The STEAM Journal

Volume 3
Issue 2 *Standing Still*

Article 9

December 2018

Towards A STEAM Underpinned Industrial Digitalisation Curriculum

Kamaran Fathulla
University of Lincoln. UK

STEAM is a bi-annual journal published by the Claremont Colleges Library | ISSN 2327-2074 | http://scholarship.claremont.edu/steam

Towards A STEAM Underpinned Industrial Digitalisation Curriculum

Abstract
This article reports on an innovative approach for designing a STEAM curriculum aimed at giving graduates the necessary skills to meet the challenges set out by onset of the Fourth Industrial revolution (ID 4.0: Industrial Digitalisation). This curriculum has been developed as part of a hefce (Higher Education Funding Council, UK) funded project at the University of Lincoln, UK.

Author/Artist Bio
Kamaran Fathulla is a senior lecturer in Industrial Digitalisation at the University of Lincoln, UK. Kamaran has a PhD in visual knowledge representation from the University of Salford, UK.

The Challenge: 21st Century Skills

Kamaran Fathulla

The World Economic Forum (WEF, 2016) report, The Future of Jobs, predicted that many skills currently deemed important may no longer be relevant by 2020. Almost half of the knowledge that students obtain from schools now will also be outdated by the same year. The pace of world change is so rapid that the jobs of tomorrow might not yet have been imagined (Immerman. 2011). In the last 20 years, digitalisation technologies have completely transformed what is possible. Given this pace of change, educators can only hypothesise what newly invented jobs will exist 20 years from now. Therefore, education should not be solely the ingestion of information, but the development of skills so students can adapt to an uncertain world. Traditional systems of teaching and learning are not necessarily providing young people with the skills they need to make it in the modern world (Gordon, 2010). What exacerbates the shortage in graduate skills is the dawn of the 4th industrial digitalisation revolution.

Industrial Digitalisation 4.0

At its most simple, Industrial digitalisation is the application of digital tools and technologies in all their forms to the value chains of businesses who make things (e.g. automotive and construction) or are operationally asset intensive (e.g. power grids, wind farms etc.). It is the merging between the physical and digital worlds to significantly enhance performance and productivity. There are a variety of supporting industrial digitalisation technologies – e.g. artificial intelligence, 'Internet of Things', robotics, 3D printing, and analytics – but fundamentally it's the integration of these cyber and physical technologies into production and logistics that allows new businesses to form, increase speed to market, integrate

and strengthen supply chains, and allow productivity gains to be realised. The application of these known and emerging technologies will continue to disrupt companies as they adapt to customer centric business models, offering personalised products through mass customisation and enhanced services.

The Industrial Digitalisation Review (Sept 2017), commissioned under the UK Government Industrial Strategy, has concluded that the potential value to the UK economy of digitalisation over the next 10 years exceeds £185billion.

The Industrial Strategy Green Paper (ISGP, 2017) highlights the importance of developing workforce skills to meet future challenges, and there is recognition, both nationally and within Greater Lincolnshire (www.greaterlincolnshirelep.co.uk), that more needs to be done to prepare current and future workforces for the challenges and opportunities of digitalisation. The skills required will not only be technical but include attributes such as creativity, curiosity, ability to work across disciplinary boundaries, leadership and vision.

The evolution of digitalisation is growing at a phenomenal speed. Research predicts that one-third of all jobs will be converted into software, robots, and smart machines by as early as 2025. According to futurists, students will be able to learn from robots in the next decade or so. ID 4.0 expects a uniquely new "mindset" which is not seen yet in many organisations and/or curriculum.

However, ID 4.0 skills are not exclusive to digital and computational skills. The (WEF, 2016) report identifies the following sets of skills needed to be included in curriculum by the year 2020:

- Complex problem solving
- Creativity
- Critical thinking

- People management
- Coordinating with others
- Cognitive flexibility

The complexity of these technical and non-technical skills sets gives rise to what is described as a new “mindset” graduates need to develop towards the future.

Embedding these skills into the curriculum is vitally important, and is mostly effective when we are providing holistic and exciting learning opportunities for our students, enabling university wide, multidisciplinary teaching opportunities so that students can not only recognise the importance of working in groups across a broad scope of specialisms, but so they can reflect on and see the bigger picture of how that experience has further developed their own teaching and learning experience.

All of this places huge demands on educators and strategists to devise and develop curriculum, particularly STEAM, effectively and deliberately.

Our Approach

Here at the University of Lincoln we have embarked on an ambitious pilot project tasked with producing precisely such curriculum. We have acknowledged that such STEAM curriculum can only be adequately developed with the following criteria in mind:

1. It must address the ID 4.0 agenda: towards this the curriculum must support the core technologies mentioned earlier.
2. It must be industry informed: we have, through our project steering group, involved a wide range of businesses and local industry to audit and provide input into what they envisage a STEAM curriculum should include.

3. The curriculum must foster cross disciplinary collaboration: students across the university (i.e. technical and non-technical subject areas) ought to get opportunities to "work together" and benefit from the proposed curriculum.
4. The curriculum must address both sets of skills mentioned earlier.

Development of our ID 4.0 STEAM curriculum expanded several stages:

Stage 1: We carried out an audit of existing STEM curriculum and formed a picture of the opportunities and gaps where a proposed id 4.0 STEAM curriculum can take on board.

Stage 2: Existing curriculum, namely Computer Science and Engineering modules, was then forwarded to our industry project collaborators for their own audit and feedback.

Stage 3: This feedback was used to begin the process of developing our ID 4.0 STEAM curriculum. A draft proposal was circulated to academics across several of our colleges and schools inviting them to give their views on how to further develop the curriculum.

Stage 4: The curriculum included a module 4 dedicated to group project work closely aligned with The Lincoln Award program, http://uolcareers.co.uk/students-graduates/lincoln-award/

A modular approach was adopted for the development of this curriculum. This allowed us the flexibility of picking and mixing modules to serve the various needs and requirements of our future learner categories.

Future development and refinement of the curriculum will take into account outcomes of curriculum auditing for other schools across the university. Currently development of our ID 4.0 STEAM curriculum has been informed by an auditing and feedback process related to only Computer Science and Engineering courses.

Appendix A lists the current status of the curriculum.

Usability of the ID 4.0 STEAM Curriculum

The proposed curriculum serves a number of purposes:

1. Start the process of thinking about and developing a STEAM curriculum built around the ID 4.0 skills requirements.
2. Colleges and schools across the university can use the proposal as a base for their "own" version of such a curriculum.
3. The curriculum can be offered as a CPD, Continuing Professional Development, training to external organisations.
4. Serves as a partial fulfilment towards the attainment of The Lincoln Award program.

This curriculum is a model for the education of scientists who will be able to create innovations in modern science and technology necessary to address the complex problems facing human society today and for the next 20 to 30 years.

References

WEF Report (2016): http://reports.weforum.org/future-of-jobs-2016/

Immerman, S. D. (2011). Letting off STEAM at Montserrat College of Art. New England Journal of Higher Education.

Gordon, E. (2010). The Job Revolution: Employment for Today and Tomorrow. Techniques: Connecting Education and Careers (J1), 85(8), 28-31.

ISG (2017): https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf

Appendix A

ID 4.0

A Proposed STEAM Curriculum Model

This curriculum model was prepared with input from various sources, including:

- College of Arts
- College of Science
- Lincoln International Business School

This proposed learning model is aimed at being delivered to students from across the various colleges and schools in the university. The model introduces students to industrial digitalisation (ID 4.0) and the opportunities and challenges it brings to the new work environment of the 21st century. The model is flexible enough to offer support for technical, non-technical students, and industry staff.

Learning Outcomes

1. Awareness of what constitutes ID 4.0.
2. Awareness of the added value ID 4.0 brings to an organisation through innovation and creativity.
3. Ability to use and/or develop technologies associated with ID 4.0.
4. Take on board the importance of collaborative working in a multidisciplinary digitalised environment.

Content Outline

Module 1: Introduction to ID 4.0.

Module 2: Related disciplines, systems, equipment, and technologies.

Module 3: Innovation, Art, and ID 4.0.

Module 4: Contextual case studies: **S. T. E. A. M.**

Note:

Certain modules could be grouped to match audience requirements.

For example:

Modules 1 & 4	Non-technical students
Modules 1 to 4	Technical students
Modules 1 & 3	Non-technical industry staff

Detailed Content

Module 1: Introduction to ID 4.0

- Digitalisation and the networked economy: maximise efficiency and productivity
- Drivers, enablers, and challenges for Industry 4.0.
- Comparison of Industry 4.0 factory and today's factory.
- Trends of industrial big data and predictive analytics for smart business transformation.
- Soft employment skills including collaboration, problem solving, discipline and time management.

Module 2: Related disciplines, systems, equipment, and technologies

- Connectivity in a Cyberphysical Systems.
- IoT.
- Robotic automation and machine learning.
- Mobile computing.
- Cyber security.
- Cloud computing basics and ID 4.0. .
- Collaborative digital technologies:
    - ✓ Participatory (co)creation and ‘making’.
    - ✓ Social and collaborative: Examples: WordPress, GIS, GitHub, Web 2.0, etc.
    - ✓ Plug and Play.
    - ✓ Digital DIY.

Module 3: Innovation, Art, and ID 4.0

- Creative and design oriented thinking to add value: seeing the big picture
- Data as a new resource for organisations.
- Harnessing and sharing knowledge in organisations.
- The bridge between Art and Innovation.
- Art and ID 4.0: IoT, Networks, and Coding.

Module 4: Contextual case studies: S. T. E. A. M

- Domain knowledge.

This module invites students across the varying disciplines to put into practice their knowledge and skills gained in previous modules into practice. The outcome of this module will be a "project" that will fulfil the requirements of the Lincoln Digital Award stream.

Student Deliverables

Project Report:

The precise format of this deliverable is flexible and in part driven by the requirements of the Lincoln Award.

Means of Delivery

- Online content is made available via Blackboard.
- Seminar and/or workshop sessions.
- Invited industry speakers.
- Webinars.

Duration/Frequency

To be considered