FROM FRENCH HORN TO SMARTPHONE: LEVERAGING DIGITAL TECHNOLOGY AND THE DIGITAL TURN

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Abstract

The shutdown due to the COVID-19 pandemic has accelerated the implementation of digital technology to advance many new applications. Digital applications were believed to be indispensable for changes in learning environments and strategies that would enhance the capacity and quality of learning through focused motivation, communicative interaction, and stronger self-determination. This text will discuss prominent arguments for digital learning and digital technologies that might initiate a digital turn. To this end, this paper reflects on the psychological and mental conditions of human learning, evaluates the potential opportunities of digital tools within the context of teaching and learning, and concludes with consequences for music learning in public schools.

Keywords: learning, perception and cognition, digital technologies, immersion, virtual reality, artificial intelligence

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The shutdown due to the COVID-19 pandemic has accelerated the implementation of digital technology in schools and teacher education.[1] It was applied to home-schooling procedures, and also for other unexpected applications. For example, for the first time entrance auditions to the Music Academy Freiburg (Germany) were performed at distant locations in real time for foreign Asian students who could not personally travel to Freiburg; two *Yamaha Disklavier* grand pianos that were digitally connected and remote-controlled were employed for the auditions, with one situated in China or Japan with a corresponding grand piano in Freiburg where the selection committee evaluated the performance from a distance of over eight thousand kilometers.[2] In this example, the digital connection in real time adds a new dimension to the more traditional mechanical musical instruments (such as orchestrions and organs) produced between 1832–1932 by Welte-Mignon in Freiburg, including their 1904 invention of a reproduction piano (based on piano roll machinery). Today, high tech digital advancement has opened new artistic options for unforeseen applications to musical performance.

Technology in music and music education resound throughout the literature on music teaching and learning[3] following major changes in the theory and practice of education in recent times triggered by a host of technological innovations. Specifically, the use of technology in the context of curricular requirements not only reflects current demands on music education as stipulated by public education policies, but also echoes the challenges experienced by music teachers in their actual teaching practices today. Learning in the digital age even poses as part of "smart education" or "smart pedagogy."[4] Hence, the call for "digitalization" of teaching procedures and for "digital learning" has recently become much more urgent and demanding.[5] However, it is not always clear what digital transformation means in the context of music learning. Clearly, the mode of learning itself is not digital, just as digital sound does not exist in the sense that digital coding of sound events is merely no more than a conversion of real sound waves to binary data.[6] However, a theoretical justification of new methods and digital tools calls for a thorough consideration of the essence of learning and how it might change within the context of digital environments.

During the past sixty years many technical innovations have been introduced to education. While technical media have been integrated into the daily practices of music education systems and school settings, such as computerized programmed learning, language laboratories for music, and smart boards, none of these has essentially changed the sustainability of teaching and learning. It should be pointed out that although they seemed to have been introduced with great promise that students would benefit from technological advancements as being more efficient and in-depth, as well as serving as a significant contributor to

increased self-determined and active learning, computer labs, learning software (for example, automated ear training programs), and smart boards, have not been used regularly in traditional music education systems. However, the discussion regarding the advantages and disadvantages of digital learning started much earlier in the 1980s along with the advent of the MacIntosh (Apple) computer in the classroom. And now, when schools have been shut down, new tools seem to have filled the gap, adapting all music teaching and learning from a position of distance far from the classroom. However, perhaps it can easily be predicted that when a more normal situation returns, such practices will again be modified.

DIGITAL LEARNING. WHAT DOES IT MEAN?

Most certainly digital technology occupies an essential part of the learning environment and has initiated the transformation from traditional personalized learning to digitized applications to learning aids.[7] "Education is becoming increasingly 'digitized' and 'datafied.'"[8] There is a broad consensus among supporters of digital learning that digital tools will supplement personal teaching activities[9] and help students to explore and acquire relevant information.[10] It is expected that digital environments stimulate more focused learning and creative thinking abilities.[11] Therefore, it has been stated that the actual learning power is driven by psychological, mental, and physical conditions of modern learners that might introduce a transformation of traditional learning systems.[12] Yet, what is called digital learning is always related to a digitized environment furnished with digital hardware (laptops, smartphones) supplemented by operational software and procedural applications. Therefore, digital learning is synonymously applied to learning in a digital environment with digital technologies and electronic media. In this respect, the digital part of learning has not yet been described–either by educators or by information scientists. Rather, the learning is strongly connected to the integration of digital tools in the process of teaching and learning. Consequently, digital learning implies the use of digital devices and materializes the application of digital technologies.

Digital learning is therefore usually associated with the increasing use of digital media in daily life as well as in schools by small children just as by teenagers.[13] Classrooms are equipped with Bluetooth-based smart boards and wi-fi extensions for internet browsing by connecting to the school's local network; computers, tablets, and smartphones have replaced traditional standards (for example, classroom practice exercises with pencil and paper and use of workbooks and readers). Today the only need is to have access to a server to download relevant information. In music education there emerges a trend to expand or even replace analogue tools (which is represented by the topos "French horn")

by digital technology and tools (which is represented by the topos "smartphone"). The pedagogical question, however, should be concerned with the proper place of digital electronic devices in education.

Digital tools are adept at presenting an artificial environment that pretends to be real by imitating reality (that is, artificial reality). These tools enable one to collect and present all kinds of information with great speed; they are perfectly designed for searching, presenting, and structuring complex issues. However, we could ask who arranges the choice of information that is received from search engines such as Google? What happens with the individual data stored in smartphones and tablets of students and teachers when they update programs? Why are big media companies so interested in the implementation of tablets in the classroom? How can automated pattern recognition (Artificial Intelligence) be used in learning environments? What is the essence of learning in a digitized context? Answers from reports about the implementation of digital tools are rather disillusioning. For example, what kind of learning is initiated by the focus on finger movements on an iPad while using a program application for musical composition?[14]

It is indeed daunting to note that the use of digital tools transpires without any tangible understanding of how they work or what effect they have; users are content as long as devices and applications function properly. However, is such pragmatic use reliable for education? The digital world itself is rigidly locked in, and inaccessible, to sensorial experience. The animated icons, which are presented to users as if real objects themselves, do not have any smell, surface texture, haptic quality, or natural color; they are synthetic and execute a programmed response when the user enacts an instructed behavior (for example, push a button, tap an underlined text, swipe screen right/left or up/down). There is no contact with real sounds, rhythms that provoke action on materials such as bodily power, movement, tension, swing. When a child wants to make sound with a recorder, they need to vitally breathe in order to resonate the air in the column. When one plays a violin, one needs to feel the bow being pulled across the strings; one can hear the effect of finger changes at the fingerboard on the pitch. And truly, all of this seems quite natural. The hands-on experience tells us a lot about the function of bodily actions. After all, to play an instrument (not a recording nor a tune streamed in from Spotify) calls for a person, a human being who initiates sound by movement. And a person can do it because of the practical experience with the options (or according to Gibsonian ecological psychology: "affordances"), that is, the possibilities and challenges which are offered by the instrument itself. Here, the action immediately causes an audible sound, a body action becomes part of the result, and does not merely initiate a hidden digital circuit.

WHAT CONSTITUTES LEARNING?

Musical learning, in a very strict sense, relates to an internal process of developing mental representations for basic musical elements (that is, genuine musical learning). This type of focus does not consider a wider position concerning everyday music interactions by which children and teenagers might develop attitudes toward specific musical behaviors or an appreciation for music (such as fandom for a particular band, artist, style, or genre). Musical learning, as outlined above, takes place neither in a pure digital environment nor with hi-tech tools, devices, gadgets, or applications. Rather, musical learning happens while one actively responds to sensations, perceptions, and experiences from the external world. It results from an interaction with the physical environment by mental activities. Therefore, it is essentially based on a process by which we develop an internal representation of the external world that can help to overcome environmental challenges. This process shapes the cognitive structure of the mind which, then, acts in retrospect of previous experience on further processes of perception and cognition. This interactive procedure is deeply embedded in social interactions with communicative functions, and connects the mind and the body, the I and the Other, represented by the vortex of the I-identity and its difference to the external Other.[15] Therefore, learning cannot be made; it happens as a consequence of how one interacts with facts, events, and real-life objects.

On the one hand, learning is founded by and grounded in the neural architecture of the brain.[16] But on the other hand, it is embedded in social actions and cultural conditions, extended toward an exchange with other counterparts, and embodied in a corporeal origin of thinking, imaging, and cognition.[17] Therefore, learning does not exclusively result in the *knowledge about* something, rather it appears as a *reflection in action*.[18] Hence, learning results in the ability to respond sensitively and appropriately and terminates in new options for thinking and understanding.

In the special case of musical learning this process culminates in the ability to think in sound which Edwin Gordon has called "audiation."[19] This is based on genuinely musical representations in the mind that have been developed through perception and performance and will be activated in recognition. Musical learning, therefore, does not aim at the verbal classification and memorization of facts, but rather it appears as a stage in a process of cognition and comprehension or as this process itself. The essence of this process of musical learning can neither be categorized as digital nor simply as analogue but instead, it is based on biological (neural) processes with strong mental and social implications. Therefore, the term "digital" learning is misleading.

HUMAN PERCEPTION AND COGNITION

It is conspicuous that in the recent debate on cognition, cognitive scientists and psychologists put the interaction of the *mind* and its *body* with the environment to the fore. This is the special focus of James Gibson's ecological theory of (visual) perception.[20] He argues against the Cartesian view that body and mind (brain) are separated and cognition is a matter of the brain. On the contrary, Gibson acts on the assumption that perception and cognition cannot be understood as mere internal processes, but rather they emerge from an intense interaction between the mind and the objects of the environment. The objects that we perceive already offer an option for action, an affordance. For example, a chair includes an affordance to sit, a trumpet to blow, a tune to sing or dance or move, a piece of wood to construct. This means that the objects of our world come into a vital interaction with our own intentions and interests. Perception needs a counterpart in the real world and functions toward the integration and incorporation of the phenomena of the external world.

This view has been extended by Mark Rowlands who also rejects the Cartesian view that cognitive processes are solely realized by neural mechanisms in the brain. Accordingly, he emphasizes that mental states and cognitive processes exceed the internal neural limitations and are always embodied, embedded, enacted and/or extended.[21] The so-called 4E cognition underpins that cognition is always interwoven with the body[22] and also entwined with both social and cultural contexts in which the cognitive activities are embedded.

The cultural sociologist Richard Sennett sees the processes of cognition and learning equivalent to those of processes of handicrafts where technical means ("–craft") and bodily imaginations of action plans ("handi–") lay the foundation even for cognitive acts by human imagination and conscious intention.[23]

What unites all three of the above theories is a comprehensive view that connects body and mind with the environmental stimulation or affordances. Cognition never acts in isolation detached from situated conditions. It is based on neural processes, but those are always integrated in a larger milieu consisting of intentions, interests, attitudes, expectations, and functions. Furthermore, and even more strikingly, we know from evolutionary biology that thinking and cognitive functions have originally evolved from movement. In this connection, Rodolfo Llinás[24] and Daniel Wolpert[25] have shown that the primary function of a brain is to coordinate movements to navigate in and communicate with an environment. Thinking in its evolutionary function is internalized movement and therefore primarily a premotor act (which is still reflected in language when we ask someone: How are you doing? Then, we are not interested in getting to know what someone does, but how he feels and thinks). In the light of these

theoretical approaches, it is rather plausible that a French horn rather than a smartphone can offer the learner many more options for musical experiences and represents an actual learning tool, because it affords meaningful actions and movements.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

A smartphone is a digital device that obviously fascinates children. One can no longer think of everyday life without it as it provides information and contacts and includes many practical applications. Therefore, representatives of telecommunication companies promote digital information systems and even educators call for an integration of such devices as tools targeting schooling because they implement some traces of the reality of life into the classroom. One believes (or envisions) that this affects motivation and even supports an autonomous acquisition of information in self determined learning settings. In music, smartphones also offer to arrange or compose one's own digital music without the need of exhaustive lessons and practice time to master an instrument. Everybody can make his/her own music, as well as participate in the social endeavor involving a community of practice.[26]

However, digital technology is strongly connected with the philosophy of machine learning and artificial intelligence. It intends to detect rules and generate solutions based on stored data and algorithmic principles to optimize strategies of problem solving. It is assumed that digitized technologies might relieve brains which instead should discover and define new problems within a given situation. Actually, what is called "artificial intelligence" is basically a matter of automated pattern recognition. Some processes may be modelled by artificial neural networks, but what is missing from the progression is prerequisite sensorimotor feedback. On the contrary, the information processing of the human brain depends on a structural coupling of neural connections with environmental input coming from the world and organic processes. Mental states always reflect an activity which is aligned with the surrounding world and its stimulating affordances. Therefore, it is striking that recent theoretical conceptions of machine learning and robotics tend to use anthropomorphic descriptions. It seems more and more clear that the key to the mind is not held by the programming of complex algorithms, but rather determined by the interplay of hardware and software and their embedment into an actual living environment (*Lebenswelt*).[27]

In view of this, smartphones offer some interesting options to advanced learners for individual application, but they can neither replace embodied and enacted experience nor refine actual learning.

IMMERSION

The term "immersion" (*Immergenz*) has appeared from the 1990s within the context of media studies and aesthetics.[28] The phenomenon refers to a special attitude of perception when people completely become immersed in an object of perception, particularly sound, the spiritual sphere, or aura of a composition. Electronic technologies with new recording techniques and the use of headphones and audio-visually supported surround-sound installation techniques are quite able to intensify aesthetic immersion. Such virtual reality has opened an entirely new dimension of aural perception, not only made possible, but much enhanced, by digital technology. However, in regard to music learning, immersion can be seen in a much broader context than that of some innovative application to information technology. More importantly, immersion can also integrate empathy with the music and its intellectual or spiritual features. However, this presupposes the listener has had previous musical experience and has acquired great informal knowledge. Although this term is mostly used in connection with virtual reality, it opens an entirely new dimension of aural perception.

Since digital tools have become a part of everyday life, technology infiltrates the habits of listening behaviors, and therefore can be used in music education as well. This provides new approaches to reaching the status of "flow"[29] and may open alternative pathways for emotional musical experiences. This can be seen as a step toward a new sensory perception (which is a prerequisite of learning), that precedes the growth of representations. However, one has to consider the differences of immersion in music practices within real environments (for example, a church sanctuary, an opera house, or concert hall), or even when playing an acoustic instrument *versus* virtual simulations created in the isolated head of a listener. These are significantly different from all aspects, including acoustic and psychological events.

SCHOOLING AND LEARNING

Before a digital turn in education can be proclaimed, educators need to re-think school and education, as well as consider the rich past of progressive education *(Reformpädagogik, l'éducation nouvelle*) where progressive teachers defined the goals of education which are still valid. Such goals concern the orientation on the learners and their interest and curiosity instead of the curriculum and formal structures; that is, switching from the object to the subject, from the curriculum to the learner, from passive knowledge to active experience.[30] The ideas of progressive education include embodied learning as a creative and active exploration of the challenges of the environment, rather than focus on

receptive strategies of teaching and learning by memorization of concepts and rules. Progressive thinking has seen school as a form of life community with democratic structures like in the ancient hellenistic *polis*,[31] and considers education as the formation of the whole personality with its intellectual, psychological, physiological, social, and emotional potential.

These ideas tie in with conceptions that evolved a century year ago. And we can go back another further hundred years to Johann Gottfried Herder who lived five years in Riga where he taught at a *Domschule* (a clerical Latin-school). Later on, Herder was responsible for the school organization in Weimar. In an address to schoolteachers, he mentioned:

> Was heißt lernen? Man hat davon falsche Begriffe, wenn man glaubt, es heiße: fremde Worte sich einzuprägen. … Was tun wir, wenn wir gehen, sprechen, zeichnen, tanzen lernen? Nicht wahr? wir üben und vollführen ein Werk; wir machen's nach, bis wir's können, bis es gelingt, mit *unseren* Kräften, mit *unseren* Gliedern. … Auch bei dem Denken findet das Lernen auf keine andre Weise statt. *Seine* Gedanken kann *mir* der Lehrer *nicht* eingeben, eintrichtern; meine Gedanken kann, will und muss er durch Worte wecken; also dass sie *meine*, nicht *seine* Gedanken sind. … Ihnen muss man folgen, an sie seine eigenen Gedanken knüpfen; so *lernt man lehrend*, so *lehrt man lernend*.
>
> What means learning? One goes wrong if one assumes that it means to memorize strange words. … What are we doing while we learn to walk and talk, to paint or dance? Isn't it what we practice and that we perform a work? We imitate until we get it and we succeed in doing so with our best endeavors, with our bodies. …With regard to thinking, there is no other way to do it. A teacher *cannot* or drum his ideas into me. *My* own thoughts can, will and must be stimulated by *his* words so that they become *my own*, not *his* ideas. … The teacher must follow *my* ideas and tie in *his* thoughts with *mine*; so one learns by teaching, one teaches by learning.[32]

This is essentially a rather modern position–although more than two hundred years old! The basics of any learning aim to acquire new forms of understanding the world through discrete acting and body experiences and to incorporate the knowledge to make it one's own.

To re-think school in a new way, to reconsider schooling and learning, one can connect the old principles with new insights from neuroscience and evolutionary biology: learning is acting on concrete tasks and working with the body.[33] Learning needs an "original encounter" ("originale Begegnung") with real objects.[34] Finally, thinking in general as well as that specifically related to music develops from internalized movement. Without corporeal feedback it is hardly possible to develop mental representations in childhood. In this connection,

Manfred Spitzer warns educators of "digital dementia" alluding to the limitations of digital experiences.[35] Additionally, one also has to take into consideration the various consequences that are observed after an extended use of digital tools during the COVID-19 pandemic which caused psychological and physiological effects through social isolation.[36] Technological addiction effects permanent stimulation and eliminates phases of consolidation which are essential for sustained learning. Since the early years are very critical regarding brain development, one needs to act with strict precaution when introducing digital tools.

THE ROLE OF DIGITAL TECHNOLOGY IN CONTEMPORARY EDUCATION

The term "digital learning" not only imposes on education, but tends to imply that learning can be supported by datafied procedures.[37] The use of digital technologies prompts learning environments that deal with data which replace real world experiences. Technologies rely on data processing neglecting the active appropriation of the sensual properties of the phenomena that are to be learnt and provide a speedy retrieval of extensive information stored in a digital mode.

Learners (especially those of younger ages) do not operate like systems that process an input of data, but rather function as organisms that perceive and respond to experiences which profoundly engrave their minds regarding further perceptions and cognitions beyond the determination of an abstract algorithm. Therefore, digitized learning quickly reaches its limits. Learning is essentially based on physiological processes, spines and synapses must grow, and this takes time. Learning does not increase by accelerating speed. The human brain needs time to adapt to new challenges; learning requires the establishment of neural networks and to consolidate accumulated information by repeated practice and rest, during which information can be stabilized by the hippocampal loop where new information circulates and consolidates.[38] Digitization, to the contrary, builds on highspeed data processing.

The debate on technologies and music teaching and learning focuses far too much on tools, devices, and applications, but far too little on pedagogics. In terms of educational theory,[39] education aims at an extension of the conscious mind through acting and bodily experience. But without sensorial input no musical thinking (audiation) can evolve. As soon as this mental condition has been established, digital tools can easily be used as a supplement and additional option to get access to new dimensions of sound by establishing novel domains of musical practice. They may successfully support information acquisition and processing, facilitate independent work, and utilize relevant expertise in a field from other sources than those that are normally available inside schools and classrooms.

However, the prerequisite always is that actual learning has already been initiated so that new digital electronic devises can efficiently be implemented. These options apply to services within the structure and organization of education, namely the provision of already available knowledge by search machines, the fast and simple acquisition of varied documents (texts, sounds, pictures), the access to data bases for a literature search as well as to sources for sound production, the immediate transformation of signs into sound, the electronic sound production and manipulation for creative experiments, compositions or improvisations, the preparation and presentation of online materials for teaching, and the use of communicative conference and learning platforms for personal interaction and communicative exchange.

However, it should be quite clear that learning management applications and digital technologies alone cannot solve educational problems beyond organizational structures. Albeit, schools do need to incorporate those technologies in their proper places because they are part of our lives. Yet, it depends on the conception of musical learning in school if, when, and how, digital devices and applications are introduced into the classroom. There is no good reason at all to follow just the tempting promises of powerful companies; their interests and agendas are purely economic rather than educational. Therefore, we may proceed from analogue procedures to digital electronic devices, as long as supporting application tools function as a completion of school teaching, which is justified only by its contribution to deep learning in a psychologically and developmentally adequate manner.

In summary, so-called digital learning refers to an important aspect within modern education systems but its scope is limited to functioning as a complementary tool. The main criterion remains how much a tool stimulates musical thinking, hearing, and performing as an individual competence, and how it acts on mental states and cognitive processes as a human faculty. The way toward such capacities is defined by the pedagogical goals of music education. And that is what needs to be debated over and over again to assure ourselves of the means we apply to music education to enhance learning. Then, we will eventually end up feeling compelled to revoke a digital turn.

NOTES

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