

MAPPING BETWEEN INDUSTRY 5.0 AND EDUCATION 5.0

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Abstract

This paper performs a mapping between Industry 5.0 and Education 5.0. and identifies how the concepts of Industry 5.0 can be applied in education. Industry 4.0, has sought to minimize human intervention and prioritize the automation of processes. To some extent, the human being has been made to compete with machines, displacing the former from a multitude of scenarios. In the case of Industry 5.0, this trend is reversed: it is about generating a balance in which machine-human interaction is capable of providing maximum benefits. The current paper considers the following perspectives of Industry 5.0: cost optimization, sustainability, personalization and creativity, and resilience for its mapping towards Education 5.0 in industrial engineering courses.

Keywords: Industry 5.0, Education 5.0, active learning methodologies, student centred methodologies, industrial engineering, university.

1 INTRODUCTION

Industry 4.0 is defined as the combination of Internet and technologies to drive a new paradigm shift in industrial production. Industry 4.0 corresponds to a new way of organizing the means of production, emphasizing and accentuating the idea of a growing and adequate digitization and cooperative coordination in all the productive units of the economy. Industry 4.0 implies the complete digitization of value chains through the integration of data processing technologies, intelligent software and sensors; from suppliers to customers, in order to be able to intelligently predict, control, plan, and produce, which generates greater value for the entire chain.

According to [15] Industry 5.0 complements Industry 4.0 by specifically putting research and innovation at the service of the transition to a sustainable, human-centric and resilient industry. Thus, "Industry 5.0 provides a vision of industry that aims beyond efficiency and productivity as the sole goals, and reinforces the role and the contribution of industry to society. It places the wellbeing of the worker at the centre of the production process and uses new technologies to provide prosperity beyond jobs and growth while respecting the production limits of the planet. It complements the existing "Industry 4.0" approach by specifically putting research and innovation at the service of the transition to a sustainable, human-centric and resilient European industry." Industrial revolutions are evolving, but not that much and in the same directions as education. According to Gürdür Broo et al., [5] "in order to be able to survive in an increasingly competitive and global market, enterprises need graduates who can manage the changes, a challenge that the engineers of the 21st-century face. The graduates of the engineering schools in this new era should be capable of going from technology to solutions and from solutions to operations. The connections between different disciplines are becoming the core of the new technologies, in a not multi-, not inter-, but in a trans disciplinary, seamless manner."

In education 5.0, centered on the student and following the principles of sustainability and resilience, we need to include interdisciplinary curriculums in the students and train them to work in multidisciplinary teams.

Interdisciplinary students involve the combination of two or more academic disciplines into the same student, drawing knowledge from different research fields, creating students' curriculum by thinking across boundaries.

Multidisciplinary student teams refer to team members from different specialties who work together but each one remains within his/her discipline while interdisciplinary brings those team members to put their expertise and science together in one integrated plan.

According to our review performed in Scopus database using the keyword “Education 5.0” within the title, only fourteen papers have been encountered that are aligned with our research work.

These works are published from 2019 to 2022, what indicates the novelty of the topic under study.










<i>Author</i>	<i>Title</i>	<i>Year</i>
[1]	Actions to be taken in Mexico towards education 4.0 and society 5.0	2019
[2]	Education 4.0 - 5.0 and the post-information transformation of university libraries	2021
[3]	Technology-enhanced learning research in higher education: A recommendation system for creating courses using the management systems in the E-learning 5.0	2021
[4]	MannaTeam: A case of interinstitutional collaborative learning and education 5.0	2020
[5]	Rethinking engineering education at the age of industry 5.0	2022
[6]	The empirical analysis of industrial work challenges in the industrial revolution 5.0 towards a grade point average (GPA) for electronic engineering education students	2021
[7]	Moderate Islamic education to enhance nationalism among Indonesian Islamic student organizations in the era of society 5.0	2021
[8]	Data modelling for analysis of readiness of municipal education in industry 5.0	2020
[9]	Engineering education 5.0: Continuously evolving engineering education	2020
[10]	The relevance of social learning designs in society 5.0-edmodo and smart education	2019
[11]	Digital literacy for early childhood education teachers in society 5.0	2020
[12]	Digital content model to promote literacy in society version 5.0 using the social study education perspective	2019
[13]	The role of education 5.0 in accelerating the implementation of SDGs and challenges encountered at the university of Zimbabwe	2021
[14]	Examining future ready accounting course (FRAC) experiences for non-accounting students: An education in society 5.0 using augmented reality and IoT	2021

2 SUSTAINABLE EDUCATION 5.0

According to the European Commission [16] sustainable development is a core principle of the Treaty on European Union and a priority objective of the Union’s internal and external policies. The United Nations 2030 Agenda [17] includes 17 Sustainable Development Goals (SDGs) intended to apply universally to all countries. It is a commitment to eradicate poverty and achieve a sustainable world by 2030 and beyond, with human well-being and a healthy planet at its core. The following Table lists the SDGs and a mapping between them and education 5.0 is made, putting a traffic light classification to indicate the strong (●) neutral (●) or weak (●) relationship between each of the goals and the topic under study, education 5.0 in industrial engineering university course programs.

Table 1. SDG vs. Education 5.0 in industrial engineering.

<i>SDGs</i>	<i>Relation degree</i>	<i>Education 5.0 mapping</i>
GOAL 1: No Poverty	●	Ensure that all men and women equal rights to economic resources, as well as access to educational services, ownership of appropriate new technologies and financial services to access their studies. Universities should not discriminate against students by providing them with the required means to advance in their studies
GOAL 2: Zero Hunger	●	Ensure practices of education to teach students for increasing productivity and production, that help maintain ecosystems, strengthen resilience to climate change, extreme weather, drought, floods and other disasters
GOAL 3: Good Health and Well-being	●	Motivate students on good health and well-being practices
GOAL 4: Quality Education	●	Ensure equal access for all women and men to affordable, quality technical, vocational and tertiary education, including university. Ensure that all students acquire the knowledge and skills needed to promote sustainable development. Ensure that teachers adapt to new ways of developing their teaching tasks

SDGs	Relation degree	Education 5.0 mapping
GOAL 5: Gender Equality		End all forms of discrimination against all women and girls worldwide. Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women
GOAL 6: Clean Water and Sanitation		Implement integrated water resources management at all levels of education, including through transboundary cooperation as appropriate
GOAL 7: Affordable and Clean Energy		Ensure universal access to affordable, reliable and modern energy services through the learning activities in specific engineering courses
GOAL 8: Decent Work and Economic Growth		In order to be able to survive in an increasingly competitive and global market, enterprises need graduates who can manage the changes, a challenge that the engineers of the 21st-century face. The graduates of the engineering schools in this new era should be capable of going from technology to solutions and from solutions to operations. The connections between different disciplines are becoming the core of the new technologies, in a not multi-, not inter-, but seamlessly transdisciplinary
GOAL 9: Industry, Innovation, and Infrastructure		Develop quality, reliable, sustainable and resilient infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all students. Promote inclusive and sustainable industrialization. Increase the access of SMEs affordable tools to adapt to the digital transition. Offer requirements for employees to be hired in new class of jobs demanding by the industrial sector enterprises. Integrate SMEs into value chains and markets, and therefore work concepts engaging the way of collaborative networks. Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries. Significantly increase access to information and communications technologies and strive to provide universal and affordable access to the Internet
GOAL 10: Reduced Inequality		Ensure the goal defined by no poverty and gender equality. Education strengthens people in terms of their independence, their own way of thinking, no manipulation and economic independence. Ensuring equal opportunities to access jobs and new requirements defined by industries due to the rapid technological changes that humanity is envisioning right now, and reducing inequalities in outcomes
GOAL 11: Sustainable Cities and Communities		Ensure the development of educational courses related to sustainable transportation systems and sustainable urbanization
GOAL 12: Responsible Consumption and Production		Ensure sustainable production with forecasting, material replenishment, production and delivery plans at different levels, enterprise and supply network
GOAL 13: Climate Action		Ensure resilience and adaptive capacity to climate-related hazards and natural disasters and enable students to acquire skills related to the replanning when disruption occurs
GOAL 14: Life Below Water		N/A
GOAL 15: Life on Land		N/A
GOAL 16: Peace and Justice Strong Institutions		Strengthen universities for international cooperation
GOAL 17: Partnerships to achieve the Goal		Promote regional and international cooperation in and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism. Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed

Universities should not only take into account the SDGs when offering a service to their students but should also consider them in order to contribute to their fulfilment as an institution and through the involvement of all members of the university (institution, professors, staff, students). Thus, students

should be trained in the content of the 2030 Agenda so that they are not only aware of it and the SDGs, but also so that they can contribute to its fulfilment through their job once they enter the working world.

3 STUDENTS-CENTRIC METHODOLOGIES

According to Richard Elmore [18] there are four modes of learning: hierarchical individual, hierarchical collective, distributed individual, distributed collective. Table 2 relates each learning mode to Education 5.0 in industrial engineering through traffic classification.

Table 2. Elmore learning modes vs. Education 5.0 in industrial engineering.

<i>Learning modes</i>	<i>Teaching Role</i>	<i>Characteristic</i>	<i>Performance</i>	<i>Relation degree with Education 5.0</i>
Hierarchical individual	Teacher	Individual learning	Each student is responsible for his/her own performance	●
Hierarchical collective	Teacher	Group activity learning	Students' progress is continuously evaluated	●
Distributed individual	Student	The students are the ones who undertake a learning process by themselves and choose their objects of study	Students choose their objects of study, determine their sources and means, and set their goals	●
Distributed collective	Student	Self-organized groups of students in which everyone is able to learn outside of hierarchical frameworks	Common priorities, respect and cooperation among community members are key to the success of this mode of learning	●

It is noted that Education 5.0 is mainly related to distributed collective and hierarchical collective modes of learning. In this regard we mention the different active teaching methodologies that enable teachers to deal with the student-centred teaching:

Reverse teaching (Flipped teaching): It is a way of working based on the learning results we want to achieve in the student, and through which the simplest or concrete results can be worked autonomously by them (generally at home), while the more complex and higher cognitive level results are worked with the guidance and support of the teacher (usually in class).

Game-Based Learning (GBL): It is an educational methodology consisting of using games and/or video games in the classroom to learn content and skills, as well as their evaluation by teachers.

Gamification: It is an educational methodology based on using game elements to design learning experiences that could take place without enjoying the playful component, but that, when planned to follow the guidelines that characterize this methodology, turns them into attractive and motivating proposals for students.

Project-Based Learning (PBL): It is a learning methodology in which students acquire an active role and academic motivation is favored. The method consists of carrying out a project, usually in a group. This project has been previously analyzed by the teacher to ensure that the student has everything necessary to solve it, and that in its resolution the student will develop all the desired skills.

Experience-based learning (Learning-by-doing): Develops the capacity of the students to learn from their own experience, always within a concrete and well-developed conceptual and operational framework.

Role-playing games (RP, Role-Playing): A role-playing game is a game in which players assume a specific business "role" and interpret their dialogues and describe their actions.

Process simulation (Simulation): Simulation techniques are used to analyze current processes (improvement and optimization) and future processes (anticipation of solutions) in order to obtain the most efficient design with different objectives.

4 RESILIENCE

Another important factor addressed in Education 5.0 is student resilience. Resilience is the ability to adapt to disruptions and challenges that students will have to deal with both once they are in the labor

market and in their personal lives. Therefore, resilience can be considered as a transversal competency that will enable them to maintain their employment. Thus, Education 5.0 has to prepare students for lifelong learning as well as learning to “relearn” when disruptions are faced.

From the university we need to support students with resilience, and this will be done as a tool to promote the necessary competences to face the learning of new concepts and technologies based on the experience that students gain along the university stage. Some competences that should include Education 5.0 are teamwork, social intelligence, positive transculturation, ability to logically analyze situations, virtual collaboration, constant training, which will not only be key in the professional future of students but also in their personal future.

Education 5.0 has to focus on the execution of applied knowledge and skills in the workplace, prepared a responsible worker, committed and willing to face any challenge, even if he changes activity within the company.

5 CONCLUSIONS

Education 5.0 is about student and the collaborative and sustainable use of technologies. This will add value to make students more resilient and sustainable, in terms of inculcate the continuous learning process. The use of technology should be seen as an enabler for adding value and increasing effectiveness in the teaching-learning process. Education 5.0 is also about the sustainable use of technologies in the classroom with the aim of creating student-technology collaboration activities.

As a conclusion, Education 5.0 is led to put together the following actions:

Sustainable students: Prepare students for continuous learning, making sure the educational contents and transversal competences offered by university courses enable students to engage in lifelong learning throughout their professional lives.

Sustainable teachers: Promote research on university teachers and constantly teach them new ways of teaching, adopting active and student-centered methodologies, which require new forms of evaluation. Engage interaction with technology and promote research and innovation in education.

Sustainable education system: Develop a quality, reliable, sustainable and resilient education system infrastructure to support economic development and human education, focusing on affordable and equitable access for all. Considering not only what companies need, but also what society and students need.

Students centric: Develop personalized curriculum goals and learning outcomes based on conventional evaluation methodologies to provide personalized learning. Establish students' qualities at the center, identifying the best capacities and enhancing them (e.g., those related to innovation, creativity, critical thinking, analytical skills, design, compassion etc.). Active learning technologies will enable students to position themselves as protagonists in the teaching-learning process.

Resilience: Teachers and students are the agents of change and need to be actively involved in new models and methods of learning and evaluating. Learners need to work on this capacity in order to enhance the students abilities that will be required in their future works.

Technologies in the classroom: Teachers have to put in common which Industry 4.0 technologies could be applied in the classroom in order to give students a more personalized education, provide them with a background on new technologies that will be the basis for their future works and allowing them to improve their resilience for any challenges they face in their future day-to-day work.

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REFERENCES

- [1] Alvarez-Cedillo, J., Aguilar-Fernandez, M., Sandoval-Gomez, R., & Alvarez-Sanchez, T. (2019). Actions to be taken in Mexico towards education 4.0 and society 5.0. *International Journal of Evaluation and Research in Education*, 8(4), 693-698. doi:10.11591/ijere.v8i4.20278

- [2] Denchev, S., & Varbanova-Dencheva, K. (2021). Education 4.0 - 5.0 and the post-information transformation of university libraries. Paper presented at the *CEUR Workshop Proceedings*, , 3061 109-115.
- [3] Dewi, P., Elihami, E., Usman, M. I., Asbar, A., & Saidang, S. (2021). Technology-enhanced learning research in higher education: A recommendation system for creating courses using the management systems in the E-learning 5.0. Paper presented at the *Journal of Physics: Conference Series*, , 1933(1) doi:10.1088/1742-6596/1933/1/012125
- [4] Flor, D. E., Henrique Molina Da Cruz, E., Possebom, A. T., Roberto Beleti Junior, C., Hubner, R., & Ruiz Aylon, L. B. (2020). MannaTeam: A case of interinstitutional collaborative learning and education 5.0. Paper presented at the *Proceedings - 2020 International Conference on Computational Science and Computational Intelligence, CSCI 2020*, 964-970. doi: 10.1109/CSCI51800.2020.00179
- [5] Gürdür Broo, D., Kaynak, O., & Sait, S. M. (2022). Rethinking engineering education at the age of industry 5.0. *Journal of Industrial Information Integration*, 25 doi:10.1016/j.jii.2021.100311
- [6] Hidayat, H., Tasrif, E., Jaya, P., Anwar, M., Thamrin, Zulwisli, . . . Asmara, D. (2021). The empirical analysis of industrial work challenges in the industrial revolution 5.0 towards a grade point average (GPA) for electronic engineering education students. *International Journal of Online and Biomedical Engineering*, 17(9), 21-34. doi:10.3991/ijoe.v17i09.25679
- [7] Jamilah, S. (2021). Moderate islamic education to enhance nationalism among indonesian islamic student organizations in the era of society 5.0. *Journal of Social Studies Education Research*, 12(3), 79-100.
- [8] Khaimovich, I., Ramzaev, V., & Chumak, V. (2020). Data modelling for analysis of readiness of municipal education in industry 5.0. Paper presented at the *CEUR Workshop Proceedings*, , 2667 1-4.
- [9] Lantada, A. D. (2020). Engineering education 5.0: Continuously evolving engineering education. *International Journal of Engineering Education*, 36(6), 1814-1832.
- [10] Opincariu, M. (2019). The relevance of social learning designs in society 5.0-edmodo and smart education-. [Relevanța modelelor de învățare socială în societatea 5.0-Edmodo și educația inteligentă-] *Revista Transilvania*, 2019(9), 73-83.
- [11] Sudarti, Abdulhak, I., Rusman, & Riyana, C. (2020). Digital literacy for early childhood education teachers in society 5.0. Paper presented at the *PervasiveHealth: Pervasive Computing Technologies for Healthcare*, doi:10.1145/3452144.3452258
- [12] Sulianta, F., Sapriya, Supriatnac, N., & Disman. (2019). Digital content model to promote literacy in society version 5.0 using the social study education perspective. *International Journal of Innovation, Creativity and Change*, 6(12)
- [13] Togo, M., & Gandidzanwa, C. P. (2021). The role of education 5.0 in accelerating the implementation of SDGs and challenges encountered at the university of zimbabwe. *International Journal of Sustainability in Higher Education*, 22(7), 1520-1535. doi:10.1108/IJSHE-05-2020-0158
- [14] Zainuddin, S. A., Nasir, N. A. M., Abdullah, T., Yusoff, M. N. H., Yasoa, M. R., Muhamad, S. F., & Said, N. M. (2021). Examining future ready accounting course (FRAC) experiences for non-accounting students: An education in society 5.0 using augmented reality and IoT doi:10.1007/978-3-030-86761-4_15
- [15] European Commission (2022) Industry 5.0. What this approach is focused on, how it will be achieved and how it is already being implemented. Accessed on January 2022 https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/industry-50_en
- [16] European Commission (2022) Sustainable Development Goals. Accessed on January 2022 https://ec.europa.eu/international-partnerships/sustainable-development-goals_en
- [17] United Nations (2022) Transforming our world: the 2030 Agenda for Sustainable Development. Accessed on January 2022 <https://sdgs.un.org/2030agenda>
- [18] Elmore, R.F. (2019) The Future of Learning and the Future of Assessment ECNU Review of Education, 2 (3), pp. 328-341.