of a phenomenon. Strong, relevant theories can enrich understanding through comparison with other instances, highlighting patterns of similarities and differences. They can also be powerful in combination, with each model applied to the relevant aspect of the phenomenon. This essay features two theoretical models that helped make sense of a surprising phenomenon that emerged in a recent study of open online music learning.

While looking at the data in a recent study of YouTube music theory videos, I was surprised by the extent of interest in using digital audio workstations (DAWS) to "cheat," meaning to avoid learning music theory. To my knowledge, no other musical instrument has been widely framed by instructors and learners as a useful tool for "cheating." DAWs are a recent invention. Their impact on music creation and education is still evolving, but some researchers see in them a potential for

positive effects, such as using engagement with technology to support student self-learning (Cipta, 2020) or remove barriers between music classrooms and wider music-making communities (Clauhs, 2020). Although the idea of using DAWs to cheat was not originally a focus of my study, the large amount of data regarding it provided an opportunity to explore a phenomenon that might have a negative effect on music education.

The two models that were useful in this exploration were Western music theory, which encompasses the knowledge that the YouTubers were trying to avoid learning, and Vygotsky's approach to understanding the relationship between tools and learning. The focus on Western music theory stems from my long-standing research interest in the ways that open online resources are used by novice music-theory learners. The end goals of this research are pragmatic: the development of open online resources that support such learners as much as possible. An earlier survey study suggested that a large proportion of those who are already using such resources are instrumentalists with little formal music education, seeking specific information to solve a musical problem they are currently experiencing (Schmidt-Jones, 2012). Following up on the survey, I acted as an online guide for instrumentalists who were finding it difficult to pursue their self-motivated theory learning without help. The results highlighted a variety of barriers that keep some informal learners from understanding or making use of online music theory resources (Schmidt-Jones, 2016), but the methodology involved a small number of participants who were highly engaged over a period of months. It offered no way to extrapolate to any larger population, and although all of the barriers are of types well known to researchers in online education, there is no research suggesting which might be the highest or most common barriers for music theory learners.

To get a better idea of the relative pervasiveness of the barriers, I decided to look next at a source of data generated by a large number of learners: the user comments attached to YouTube videos. YouTube is a popular resource for large numbers of informal learners (Bordignon, 2020). As a data source for this study, the user comments provided a large range of perspectives, but they were not fit for quantitative analysis. Opaque skewing forces, such as YouTube's power to promote some videos over others (Lewis, 2018) and the power of video producers to police their comments (Rudolph & Frankel, 2009) make it impossible to judge the accuracy or precision of any numbers generated by the data. Partly due to these data-set challenges, and partly because I did not want to miss barriers that might exist but did not show up in the small study, I chose a qualitative, grounded-theory methodology, which would allow the analysis to be guided by the content of the data rather than by my expectations or hypotheses.

The resulting analysis did produce some insights, published elsewhere (Schmidt-Jones, 2021), regarding the barriers facing these learners. However, as discussed below, the strengths of grounded-theory methodology include its ability to call attention to issues that are not yet in the researcher's view, and to investigate what those issues mean to the participants (Charmaz, 2006; Glaser & Strauss 2012). In this case, the analysis unexpectedly revealed that a large proportion of the YouTube instructors and viewers were concerned, not with teaching and learning music theory, but with using their DAWs to "cheat." It was not obvious whether this use of DAWs might be a barrier to music learning or a means of overcoming barriers. The issues involved included the meaning of "cheating," the cultural knowledge represented in the DAW as a tool for making music, the effects of the knowledge and the tool itself on the learners who use it, and the ways that learners' experiences become connected to a culturally-approved, codified knowledge base such as Western music theory. Such issues were central to Vygostsky's theories of learning, so I chose his ideas to provide the theoretical framework for this analysis.

The results suggested that learners benefit from using DAWs with interfaces that unambiguously display user actions in terms of music theory concepts. Regardless of learners' intent to understand or to "cheat," tying their actions to named concepts would support both their current efforts to create music and any future efforts to understand theory. DAWs come in a wide variety, with user interfaces that offer distinctly different approaches to basic theory concepts such as scales and chords. Some interfaces make the concepts visible, while others conceal or even confound them. The DAW used by a music learner may therefore act as either a barrier or a support to theory understanding, depending on its user interface.

Similar issues might arise in any area in which novice learners have easy access to powerful technologies that are used to do work in those areas, with results that might be more carefully hidden by the learners and potentially more serious than a failure to learn music theory. Unlike many academic subjects, music theory offers few extrinsic rewards. Academic credentials and knowledge rarely matter when musicians look for work. The intrinsic rewards for learning it are most easily discerned not in performance, but in improvisation and composition, where conscious knowledge is useful in choosing and notating harmonies, melodies, and rhythms. Meanwhile, new technologies have made it significantly easier to compose music without mastering theory or notation. Some educators and researchers have argued for the educational value of using technology in general, and DAW-type tools specifically, in early music classes, in order to emphasize creative expression rather than theory and notation (Brown, Stewart, Hansen & Stewart 2014; Nilsson and Folkestad, 2005; Savage 2005b).

As described below, a similar use of DAWs appeared to be what the YouTube users meant by "cheating." A main goal of this inquiry was to problematize this usage, in order to better understand what they were doing and how it might affect their musical development. By common definition, the term *cheat* denotes the idea of gaining an unfair advantage by breaking the rules, in this case a long-standing implicit music-education "rule" that mastering music theory is prerequisite to creating acceptable music. For example, music students are expected to gain a working knowledge of all scales and keys, even those they rarely or never encounter in real music, as well as knowledge of chords and functional harmony, even if their instrument does not play chords or their goal is to compose music that is not based on functional harmony.

As informal learners, the YouTube users were not competing for grades or credentials, nor were they compelled to gain any knowledge that they did not find useful. Because academic fairness was not an issue, the "cheaters" were open about their activities, and the analysis could focus on whether their musical development or accomplishments might be harmed. Are they actually avoiding learning music theory, or are they perhaps simply delaying that facet of their education, or learning to represent or think about theory in a non-standard way? Is the traditional music-education treatment of theory in need of an update?

Many musicians, including many professionals and highly capable amateurs, have little or no formal music education. Their development relies instead on self- and peer-teaching in informal settings (Folkestad 2006; Green, 2002). These days, much informal music learning is mediated through modern technologies such as DAWs and the Internet (Peppler, 2013; Savage 2005a, Waldron 2009). The developers of open online resources seek to use the Internet to broaden access to education in all subject areas, by removing some traditional barriers to access, such as the high cost of texts (Baraniuk, 2008). But learners who use online resources still face a variety of possible barriers, so understanding and lowering these barriers is an essential goal of research in this area (Kanwar, Kodhandaraman, & Umar, 2010).

In this case, an exploration of the barriers presented by open online lessons in music theory took a turn towards understanding the involvement of DAWs, a music technology that can also be freely accessed through the internet. DAWs might provide crucial support to informal music learners, particularly those without access to other musical instruments (Gall and Breeze, 2005), but the focus on "cheating" found in the data suggested that reliance on DAWs might instead create a barrier to musical understanding.

It was useful to take a Vygotskian approach to understanding the phenomenon, because Vygotsky focused on the differences between knowledge that relies on external tools and knowledge that has been thoroughly internalized. While the former may be an important developmental step, he found that internalized knowledge can be used more quickly and easily to accomplish more complex tasks. For example, musicians can rely in part on instruments such as DAWs to act as composition tools, but it is internalized music theory knowledge that allows a composer to quickly construct a desired harmony based on the function of chords within a key, instead of the much slower and more frustrating process of exploring possibilities by ear on a DAW, or any other instrument.

The dualism of this contrast does oversimplify music learning and creation, which are deeply complex experiences that involve a rich interplay among the body, intellect, emotions, prior experience, tools such as musical instruments, and the social and physical environment. Composers who have formal theory knowledge are also affected by the sound of a harmony when played on an instrument, while many of those without the formal knowledge have extensive experience that creates a tacit functional knowledge of theory. The purpose of collapsing this complexity along a single axis is to explore the question of how a particular tool might affect the development of internalized knowledge. It cannot offer strong conclusions, but in line with the goal of exploratory research, may point to possible hypotheses and fruitful research pathways.

An axis that contrasts conscious theory comprehension versus musical instruments as theory-implying tools was chosen because that was the contrast implied by the YouTube users' "cheats." The analysis found that YouTubers were using a variety of DAWs, so the cheats relied on different user interfaces. Some interfaces made it relatively easy to infer the relevant music-theory concepts, while others obscured or actually confused basic concepts, and the differences were great enough that they could be expected to affect the understanding and development of novice theory learners. Given the current plethora of new technologies developed by competing companies whose goals focus on sales rather than education, similar disparities might be found in the tools used by novice learners in many other situations, which makes this finding of general interest to both researchers and instructors.

The following section introduces concepts relevant to the analysis. The study is then described, with a focus on the relevant elements; a more complete description of the study is available elsewhere (Schmidt-Jones, 2021). The literature review then provides overviews of Vygotsky, traditional Western music theory education and the use of YouTube and DAWs by informal music learners. The findings section focuses on the differences among the DAW user interfaces, and the way they reveal, conceal, or confuse basic music theory concepts. The conclusion focuses on the implication that some of the DAWs help music novices understand music theory, even when they are used to "cheat," while others hinder the development of understanding.

Music Theory and Instruments as Vygotskian Tools

One cornerstone of Vygotsky's theories was the idea that the "higher mental functions" cultivated by education are impossible without the physical and mental tools created and transmitted by human cultures (Vygotsky, 1978). In this view, mental tools such as language are especially crucial to the development of insight and judgment. Identifying and naming the specific qualities of an object or a situation is a necessary step in the pursuit of activities that create higher understanding, such as classification and comparison. Mental tools cannot be fully replaced by physical tools, no matter how sophisticated, but using physical tools can be crucial to the development of mental ones.

For example, an aural experience such as music can be enjoyed holistically, but tools are necessary to break down that experience into concepts that can be contemplated, discussed, and deliberately acted on. Physical tools, such as a piano keyboard, help people visualize, demonstrate and explore relevant concepts, but the most powerful tools are the words that allow coherent and precise thought and discussion about the experience, words such as *beat*, *note*, *chord*, or *scale.*

A cultural tradition of such terms is a theory of music. Western music theory is strongly associated with formal music education, and with classical and jazz genres, which generate harmonically complex musical works. Popular genres feature simpler works that are easier to grasp intuitively, creating cultural spaces in which talented self-taught and peer-taught musicians can flourish using informal and tacit understandings of the concepts (Green, 2002). Lack of formal music education is even considered a sign of musical authenticity in some of these genres (Green, 2002; Lilliestam, 1996). However, even successful self-taught musicians can eventually want to learn more formal approaches (Green, 2002); the basic skills and concepts are relevant and useful in popular genres. In the current study, most of the informal learners were motivated to seek theory information by their creative activities in popular music genres.

Recent proliferation of free online educational resources has attracted, among others, people pursuing self-directed music-theory learning. This includes self-taught musicians as well as current and former students seeking to build on their formal training (Schmidt-Jones, 2012). YouTube is a particularly popular platform for such resources, in part because it permits enthusiastic amateurs, as well as professionals, to share their perspectives and understandings (Burgess & Green 2009), encouraging a proliferation of short videos that cover a wide variety of subjects, from cooking and home repair to history and music. This phenomenon is new enough that researchers have not yet had a chance to thoroughly study its effects on learning. Those effects are likely to be both profound, due to the popularity and ubiquity of online videos, and complex, with numerous positive and negative effects that are difficult to untangle. In this context, studies that explore specific effects in specific areas can suggest fruitful directions for further research and start the process of building relevant theoretical frameworks.

A Study of YouTube music Theory Videos

This study examined YouTube videos that present music theory in the context of either guitar or DAW, because these instruments are particularly popular among self-directed music learners. As tools for making music, guitars enjoy a long and broad history linking them worldwide to folk and popular genres and to a wide variety of music-learning traditions.

DAWs are computer programs designed to assist in creating music. Users can manipulate the characteristics of sounds ranging from individual notes and sound effects to extensive samples

of existing musical works. DAWs are a recent invention compared to other musical instruments and are strongly associated with modern popular genres. Some can be downloaded from the Internet at little or no cost, and Tobias (2012) has called them part of a digital democratization that has made creative musical activities much more inexpensive and widely available.

The current study focused on the videos that ranked highest in December 2017 in YouTube searches for music theory for guitar or DAWs. The data collected included the theory concepts covered in each video, the terminology and examples used, and any evidence regarding the instructor's attitude towards music theory, as well as the YouTube analytics, links and channels associated with the video, and the comments publicly attached to it. Over 100 videos and over 15,000 viewer comments were included in the analysis.

A grounded-theory analysis was used to identify issues that were important to this community of informal teachers and learners. A fundamental aspect of grounded theory analysis is its systematic approach to developing themes that emerge from the data, including those that are not expected by the researchers (Charmaz, 2006; Glaser & Strauss 2012). Qualitative coding is done in iterative steps, with preliminary categories and themes identified and developed from the data, using constant comparative methods. In later iterations, gaps in the data are identified, and additional data is gathered to help fill them. This process can include clarifying the meanings or relative importance of the original themes and categories, from the perspectives of the participants. Instead of focusing exclusively on data that are relevant to pre-selected theories and hypotheses, in a top-down approach, theory is built in stages, from the bottom up, with each iteration grounded in the data available at that stage.

Grounded theory was developed by sociologists and "provided a powerful argument that legitimized qualitative research as a credible methodological approach in its own right rather than simply as a precursor for developing quantitative instruments" (Charmaz, 2006, p. 4). One of its strengths is an increased ability to identify what the research participants view as problematic, separately from the prior views of the researchers. Ethnographers have used it to analyze extant texts and archived data, including Internet-based texts and archives, for context, structure, form, presentation, and audience, as well as content. From a grounded-theory perspective, this study can be framed as further development of a prior study that identified possible barriers to self-motivated online music theory learning, with a focus on gathering more, and different types of, data regarding that problem, in order to fill in gaps in understanding. This analysis is then a step in the theory-development process that may help determine the direction of further studies, grounded in data from learners who had real-world motivations to use online resources.

The current study yielded evidence of several of the expected barriers to learning (Schmidt-Jones, 2021) but the most prominent unexpected theme by far that emerged from the analysis was the idea of using the capabilities of DAWs to “cheat” or "hack" music theory. For example, among the top search results for DAWs, videos that featured hacks or cheats were more common than those that featured explanations of music theory; and some videos that did focus on explanation included similar cheats, framed as aids in using the theory. A small number of viewer comments expressed negative views of cheating, but overall, the positive response of viewers to the most popular cheat videos was similar to that of the popular theory-teaching DAW videos. In contrast, the music-theory-for-guitar videos in the study did not promise, or even mention, cheats or hacks, nor did viewer comments request or discuss them.

The prevalence of this theme demanded attention, particularly since it was unclear whether "cheating" might represent an unexpected barrier to learning. The stereotypical academic cheater aims to satisfy course requirements without learning the required knowledge or skills. These were

self-directed, self-motivated learners, however, and their comments indicated that they believed that the cheats offered were themselves knowledge worth learning. One indication of their perspective was that the words *cheat* and *hack* were used interchangeably to describe the same methods. Among internet users, *hacking*, rather than implying a lack of interest in knowledge, implies access to valuable knowledge that authorities keep locked away.

Another consistent difference between the guitar and DAW videos suggests another useful clue. The guitar videos focused on explaining, and providing examples of, the concepts themselves. Any discussion of how to put the concepts to practical use, for example in improvising solos or writing songs, was rare, and was never the central focus of the video. In contrast, nearly all of the DAW videos, whether offering theory explanations or cheats, focused on how to put the knowledge to use in composing music. This probably reflects differences in the instruments as tools. Guitars are often used for live performance and participatory music-making. Many guitarists take an informal path to proficiency, "learning by doing" within the communities of practice that form around such activities (Waldron, 2009; Wenger, 1998), before developing a serious interest in composition or improvisation. Due to this common progression, many guitarists with a budding interest in theory already have a tacit understanding, not only of theory concepts, but of their practical uses. This depth of experience also typically includes symbols and terms, such as named chords, that can act as a basis for building a conscious understanding of theory.

In contrast, a DAW is typically used for composing in a private setting, not for live performance or participatory music-making. Opportunities to learn informally, by making music with others, are limited. Many of the novices who commented on the DAW videos appeared to be lacking in the musical experiences and tacit knowledge that make it easier to grasp concept definitions, follow explanations and examples, and put new ideas to practical use. This lack of practical experience would help explain the high interest in hacks that offer the ability to use the concepts without understanding them. In fact, several of the DAW-cheat instructors admitted that they themselves did not know music theory, arguing that their capabilities as composers were evidence that theory learning could be avoided or delayed. Analysis of the videos strongly suggested that some of the other DAW instructors also had a poor or idiosyncratic grasp of terms and concepts. Again, this was in strong contrast to the guitar videos; all but one of the guitar instructors provided explanations that were clear and correct by formal standards. A specific example of this phenomenon is discussed below.

A lack of theoretical knowledge can eventually create barriers to a musician's development, because understanding aids creativity. Those who operate within conceptual systems with little understanding are bound by those systems, while those who are conscious of them as systems can operate deliberately, finding creative ways to push the boundaries and even maneuver among various systems at will (Vygotsky, 1986). However, at the novice level, a more immediate barrier may be created by requiring that learners master theory before experiencing success in personally-satisfying creative activities. The high interest in, and satisfaction with, the "cheat" videos suggest that they lowered barriers to initial successes in DAW-based musical activities. If so, this raises a question about subsequent learning: Does using the "cheat" create pathways or barriers to higher-level, theory-rich comprehension?

As outlined below, a Vygotskian analysis of music theory and DAWs, as mental and physical tools for composing music, suggested that the DAW cheats rely on music theory knowledge that is incorporated into a DAW's program. Reliance on conceptual knowledge programmed into the physical tool can reduce the need to rely on conscious understanding of the concepts, while still encouraging the development of understanding. A piano keyboard, for example, offers visual

cues that permit a novice to develop a theoretical understanding of major keys and scales through playing them (Schmidt-Jones, 2016). This feature has made the piano the preferred instrument for traditional music theory pedagogy and composition, in part because most other instruments lack such clear visual cues. The interface of a DAW provides visual cues to the musician using it, and thus may also encourage theoretical understanding, but is different enough from a piano keyboard that it cannot be assumed that the effects on the musician will be the same.

Literature Review:
A Vygotskian View of Context, Tools and Understanding

Vygotsky's most influential experiments involved the use of physical memory aids at different stages of mastering tasks. His cultural-historical view of psychology, which has strongly influenced subsequent sociocultural theories in the area of education, postulated that the tools that mediate human activity play a central role in creating and transmitting human perceptions of the world. Material and symbolic tools "encode the knowledge that went into their production and... make it available to other people" (Wells, 2001, p. 178). Material tools, such as hammers and pianos, act on the world; their purpose is mastering nature. Symbolic tools, such as language and music notation, act on the mind; their purpose is "mastering oneself" (Vygotsky, 1978).

Although there are many symbolic tools, Vygotsky claimed a preeminent role for language. "Thought is not merely expressed in words; it comes into existence through them" (Vygotsky, 1986, 218). He demonstrated that concept formation develops through focused attention in the context of relevant cultural activities (Vygotsky, 1986). Naming concepts focuses attention on specific characteristics of experiences, allowing them to be compared, classified, discussed, comprehended, and remembered. In this view, the goal of education is the development of the higher mental functions that rely on concepts (Vygotsky, 1978).

Vygotsky observed that learners' success in difficult tasks could be improved by mediation with physical tools, yet performance also improved when learners subsequently abandoned the mediating tools (Vygotsky, 1978). From this he developed the concepts of the *zone of proximal development* (ZPD) and the *internalization* of concepts. The ZPD consists of tasks that the learner cannot accomplish alone, but can accomplish with appropriate help. This ZPD-oriented temporary help is now called *scaffolding*.

Once a concept becomes internalized, it becomes a part of the learner's thought processes and is integrated into the perception of related tasks. Such tasks can then be accomplished more quickly, without external aids or scaffolding. This ability to generalize a concept and apply it, not only in the specific task learned, but in any appropriate situation, is a crucial goal of education (Vygotsky, 1986). With generalization, the concept becomes a tool that helps learners organize and control their own minds, through internalizing their cultures' ways of thinking and acting (Vygotsky, 1981). However, because learners begin with different understandings and experiences, "the turning points at which a general principle becomes clear. . . cannot be set in advance by the curriculum" (Vygotsky, 1986, p. 185).

The most effective instruction occurs within the ZPD (Pressley, 1995; Vygotsky, 1978), but learners' ZPDs are formed by previous experiences, so good pedagogy incorporates contexts that makes sense to the learner (Folkestad, 2006; Meacham, 2001). One reason that peer teaching can be effective is that peers tend to work within similar ZPDs (Green 2008; Vygotsky 1978). This may partially explain the popularity of the YouTube "cheat" videos; many of them are created by peers working with similar goals in similar musical contexts.

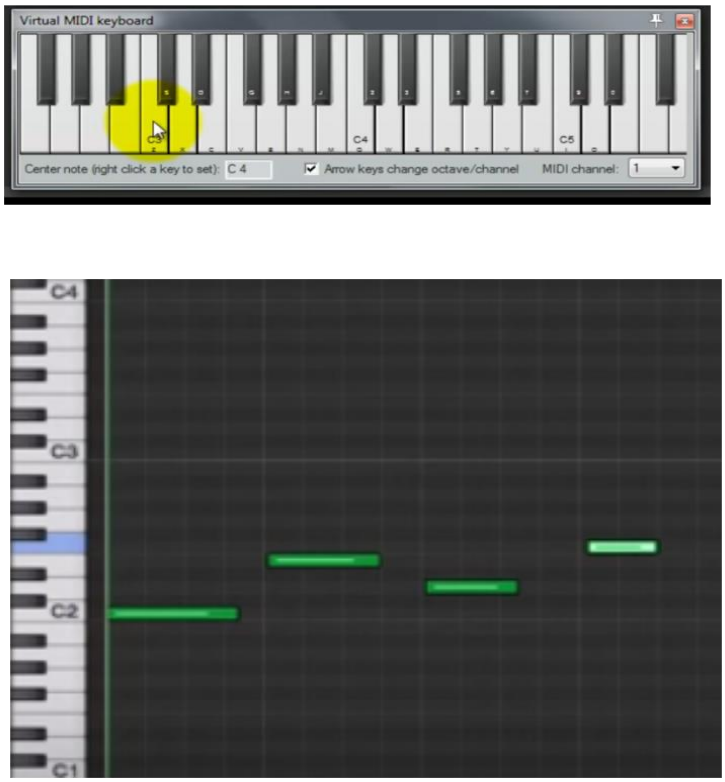
As Vygotsky's experiments demonstrated, tools can also scaffold the development of competence. Research paradigms based on this insight, such as activity theory, give tools a role in the development of concepts in individuals, alongside other factors, all of which might be improved, given goals such as social equity or organizational collaboration. From this pragmatist perspective, "in *order for a technology to count as educative*, it *must be allowed to reveal"* (Blacker, 1993, p. 190, emphasis in original). Kaptelinin and Nardi (2006), who work within the context of activity theory, claimed that this view is similar to Heidegger's philosophical concept of tools as "equipment." From an activity-theory perspective, when an activity is unsuccessful, for example not producing the desired musical sounds, attention turns to the tools employed in the activity. At this point, the activity may shift towards a focus on learning, but what can be learned, in fact what can even be recognized as something that it is possible to learn, is constrained, or in Heideggerian terms "enframed," to the extent that the technology is a "black box" that does not reveal the knowledge that went into it (Hamilton & Friesen 2013). However, there appear to be crucial philosophical differences between the perspectives. Heideggerian critiques are fundamentally wary of the encompassing effects of modern technology, focused on concern that "these new systems operate by fixing how things show up in a way that violates human choice and freedom" (Lines, 2015, 62). Activity theorists, in contrast, do not make distinctions between older and newer technologies, preferring to focus on the individual's conscious experience within "a rich social matrix of *people* and *artifacts*" (Kaptelinin & Nardi, 2006, p. 8, italics in original), and working from a Vygotskian position that passing on cultural understandings through tools is generally educative.

Formal Western Music Theory Education

Music theory education provides a relevant example. People are enculturated at an early age to make sense of certain sounds as music. This fundamentally shapes their experiences of such sounds. Theory concepts allow specific characteristics of musical experiences to be compared, categorized, and understood. For example, in many Western music traditions, sounds are commonly understood as being composed of individual *notes*, and one way to compare and categorize notes is through their place within repetitive patterns called *scales*. Complex patterns of harmony can then be analyzed by categorizing sounds as scale-based *chords*.

For Vygotsky, the best path to comprehending such concepts is to pay attention to them in the context of desirable cultural activities (Vygotsky, 1981). In music, desirable scale-based activities include improvising solos on a guitar and composing melodies on a DAW. Instruments such as guitars and DAWs are physical tools that act on the world by making sounds. They enculturate musicians into concepts such as scales by making it easier to do musical activities in ways that align with the concepts. For example, some instruments have physical features, such as the guitar fretboard or the piano keyboard, that not only make it easier to play sounds that are in a scale; they also literally make it easier to see the patterns that generate scales and chords. Most DAWs have a *piano roll view* that mimics the visual pattern of a keyboard (see Figure 1, next page).

Figure 1. Notes are typically made visible to a DAW user either through a representation of a keyboard or a "piano-roll view" that displays notes as bars on a grid that uses the same white-key / black-key pattern.



Symbolic tools such as notation also scaffold comprehension of scales, but musicians become even more adept at desirable activities when they *internalize* the concept. Internal representations of scales restructure the learner's consciousness, making scale-based activities, such as composition and improvisation, faster and easier. They also function as internal scaffolding for understanding other concepts, such as chordal harmony, which further facilitate such activities.

A lack of formal education, including theory, is not a barrier to high-quality, successful musicianship (Folkestad 2006; Green 2002). Nilsson and Folkestad (2005) found that substantial empirical research in the area of music supports Vygotsky's view that creativity is a basic human function, not a special gift granted to only a few. A deep intuitive sense of music can be developed

through careful listening and experimentation, and a practical understanding of concepts such as *note* and *chord* can be fostered through working with other musicians. When musicians educate each other, verbal language is needed for sense-making, even when the focus is on non-verbal performance (Pramling & Wallerstedt, 2009; Reimer 1997). Conceptual systems don't simply mediate naturally-occurring activities; "they allow and even lead to the creation of types of activities that would not otherwise exist" (Wertsch, 1981, p. 26). Much of the power of music resides in its ability to express in ways that are not translatable to language (Reimer, 1970), but named concepts are still crucial to the creation process.

The goal of formal music theory education is to communicate a conceptual structure that supports the creation of highly complex works. Traditionally, this goal has fostered a pedagogy that primarily consists of analyzing highly-regarded classical works. Simpler, popular works are typically not analyzed, although they can provide good examples of basic concepts (Bresler, 1993). Creative activities such as improvisation and composition are not included, although philosophers of music education have long recommended composition as "a mode of musical study which can be most effective for clarifying how music works" (Reimer, 1970, p. 118) that should be offered at every age. Instruments other than piano are rarely used in demonstrations, although musicians' understandings may be inseparable from their preferred instruments (Partti, 2014).

The ZPD is a zone of psychological vulnerability. Learners who are reluctant to expose their lack of knowledge require internal motivation to enter it (Blair, 2009; Vygotsky, 1986). Socially desirable tasks that reveal the usefulness of the knowledge – as composition does for music theory – provide such motivation, in a way that analyzing music from a less-familiar genre, using a less-familiar instrument, does not. While other areas of music education have been evolving to reflect the breadth of musical interests that engage students (Green, 2002, 2008; Rudolph & Frankel 2009; Stowell & Dixon 2014), "the structures of music theory pedagogy remain largely unchanged" (Smith, 2018, p. 166). This may partly explain the appeal of DAWs and YouTube for self-motivated music-theory learners.

Learning Music Theory through DAWs and YouTube

Folkestad (2006) linked musical creativity with the ability to perceive or reconceive the affordances of the tools used. Incorporating learners' preferred instruments also taps into their innate interest in developing personal musical identities, because tools play a crucial role in identity formation (Hung & Chen 2002). Partti (2014) found that "for the digital musicians, musical understanding seems to be inseparable from the instruments they use" (9) but noted that current research into musicians' development and identities rarely focuses on digital music. The values and understandings of digital musicians are not well understood by music educators and researchers, and better understanding of this growing community of musicians would strengthen the accessibility and perceived relevance of formal music education.

It may also help make music instruction more equitable. From a Vygotskian perspective, DAWs allow composers to remain focused on the activity of creation (Savage, 2005b), rather than on theory analysis, while also providing alternative ways of conceptualizing music (Thibeault, 2011). DAW musicians need not master a traditional instrument (Peppler, 2013) or traditional notation (Gall & Breeze 2005), skills that are often not accessible to low-income students. This may be leading to identification of DAWs with the music of underprivileged communities. In this

study, DAW instructors displayed much more sociocultural, ethnic, and gender diversity than guitar instructors, and their exhortations to "share the knowledge" were sometimes couched using language that signified ethnic or sociocultural identity.

Informal online music education offers other possible attractions. Computer-based scaffolding can lower the sense of psychological vulnerability when learners are hesitant to reveal their ignorance to other people (Blair, 2009). Divergent viewpoints, cultural exchange, and peer instruction are available (Anderson & Dron 2011), so it may also be possible to find the knowledge contextualized in ways that makes sense to novice learners.

YouTube is by far the most extensive and most visited platform for informal educational videos (Burgess & Green 2009; Rudolph & Frankel 2009). Even formal music students and teachers often prefer YouTube-based offerings over vetted resources, due to ease of use and breadth of content (Dougan, 2014; Stowell & Dixon 2014), but much of that content is created by amateurs (Burgess and Green, 2009). Faced with an extensive, uncurated collection of possibilities, self-teaching novice music theory learners can experience severe difficulties choosing the most relevant resources for their situation (Schmidt-Jones, 2016). Many of the specific characteristics of the Internet make it difficult to weigh the truthfulness of knowledge claims (Miller & Bartlett 2012), and as discussed below, even highly-ranked resources created by well-meaning peer instructors may include incorrect or misleading information.

Study Findings Regarding DAW-Based Cheats

In this study (Schmidt-Jones, 2021), most of the DAW videos appeared to be created by amateurs acting as peer instructors, with ZPDs that overlapped those of many of their viewers. By far the most prominent unexpected theme that emerged from the grounded-theory analysis was the pervasiveness of the idea of using DAWs to cheat or hack music theory. Among the top search results for DAW music theory, only 26 videos focused on teaching theory in a DAW context, while 30 focused on teaching ways to use the instrument to cheat or hack theory. In addition, eight of the 26 theory-teaching videos included a cheat as an aid in using the knowledge. Other highly-ranked videos either focused on something other than theory, such as DAW production techniques, or taught theory without reference to a DAW.

Quality of pedagogy was an issue. In general, likes and positive comments were far more common than negative viewer reactions, but some top-ranked DAW videos received relatively large proportions of “dislikes” and/or negative comments. Analysis of the videos suggested that negative viewer reaction correlated with a lack of accurate definitions, clear explanations, and helpful examples, not with whether or not a cheat was offered.

As a group, the cheat videos appeared to be as well received by viewers as the theory-teaching videos. DAW theory videos together garnered around 1500 entirely-positive comments and over 500 comments that included a criticism. Cheat videos garnered around 1400 entirely-positive comments and fewer than 200 comments that included a criticism. Individually, more cheat videos than theory videos—eleven versus four—had an unusually high proportion of negative comments. But because these videos received relatively few visits or comments, their negative reception was more than balanced by the enthusiastic response to the popular cheat videos.

This was in spite of the fact that many cheat videos were not titled as such. Of the thirty DAW videos in which the instructor verbally promised, and then focused on teaching, a cheat, only ten had titles that included words such as “cheat,” “hack,” “tricks” or “without knowing music theory.” Nine of the titles promised music theory, with no mention of cheats. Eleven offered to

teach a music-creation activity, mentioning neither theory concepts nor cheats. As discussed above, such activities would be highly attractive to DAW novices. Only six of the theory videos and five of the cheat videos limited their discussions to the more abstract topics featured in the guitar videos, such as "finding" chords or scales. The rest presented concepts in the context of skills such as:

- creating pleasing melodies, bass lines, or chord progressions;
- creating music in a specific style or mood; or
- transposing music to a different key.

Scales and keys are central to all of these activities. They are closely related concepts; a scale is essentially a list of the notes that are permitted in a key. Many of the DAW instructors used the terms interchangeably or conflated their meanings, with the term *scale* strongly preferred over *key*.

Scales and keys are widely recognized to be a major challenge for novice musicians. Using the capabilities of a DAW to bypass the need to understand or keep track of scales and keys was by far the most common type of cheat offered. Of the thirty cheat videos, twenty demonstrated how to use the instrument to ensure that all of the notes in a melody, bass line, or chord progression were in a specific scale or key. The purpose of the cheat, then, was to bypass the need for the learner to understand the concept in a usable way. The videos presented different methods for bypassing the knowledge, because the instructors used DAWs that offer different ways of interacting with scales. Because of these differences, the methods varied greatly in the extent to which scale patterns remain noticeable when a knowledge-bypassing cheat is used (see Figure 2). In many of the bypasses, notes that are not in the scale disappear from view or become impossible to choose, but in others they are still visible and audible choices.

Of the ten remaining cheat videos, five bypassed the concept of scales altogether to provide a different route to building chords. That bypass will not be discussed here, because it is not instrument-based. Four videos bypassed scales by beginning with a chord progression found on the Internet or in the DAW. The same "folding" or "greyed out" methods illustrated in Figure 2 were then used to limit the melody to notes in the chord progression, rather than to a scale.

The final video that promised "music theory cheating" presented a way to use a production technique to create impressive-sounding arpeggios, as if a piano were being played by a very skilled performer. Interestingly, twenty-four viewer comments claimed that this was not a cheat. A common argument was that the purpose of the tool was to do such things, and using it well for its designed purpose could not be considered cheating. Some compared the process to notating a composition with the expectation that it would be read and performed by someone with more facility on the instrument than the composer. Comment arguing that it was cheating seemed to frame it as a cheat on playing piano, rather than on theory. A similar "that's the purpose of the tool" argument could reasonably be applied to DAW scale bypasses. None of the other cheat videos received comments arguing that it was not really cheating, but one viewer of a theory-teaching video that included a bypass did respond to comments that the bypass was cheating with a comment supporting the instructor: "Clearly you understand the laws and rules of music but choose to execute it differently; how is that cheating?"

Two videos that garnered high numbers of views and comments provide further insight into the wide variety of viewer opinions regarding theory, cheating, and knowledge bypasses. One video promised to teach the theory that underlies good melodies and bass lines, but the instructor

explicitly admitted that he did not know the term for one of his note choices and could not explain the theory behind another. He also appeared to use unconventional terminology, for example saying "in tune" where conventional usage would be "in the key" or "in the scale." Several DAW instructors used this "in tune" terminology, so it may be widespread in the DAW community, but this could lead to confusion when communicating with other musicians, for whom "in tune" refers to pitch accuracy, not scales. Although thirty percent of the 292 comments on this video were entirely positive, the instructor also received dozens of comments that pointed out specific errors, noted that he did not seem qualified to teach theory, complained that the theory was difficult to understand, or offered a suggestion for the term he admitted not knowing. The video used a scale bypass, but did not clearly demonstrate how to set it up. Numerous comments requested or supplied additional information about the bypass. A small number of comments expressed negative views of theory, for example:

- I've taken countless music theory classes, but I kinda feel like it destroys one's ability to write techno music.
- I don't use theory when I'm producing. I'm using my feelings.

However, some comments that criticized the instructor claimed that theory is essential, for example:

- If you really want to learn how to make interesting and musical melodies, whether bass or not, LEARN THEORY.
- Without music theory you're not gonna get very far using FL Studio [the DAW used by the instructor].
- If you really are so uneducated in music theory that literally someone telling you that you should follow a scale in a song is mind blowing, you probably should uninstall FL studio, take a music class, then come back when you can actually make music.

Another comment took issue with this stance, however, in ways that evoke the themes in this essay:

- I know some basic music theory, but I wouldn't suggest to anyone who didn't know theory that they need to know some before using the software. That's part of the beauty of FL; it's so simple and visual that you don't need to understand the theory…It's stupid to discourage people from the software by making out that you have to know the music theory to use it.

One other instructor also inspired numerous comments about both theory and cheating. He offering a scale-based bypass for building melodies and chords, claiming it "eliminates the need to buy any music theory courses or any of that kind of crap. You really don't need it, because FL Studio has everything built into it already. You just need to know how to use it." Unlike the theory instructor, however, the cheat instructor used theory terminology such as "in key" extensively and in standard ways. Although some viewers complained that they could not get the scale bypass to work, none complained that they did not follow the theory explanation. Over 60% of the 738 comments were generic positive statements, and an additional 49 comments included specific praise regarding the usefulness of his method, for example:

- I've been struggling so much making melodies and this helped so much. Thank you.
- Thanks for this. Absolutely amazing! Excellent for beginners like me.
- This video is amazing. Building chords kinda hard lately. Thanks.

In this positive atmosphere, the handful of pro-music-theory comments all pointed out that while this successful instructor did not recommend learning theory, he clearly knew it well himself. There were no comments that echoed the instructor's strongly negative stance, but there were a few that claimed theory is unnecessary. One particularly thoughtful comment noted:

- We all know that music theory knowledge is not needed to create music...Music theory just helps you with analyzing existing music to learn from and apply the techniques in your own...In the end this just saves you time you otherwise would have to invest in listening over and over again: it helps you to save a little more time to be creative…For a long lasting career in music it is a very useful way to keep yourself going when inspiration is low; it helps you analyze new sorts of music aside from Hip-Hop and trap and lets you understand where that specific sound is caused by. But like I said, nothing is a must. Someone who knows his theory doesn't automatically make better music.

Overt antipathy to learning theory was rare among cheat instructors. Most of them framed bypasses either as a matter of personal preference or as scaffolding on the way to learning it, for example:

- This will allow you as a beginner to focus more on writing the melodies and chord progressions rather than spending a lot of time worrying about the theory behind it, because this helps put the theory right in front of you and makes it really easy.
- Someone has their own sound; that all comes out of practicing what we all call music theory. So it's not like you can read a book about it or watch this video and overnight, you're a maestro.
- If you don't know your music theory…this might take a while to come up with…There's a convenient way that's both productive and fast.

A few other instructors admitted that they themselves did not know theory well, for example:

- Because I don't know music theory, I have to really rely on my senses and my ears and the emotions that the chords give me.
- I myself struggle with theory…haven't had a chance to put in the time…You should, but in the meantime, these will make you sound better at music theory than you are.

Again, in contrast to the DAW findings, no guitar instructors or commenters offered, suggested or requested theory "cheats." However, among the high-ranking videos, one focused on, and another included, a guitar-based theory-knowledge bypass called the *CAGED system*. This system provides a method for quickly generating the most common chords in any key, using the guitar fretboard as a guide instead of conceptual knowledge. It is clearly an instrument-based theory bypass, but was not framed by anyone as a "cheat." In fact, many guitarists consider another fretboard-based theory bypass to be an essential performance skill: memorizing scales as fingering

patterns that can be shifted in order to improvise in any key, with little need for conceptual knowledge.

Discussion

Unlike DAWs, guitars have been around for centuries and have inspired a wide range of long-standing instructional traditions. The communities of practice that transmit popular or folk traditions sometimes value instrument-based approaches, such as the CAGED system, that might be considered cheating in the context of formal theory instruction. These approaches allow novices to begin, not with concepts such as scales, but with activities oriented towards sociocultural participation, such as improvising solos or playing chordal accompaniments in a band. The lack of insistence on mastering formal theory and notation allows novices to reach their initial personal and participatory goals relatively quickly and easily, which may be one reason for the popularity of guitar among self-directed learners. Nor does it appear to cause a permanent lack of interest in theory; the plethora and popularity of guitar theory videos suggest that many self-directed guitarists become motivated by their experiences to learn about theory.

It stands to reason that DAW novices also want to experience relatively early and easy successes in activities appropriate for their instrument, such as composing acceptable melodies and chord progressions. A large proportion of the highly-rated videos were clearly focused on such activities, and the bypass videos, as a group, received a viewer reaction similar to the theory-teaching videos. Most of the negative viewer reactions appeared to be related not to the choice of teaching or bypassing theory, but to other issues such as poor pedagogy. It is to be expected that more bypass videos than theory videos would be pedagogically weak. Many DAW musicians who rely on ear and bypasses to create their own music might make good peer instructors in informal, one-on-one situations. However, because verbal language is so central to sense-making, even in non-verbal activities (Pramling & Wallerstedt 2009), a lack of conceptual knowledge would impede a peer-instructor's ability to provide clear explanations and demonstrations, even in mildly formalized situations such as YouTube videos.

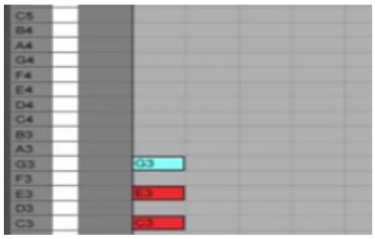
Many novices may not care whether they learn or bypass theory. The large proportion of popular DAW videos that taught theory in the context of desirable sociocultural activities, such as creating melodies or chord progressions, suggests, as Folkestad (2006) or Green (2002) would predict, that learners want to focus their attention on actually making music, rather than on learning how to make it. Rather than framing DAW-based approaches as cheating on music theory, it may be more useful for music educators to consider the instrument as a tool that, like a guitar fretboard, can scaffold difficult tasks that motivate novice learners. DAWs, like guitars, attract many self-directed music learners. By allowing novice composers to shift attention away from concepts and towards sound (Savage, 2005b), while providing alternative ways of visualizing and conceptualizing music (Thibeault, 2011), DAWs permit early success that requires a minimum of theory comprehension, while simultaneously offering pathways and motivation to expand that comprehension.

By adopting some of the most popular cheats and reframing them as scaffolding, courses that teach music theory in a DAW context could support students in early efforts at composition, while also revealing the creative value of theory. Scales provide a case in point. That novices struggle to master scales, and that this struggle is necessary because of the centrality of scales to Western music, is widely taken for granted among music instructors. In Vygotskian terms, educators should welcome tools that mediate the use of scales, providing scaffolding until the relevant concepts become internalized.

It is crucial, however, that the tools reveal the concepts to learners, so that they can be internalized. A tool can either reveal or conceal the concepts that it embodies (Blacker, 1993). For example, "folding" the piano roll view of a DAW to a scale hides crucial characteristics of that scale (see Figure 2, below).

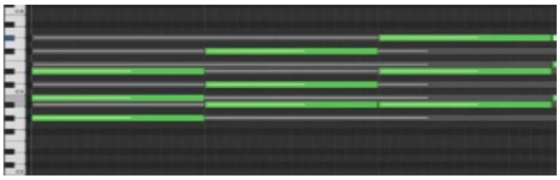
Figure 2. Different bypasses afforded different levels of awareness of the theory.

"Folding" to a scale made pitches outside the scale invisible. For example, note that "folding" to a C major scale causes all of the black-key notes to disappear.



"Locking" to a scale often meant that pitches outside the scale are visible but not heard. Choosing a "wrong" note caused a nearby "correct" pitch to sound. For example, playing a C sharp on a keyboard locked to C major would cause the C natural to sound.

"Greying out" a scale typically meant that pitches outside the scale were still visible and usable. It was clear which notes are outside the scale, but the user was free to choose whether and when to avoid them. For example, "greying out" can make a scale other than C major visible against the piano-roll grid, as a series of grey lines.



Novices using this bypass have little opportunity to think about the notes that are not in the scale, or about the note patterns and relationships that determine whether a scale is major or minor. The bypass in which users hear a note in the scale, even when they "play" a note outside of it, is conceptually even worse. By actively blurring distinctions among the notes, it may delay ear training as well as theoretical understanding. By far the best choice, from a Vygotskian perspective, are bypasses in which non-scale notes are identified but still usable. Scale-based patterns and relationships become visible, perhaps intriguingly so for those who like to experiment, while scaffolding to choose notes in the scale is provided.

Conclusions

The grounded-theory goal, of developing theory directly from the gathered data, is particularly apt for exploratory studies, when researchers do not have sufficient knowledge to choose the most suitable theories and hypotheses beforehand. Theory developed in this way does not offer verified knowledge, but rather a "plausible account" (Charmaz, 2006, p. 132) that provides directions for further investigation. Without quantitative testing, it cannot be asserted that some DAWs are better than others at scaffolding the development of music-theory comprehension. However, such a finding would be well in line with what is widely understood to be true of more traditional instruments; pianos are preferred in traditional courses because they reveal theory more clearly than do, for example, clarinets or trumpets.

The more interesting possibility is that some DAWs may reveal some aspects of theory more clearly than do pianos. While Vygotsky treated the enculturating aspects of tools as assets to be encouraged in education, their tendency to enframe the user is the negative side of this enculturation, and one that is not limited to new technologies. Using a piano and common notation, for example, severely limits a composer's ability to consider notes or tunings outside of the Western classical tradition. It also strongly implies a creative focus on pitch and rhythm. DAWs can make it easier to explore non-Western tunings and to experiment purposefully, not only with pitch and rhythm, but with other characteristics of music, such as dynamics, articulation, and timbre, that have been neglected in traditional composition, representation, and theory (Thibeault, 2011).

Nor is such theory learning of interest only in regard to training composers; it also has repercussions for basic music education. Reimer asserted that "What language does so powerfully for the experience of music is to disclose, which means 'to cause to appear; allow to be seen; lay open to view…'The acquisition of such recognitional/perceptual ability is the basis for *aesthesis*—the kind of knowing that is perceptual in essence and the key characteristic of the wisdom Aristotle called *phronesis*" (Reimer, 1997, p. 104).

Further research on this issue could help to clarify how the design of a tool affects its ability to scaffold theory comprehension and learning. The current findings suggest that early practical success in creative musical activities can be supported by instruments that scaffold difficult-to-master skills such as composing music within a specific key, and that may, but may not, simultaneously scaffold the development of conscious understanding of the process. DAWs and other tools that do both should be preferred by music educators. Because scaffolding can be intentionally designed through programming, DAWs can be particularly capable of providing effective scaffolding through good interface design, but there is currently no incentive for them to do so.

Although the data for this analysis drew from many informal instructors, learners, and tools, the focus on DAWs essentially dealt with a single instance of a technology that can either scaffold theoretical understanding more broadly than traditional tools or hide it more completely, particularly when used by novices with little prior experience or comprehension. Similarly powerful technologies that benefit users in other areas of expertise are becoming easier to use and more widely available; warnings of the dangers of tools that conceal from the user the knowledge they incorporate are appropriate. However, along with such warnings, a pragmatist perspective can be offered that recognizes that technologies can and should be designed to reveal incorporated knowledge to users, scaffolding the development of internalized understanding that does not need the technology, and that, when necessary, can stand in opposition to its implied world view.

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