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# Aligning Education for the Life Sciences Domain to Support Digitalization and Industry 4.0

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**Abstract**

Emerging technologies like Internet of Things, Data Science, Deep Learning, Augmented Reality, Edge Computing, and Digital Twins are bringing new opportunities, challenges, and solutions for many domains including agriculture, plant sciences, animal sciences, food sciences, and social sciences. These disruptive technologies are at the center of the fourth industrial revolution, but are we ready yet to educate and prepare new generations to help society, science, and humanity adapt them? How can we change the current curriculum to reflect these technological innovations? How can we help the new generation to develop not only left-brain skills but also right-brain skills? The Netherlands is the second largest food exporter in the world after the United States and the agricultural related exports generated €45 Billion in 2018 for the economy. R&D in Dutch companies and innovation in universities in the Netherlands play an important and active role in this context. In this paper, we provide a general framework for supporting education in the context of Industry 4.0. We adopt the case study of Wageningen University at which we were actively involved in designing and customizing academic courses related to Industry 4.0. Wageningen University, which has the highest rank in the field of Agriculture & Forestry according to influential university rankings and has a rank 59 according to Times Higher Education, is traditionally a life science university but has taken also an active strategy for aligning with the developments in IT and Artificial Intelligence. Apart from the content-wise shift, skills such as critical thinking, creativity, and problem-solving are addressed by applying project-based evaluations. We discuss the lessons learned and address the issues related to Industry 4.0 and education.


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*Keywords:* Education; Internet of Things (IoT); Industry 4.0; data analytics; machine learning

## 1. Introduction

Industry 4.0, which is the fourth industrial revolution, is making positive impacts not only on manufacturing processes but also the digital transformation of organizations. The first industrial revolution began with the use of steam power in mechanical production plants at the end of the 18th century [1], the second one utilized from the

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electrical energy for mass production at the beginning of the 20th century [2], the third industrial revolution was based on the application of information technologies and electronics in manufacturing for automatic production in 1970s [2], and nowadays the fourth industrial revolution, namely Industry 4.0, is applying several disruptive technologies and paradigms such as Internet of Things (IoT), big data analytics, edge & fog computing, 3-D printing for additive manufacturing, data science, deep learning, augmented reality, collaborative robotics, machine learning, smart manufacturing, secure IoT, cloud computing, Cyber Physical Systems (CPS), and digital twin.

The smart manufacturing based on the application and integration of heterogeneous data [2] is one of the critical elements of Industry 4.0, however the manufacturing is not the only component which is affected. In addition to the manufacturing, Industry 4.0 also considers the overall digital transformation and integration within the organization and the way how machines communicate are indeed redefined in this industrial revolution. While the above-mentioned technologies and paradigms make the industrial systems more and more smart, many challenges arise regarding the security, reliability, privacy, and integrity [1, 3]. For instance, automated data acquisition for CPS is a significant challenge for some of the small and medium-sized enterprises (SMEs) [3]. Lessi et al. [4] developed a reference framework for cybersecurity in Industry 4.0 and presented a list of countermeasures. Moktadir et al. [5] presented the implementation challenges of Industry 4.0 such as unstable connectivity among companies, high investment, complexity in integrating information technology (IT) and operational technology (OT), lack of technological infrastructure, and lack of skilled management team.

The main benefits of Industry 4.0 are increased operational efficiency, high-level automation, and higher operational productivity [6] and main features of Industry 4.0 are optimization & customization of production, automation & adaptation, automated data exchange, value added services, and human machine interaction (HMI) [2, 7, 8]. To implement these features, a large number of data are collected from operational systems with the help of several types of sensors and the other information sources. From technical and technological perspective, a multi-criteria decision making approach using data analytics technology is required to improve the efficiency in manufacturing plants at production, stocking, and delivery levels [9].

Due to the huge benefits of Industry 4.0 and the required knowledge, technologies, and expertise for the implementation and management of these systems, not only the industrial companies have high ambition to learn relevant technologies, but also the academia is interested in changes of educational curriculum to include and reflect on the new technologies, concepts, and paradigms. In this paper, we aim to address the questions similar to the following ones to reflect on the required adaptations in higher education: How can we prepare and educate new generations to help society, science, and humanity adapt new disruptive technologies? How can we change curriculum to reflect these technological innovations?

We present our case study from the Netherlands which is the second largest food exporter in the world after the United States and last year the agricultural related exports generated €45 Billion for the Dutch economy. The Dutch economy earned € 6 billion from horticulture, € 4.7 billion from eggs and dairy food, € 4.1 billion from the meat sector, and € 3.8 billion from vegetables in 2018. The power of R&D in Dutch companies and the innovation environment in universities in the Netherlands are helping for this huge success. In this paper, we specifically discuss how data science and relevant technologies, which are crucial for Industry 4.0, are being addressed with the design of new courses in Wageningen University in the Netherlands. These courses are not designed for Computer Science students, instead they have been specifically planned for the future's agriculture experts, animal scientists, food experts, and plant scientists. Apart from this content-wise shift, skills such as critical thinking, creativity, and problem-solving are also strongly addressed by using project-based evaluations during the teaching and learning activities. In order to deliver a relevant education in the Netherlands, many universities are organizing advisory board meetings to reflect the required knowledge to the educational context required by the innovative companies. We explain how to address these changes with the help of advisory board meetings in data science and also present some of the new courses designed for specific programmes.

The rest of this article is organized as follows: Section 2 discusses the related work and section 3 introduces the methodology. Section 4 presents the case study and section 5 explains the conclusion.