Cognitive eTransformation Framework for Education Sector

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Abstract—21st century brought waves of business and industry eTransformations. The impact of change is also being seen in education. To identify the extent of this, scenario analysis methodology was utilised with the aim to assess business transformations across industry sectors ranging from craftsmanship, medicine, finance and manufacture to innovations and adoptions of new technologies and business models. Firstly, scenarios were drafted based on the current eTransformation models and its dimensions. Following this, eTransformation framework was utilised with the aim to derive the key eTransformation parameters, the essential characteristics that have enabled eTransformations across the sectors. Following this, identified key parameters were mapped to the transforming domain-education. The mapping assisted in deriving a cognitive eTransformation framework for education sector. The framework highlights the importance of context and the notion that education today needs not only to deliver content to students but it also needs to be able to meet the dynamically changing demands of specific student and industry groups. Furthermore, it pinpoints that for such processes to be supported, specific technology is required, so that instant, on demand and periodic feedback as well as flexible, dynamically expanding study content can be sought and received via multiple education mediums.

Keywords—Education sector, business transformation, eTransformation model, cognitive model, cognitive systems, eTransformation.

I. Introduction

SINCE its commencement in the 11th century, university education has been conducted in the lecture halls. Consequently, frontal teaching style dominated. When teaching in lecture halls, instructors are often the primary sources of information. Throughout the 19th and 20th centuries, instructors commenced to enhance their presentations with the uses of blackboards and whiteboards with the aim to explain the paradigms discussed in more detail. In the late 20th century, overhead projectors and document cameras became utilised, so instructors could in more detail explain the presented data. These days, use of overhead projectors and document cameras has almost vanished. Inventions of computerised devices, applications and digital tools have allowed images displayed on the computer screens to be shared instantaneously with the audiences. These days, presenters often utilise slides that are commonly designed utilising software such as Power Point or Keynote. Digital inventions have also enabled introductions of colours, images,

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diagrams and interactive materials that can be displayed, shown and even interacted with while explaining them. However, even though computer based support tools have been introduced and some universities have even commenced to utilise project based interactive learning, frontal style of teaching continued to dominate up until the very end of the 20th Century.

Today, in the 21st century, with the advancements in technology we are seeing that the traditional definitions of university teaching are slowly starting to change. This transformational change is not only visible in education, but is present across the industry sectors.

Research indicates that traditional lecture halls for hundreds of years were seen as the icons of learning and teaching at the universities world-wide [7]. These days, use of lecture halls is gradually diminishing [11]. Furthermore, it is also noted that gradually at some universities students' attendance in lectures has been on a decline [9]. Consequently, some universities have initiated the removal of the traditional lectures [3]. Those universities have commenced to incorporate blended learning and mixed modes of teaching [8], which often substitutes lectures for learning pods, interactive workshops, quizzes, flipcharts and electronic simulations. Furthermore, universities across the world are these days also looking into how best to internationalise curriculum [6] and make it more engaging and interactive, so they can provide students with industry experiences via simulations, projects, placements and internships.

It is evident that the education as we have known it for centuries is in a process of transformation and change. To understand the process of change in more detail and to understand how transformations across businesses are impacting industries, and in this case the education, this research reviews the current business transformation literature. Following the literature review, findings are applied to industries namely: crafts making, manufacturing, finance and medicine. Analysed data are aggregated, so that the innovations across industry sectors can be studied and parameters that may be used to guide the transformations in education sector identified.

II. Business Transformation

Considering business transformation is seen across industry sectors, a review was undertaken to identify how business transformations are being impacted and how such changes could be applied to the field of education.

This research draws upon the eTransformation Model [4] that has been developed with the aim to assist businesses to

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eTransform, so they can become more competitive on the market. eTransformation Model is composed of:

- *Strategy* - goals and objectives of the organisation, or for this research goals of the industry;
- *Structure* – organisation's or industry's model - defining who does the work, how the work is done, who takes charge and how decisions are made;
- *Business Processes* - activities and tasks that need to be undertaken, what is required for them and what the expected outcomes are i.e. product and/or service; and finally,
- *IT Tools and Systems* - technologies required for the operations to be undertaken.

More recent studies point out the importance of the domain in which the change or the transformation is happening. This change is defined by the eTransformation Model for the Cognitive Wave [5]. This model points out that in order for the change to happen there is a need to understand the domain, in this case, the education area and the context in which education needs to be delivered. The model also identifies that the structures of the education delivery may need to be changed as the teaching or the delivery tasks dynamically change. This is analogue to what happens when processes in manufacturing become automated or just in time delivery is introduced. Consequently, content and the style of delivery need to be changed in different times and places based on the specific needs and demands of the student groups. For example, teaching the industry representatives about the new tools or technologies requires quite different teaching styles to those when teaching a group of the undergraduate students. Therefore, initial aim of the study is to identify changes that have happened over time across industries over the last couple of decades. To do so, cross-industries transformation data were collated and categorised with the goal to identify: 1. How specific industries operated before the technology implementations; 2. How they currently operate; 3. What are some of the current issues they are experiencing; and 4. How cross industry operations could be applied to education (Table I).

A. Industry Transformation

As a part of this study, it was identified that with the technological advancements, changes have started to be noticed across industries. Consequently, a review was undertaken to study how hand made goods and crafts are being produced and how such productions with technology implementation have changed, how research and innovation have been applied and adopted over centuries, how technology has impacted fields such as manufacturing, medicine and how business transactions have over time been changed with the aim to make payments more simplified. Following the scenario descriptions, data gathered cross industries were then categorised and applied to education.

Hand Made Goods and Crafts

These days quality hand made goods are still well regarded. Over the years, many craft stores that required manual labor where either pressured to diversify, automate or close down. In the cases where hand work was repetitive, activities have been translated into the program code that can be read by machines. This allowed factory floors to be automated. As a result of the automation many handmade productions have closed down and instead large factories are opened. In some industries, where factories were not able to do the same type of work as machines, crafts makers have remained, however the prices of their products have increased and their customer numbers often decreased. For example, this is often seen in a production of handmade jewelry, leather goods, some clothing and pottery. Business strategy, therefore, for the crafts makers, is often to produce unique goods, those that cannot be purchased in large stores and cannot easily be designed via factory productions.

Structure of operations in such businesses remained similar to what it was like before the technology implementations. In crafts development, usually only certain trained individuals have the required manual and creative skills and it often takes years for such skills to be mastered. However, even though crafts making operations predominately require manual labour they have in recent years commenced to utilise Information Technology Tools and Systems. The primary objective of this is often to promote their business, via online platforms, websites and applications.

Manufacture and Supply Chain

Following the aggregations of the repetitive craft operations, automation of work and mass production were created. Factories have allowed prices to drop and therefore larger number of people to gain the access to goods. Strategy in this instance was to meet the demands of large groups and deliver the quality goods that meet specific requirements and regulations to customers.

Operational structures in factories often require raw material goods to be obtained, so that the manufacturing floors could build the finished products. Following this, finished products would be transported to the warehouses and stores. Such processes defined very traditional factory floor operations. In more recent times, factory processes have been transformed to incorporate new IT tools and systems. Many factories these days design just in time goods and are able to produce customised goods with the use of applications and manufacturing tools. Furthermore, for many manufacturers over the past two decades, product and process diversifications have been a key to success. eCommerce implementations and ease of products' delivery have given manufacturers the opportunity to bypass traditional stores (i.e. Dell) and sell goods directly to the consumers themselves. Manufacturers have also been given the power to open the stores themselves and sell both online and offline (Apple).

Research and Innovation

Research, innovations and new products are continuously facing consumers. Strategy in this instance is to produce something novel and attractive that is cutting edge and useful to a consumer. Strategy explains the nature in which such

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goods are delivered and utilised. This could be via a known company such as Apple which not long ago introduced the Apple watch as one of its new flagship products. Another example is Uber that started its operations utilising the completely novel business model. For the new products or services to be accepted, it is essential to have the well planned and integrated processes comprising of both specific business activities and the supporting technology integrations.

It is also possible to see that digital technology is allowing companies to reach the markets much quicker than it was previously possible. Before the information technology implementations and the online connectivity, it would take decades for the new products to be adopted and for them to reach 50 million users. Research indicates [12] that adoption of telephone took 50 years to reach 50 million users, Television 22 years, Internet seven, Twitter two years, while an online game Pokémon Go only 19 days. Data presented support the notion that technology in a form of social media and global advertising is the key driver of adoptions and implementations of novel paradigms.

TABLE I
INDUSTRY TRANSFORMATIONS

Industry/ Operation	Previous	Current	Current Issue	Education Updates
Crafts, hand work	Specific skill, requires time to be acquired, predominately manual	Expensive, small quantities produced, Specific skill required, has niche customers	Only possible for those with funds to keep as production takes time	Personal advise given to students where they receive feedback and have advisors to assist in tailoring their progress
Supply chain	It took time for goods to be transported from manufacturer to store and then purchased by consumer	Manufacturer can now sell goods directly to customer with the use of technology. Stores in physical means are not necessarily required – online sales are possible	Locations of warehouses become crucial for speedy and effective delivery. Tracking systems are implemented for assurance of meeting requirements. Technology drives such implementations.	Publishers now can deliver content and even run some certifications. Companies run certification courses and some provide detailed training. Businesses can be utilised as learning grounds. Progress can be tracked.
Factory Work	Work on a specific task, production for masses.	Largely substituted by robotics, requires specific human skills, allows customisation.	Factories for large production are located only in countries that specialise in certain types of production.	Online content substitutes mass delivery – i.e. note taking Customisation – education is individual student journey
Medicine	One doctor looked after all sick patients	Medical specialists are present for each specific condition. Technology is readily used for analytics and decision making	Data analysis is becoming widely multidisciplinary engagement – tracking devices, smart tools, operations using robotics.	Expert systems may be utilised to allow students to learn based on scenarios and gain real life feedback Multidisciplinary understanding is required in many fields.
New inventions	Telephone adoption took 50 years and TV 22	Adoption of Internet took seven years and Pokémon Go 19 days	New technologies are being introduced. Reliable tools/technologies those with potential stay, those that are not able to meet requirements disappear.	Important to have the cutting edge but be flexible to grow and adopt based on the new requirements
Services i.e. banking	Done at the bank's branch – check, money exchange	Easily done from any location in the world – credit cards, online payments, smart devices	Some banks for example still do not accept Apple pay. Security issues	Requirement for 24/7 presence, from any device

Field Example: Medicine

Medicine is another field where a century ago it would be a requirement of a single field medical doctor to identify how best to cure a patient. Strategy of the medical field over the years has changed. New specialisations and even sub specialisations have been developed which are allowing for the diagnosis in specific areas to be made more precisely. Business processes or the steps required to make the diagnosis over the time have become more specialised with the aim to make use of the specialised tests and medical imaging, so that based on the collected results decisions can be made. Multi-disciplinary processes require changes across the industry fields. For example, when the pharmaceutical industry is developing medicines (Pharmacy), it is important to take into the consideration chemical contraindications (Chemistry), physiological (Physiology) responses as well as identify which mixes of chemical will give best results (Medicine).

Use of IT Tools and Systems has allowed for the expert systems to be implemented, robotics to be embedded into patient monitoring, lab testings to be coded and streamlined, genome mapping to be conducted and even remote surgeries undertaken.

Business Transaction Exchanges

For the businesses to operate successfully, their main strategy focuses on the exchange of goods and services with the aim to meet the financial outcomes and achieve a positive return on the investment. Structure that allows for the transactions to be conducted has changed over time. Previously, processes required exchanges via the banks directly for the checks to be processed. In late 20th century, ATMs and the plastic chipped cards were the tools that revolutionaries fund transactions. Today, technology driven exchanges which are supported by the credit card transactions are driving the global exchanges and payments.

Novel IT Tools and Systems have also in recent times allowed new payment systems to support introductions of payments such as: PayPal and Apple Pay.

Based on the data presented above, it is clear that each industry described above, has been changed and to an extent transformed with the uses and the applications of technologies. For some, operations have initially been automated such as in manufacturing and lab testing while in many other instances

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technology has allowed for the business operations to change, diversify and update such as for example in just in time delivery, online shopping, innovative businesses as Uber and medical testing and genome mapping. Summarised and aggregated data analysis is presented in the next sections.

III. Industry Transformations: Aggregated Data Categorisation

Based on the case descriptions above, utilising the scenario analysis [1] and categorisation techniques, Table I summarises how particular sectors/industries operated at the end of 20th century, how they operate today, what some visible current issues may be for some sectors across eTransformation domains, and based on the data gathered, help identify operations that could possibly assist and be implemented in the field of education.

Based on the current industry analysis and trends, it can be seen that each industry has over the last five decades had its own key eTransformation changes. Consequently, it can be seen that for the education to transform to its full potential, it would be essential to identify to which extent the eTransformed strategies that are present in other industries, could be applied to education and which mechanisms of implementation would be required for these changes to be fully implemented. To do so, characteristics gathered from the scenario analysis are extracted and applied to the eTransformation Framework for the Cognitive Wave [5] which assisted in the proposal and the generation of the Cognitive eTransformation Framework for Education Sector.

A. eTransformation Model for Education

As a part of the further eTransformation investigation, university based education was studied. Across the world, university education is often delivered via lectures, tutorials and in some cases workshops, seminars and internships. In more recent times universities have also commenced to offer courses online.

eTransformation Strategy for the university is to deliver best possible education and produce research that is widely applied and is making a difference for the industry sector, the students and the research community. Universities are also drivers of innovation and are hubs of new knowledge and improvement.

To assess and analyse structure, based on the gathered data lecture type education can be correlated to mass production where specific segments of data are identified, individuals with skills sought so that processes can be undertaken and outcomes achieved. Similar can be said for online course deliveries. Both mechanisms can be a way to deliver large quantities of data via a single medium. Research education particularly for those undertaking the Higher Research Degrees widely differs and can be correlated to just in time customised products and test deliveries. In many cases it may also be correlated to craftsmanship where specific detailed steps are required for some processes to be conducted. Outcomes of such inventions often have the potentials to be adopted or funded by larger bodies, however for this to happen

they need to display that they have the potential to benefit certain groups of customers.

For students, their main focus is to learn the required skills, so they can progress, complete the degree and gain the required skills. To do so effectively, students rely on feedback and grades achieved which these days they can often master via simulation tools and gain instant online feedback such as for example via Pearson labs [10].

In factories, once data or raw material products are delivered, factories these days allow for the production to be tracked. This in education could very closely be correlated to online learning tools and analytics. Students however may also like to build their own course progression or study in their own time which may require just in time delivery or customisation of particular products or services. This is also now also seen in manufacture.

It is evident that education which assumes that data required for the exams are just in set books and lecture notes is slowly been replaced by notes that are stored in electronic repositories and are accessible 24/7 as slides and/or videos. Furthermore, these days much wider sets of skills are required. Such skills are often multidisciplinary and can be acquired via multidisciplinary student collaborations, on the job, via projects and internships. The requirements of the multidisciplinary skills are very evident when assessing how for example medicine requires the skills of pharmaceutics, engineering and programming in order for the genes mapping and sequencing.

Libraries these days at many universities are not just simply places where books are kept and countless hours spent reading but have today become places that hold electronic resources, have seating that stimulates discussions, research, innovations and further investigations. It is also evident that traditional classrooms are changing in design and are giving students more opportunities to sit in teams, work on collaborative projects and work on real problems.

Based on the gathered data and the undertaken categorisation, Fig. 1 was developed. It outlines specific characteristics of the studied industries and based on it identifies parameters that may be applicable to education.

It is evident based on the undertaken study that current technology systems are changing. When aligning the identified changes with the previously developed model for eTransformation Framework in the Cognitive Wave [5], it was identified that the characteristics that define the industry waves of eTransformation can be further classified. Preliminary findings are presented in Fig. 1.

To further explain the identified characteristics, Cognitive Wave [7] parameters were used. Therefore, domain knowledge, in the field of education represents what is being taught. Teaching is primarily done by the industry expert often an academic within the specific discipline. In more recent times it is possible to see that teaching and content delivery may also be done by the business professionals. Context, as defined by the framework, explains the nature in which such knowledge is transferred or gained. Therefore, for the teaching to be successful, it is essential to identify specific Contextual

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Knowledge. This knowledge defines a group of students, their needs, their gaps in knowledge, requirements and their current

experiences. Knowledge as per the cognitive wave model is delivered via both static and dynamic context.
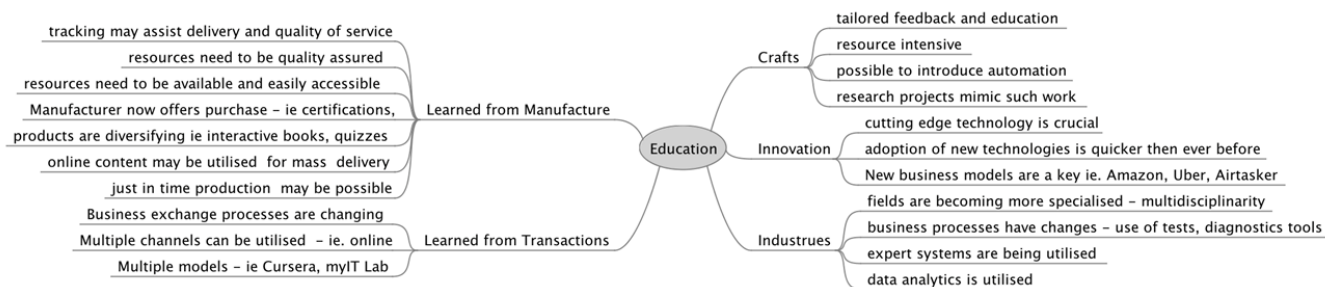

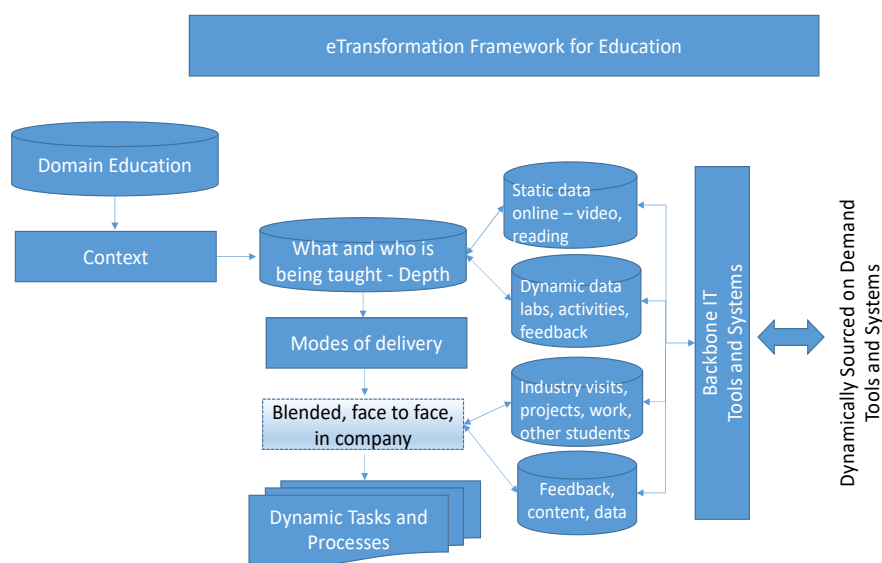Fig. 1 eTransformation Parameters for Education

Fig. 2 Adopted from the eTransformation Framework for the Cognitive Wave [5] or Education

Static Context is defined as the knowledge aimed at the specific audience with the specific requirements which do not change quickly. Such material is often delivered via lectures and in more recent times, is also being delivered online via videos, discussions and segmented components of data. Furthermore, it can also be seen that such context can also be delivered while being embedded into workshops and seminar activities. Dynamic context, on the other hand, is provided via the simulated activities where scenarios change and students learn based on the encountered events. Furthermore, feedback may be dynamically provided, so students learn based on the undertaken activities either synchronously or asynchronously. The feedback provided can be coded, so it can be provided just in time often by the system based on the online activities conducted or provided by the instructor following the completion of the particular activity often with the time delay.

In the cases when feedback is provided synchronously, data analytics is being used to provide the feedback and assist and direct the learners to the available content. Content available can be provided to large numbers of students at ease. Students can also decide when and where they would like to access the content and system can be coded to increase the level of

difficulty and complexity based on the learners' previous performance.

With technology being implemented, instructors are also able to utilise quizzes, discussion boards and simulate activities for the assessments which can provide just in time review of how students are progressing. Furthermore, discussions can also allow dynamic participation and give students opportunities to collaborate and learn from one another.

Novel business transformations and changes often require the understanding of the External stimuli that have a direct impact on the studied industry sector, in this case the education. Consequently, this means that learners these days are required to embrace industry exposure either partially or fully. This also seems to be evident by current industry proposals [2]. It is expected that such engagements would also encourage flexibility for students to gain new skills and also provide new mechanisms for the assessment delivery. Novel assessments may for example be done while students are performing real business tasks.

Fig. 2 outlines the parameters of the Cognitive eTransformation Framework for the Education Sector.

Parameters highlight the importance of: 1. Domain in which activities are being undertaken, 2. Dynamic and Static Context and 3. Importance of technology that needs to be implemented; so that on demand, periodic and continuous feedback can be sought and received.

IV. CONCLUSION AND FURTHER STUDIES

In conclusion this study highlights that the future of education, as for many other industry sectors, requires a holistic industry transformation. This change requires not just the mare implementation of technology that is utilised for the purposes of data collection and resource distribution but necessitates the implementation of the technology for the learning and teaching in the 21st century. Therefore, it is evident that traditional classroom teaching may in some instances stay as it is. However, in addition to it teaching will also be conducted online and on demand. Education will also become flexible and available based on the requirements. It will continue to be delivered via traditional modes of learning and teaching and also via the industry projects and internships.

Students will readily be able to seek feedback via series of simulation activities, on the job and via assessments. Feedback will be provided by peers, academic instructors and industry. Many of these scenarios in isolation are present nowadays, however there is currently a very small number of degrees that incorporates all aspects of the engaged, novel and transformed learning.

For the full and immersed education models to be fully developed and implemented, further studies are required to identify best methods in how to ensure scaffolding, progressive learning that is engaged and supported. It is further speculated that such new modes of learning and teaching will demand flexibility to accommodate dynamic changes, yet have a clear guidelines, outcomes and objectives, so such degrees can be fully approved and accredited by the academic institutions and industry bodies.

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