

EDUCATION 4.0

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ABSTRACT

Education, both as a system and as a process, intertwines with its contemporary level of technological development. Educational processes can be expressed using predictive algorithms, with the exception of creative activities that require a different type of algorithms called *adaptive algorithms*, currently used mainly in the development of applications related to the field of general artificial intelligence or AGI. The present study discusses education assisted by artificial intelligence through the lens of the fourth industrial revolution.

Keywords

Artificial intelligence, education, algorithm, personalized education, transfer

INTRODUCTION

An algorithm is a set of instructions that translate into actions that, when followed exactly, lead to an expected, pre-planned result. Eloquent examples would be the instructions to change a car tire or the set of actions we follow every day to consume, for example, a coffee, to cross the street or to drive a car.

Therefore, any process can be expressed using an algorithm. As long as the result of the set of instructions is known, we are dealing with a predictive algorithm. It can have any level of complexity, however it cannot handle exceptions unless they are described in the algorithm, case in which they can no longer be treated as exceptions but are included as variables. Authentic exceptions, if and when they occur, are ignored or result in an error, in which case the algorithm no longer leads to the expected outcome. Predictive algorithms are robust and reliable, but specialized and rigid at the same time, meaning that they will always lead to the expected result and are not subject to degradation over time, they have a precise destination and cannot handle exceptions. Thus, this type of algorithm does not have the ability to adapt to unforeseen situations or to interact, outside of its own paradigm, in a way that can be defined as creative.

The immediate and at the same time natural consequence of the characteristics of this type of algorithm is that the applications in the field of artificial intelligence developed so far follow a similar productivity model characterized by an unmatched efficiency in any narrow domain, yet very limited in scope and applicability further on. In other words, this type of artificial intelligence can easily win chess or Go matches played with human world champions, but it cannot do anything else, as does not have the ability to transfer the skills thus acquired to other fields or domains of activity. Artificial intelligence based on this type of algorithm is also known as ANI, more precisely Artificial Narrow Intelligence or weak A.I. (Narrow or weak Artificial Intelligence).

The exceptional results obtained by ANI in the fields in which it was applied led to a colossal pressure from both the economic market and the governments of the most developed countries to create a new type of artificial intelligence, mainly AGI or Artificial General Intelligence or strong/full AI. This type of AI is able to learn by interacting with the environment and to creatively improve its operating algorithms, in other words to edit its own code, more precisely its operating software together with its routines and subroutines, through an educational process modeled after the way the human brain learns. In theory, this type of artificial intelligence would mimic the cognitive abilities and modus operandi of the human brain in order to eventually gain self-awareness and an unimaginable level of intelligence that, by exponential means, would quickly become trillions of years more developed than that of the humanity that made it.

Cognitively similar to the human being, therefore able to create, AI would not be constrained in any way by specific human limitations such as: conditional access to information; a relatively short period of maximum brain plasticity; data storage capacity and access speed; dependence on a body, varied food and sleep; metabolism; disease; aging and death, etc. As an autonomous system with the ability to control all planetary resources, given that access to information would be infinite due to an exponential development of intelligence, being self-aware and capable of creation, artificial intelligence would dominate without recourse all aspects of planetary life, and therefore education, in the shortest possible amount of time. How the involvement of artificial intelligence in human education will eventually manifest itself is the subject of numerous debates that include but are not limited to politics, economy and especially ethics.

PERSONALIZED EDUCATION

Regardless of the current origin, methods, aims and nomenclatures, all education systems can be classified into several categories:

1. that do not use technology
2. that use analog technology
3. that use hybrid analog-digital technology
4. that use only digital technology (currently no education system is purely digital)
5. that use artificial intelligence

There is a fundamental difference between using a technology and relying entirely on that technology, in other words to fully generate the educational process using, for example, artificial intelligence. Education and technology have had and continue to have a parallel evolution, however with many points of interaction where they influence each other. Specifically, education becomes the cause of further technological developments, which in turn make these technologies available to education.

Artificial intelligence is still in its infancy regarding its current stage of development, however is already present in many domains of activity such as military, commerce, social media, medicine, engineering, law, construction, statistics, design, creation of media content, stock market, aeronautical industry, trade, etc. Its applications are currently found in the form of virtual assistants or chat-bots; in agriculture; in autonomous flight; retail, shopping and fashion; security and surveillance; sport activities and analysis; manufacturing and production; animal resource and inventory management; autonomous

vehicles and machines; health and medical imaging analysis (Cogito Tech LLC, 2019), law (Harmon, 2019) and engineering (Hughes, 2019).

The logarithmic evolution of artificial intelligence, as well as the clearly superior advantages it brings to the negotiating table of any kind, makes inevitable its integration into the present educational systems, fundamentally changing them and resulting in a novel educational paradigm.

There are a number of scenarios that predict social unrest and devastating consequences as a result of current developments in disruptive technologies such as quantum computing, robotics and, in particular, artificial intelligence (BBC, 2014; Clifford, 2018; Rawlinson, 2015), including a potential cashless society (Desai, 2020) and a universal basic income or UBI (Wispelaere and Stirton, 2004) due to robotics replacing human subjects in most of the production processes, drastically reducing job offers on the labor market. However, artificial intelligence could certainly play a significant positive role in the development of humanity. Education 4.0 is a new educational paradigm that can be the beginning of personalized education, an approach that has the greatest potential to serve the genuine interests of the student, in a never-seen-before manner and with unprecedented efficiency. This type of education is authentically inclusive and exclusively healthy, meaning that it has no prejudices of any kind, but has the ability to discern what is really necessary and beneficial at the individual level, for each separate case.

As a natural consequence of complexity, every human being is physically, metabolically and cognitively unique. The role of the environment is crucial in the developmental process of each individual, however each is born with a particular set of inclinations and more easily develops certain skills based on a complex set of factors, normally as a result of long-term educational training. These individual differences can be observed all the more so and especially in the modern global society, which tried to level the standard of living of all individuals in three distinct economic classes (rich, middle class and poor).

Therefore, the vast majority of mass-education systems operate on the basis of general standards imposed upon the entire population of students and on which basis the individual performance of each student is assessed. This is done without taking into account what, in an exceptional way, would constitute a personal educational profile of each individual, this being fundamentally different, for example, from the current transcripts. The latter, or any other similar document, is not an educational profile, but an index of results at a given moment in time. In other words, there is a set of knowledge and skills considered at one time by society and the labor market as necessary for any individual, regardless of their background and aspirations, as well as a customized set of knowledge and skills to specialize in different fields of activity.

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General education has the largest share in the formation of the individual and is, at the same time, the least flexible in adapting to personal needs, with the tendency to become

more and more rigid as it is exposed to “reforms” lacking overall vision. An eloquent example is the exclusion of calligraphy from schools on the grounds that in today's technological society handwriting is no longer useful, although there is numerous research showing the direct link between the fine motor coordination movement of the wrist and fingers of the hand and the development of the morphological structure of the brain, especially in the years of maximum neural plasticity.

There are many distinct reasons why the state of affairs of education everywhere is at the stage it is in today, however, this study does not discuss the improvement of these systems, but a fundamental paradigm shift. More specifically, in the context of the current globalization, one can observe the further disability of an educational system based on general rules applied in the "Procrustes' bed" style to the entire population and it is proposed here to adopt a fundamentally different paradigm that treats each student as an entity in itself and personalizes the educational process according to the authentic needs of each individual. Of course, the system of assessment and recognition of capacities also needs to be rethought, parallel with the system of qualification and recognition of native and acquired skills.

EDUCATION 4.0

Still true to the parallel development between education and technology, Education 4.0 or artificial intelligence-assisted education gets its name from the current industrial revolution, also known as the Fourth Industrial Revolution, which unites the physical world with the biological world and the digital world in an unprecedented manner.

A careful analysis can lead to the conclusion that the offer of artificial intelligence is impossible to ignore from any point of view we may use to approach it. At least in theory, it initially does not discriminate voluntarily, does not sleep, does not need a break, does not depend on traffic, weather, time zone, subject, language, body, metabolism, health, psychological state, hobbies, vices, time, space, subscriptions, politics, cultural, economic or military interests, etc., which paints an interesting portrait for a possible such teacher.

Having access to a database of dimensions impossible to comprehend mentally and which is constantly increasing with each passing minute, the capacity of artificial intelligence for statistical analysis and, therefore, for correct prediction of the incidence, evolution and outcome of a phenomenon, together with the most suitable approach for solving a problem, it evolves exponentially. Without limits and boundaries, a teacher who knows everything there is to know about the educational process and methodology seems to be an ideal choice. Over time, the same artificial intelligence will be able to become the repository manager of all data in the educational profiles of each being, passing through countless generations, so that its ability to perceive and cultivate individual skills that are even invisible to today's education systems is a difficult reality to ignore. A unique artificial intelligence, always present, always incorruptible, always available, always in its full capacity to evaluate the educational profile of a student seems to be the promise of current research in this field of advanced technologies.

For example, although still in its infancy, the acquisition of skills in the form of a program to be downloaded directly into the cortex and the transmission of data from brain to brain is the subject of intense concern for the contemporary researchers (Shelly, 2016; Poda et al., 2016; Armstrong & Ma, 2013). When the specialized knowledge currently acquired with effort and dedication will be available to anyone, the only and most

important individual skill will remain creativity. The reason is unpredictability, completely incompatible with predictive algorithms that underlie all non-creative processes. A predictable creation is no longer a creation, but an execution, and although there are currently many areas of interference between authentic creation and the creative approach to a phenomenon, they are still distinct. As far as creation is concerned, for as long as we further consider its transcendent character, it remains the only asset that humanity can have in the face of artificial intelligence, as well as the only quality that would justify, to some extent, a "shadow" of equality with it.

Even if these creative approaches in the field of AI are just at the beginning, their evolution is fulminating. For example, the current music creation engine known as AIVA (AIVA 2020) creatively approaches existing music patterns by algorithmically processing them and generating soundtracks that are ultimately chosen or not and therefore validated or invalidated by a human factor. However, AIVA does not, in fact, create anything, but makes combinations, arrangements, permutations and processing of pre-existing material. Therefore, the problem of an authentic AIVA creation cannot be raised at the moment, but of a creative manipulation for commercial purposes of some pre-existing musical models. When artificial intelligence became self-aware and proved a volitional act of creation, this manipulation would become creative, and the resulting music, this time an authentic creation, would be composed and evaluated by its author in a completely original way, from the very beginning, without copying material from other already existing creations, being at the same time consciously assumed by it. Directly relevant in this context, the aesthetics of authentic creation remains a topic of discussion far too broad to be debated in the limited space of this article, but we retain the paradigm for its value in the context of *Education 4.0*.

MUSIC EDUCATION

Music education, in particular, is one of the most suitable environments for research in this new educational paradigm, due to the natural amalgamation of individual and group educational methods that are, from the very beginning, part of music teaching strategies. Moreover, the peculiarities of instrumental education that positively and overwhelmingly affect the morphological development of the brain and, as a consequence, the cognitive development as well, can be used as a strategic mechanism for developing a set of exceptional skills with significant transfer potential to other fields of activity. Therefore, music education can serve as a method of cultivating brains with exceptional abilities, regardless of the subsequent evolution of the individual in terms of a career or vocation.

Associated with other fine arts, sports sciences, contemplative arts (which have the chance to acquire the status of contemplative sciences based on multiple research efforts in this field), nutrition, ecology and the exact sciences, music education can, in a unique way, by the simple reconsideration of its role in general education, to respond competently to the authentic development needs of the student of tomorrow.

For example, the different types of educational methods used to develop a significant number of cognitive skills necessary for a complete music education provide a complex range of student development offers both as an individual entity, unique, as well as an active and fully involved member within a community. These skills are related to the inherent complexity in mastering vocal and instrumental performance (solo and ensemble), composition, conducting, various types of spectacular events, as well as pedagogical and

theoretical approaches that propose, support, evaluate, discuss and teach all these types of music education.

Of course, there is a dose of skepticism about the possible role of artificial intelligence in the reality of music education. For example, in a class such as math, an interactive virtual teacher can teach topics from the simplest to the most complex, with outstanding results. Online courses with video-recorded teachers are already a step towards this paradigm, with the difference that they are real people being videotaped, and the possibility of interactivity must be achieved technologically in specialized ways. However, online interviews for positions with interactive avatars are already a reality for a growing number of companies, which now brings the opportunity to offer a similar facility in digitized education supported by artificial intelligence.

Today's technology is still far from being able to assess class performance and provide useful instructions to a first-grader learning to play the violin, especially when physical adjustment of posture, bow position, fingering or auditory feedback is required regarding these details in relation to pitch and sounds produced, coupled with the teacher's practical demonstration customized to any given situation. There are already programs used in hearing development (Demenescu, Cinč and Oz, 2016), as well as specialized programs that examine students on violin, clarinet, saxophone, flute and trumpet using artificial intelligence (Yung and Nedelcuț, 2018), although computerization is sometimes still reluctantly viewed when approaching the learning of vocal technique (Chifu and Ardereanu, 2018).

INTELIGENȚA ARTIFICIALĂ GENERATIVĂ

Unlike general artificial intelligence or AGI, generative artificial intelligence or Generative AI is a set of applications such as deep machine learning software or deep automated learning software that is executed by an artificial intelligence. They are able to use text, audio files and images to create media content. Therefore, the algorithms underlying these applications can spontaneously generate any specific type of feedback by displaying or audio-visual playback. Considering the possibility that the specific algorithms are of adaptive type, they can adapt in real time to specific situations of an environment with which they interact in real time. Therefore, if 3D technology and advanced robotics are taken into account, it has the potential to behave like a teacher in the classroom. Consequently, generative AI applications can be adapted for music education, when the orchestra will be conducted by a robot becoming a possible reality of the near future, as long as there are already robots playing the piano (CCTV Video News Agency, 2018) and violin (Taylor, 2007).

In the context of music education, in addition to the obvious role of a possible teacher, artificial intelligence can have the role of facilitating direct but personalized access of any student to this type of training, to the most harmonious and competent development of personal skills in order to transfer them to other fields of activity. For example, self-discipline, strategic thinking, intelligent management of resources over time, empathy, leadership, robust development of the neural constellation due to the specificity of this type of training, emotional control, healthy tendency towards perfectionism, dedication, long-term investment in self-development, as well as exceptional short- and long-term memory specific to instrumental training are valuable cognitive skills in any other fields of activity.

Community sense, the ability to collaborate and work in a team for a common goal, the ability to listen carefully and harmonize in groups are just some of the skills that are developed in orchestral, choral or spectacular activities. Eloquence, the ability to articulate concepts clearly, the management of stress and performance anxiety as well as the harmonious psychosomatic development, imagination, the development of a wide emotional spectrum, and the ability to adapt to unforeseen situations are just some of the transfer skills cultivated in singing. Analytical, transdisciplinary, psycho-pedagogical, economic, ecological, social and anthropological thinking are also some of the many other dimensions of musical thinking stimulated by the theoretical sciences which, in the case of music, always have immediate practical applicability, making them equally susceptible to transfer. Furthermore, all areas of music training develop additional skill sets with significant transfer potential. The latter form both the basis of musical training and a solid foundation for any other field of activity. Therefore, in the broader educational context, artificial intelligence can strategically use this type of training in order to facilitate the transfer of skills acquired in music education to other fields of activity, since it has direct access to all types of education, which for a human teacher, in the vast majority of cases, is not a viable option since far too few music teachers teach exact sciences and vice versa.

CONCLUSIONS

Generative artificial intelligence in the context of general artificial intelligence is the opportunity to create a personalized type of education that fits the educational profile of the student represented by his/her authentic needs, abilities and native tendencies, as well as a predictive statistical evaluation of some skills which today cannot be foreseen, but may become necessary in the future. A close collaboration between fields of knowledge such as music education, cognition, information technology, artificial intelligence, mathematics, psychology and medicine can create the basis for fundamental and applied research in this transdisciplinary field of artificial intelligence-assisted education. It is able to develop key questions, suggest directions of applicability and provide theoretical, philosophical and practical answers to in-depth questions about Education 4.0.

REFERENCES

- [1] *** (2020). *AIVA. The Artificial Intelligence composing emotional soundtrack music*. Accessed February 2, 2020 (<https://www.aiva.ai>).
- [2] Armstrong, D. și Ma, M. (2013). „Researcher controls colleague’s motions in 1st human brain-to-brain interface”. *UW News*. Accessed February 2, 2020. (<https://www.washington.edu/news/2013/08/27/researcher-controls-colleagues-motions-in-1st-human-brain-to-brain-interface/>).
- [3] BBC (2014). „Stephen Hawking: 'AI could spell end of the human race'.” *BBC News*. Accessed March 7, 2020 (<https://www.bbc.com/news/av/science-environment-30289705/stephen-hawking-ai-could-spell-end-of-the-human-race>).
- [4] CCTV Video News Agency (2018). „Robot VS Human: Pianist Battle Debuts in Beijing.” *Youtube*. Accessed March 1, 2020 (<https://www.youtube.com/watch?v=JFce7I7N1w8>).
- [5] Chifu, D. S. and Ardereanu, I. A. (2018). “Singing Lessons Delivered with the Help of Electronic Means of Communication – a Controversial Approach to Teaching Vocal Skills.” *ICTMF* Vol. nr. 9/2018. Cluj-Napoca: Editura Media Musica. Accessed February 2, 2020

(http://www.tic.edituramediamusica.ro/reviste/2016/2/ICTMF_ISSN_2067-9408_2015_vol_7_issue_2_pg_no_19-22.pdf).

[6] Clifford, C. (2018). "Elon Musk: 'Mark my words — A.I. is far more dangerous than nukes'." *CNBC*. Accessed March 7, 2020 (<https://www.cnn.com/2018/03/13/elon-musk-at-sxsw-a-i-is-more-dangerous-than-nuclear-weapons.html>).

[6] Cogito Tech LLC. (2019). *Where is Artificial Intelligence Used Today?* Accessed March 1, 2020 (<https://becominghuman.ai/where-is-artificial-intelligence-used-today-3fd076d15b68>).

[7] Demenescu, V. L., Cinč, E. și Oz, D. O. L. (2016). „Solfeasy”. *ICTMF* Vol VII, nr.1. Accessed February 2, 2020,

(http://www.tic.edituramediamusica.ro/reviste/2016/1/ICTMF_ISSN_2067-9408_2015_vol_7_issue_1_pg_no_17-23.pdf).

[8] Desai, M. (2020). „The benefits of a cashless society”. *World Economic Forum*. Accessed March 1, 2020 (<https://www.weforum.org/agenda/2020/01/benefits-cashless-society-mobile-payments>).

[9] Fan, S. (2016). „Can You Download Knowledge Into Your Brain With Electricity?” *SingularityHub*, March 5, 2016. Accessed February 2, 2020 (<https://singularityhub.com/2016/03/06/can-you-download-knowledge-into-your-brain-with-electricity/>).

[10] Harmon, L. (2019). „Artificial Intelligence Is on the Case in the Legal Profession.” *Observer*. Accessed March 1, 2020 (<https://observer.com/2019/10/artificial-intelligence-legal-profession/>).

[11] Hughes, J. (2019). „The Key Roles of AI Engineers.” *Engineering Management Institute*. Accessed March 1, 2020 (<https://engineeringmanagementinstitute.org/key-roles-ai-engineers/>).

[13] Podda, M., Cocco, S., Mastrodonato, A. *et al.* (2016). „Anodal transcranial direct current stimulation boosts synaptic plasticity and memory in mice via epigenetic regulation of Bdnf expression”. *Sci Rep* 6, 22180. <https://doi.org/10.1038/srep22180>.

[14] Popean, M. (2018). „Algorithm Applications in Music Education as part of General Aicology”. *ICTMF* Vol. X, nr.1/2018. Cluj-Napoca: Editura Media Musica. Accessed February 2, 2020 (http://www.tic.edituramediamusica.ro/reviste/2018/1/ICTMF_ISSN_2067-9408_2018_vol_9_issue_1_pg_no_007-015.pdf).

[15] Rawlinson, K. (2015). „Microsoft's Bill Gates insists AI is a threat.” *BBC News*. Accessed March 1, 2020 (<https://www.bbc.com/news/31047780>).

[16] Taylor, M. (2007). „Toyota's violin-playing robot.” *IEEE Spectrum*. Accessed March 1, 2020 (https://spectrum.ieee.org/automaton/robotics/robotics-software/toyotas_violinplaying_robot).

[17] Yung, E. și Nedelcuț, N. (2018). „Scalebook and Vemus, literacy software tool” (Scalebook și Vemus, programe dedicate educației instrumentale). *ICTMF* Vol. nr. 9/2018. Cluj-Napoca: Editura Media Musica. Accessed February 2, 2020 (http://www.tic.edituramediamusica.ro/reviste/2018/1/ICTMF_ISSN_2067-9408_2018_vol_9_issue_1_pg_no_007-015.pdf).

[18] Wispelaere, J. D. and Stirton, L. (2004). „The Many Faces of Universal Basic Income”. *Political Quarterly* Vol. 75(3). DOI: <https://doi.org/10.1111/j.1467-923X.2004.00611.x>. Accessed March 1, 2020.