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From Education 1.0 to Education 4.0 – Challenges for the Contemporary School

Abstract

The rapid pace of digital media development implies social and cultural changes. The role of the school is to prepare the human being for the world dominated by these changes. Education 4.0 is one of the concepts for the comprehensive development of the human being. The first part of the article presents the chronology of changes in education in relation to the evolving digital media. Hence, the source of the changes and the subsequent stages of the concept from Education 1.0 to Education 3.0 are described. The second part of the article describes Education 4.0 and its components, the implementation of which in the learning and teaching process is a challenge for the contemporary school. The components described include: -Internet of Things, -the Cloud Computing, -Big Data analytics, -Autonomous Process Organisation, -Augmented Reality, -Horizontal and Vertical Integration, -Advanced Robots and Co-robots. The practical considerations on Education 4.0 follow from the reflections presented by a primary school headmaster who is also an academic staff member.

Key words: *school, Education 4.0, digital media, Industry 4.0, Covid pandemic*

Introduction

The omnipresence of the media in various aspects of human activity causes a great breakthrough in the common understanding of the existence of the world. As a result, in the humanist mind, the coexistence of the digital world with the ana-

logue world is increasingly being confronted. The idea of a post-digital world that is critical of intangible digital technologies, while still based on these technologies, is emerging (Juszczyk, 2021). Thus, it is a world in which the limits of using digital technologies are exceeded in many aspects, including the educational aspect. It should be noted that the implications of digital technologies with education have set new directions for the development of human competences, which at present take the form of Education 4.0.

The discussion on Education 4.0 focuses mainly on the new qualification requirements and on adapting curricula to Industry 4.0. Some of the scientific analyses also tackle changes in education itself in a similar way to the development of Industry 4.0 (Coşkun et. Al., 2019). However, it should be noted that the vast majority of the discussions only apply to vocational education, leaving general education aside. According to Hans-Peter Blossfeld and Jutt von Maurice (2011), education in modern societies has become a lifelong process. This process (Juszczyk, Kim 2020) is a kind of open education, namely the idea of how people can create, disseminate and construct their knowledge in various aspects of their lives. Therefore, when building the vision of Education 4.0, we cannot ignore general education including primary and secondary education as well as social sciences and the humanities.

From Education 1.0 to Education 3.0

The technological evolution that we have seen in the last fifty years is a smooth process of changes resulting from the social and economic needs of a human being. We are witnessing how much technology linked to the development of the Internet transforms the world. The process of these changes also includes education. These changes were identified by Jacke Gerstein (2014) as Education 1.0, 2.0, 3.0. The development stages of Education 1.0, 2.0, 3.0 were correlated with the development of Web services 1.0, 2.0, 3.0.

In the past, educational changes were based on **Web 1.0**. It is a period of time in the global network, which had the feature of low ergonomics. Websites were based only on the HTML code and contained poor graphics. The interfaces were unintuitive and operated through connecting with other websites. Web 1.0 was a one-way communication model. Content was only managed by creators who had specialist knowledge in this regard. Internet users could only be passive users, without being able to comment on online content (Sarowski, 2017).

Education 1.0 looked the same, with knowledge being passed on by the teacher. In this teacher-focused model, students had access to information via e-books

and websites. However, these media were not interactive. Students were unable to comment, share or interact with the content. Thus, the use of this technology was based only on passive acquisition of online knowledge (Gerstein, 2014).

The next step in the evolution of the Internet was the **Web 2.0** concept developed and popularised in 2003 by Tim O'Reilly, a media market entrepreneur. The strategic goal of this concept was a website seen as a continuously evolving platform, allowing the user to control (edit) their own content. In addition, Web 2.0 was based on the assumption that its users who work together are its architects. Therefore, collective intelligence was an important part in creating Web 2.0 (Oreilly, 2005). The development of Wikipedia, a collectively edited encyclopaedia where users create a certain value, which is also controlled by other users (Lister, et. al., 2009) can serve as an example.

Web 2.0 is a technological breakthrough because the way resources were used changed. The boundary between the creator and the recipient gradually started to blur. Any Internet user could also be the creator of specific content without holding specialised (IT) competencies in this regard. Internet blogs, allowing for interactivity, personalisation and individualisation of content have contributed to the way the Web works (Sarowski, 2017). In addition, Web 2.0 made it possible to combine the real and virtual world via Internet technologies, which were innovative at that time. Such a combination of the worlds gave rise to a greater number of educational opportunities by enriching and diversifying experiences gained by children, teenagers and adults. The Elearning Guild Research report lists the following Web 2.0 technologies: social networking sites, wiki, blogs, resource sharing, tabs, events, cloud computing, audio services, video services, discussion forums, chats, instant messaging, e-mail, and other information channels such as SMS and MMS (Shank, 2010).

Education 2.0, just like Web 2.0, was a milestone in the evolution of the education process. According to this concept, education takes place between a student and a teacher, a student and a student, a student and content as well as a student and an expert. In synchronous and asynchronous communication, students could implement educational projects not only locally but also globally. The work on a project was carried out in a specific online community, whose members can physically be on two different continents. Education in the "online world" had the feature of the opportunity to comment and interact directly with content by changing content and sharing it in social networks (Gerstein, 2014).

Artificial intelligence is a "milestone" that differentiates Web 2.0 from **Web 3.0**. It is owing to artificial intelligence in Web 3.0 that computers can understand

information, just like people in order to deliver faster and more accurate results. They become more intelligent as to meet the needs of the users (Issa, Isaias, 2015).

Web 3.0 is based on intelligent tools that provide information in a targeted and user-preferred manner. Therefore, by assumption, an Internet user seeking specific information in the Web will receive (as a result) well-selected references. One should be aware that Web 2.0 allows us to receive many references, some of which are not useful (Sarowski, 2017). Ruth Reynard (2010) also adds that Web 2.0 provided us with social tools, while Web 3.0 enables the creation and recording of entire cultures based on thoughts, ideas and perceptions.

Web 3.0 includes an integrated Web environment in which a "machine" is able to understand and catalogue data in a human-like manner. A "machine" obviously means "bots", i.e. computer programs that perform certain activities without the presence of a human being (Rudman, Bruwer, 2016).

Web 3.0 is also referred to as a "Semantic Web". It is a concept of processing the content of websites, the key elements of which include: – new programming languages which categorise and manipulate data in order to enable the machines to understand these data and the phrases which describe them; – obtaining information from an increasing range of sources, from inaccessible applications; – creating and sharing all types of data across all types of the Web via all kinds of devices and machines (Jacobus, Rudman, 2015). Therefore, Web 3.0 additionally recognises the intentions of Internet users based on the context of data transmission as well as facilitates and accelerates the collection of the information they search.

What are the characteristic features of **"Education 3.0"** based on Technology 3.0 then? According to this concept, education consists in personalised learning based on the student's interests, innovation and creativity. Thus, in "Education 3.0", students themselves play a key role as creators of "knowledge artifacts" that are shared in online communities (Gerstein, 2014). Similar characteristics of Education 3.0 were defined by Derek Keats and J. Philip Schmidt (2007). In their opinion, firstly, the role of the teacher has changed as they no longer provide knowledge or guide the students in its processing. The teacher organises an educational environment in which the students develop their knowledge together. Another feature of "Education 3.0" is the change in sharing of content that should be free and open to students as well as available for modification by them. Thirdly, new technologies are used in the training process to enable creative networking. Fourthly, "moving from passive to active approach" in "Education 3.0", the student's behaviour transforms into a strong sense of value for their own education, co-creation of resources and proactive choice.

From Industry 4.0 to Education 4.0

The assumptions of Education 4.0 are directly related to the idea of Industry 4.0, which was created in Germany. One of the main challenges of Industry 4.0 is sustainable development in production processes (Paravizo, et. al, 2018) and the integration of these processes with the digital media (Dalenogare, et. al, 2018). Industry 4.0 aims to achieve higher productivity rates through real-time monitoring and diagnostics. Industry 4.0 solutions will increase production efficiency as well as reduce time waste and resources consumed (Coşkun, et. al., 2019).

A well-planned educational process is required to make the vision of Industry 4.0 a reality. Both industry and education should develop equally and their components should be compatible. Therefore, it is for the assumptions of Industry 4.0 to lay foundations for modern education.

According to Selim Coşkun, Yaşanur Kayıkcı and Eray Gençay (2019), more and more conceptual articles are being developed to analyse the transformation of education itself in accordance with the rules of Industry 4.0. Although these are mainly articles related to higher education and vocational education, it is also important to identify solutions at the level of general education, including the humanities. This means that Education 4.0 should also be developed at the primary, secondary and higher education levels which include the humanities.

Education 4.0 opens a new phase in which the humanist ideas are integrated into the digital world. At present, we observe the following trends in Education 4.0 (Fisk, 2017):

1. Internet 4.0 services offer great remote learning opportunities at the student's own pace, anywhere and anytime. So the approach of the inverted class is followed, where the theoretical part can be studied outside the class hours.
2. Computer applications will allow students to personalise their learning experience.
3. The use of their own digital media, including mobile media for learning (the so-called BYOD Bring Your Own Device approach) gives students the choice how they want to study.
4. Studying is based on practical activities, including implementation of projects that help to master organisational, cooperation and time management skills which are useful for a future academic career.
5. Studying will consist of data interpreting, where students will have to apply their theoretical knowledge to figures and use their reasoning skills to deduct on the basis of logic.

6. Educational achievements are evaluated in a different way than it has been done so far. The actual knowledge held by students can be evaluated during the learning process, and the application of that knowledge can be assessed when working on projects in the field.
7. In the teaching process, the opinion of students is important and will be taken into account when designing and updating the curriculum.
8. The main education responsibilities will be transferred from teachers to students.

Education 4.0 offers new opportunities resulting from deeper symbiotic, including emotional, interaction between a human being and a machine (Demartini & Benussi, 2017). Education 4.0 can be seen as the implementation of transhumanism. This idea focuses on improving a human being, calls people to take control of the evolutionary process through technological knowledge in order to free the human species from its biological constraints (Young, 2005). But is this the education we really want? What are the social expectations of Education 4.0 and what are the concerns about making the idea of this education model a reality? What is the Education 4.0 model supposed to look like at social school? These are just some of the questions to be answered when introducing the vision of Education 4.0 into schools.

Education 4.0 – practical solutions at school

The vision of Education 4.0 is constantly being developed and implemented stage by stage at the contemporary school. As the new media are a constant component in the social and cultural life of the human being (Huk, 2016), parents, teachers and students have expectations of the new school model. We want a "new school" where education will be a pleasure, not a sad duty with the digital media used facilitating education rather than dominating it.

The solutions proposed are the result of a literature analysis and the initiated "in-action study". The study was conducted between May 2020 and June 2021. Based on the interviews conducted with the primary school principal and a researcher, the implementation of the Education 4.0 was described. The study was carried out during the Covid pandemic. As a result of health and epidemiological restrictions, the school changed the way of its operation overnight. Many schools abandoned traditional teaching and implemented the concepts of Internet-based and mobile media-based Education 4.0. Thus, the proposed solutions are ideas that are already being implemented or can be implemented in educational practice in the future.

Education 4.0 is a concept aimed to ensure sustainable development for people by integrating social, cultural and educational activities into the digital media. The integration of human activities into these technologies enables real-time monitoring and diagnosis of the competences being developed. The foundation of Education 4.0 is the continuously improved artificial intelligence (AI). However, the ideas following from Industry 4.0. are typical components of Education 4.0, the set of which is not closed. They include (Wrobel-Lachowska, et. al., 2019; Salomon, 2019; Ciolacu, Tehrani, Binder, Svasta, 2018):

- Internet of Things,
- The Cloud Computing,
- Big Data Analytics ,
- Autonomous Process Organisation,
- Augmented Reality,
- Horizontal and Vertical Integration,
- Advanced Robots and *Co-robots*

Internet of things (IoT) is an open network of intelligent objects that are capable of self-organising, providing real-time information, data and resources, responding to environmental changes and situations and taking relevant action (Madakam, 2015). The operation basis of IoT is the presence of various objects around us, which, when cooperating and interacting, will help to achieve a common goal (Atzori, et. al., 2010).

With the use of (IoT) at school, teachers could spend less time on organisational matters related to documentation preparation and more time on working with students as to monitor their progress (Gul, et. al, 2017).

In the school environment, there are many objects or items that can be part of the IoT network. These include:

- school entrance doors and doors to individual classrooms which would monitor the presence of students on the school premises;
- student lockers which inform the student and his/her parent about textbooks and other school supplies located in the locker;
- benches and even students' chairs which, equipped with appropriate sensors, could adjust their height to the height of the student;
- surveillance cameras located in school corridors and on school fields that would be equipped with thermal sensors to identify students, teachers and other school staff, including those who for example have an elevated body temperature. Surveillance cameras and public address systems through which the headmaster of the school could monitor the school premises;

- sets of surveillance cameras, speakers and microphones in classrooms that allow for conducting a class in a traditional manner and online at the same time. School students who are absent (e.g. due to illness) could participate in classes from a different place;
- smart watches designed to monitor the students' health. The current information on the worrying condition could be provided through the Web to the teachers and students. For example, during physical education, respiration, heart rate and blood oxygenation could be monitored;
- smart watches and smart phones designed to inform the students and their parents or the teacher of: class schedule change, homework, out-of-school activities, training plans or learning progress.

The Cloud Computing is a technology that allows access to system resources and data processing via the Internet (Jaeger, et. al, 2008).

The cloud computing enables educational data to be collected and analysed through the cloud computing software. The data that can be collected and analysed include: student work, evaluation survey data, recorded class video and recorded video data from the school surveillance system.

Big Data Analytics – processing large and diverse data sets (Kambatla, et. al, 2014). The number of data collected at school is growing steadily. Big Data aims to: -improve school operation, -optimise the educational process of each student, -track the student's progress throughout their education experience (from kindergarten to college/university), -create and modify the development path of each student, -adapt the educational requirements to the students' abilities, taking into account disability and other developmental disorders, -optimise the school running costs (water consumption, electricity).

Augmented Reality can be defined as a reality that has three basic features: a combination of real and virtual worlds, real-time interaction and accurate recording of virtual and real objects in 3D (WU, et. al, 2013).

At school Augmented Reality can be used to navigate in the school building. This technology is much better than Virtual Reality in educational uses. Augmented Reality is not just about staying in a virtual environment. Augmented Reality can be used during field classes, where students get to know the world around them by looking at what exists, complemented by virtual elements that relate to the past, presence and future.

Autonomous Process Organisation that refers to Autonomous Production (Scholz-Reiter, et. al, 2007). Organisation of components of the educational process with minimal human participation. Planning the school year, creating a class schedule even though it is not yet perfect, it is already computer assisted nowadays.

In addition, computer applications used at schools could allow for automatic substitution for absent teachers and planning of education for each student.

Advanced Robots and *Co-robots* (cobots) – robots that cooperate and interact physically with people in the areas of their operation (Wrobel-Lachowska, et. al., 2019).

At school, these can include: – robots that clean the school corridors, – robots designed to prepare the teaching resources for class – robots designed to distribute meals in school canteens, – robots assisting students with special educational needs, – robots that control lighting, air temperature, water and electricity consumption on the school premises.

Horizontal and Vertical Integration – a type of strategy based on the vertical and horizontal organisation activities (Wrobel-Lachowska, et. al., 2019). At school, this includes the use of digital media in the process of horizontal education involving the activities of a student at a given educational stage and in the process of vertical education involving the activities of a student in respect of each educational stage. Thus, in the vertical educational process, it is the intentional development of specific competences, i.e. lifelong learning.

Conclusions

The ideas of Education 4.0 are formed by components that are modified and adapted to the educational process. Making this idea a reality at school requires a holistic approach, where "the whole" is something more than the sum of its components. Hence, Education 4.0 at school is a comprehensive system subject to certain regularities which should not be assessed from the perspective of the regularities that govern such components.

Education 4.0 is a kind of vision of the school in the future that can contribute to educational changes. With the use of artificial intelligence, these changes also extend to students with special educational needs, who will be accurately and continuously diagnosed in terms of their progress and educational achievements.

The concept of Education 4.0 is being materialised step by step in the same way as mobile phones became the school reality, the problematic use of which was described in 2008 by Anna Broch in one of her articles (2008). In conclusion, it should be stressed that the holistic implementation of Education 4.0 requires a new look at human development and a great involvement of parents, teachers, a well-functioning Internet on the school premises as well as modern digital media

at schools. The idea of education is to prepare a person for proper functioning in a society, which at presence is already being created as Society 5.0.

References

Atzori, L., Iera, A., Morabito, G. (2010). The Internet of Things: A survey. *Computer Networks*, 54, 2787-2805.

Blossfeld, HP., von Maurice, J. (2011) Education as a lifelong process. Z Erziehungswiss, 14, 19–34.

Brosch, A. (2008). Text-messaging and its Effect on Youth's Relationships. *The New Educational Review*, 14, 91-101.

Ciolacu, M., Tehrani, A.F., Binder, L., Svasta, P.M. (2018) „Education 4.0 – Artificial Intelligence Assisted Higher Education: Early recognition System with Machine Learning to support Students' Success," 2018 IEEE 24th International Symposium for Design and Technology in Electronic Packaging (SIITME), 2018, pp. 23-30, doi: 10.1109/SIITME.2018.8599203.

Coşkun, S., Kayıkcı, Y., Gençay, E. (2019). Adapting Engineering Education to Industry 4.0 Vision, *Technologies* 2019, *7*(1), 10.

Dalenogare, L., S., Benitez, G., B., Ayala, N., F., Frank, A., G. (2018).

The expected contribution of Industry 4.0 technologies for industrial performance. *International Journal of Production Economics*, 204, 383-394.

Demartini, C., Benussi, L. (2017).: Do Web 4.0 and Industry 4.0 Imply Education X.0? *IT Professional*, 19, 4-7.

Gerstein, J. (2014) Moving from Education 1.0 through Education 2.0 towards Education 3.0. In: Blaschke, L.-M., Kenyon, C., Hase, S. (et al.) Experiences in Self-Determined Learning. Create Space Independent Publishing Platform, 83-99.

Gul, S., Asif, M., Ahmad, S., Yasir, M., Majid, M., Arshad, M.S. (2017). A Survey on Role ofInternet of Things in Education. *International Journal of Computer Science and Network Security*, 17,159-165.

Fisk, P. (2017). Education 4.0 … the future of learning will be dramatically different, in school and throughout life. Retrieved from http://www.thegeniusworks.com/2017/01/future-education-young-everyone-taught-together

Huk, T. (2016). Use of Facebook by Children Aged 10–12. Presence in Social Media despite the Prohibition. *The New Educational Review*, 46, 17-28.

Issa, T., Isaias, P. (2015). Artificial Intelligence Technologies and the Evolution of Web 3.0. IGI Global, USA.

Jacobus, H., Rudman, R. (2015). Web 3.0: Governance, Risks And Safeguards. *The Journal of Applied Business Research*, 31, 1037-1056.

Jaeger, P.T., Lin, J., Grimes, J.M. (2008). Cloud Computing and Information Policy: Computing in a Policy Cloud? *Journal of Information Technology & Politics*, 5:3, 269-283.

Juszczyk, S., Kim, S. (2020). Distance Learning in the Polish and Korean Universities During COVID-19 Pandemic. *The New Educational Review*, 62, 115-127.

Juszczyk S. (2021). Otwarta edukacja i społeczne uczenie się wyznacznikami współcz-esnej edukacji post-cyfrowej [Open Education and Social Learning as the Determinants of the Contemporary Post-Digital Education] in: ed. J. Szempruch, J. Smyła, M. Kwaśniewskiej, Edukacja wobec wyzwań zmieniającego się świata. Diagnozy i projekcje rozwiązań [Education in the Face of the Challenges in the Changing World. Diagnoses and Projections of Solutions]. Kielce KTN 2021, 319-328.

Kambatla, K., Kollias, G., Kumar, V., Grama, A. (2014). Trends in big data analytics, *Journal of Parallel and Distributed Computing*, 74, 2561-2573.

Keats, D., Schmidt, J.P. (2007). Genesis and emergence of Education 3.0 in higher education and its potential for Africa. *First Monday*, 12. http://firstmonday.org/ojs/index.php/fm/article/view/1625/1540, 12.08.2018

Lister, M., Dovey, J., Giddings, S., Grant, I., Kelly K. (2009). New media: a critical introduction. Second edition. Routledge. New York.

Madakam, S. (2015). Internet of Things: Smart Things. *International Journal of Future Computer and Communication*, 4, 252-253.

Oreilly, T. (2005). What Is Web 2.0 Design Patterns and Business Models for the Next Generation of Software. http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html dated 25.08.2018.

Paravizo, E., Chaim, O., Ch., Braatz, D., Muschard, B., Rozenfeld, H. (2018). Exploring gamification to support manufacturing education on industry 4.0 as an enabler for innovation and sustainability. *Procedia Manufacturing*, 21, 438-445.

Reynard, R. (2010). Web 3.0 and Its Relevance for Instruction. Transforming Education Throught Technology. https://thejournal.com/articles/2010/02/03/web-3.0-and-its-relevance-for-instruction.aspx (30.08.2021)

Rudman, R., Bruwer, R. (2016). Defining Web 3.0: opportunities and challenges. *The Electronic Library*, 34, 132-154.

Salmon, G. (2019). May the Fourth Be with You: Creating Education 4.0. *Journal of Learning for Development,* 6, 95-115.

Sarowski, Ł. 2017). Od Internetu Web 1.0 do Internetu Web 4.0 – ewolucja form przestrzeni komunikacyjnych w globalnej sieci. [From Web 1.0 to Web 4.0 – Evolution of Communication Space Forms in the Global Network.] *Rozprawy Społeczne [Social Considerations],* 11, 32-39.

Scholz-Reiter, B., Freitag, M. (2007). Autonomous Processes in Assembly Systems. *CIRP Annals*, 56, 712-729.

Simon, Y. (2005). Designer Evolution: A Transhumanist Manifesto . Amherst , NY : Prometheus Books.

Shank P. (2010). Learning 2.0, the Elearning Guild Research.

Wrobel-Lachowska M., Polak-Sopinska A., Wisniewski Z. (2019) Challenges for Logistics Education in Industry 4.0. In: Nazir S., Teperi AM., Polak-Sopińska A. (eds) Advances in Human Factors in Training, Education, and Learning Sciences. AHFE 2018. Advances in *Intelligent Systems and Computing*, vol 785. Springer, 330-331.

Wu, H-K., Lee, S., W-Y., Chang, H-Y., Liang, J-C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education*, 41-49.