Impact of Knowledge Management Strategies on Academic Performance in the Context of the Transition to Education 4.0

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Abstract

The concept of Education 4.0 emerged linked to trends regarding Industry 4.0 and Internet 4.0 and is based on the integration of emerging technologies to revolutionize the way education is delivered. The use of these emerging technologies has created a vast amount of data that requires careful and thorough management in order to obtain the most possible benefits such as developing personalized learning experiences, smart ways of tracking student progress and providing feedback to all parties involved in the educational process. Therefore, knowledge management tools and strategies are gaining more importance, especially in the context of higher education institutions which have been identified as important sources of knowledge creation and sharing. The implementation of specific knowledge management strategies can furthermore help facilitate the transition to Education 4.0 by embracing key aspects of Industry 4.0 and Internet 4.0 such as promoting a culture of innovation, collaboration, continuous learning, providing a support system for streamlining administrative processes, cost reduction and improving the decision-making process. In the current paper, the authors analyse the current trends regarding knowledge management strategies deployed in Education 4.0 and propose a set of possible approaches which take into account knowledge management practices for an efficient transition to Education 4.0. The set of possible approaches and Industry 4.0 tools that could facilitate the transition have been organized in a structured, easy to follow model based on a four-stage process that relies on the feedback loops from both the process inputs and outputs. Using the

proposed model facilitates the transition to Education 4.0 and helps practitioners understand the main aspects of each stage and select the Industry 4.0 tools that can be used in their respective context in order to yield most benefits.

Keywords: education 4.0, higher education institution, academic performance, knowledge management, knowledge transfer.
JEL Classification: I19, I21, I23.

1. Introduction

Born as a trend closely linked to Industry 4.0, Education 4.0 emphasizes the use of personalized and adaptive learning approaches that are tailored to the individual needs and preferences of the student, with the help of technology-enabled learning platforms and mediums that provide students with access to a wide range of learning resources, tools, and interactive experiences. The changes brought by Industry 4.0 trends have manifested in Higher Education Institutions (HEIs) as well, where it has been noted that the relatively stable environment in which they operated has shifted to a volatile and dynamic one. In this context, successful HEIs are those that can constantly create knowledge, implement it in order to get bottom-line benefits and disseminate it widely through their systems (Adhikari, 2010).

There are a number of limits and factors hindering the convergence of KM (Knowledge Management) systems and practices with the institutional settings and trends in Education 4.0, among these factors the more salient are: the implementation of KM systems is a costly and long term process requiring organizational commitment and compliance, the fast-paced evolution of technology asks for flexible KM procedures and solutions, the necessity to design and train a KM organizational department in universities or to assign specific KM processes to faculties and departments (both types of organizational processes might be time consuming since they would entail various negotiations, procedures and tasks assignments that are prone to be considered a foreign intrusion of business practices in the universities). These factors point to the need to balance the KM efforts with their measurable contribution to the achievement of organizational goals, a plea for KM in educational contexts should be made convincingly by reference to

objective quantifiable outputs and through systematic KM audits (Becerra-Fernandez & Rajiv, 2015).

Through implementing the achievements of Industry 4.0 HEIs are in the position to acquire and handle at a very large-scale data on student attendance, assessment, and progress. In order to constantly comply with the legal requirements on personal data protection, universities should insure that students are constantly informed on the legal setting of using their data (based on a legal duty or personal consent) and on the means by which their personal data is stored, used, modified, accessed or shared with third parties (Siegert, Silber-Varod, Carmy, & Kamocki, 2020). In the same respect, in order to evaluate the load of data needed – each functional unit of the universities has to supply the KM function with the typology of data they need, in strict accordance with their organizational role, and with the calendar for storage period of the data they need (Siegert, Silber-Varod, Carmy, & Kamocki, 2020).

The broadening of communication means and increased availability of storage space represent a factor pushing for the international collaborative pursuits designed to globally integrate KM systems of multiple HEIs. In HEIs, knowledge management systems have to be aligned with the organizational mission of the institutions. Alexandropolu et al. (Alexandropoulou, Vasilis, & Mavri, 2009) notice that the three dimensions of universities' mission (research, teaching, and service to society) are aptly coupled with specific knowledge processes – knowledge creation, knowledge dissemination and knowledge transfer – respectively. Of course, the three-folded mission domains could exhibit an ongoing knowledge interaction between research informing education towards practical transfer, a transfer which in its own turn can inform research agendas. This is consonant with the interplay between teachers and students in the Education 4.0 trend. At the university level, a KM perspective and convergence is also deemed suitable to the process related to publishing the results of academic research portrayed as creation, dissemination and transfer of knowledge.

On the institutional side of managing knowledge in the context of Education 4.0, one of the most frequently used KM concepts crossing disciplinary boundaries is the notion of communities of practice, portrayed as environments where professionals have a structured opportunity to share knowledge created in their personal experiences. There is already an ongoing pursuit of establishing, under the influence of KM studies, communities of practice for teachers (Corcoran

& Duane, 2019), as settings where the adequacy of research programs, teaching styles, principles and methods is pondered through the variegated experiences shared by the members of those communities.

In the paper, the authors look at Education 4.0 and KM in HEIs trends and propose a model that could help facilitate the transition of these institutions to Education 4.0 while also setting in place some good KM practices to draw from the observed benefits of HEIs implementing and using KM systems.

2. Literature Review

Identified as a trend in which HEIs focus on applying new learning methods based on innovative didactic and management tools while at the same time building a smart, sustainable infrastructure that integrates new technologies in order to improve knowledge generation and transfer processes (Miranda, et al., 2021), Education 4.0 emerged as a concept closely linked to Industry 4.0 (Moraes, et al., 2022).

Another aspect identified regarding the evolution of Education into Education 3.0 and eventually Education 4.0 is the progressions registered by this trend in relation to the information technology sector and emerging web technologies such as Web 2.0, Web 3.0, and Internet 4.0 (Huk, 2021). This evolution, the main milestones in the development of Education 4.0 along with the main aspects and strategies specific to each stage can be observed in **Figure 1**.

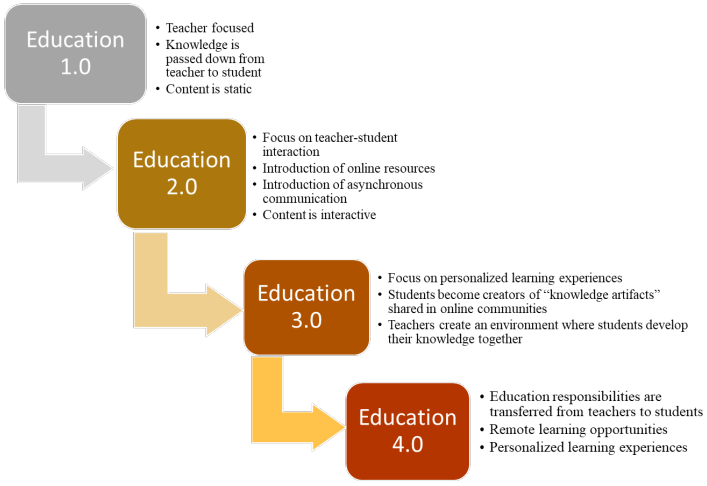

Figure 1. Evolution of Education to Education 4.0

Source: Huk, 2021.

As it can be observed from **Figure 1**, one of the main changes that occurred has been the shift from a teacher focused approach to education where the teacher is the main holder of knowledge and also the one responsible for imparting this knowledge with the students to a knowledge discovery facilitator where the main responsibility of the teacher is not to share knowledge but rather to create an environment in which the students can discover, acquire and share knowledge along with providing chances for the students to have personalized learning experiences and remote learning opportunities (Huk, 2021).

Some authors argue that aspects of the Industry 4.0 trend along with a willingness for embracing risks and combining foresight with design thinking should be the main focus of the Education 4.0 strategies (Salmon, 2019). This, they argue, is an essential aspect to ensuring that the students of Education 4.0 develop the required critical thinking and cognitive thinking skills and facilitates the application of new technologies which in turn is going to make them more likely to come up with innovations and substantiations productions of knowledge (Agrawal, Sharma, & Bhatnagar, 2021) (Puncreobutr, 2016). Other important trends identified in Education 4.0 relate to the use of social media channels as a communication medium used by students and teachers (Kadiyono et al., 2020); the vital role of e-learning resources and practices (Selvakumar & Maran, 2019); the usage of technologies for connectivity, "smartification", digitalization, virtualization and datafication (Ramírez-Montoya, Castillo-Martínez, Sanabria-Z, & Miranda, 2022); an emphasis on new mobile technologies and the usage of technologies for supporting the mental health and overall student wellbeing (Bonfield, Salter, Longmuir, Benson, & Adachi, 2020).

Other authors place an emphasis on person-based implementation and shift the focus from Industry 4.0 technologies such as: cloud computing, Internet of Things, Virtual and Augmented reality, Big Data and Artificial Intelligence to social based principles such as: placing an emphasis on mentoring, practical application curricula and project-based learning, evaluation rather than examination, system management, ownership and collaborative work (Caballero-Morales, Cordero-Guridi, Álvarez-Tamayo, & Cuautle-Gutiérrez, 2020), developing a growth mind-set, creative thinking skills, STEM learning, flipped learning, maker learning and cloud classroom (Keser & Semerci, 2019). The field of KM appeared in the context of Drucker's pointing to the transition in industrial societies form regarding employees as merely operating work force to the employees being highly qualified knowledge works (Drucker, 1994). This

vision of the role of knowledge resources (hence - a proper object of the managerial domain) in a knowledge economy has proven to be the actual description of contemporary societies.

While there are a significant number of definitions ascribed to KM as a subdomain of managerial disciplines, most of these definitions have at the core one of the following accents. On one hand, KM is portrayed as concerned with the managerial roles and tasks related to the knowledge cycle phases in organizations (form knowledge creation to knowledge codification and storage), phases which are to be guided by managerial efforts for reaching organizational goals. On the other hand, KM is preoccupied with acquiring and applying organizational knowledge, a process asking for describing various forms of organizational knowledge (from tacit/implicit/biographical knowledge to explicit/articulated/codified/stored knowledge) (Nonaka & Takeuchi, 1995) (Nonaka & von Krogh, 2009).

Being a supplier and distributor of knowledge is the most prevalent social role enacted by the social HEIs, so it might seem natural that KM practices would be most suitable for (and fostered by) these organizational contexts. But both the research and the systematic practice of KM in higher education are still scarce, relatively speaking, KM concepts and models being at times ignored in the educational field (Bolisani, 2019). The literature dealing with the convergence between KM and higher education exhibits two main directions: the introduction of KM in educational institutions or designing educational institutions as learning organizations – in the managerial sense (Alexandropoulou, Vasilis, & Mavri, 2009) (Asma & Abdellatif, 2016) (Bak, 2012); innovations in teaching form a KM perspective (especially the role of student work groups) or the application of IT tools for teaching (Kagwesage, 2014) (Trevitt, Steed, du Moulin, & Foley, 2017). Some studies also focus on individual KM processes such as knowledge creation and sharing in higher education contexts (Kaba & Ramaiah, 2017) (Poce, 2012). Some authors are using the concepts and themes of Intellectual Capital development and measurement in relation to the social role of HEIs as knowledge producers (Martin-Sardesai & Guthrie, 2018).

3. Research methodology

This study aimed to propose a model for the implementation and transition to Education 4.0 based on a comprehensive review of existing literature. The research scope of the study was to

identify the most efficient framework for the transition to Education 4.0 among higher education institutions. For this, a couple of research objectives have been established:

- Identifying if there are currently any frameworks for the transition to Education 4.0.
- Identifying if there are such frameworks dedicated for HEIs.
- Understanding what the transition to Education 4.0 implies.
- Identifying the role of Knowledge management strategies in the context of Education 4.0 and the transition to it.

The main methodological tool used for the current research was documentation, which provided the basis for shaping the proposed model. For this a comprehensive review of existing literature related to Education 4.0 implementation and transition was conducted. The search for relevant literature was performed using various academic databases (Web of Science, Scopus, Google Scholar, etc) and the search parameters were the following:

- The title had to include "Education 4.0", "Industry 4.0", "Knowledge management in education", "Digital education", "Academic performance", "Education 4.0 in Academia", "Framework", "Education 4.0 Framework", "Knowledge management framework" and/or a combination of these terms.
- The search was limited to articles published in peer-reviewed journals between 2010 and 2023.
- The articles had to be one of the following: research articles or conference papers.
- The articles had to have been written in English.
- Articles had to be focused on Education 4.0 implementation and transition.

Running the search returned 25 results in the Web of Science search engine, 215 results in Scopus and about 1000 in Google Scholar but out of these only 2 results for the transition to education 4.0. After manually checking the identified articles for relevancy and possible additional literature sources the most relevant data was collected from the selected literature including information about the main results of the studies, name of author/s, year of publication, research design, sample size, data sources, key findings, and limitations. Based on this analysis, a model for the implementation and transition to Education 4.0 was developed.

Frameworks and models for the implementation or transition to Education 4.0 have emerged in hopes of filling an existing knowledge gap. While the models may vary in some ways, they all

emphasize key aspects of Education 4.0 such as the use of personalized and adaptive learning approaches that are tailored to the individual needs and preferences of the student, with the help of technology-enabled learning platforms and mediums that provide students with access to a wide range of learning resources, tools, and interactive experience.

One such framework focuses on the five core components of Education 4.0 that enable designing innovative learning experiences (Ramírez-Montoya, Castillo-Martínez, Sanabria-Z, & Miranda, 2022). The main idea of the framework is the integration of the core components of Education 4.0 within the education process so that the learners can develop both disciplinary competencies and transversal meta-competencies.

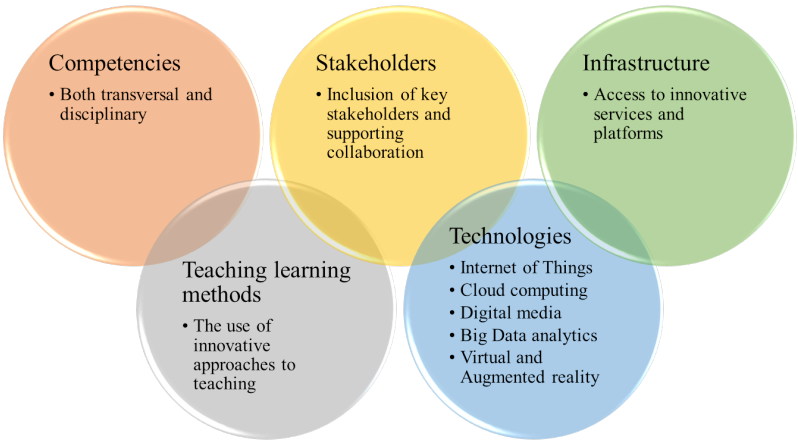

Figure 2. Education 4.0 framework based on five core elements.
Source: Ramírez-Montoya, Castillo-Martínez, Sanabria-Z, & Miranda, 2022.

We can see this being achieved not only by integrating Industry 4.0 technologies such as Big Data analytics, Virtual and Augmented reality, Internet of things, Blockchain and so on, but also by encouraging and facilitating the collaboration with stakeholders and ensuring a proper infrastructure and proper teaching tools and methods.

Another model proposes identifying the key participants to the educational process (school managers, teachers, students, and family) and focusing on ensuring that each party provides the necessary set of skills and competencies in order to create practical school activities that start with skill development and continue with applying principles of innovation, meaningful teaching and developing critical thinking skills (Silva, Viana, & de Barros Vilela, 2020).

One model proposes an approach to teaching for Education 4.0 where student backlogs are organized with the help of cycles associated with activities, objectives, rules, and constraints in order to help students achieve their learning goals while performing cumulative and formative assessments (de Amorim Silva & Filipe, 2021).

4. Results

After identifying key aspects of Education 4.0 and the relationship between Knowledge Management stages and the stages of the educational process, the authors proposed a model based on principles of Education 4.0 and key elements of Industry 4.0 for a transition to Education 4.0 that also takes into account the knowledge management component, identified as an important part of higher education institutions that transition to Education 4.0. The proposed model is a student-centred learning model based on core aspects of Education 4.0 and KM practices in HEIs.

The concern for knowledge management practices in this context comes as a result of an existing debate regarding the high potential of HEIs of becoming beacons of knowledge, especially given the large amount of data that will become available once Industry 4.0 tools will be implemented and used. A possible approach to the integration of these tools in each stage of the KM process can be observed in **Figure 3**.

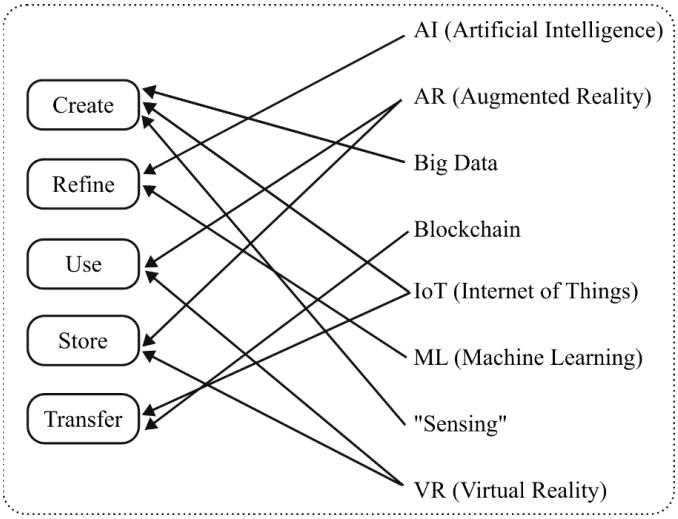

Figure 3. Industry 4.0 tools in the KM process cycle.

Source: Graphical analysis made by the paper authors.

Figure 4 presents the proposed model in a graphical form, after integrating the approach to Industry 4.0 tools usage presented in Figure 3. As it can be observed from **Figure 4**, the proposed model requires the involvement of all parts of the educational process and not just the student and aims at providing the learner with key skills such as: Critical thinking, Creativity, Innovation and an ability to acquire, make use of, refine and share knowledge. We can also observe the important role of feedback in the model, as outputs will often become inputs in an effort to fine-tune the learning experience and yield most value from it.

At the core of the model, the key instruments and tools of Industry 4.0 are matched to knowledge management stages to help propose a possible approach to the implementation of these in the context of the educational process.

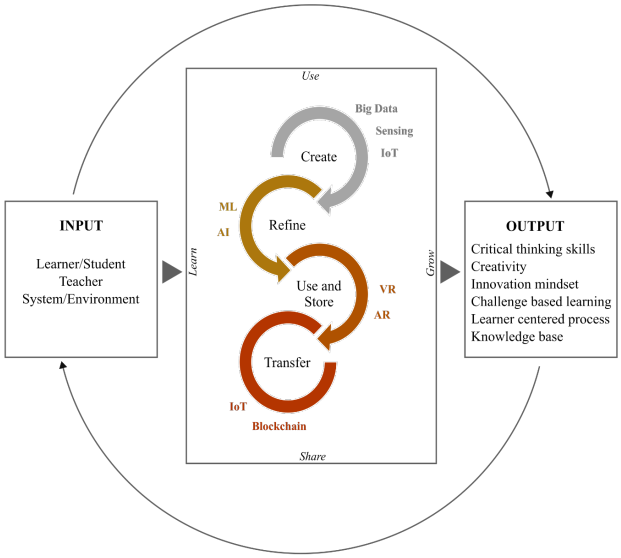

Figure 4. Student-centred learning model for Education 4.0.

Source: Graphical analysis made by the paper authors.

It can therefore be noted that for the creation process, the focus is placed on the means of gathering and filtering the data that can be collected in institutions that are transitioning to Education 4.0. For the knowledge refining process, Industry 4.0 tools like Machine Learning (ML) and Artificial Intelligence (AI) have been identified, and for storing and using the knowledge base tools that offer Virtual Reality (VR) or Augmented Reality (AR) features have been selected. Industry 4.0 technologies such as Blockchain can be used in the context of Education 4.0 and knowledge transfer to secure storage and sharing of educational credentials, to

help decentralize learning management systems and provide a tamper-proof method of recording and sharing assessment for grading data.

The KM cycle in higher education settings should exhibit steps of managing knowledge rather similar to the KM process in business settings, these steps consisting of: identifying the knowledge needs which are to be satisfied by knowledge acquisition and/or knowledge creation, followed by knowledge application, transfer and knowledge documentation (Gasik, 2011). As for the approach used by the authors for the model regarding the stages of the KM cycle, a traditional five stages model was used, where the KM cycle begins with the "Create" phase – the phase in which knowledge is created with the help of activities such as research, development, experimentation and collaboration, followed by the "Refine" phase for evaluating, ensuring accuracy and improving the knowledge, the "Use" phase for using knowledge in order to solve problems, improve processes and create new opportunities, the "Store" phase where the necessary and optimal means of storing the knowledge must be identified and used, and the "Transfer" phase where the knowledge is shared with interested parties both within the organization and outside it. All the phases of the knowledge cycle would constantly require decisions upon the relevance and obsolescence of various types of knowledge assets. The similarity of knowledge cycles in different organizational settings is not meant to point that similar KM solutions are also suitable for organizations with very different work processes and outputs – the educational process being complex enough to require not only the adoption, but at times, rethinking KM solutions altogether.

The authors tried to shape the model so that it could provide a framework for HEIs in order to leverage the power of information and technology to improve the quality, accessibility, and relevance of education. The main directions of focus for the model were:

- Improved access to knowledge through knowledge management systems that could provide students and teachers with access to a vast repository of knowledge, while allowing them to contribute to improving these repositories.
- Enhanced collaboration and knowledge sharing both within and across institutions.
- Better decision-making processes, by providing decision-makers with access to timely and accurate information.

- Continuous improvement based on key metrics monitored with the help of some of the Industry 4.0 tools described in the paper.
- Providing a platform for innovation which in turn could lead to the development of new pedagogical models, technologies, and tools that enhance the learning experience.

Upon implementation, the model could be improved based on obtained results and observed benefits and drawbacks of using it. Therefore, authors suggest further studies in this regard should focus on results obtained after implementing and/or using the model.

5. Conclusions

Education 4.0 is a trend in which HEIs focus on applying new learning methods based on innovative didactic and management tools while building a smart, sustainable infrastructure that integrates new technologies to improve knowledge generation and transfer processes. This concept is closely linked to Industry 4.0, and it involves a shift from a teacher-focused approach to a knowledge discovery facilitator approach that provides personalized learning experiences and remote learning opportunities for students. Education 4.0 involves the use of social media channels, e-learning resources and practices, mobile technologies, and technologies that support mental health and overall student well-being.

Various frameworks and models have been proposed for implementing or transitioning to Education 4.0. One such framework focuses on the integration of core components of Education 4.0 in the education process, such as industry 4.0 technologies, collaboration with stakeholders, proper infrastructure, and proper teaching tools and methods. Another model proposes an approach to teaching for Education 4.0 where student backlogs are organized with the help of cycles associated with activities, objectives, rules, and constraints in order to help students achieve their learning goals while performing cumulative and formative assessments.

KM practices are essential in HEIs as these institutions play a significant role in the production, dissemination, and transfer of knowledge. The implementation of KM systems in HEIs must align with the institutional mission of research, teaching, and service to society. Communities of practice are a promising direction for knowledge dissemination through interactive teaching, and the KM cycle in higher education settings should exhibit similar steps to the KM process in business settings including identifying knowledge needs, acquiring, and capturing knowledge,

sharing and distributing knowledge, and applying knowledge. In HEIs, KM can be used to inform teaching, research, and service to society, which are the three dimensions of universities' mission.

In the paper, the authors propose a different model for the transition to Education 4.0, one that takes into account the KM aspect in hopes of addressing the observed gap of approaches taken by HEIs when managing the existing knowledge base that they possess.

The main contributions of the research to the body of knowledge and practice come from addressing a gap in research regarding the practices and knowledge management aspects of the transition to Education 4.0 for HEIs and it provides a possible solution for facilitating this transition. There are however some research limitations to the study. The most important research limitation is related to the theoretical aspect of the study and the inability to provide real time results of applying the proposed model. Without testing the proposed model and gathering feedback from HEIs on how the implementation and transition to Education 4.0 was influenced and/or aided by the proposed model, we might be unable to identify hidden flaws within the model which may lead to a suboptimal transition or may even burden the transition process. It is therefore recommended that future research directions cover the applicative aspect – and highlight the results obtained when using the proposed model to integrate Education 4.0 in the current educational context.

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