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Towards A Conceptual Pramework for Educational Innovation in Fulfilling Students Diversity in the Era of 4.0

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Abstract: This paper proposes a conceptual framework to transform the current educational practices found in schools into a neoteric and dynamic practices. The paper begins with discussing the idea behind education, highlighting the changes (or lack thereof) it faced in the advent of industrial age revolutions (the Fourth Industrial Revolution). It then proceeded to explain the problem that stems from the rapid changes in technology and the industry, and how that affected the education field. The paper then illustrates the usefulness of a conceptual framework adapted from Salmon's (2014) framework for learning innovation, to be mapped onto the existing practices in schools. The four quadrants of the transformative framework highlight a range of possible steps and practices that can help educators to determine the appropriate measures in innovating their practice. The paper concludes by noting the tensions and future directions.

Keywords: education innovation, technology, student diversity, industrial revolution

1. Introduction

Education is a process by which a community progresses forward. It is the key to sustain the social and economic development of the community and the nation [1]. Despite its importance, millions of kids still lack access to quality education. Reasons for such impediment ranging from being in conflict zones, cultural barriers, to poverty-stricken families that compels these kids to drop school and take up low paying jobs to make ends meet. Nevertheless, multiple measures have been taken by various parties and organisations to address this issue worldwide. Learning as an act of transferring known values, knowledge, and skills values from one generation to the next has been the default mode for centuries before, and possibly for centuries into the future. Although education and learning share the same purpose, the process by which a learner experience them both is somewhat different. The former is imposed upon a learner, whereas the latter is what one experience oneself. In another perspective, education is what a person received when he or she attended a school with a structured curriculum, and learning is something that the person experiences while being in that school. However, there is a caveat. Learning can happen irrespective of ones' location. Learning can happen in the classroom, and learning can also happen while cycling back home. Learning can happen while waiting for a bus, and learning can also happen while daydreaming - perhaps.

When people say that a person has been well educated, often they meant that the person had undergone formal education. For education to be considered as formal, the learning experience has to be institutionalised, chronological, and involve hierarchically graded learning. There are other forms of learning, i.e. informal learning and nonformal learning. The former includes the lifelong process of

acquiring and accumulating knowledge, skills, attitudes, and insights from experience and exposure and takes place outside of the formal curricula, while the latter involves any organised learning experiences carried out outside of the formal system. These differentiations are useful in helping us identify the characteristics of learning, to see opportunities for meaningful learning. This also shows us that learning is dynamic and that no formula that can guarantee learning, whether or not is it formally organised. Students may be physically present in the classroom to follow teachers' set of instructions and may appear to be involved in the process of education, but a more important question to ask is, *are the students actually learning?*

Learners come from diverse backgrounds. Students, when entering a classroom, brought with them rich personal experiences that are unique and have a different set of perspectives of what is deemed valuable to them. Value in learning is often placed on the things that are deemed useful. Disengagement between students and the learning material may happen when the students could not see the value of the learning material over their life. Perceived usefulness is missing, thus lowering its 'preferential rank' in the students' perceived value on the new knowledge and skills. It is up to the teachers to ascertain the importance of such topics and themes to make that meaningful connection to the students' life. Earlier I have posed the possibility of a person learning from his or her daydreaming episode. If we apply the idea of valuing experience to identify instances of learning on this daydreaming analogy, a possible instance of learning may occur if the person daydreaming managed to perceive a value to what he or she has daydreamed. Alas, further investigation into this issue is needed and may be quite an interesting one.

Teachers often resort for a structured, behaviouristic teaching method. Drill and practice and repetitive memorisation are some of the examples of behaviouristic approaches teachers often use in the classroom. These have become favourites among teachers due to several factors including, 1) the teaching process becomes more manageable, due to the systematic, almost programmable approach of teaching and learning, 2) the outcome of the teaching process can be predetermined, and 3) through the repetitive model of teaching, the results of learning can be assured, or standardised. From this point of view, we can say that there is a pattern of conformity, objectivity, and structure in the way we educate our youngsters. This approach into teaching and learning has its root dated back in the industrial age, and the effects will be discussed in the next section. Nevertheless, this is not the only approach available to be perused by educators.

The recent take up of a more constructivist way of teaching opens a more dynamic path into the pedagogies of the future. [2] stressed the importance of good pedagogical design to support a truly ‘scholarly approach’ to educational reform. This pedagogic change is thought to be fuelled by the realisation that students nowadays are being exposed to all sorts of things that we, as a learner 20 years ago, did not have. This change begs the question "Does this environmental change brings together a characteristic shift among our youngsters?". With the advent of the World Wide Web, and the technologies that are enabled by it, students are more connected now, and that access to shared knowledge is a click away. Students at schools now are often labelled as 21st century learners [3], and are thought to embody a different set of traits, unique to its generation.

The generational shift, from Generation Baby Boomers to now a generation being dubbed as the Alpha Generation, brings forth a few questions worth answering: *Do these younger generations learn how we learn back then? If it is different, how different they are?*

2. Discussion

2.1. The Influence of the Industrial Revolution

The shift from agricultural communities, to industrial societies, have a significant impact on education, worldwide. To understand the impact, we must first examine the progression of one of the biggest revolutions in human history - the industrial revolution.

The industrial revolution purportedly started circa the late 1690s, with the introduction of the steam engine. Before this, factories were powered by manual labours, which not only cost the industrial tycoons a considerable chunk of his or her wealth, but the labours were limited to what rational human beings could do. With the introduction of the steam-powered engine, developed commercially by Thomas Savery, perfected and patented by James Watt by the late 1780s, factory owners saw the potential of replacing manual labours with the automated machinery. This resulted in better production of goods, an increase in productivity and of course an increase in profitability. Coal, irons, railroads, and textile were some of the industries that were affected by this new finding. The newfound technology to power the machines have made an enormous impact on the human lives that it is dubbed the First Industrial Revolution.

After the steam engine phenomenon during the First Industrial Revolution, improvements upon improvements were made to the process of producing goods. The growth of the industry was becoming exponential. Advancements in electrical and electronics powered the subsequent industrial revolutions up to a point where we started to integrate computer circuits to make the machines smarter. By the time the third Industrial revolution came, it was about the integration of a more refined technology such as electronics, the Internet, and information technologies to produce more reliable, faster, and automated machines. High precision pieces of machinery were introduced to the assembly lines, forming an orchestra of steel arms. This was of course at the expense of more manual labours. There was, and still is, a particular thematic allergy, a pseudo-dynamic relationship between humans and machines, from then until now. If all those years, people battled their way against the rise of the machines relieving of their jobs, people of today fear with the rise of artificial intelligence, for the same reason.

Artificial Intelligence (AI) marked the next growth in the historic industrial revolutions. The Fourth Industrial Revolution (IR4.0) is characterised by the advent of cybernetics, humanoid, cyber-organism or cyborg, machine learning, artificial intelligence, augmented realities, the Internet of Things (IoT), the Internet of People, and quite possibly, the Singularity. Machines talking to one another, understanding the environments through sensors, and acting on those environments through actuators are some of the technological marvels that we can find bountiful nowadays. There are those who dismissed the idea of a fourth industrial revolution, stating that this is only the extension of the third revolution, with even faster development in computer sciences [4] [5].

So far, what we have discussed in this section is the progression of industrial revolutions towards the IR4.0. What we have yet to discuss is how this progress affected education. What we know now is that there is a shift in human dynamics that happened during the first industrial revolution. Prior to the industrial revolution, we were accustomed to the agrarian life of crops cultivation, living in small, close-knit communities. Education was mostly of cultural and religious in nature, spearheaded by monasteries and churches. The waves of modern society seeped through, and the demand for a skilled workforce increased. Schools were erected to train the future workforce with standardised skills needed to meet the demands of the industry. Fast forward to 2019, the industry has undergone at least

three significant advancements, but schools mostly stayed the same. Schools are still training the future workforce with outdated pedagogies and curriculum, and this affects the quality of the workforce. This is the gap. This is what we educators are trying to address today [6].

The fact that formal education is often based on a structured, hierarchical, and methodical system of learning and the foundation of the education system itself is rigid, and this may have been the cause of such a lack of progress in the field. Many countries adopted a centralised and standardised national curriculum and schools have to work within these boundaries, to meet a specific set of educational assessment criteria. Revisions of the curriculum were lacking, making the learning materials that are being used in the classrooms to be outdated. This situation creates a mismatch between the skills of the future workforce which are being trained in schools and colleges, with the ever-increasing and ever-changing demands from the industry. A situation like this often does not provide adequate space for innovation, and motivation for educators to embrace the change that is needed.

A disruptive change is needed for the education field to evolve into a more relevant state, at par with the demands from the industry [7]. Educationists need to re-look at how learners learn, how their system of values changes with the progression of society, technology, and human development in general. A change is needed in the curriculum design to be more fluid and dynamic, for pedagogical approaches that cater to the different needs of the learners, for more effective educational technology implementations, and for more innovative assessment strategies.

2.2. Educational Innovation in IR4.0

The recent development of the IR4.0 has impacted future job scopes. With the proliferation of the use of AI in fields such as engineering, computer science, medicine, and design, there is a growing concern that in due course, AI will replace many jobs with a smarter, more autonomous, low maintenance robotics and intelligent systems. While there is a basis to that concern, AI will never replace jobs that have a high level of taciticity, i.e. teaching. While AI can definitely replace a teaching job with an intelligent, adaptive system of personalised learning, there are aspects of teaching that may not be augmented by computers. Empathic, passionate, and internally motivated are some of the traits of educators that cannot be easily augmented by robots.

With that being said, the advancements that IR4.0 brought forth changes the landscape of future jobs in many nations. There are jobs that are currently being advertised, which were practically non-existent ten years ago. Jobs like Social Media Manager, Search Engine Optimisation (SEO) Specialist, Uber Driver, and Drone Operators were nowhere to be found in the year 2000, but they are on high demand nowadays. Social Media Influencers are treated as important persons in digital media, redefining the idea of celebrities and fame. Experts in computer vision, neural network, deep learning, and adaptive system are needed. IR4.0 made new technologies available to be perused by industries at an exponential rate, and industries are trying to catch up with this development, requiring more skilled workers for the job. This changing landscape of jobs is the epicentre of the mismatch between industry and educational institutions mentioned earlier i.e. gap between supply of skilled workforce and the demand from the industry [8].

Schools, colleges, and higher learning institutions were erected to meet the ever-increasing demands from the industry for a skilled workforce. Innovative strategies for new ways of teaching aligned with the recent technological development is on the rise. For example, the idea of a ‘Teaching Factory’ [9]. Generally, learners are expected to undergo the many levels of

education, with each level progresses forward to develop them into specialised workers of specific fields of study. In Malaysia, the primary and secondary levels of education focused on equipping learners with adequate general knowledge from a variety of fields of study. Often when they reached the upper level of secondary education, they began to choose a specialisation, based on their interests, but more often, based on how well they performed in select subjects related to the field of specialisation that they want to pursue. Further specialisation is expected when the learners enter the tertiary level of education. This is how a formal, systematic, hierarchical education looks like. Let us look at how can this experience be 'disrupted'.

While the default mode of education (and that of learning) is for the fulfilment of industrial needs, let us take a step back, and look at how we can approach this issue in a different, not necessarily fresher, way. John Dewey, a well-known American educationist, suggested reforming education in his *'Experience and Education'* [10], that instead of looking at education in schools as conforming to industrial needs, schools should be looked as an extension of the community. This type of *'progressive education'* paradigm looks at educators and students as a part of a community - a functional member in a network of local people, akin to a rhizomatic network [11], and the task of an educator is to create an educative experience, based on the prior engagement of the students in the community, socialisation to form a genuinely interactive process of learning. As highlighted earlier, students attending the school are not without their rich experience and pre-defined thoughts and beliefs.

Experiential learning can become the starting point, where educational innovations can be ideated and experimented. Innovating the process (and product) of experiential learning involves a careful organisation of pedagogical approaches, materials development, and assessment strategies that are suitable and support the fluidity of the learning experiences. Within this, there is a value of looking into the model of teaching in social constructivism paradigm, where learning is seen as an interactive social phenomenon, and that meaning making involves definition and re-definition of one's understanding, based on active participation in discussions. Grounding of unfamiliar learning materials within the scopes of one's own life can help bridges the knowledge gaps. However, the practicalities of having such a design in an education system are duly noted.

Teachers have been accustomed to managing every aspect of the teaching and learning process and experience, up to a point where they can continuously produce students who performed highly in examinations, based on the age-old principle of repetitive learning/ rote learning. When a more fluid and dynamic paradigm of teaching (and that of learning) is being introduced, it further complicates the matter. Each educator has their own sets of Key Performance Indicator (KPI) that they need to achieve, e.g. more than 80% of his or her students scored above average. With the old method, that KPI is easily achievable. The fact that the nature of the new approach is more towards student-centred and dynamic makes it difficult for educators to ensure that their KPI can be attained. This problematic situation may happen due to the responsibility of learning that has been handed down to the students themselves rather than is being predetermined by the teacher. The assurance of achieving that KPI now depends solely on their creative pedagogical design, to aid the students to achieve meaningful learning organically.

2.3. Towards A Conceptual Framework for Education Innovation

There are two ways to introduce educational innovation culture among academics, i.e. 1) institutional, systemic,

large-scale, top-down centralisation of the new services provision, and 2) a more incremental bottom-up departmental approach, introducing easy-to-use, familiar technologies. The latter can build up to longer retention and ownership among academics [12].

A systemic change is needed to address the problem raised in the previous section. Not only educators need to embrace the more dynamic approach in teaching and learning, curriculum design and assessment strategies should also be innovated. For this to happen systematically, we need to look into the literature, to find existing frameworks that may provide a lens in which we can understand and inform us on how to go about solving this issue. For this, I found Salmon's Transformative Framework for Learning Innovation [13] to be both useful and instructive.

Gilly Salmon originally proposed the transformative framework for learning innovation in 2014 for the use in higher education, but the framework is seen as generic enough to be implemented across the board. The framework is founded based on improving the online and blended practices often found in tertiary education institutions. Among the main ideas behind the framework is to highlight the sound pedagogical design that should be accompanied in the delivery of a technology-based educational solution. Often researchers and practitioners focused on the technology attributions as the main reason of the success (or failure) of digitally enhanced teaching, and do not put enough emphasis and exposure as to the pedagogical assumptions that became the basis of the practice.

The original framework consists of four quadrants, with each representing different segments in the higher education institutions practice for digital learning. For relevance and generalisability of the framework to the scope at hand, I will attempt to customise the four quadrants to correspond to the general problem we are facing today.

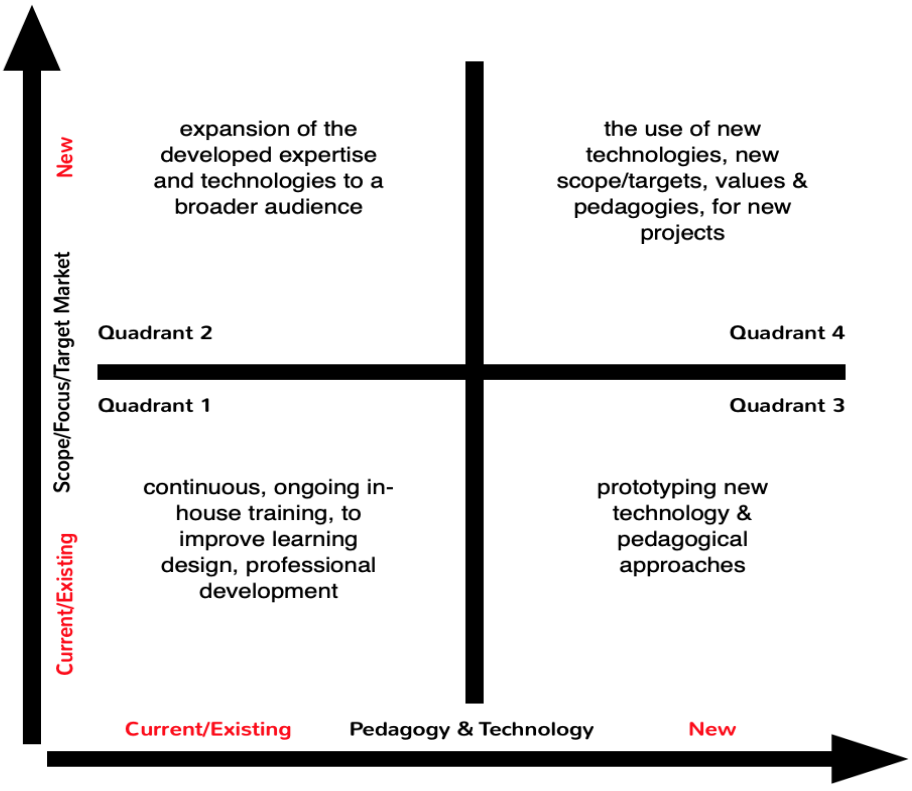

Figure 1: Educational Innovation Framework (Adapted from Salmon, 2015)

Summary

- **Quadrant 1** proposes a more organic growth of innovation among academics through incremental adoption of technology, easy-to-learn training modules and further knowledge and skills development opportunities. Quadrant 1 suggests continuous, ongoing in-house training to be provided to academics to improve their learning design, professional development and support. This quadrant might involve lower cost and risk. Example of such practice - *LADAP (In-Service Trainings) in Malaysian schools.*
- **Quadrant 2** suggests a different scope/targets for the incremental growth of educational innovation, using existing pedagogies, and technologies. If Quadrant 1 focusses on internal organic development, Quadrant 2 focusses on the expansion of the developed expertise and technologies to a broader audience, outside of the school boundaries. Example of proposed practice - *schools to engage with the local community, providing technical training or social-educational innovation projects that are of value to the locals.*
- **Quadrant 3** suggests the deployment of the schools' vital pedagogical strengths, adjusted to adapt to new technological advancements. This quadrant requires schools to dabble into new systems and applications that may result in inventive technological projects that are of a prototype in nature. Example of such quadrant in practice - *experimenting new technology with a familiar pedagogical approach.*
- **Quadrant 4** suggests a more radical way of innovating education. This quadrant proposes a more holistic use of pedagogy and technology, with even larger scope. The use of new technologies, focusing on new scope/targets, values, and the take up of new and different projects, involving comprehensive planning, execution, and evaluation. This quadrant poses a higher risk but potentially valuable return. Example of such quadrant in practice - *inventing a generic platform to facilitate the process of carrying out an alternative assessment in educational institutions.*

2.4. Framework for Educational Innovation - an example of UPSI

The Universiti Pendidikan Sultan Idris (UPSI) is engaging with the Ministry of Education Malaysia (MOE) to develop a Quadrant 4 educational innovation project. The project focusses on the classroom-based assessment in schools. Assessment of students' performance has been an integral part of any education system in the world. Educators are well informed with the dimensions of assessment, i.e. formative and summative assessment, ranging from midterm tests to final examinations to track students' progress over the academic year. This measurement of performance is used to indicate students' readiness to pursue jobs, and other opportunities once graduated from learning institutions.

We can see the rapid change in society nowadays and most importantly, in the industry where the need for a skilled workforce is more significant than before. The business and workforce landscapes are changing, with the ever-growing disruptive technologies and services, opening more opportunities for health, wealth and knowledge creation at an exponential rate. To face this demand, agility and readiness to carry out on-the-job learning are among some of the traits employers are looking for when recruiting. It is then, part of the educators' job, to nurture neoteric graduates who have these and other required skills, preparing them for the uncertain future.

Nevertheless, moving from a structured instruction to a more dynamic one calls for a new form of assessment. In line with the Quadrant 4 description of educational innovation, UPSI has developed a functional prototype of an alternative assessment platform that utilises learning

analytics and artificial intelligence, to categorise the students' performance, and predict their best fit in terms of skills and future jobs compatibility. This platform is generic enough to be implemented from as early as kindergarten to the tertiary level of education. The system is now being piloted under a new initiative by the MOE in select schools in Malaysia.

3. Moving Forward

Changes in the education system are inevitable. We can start to see shifts that have been put into place, to reform the traditional ways of learning and teaching, into a neoteric pedagogy. The old approaches to teaching and learning, e.g. ‘sage on stage' lectures are being replaced with a more interactive mode of teaching and learning. The role of educators is morphing from the knowledge-giver into guide-on-the-side. Social constructivist approaches are in-trend, and students are required to be active participants in the classrooms, forming understanding and building knowledge together. These changes propounded on a premise of nurturing critical thinking, problem-solving, and creativity in our students as part of the skills to prepare them for the uncertain future.

Navigating through the plethora of technological solutions to find a suitable match to our pedagogical approaches is tricky, and the framework presented in this paper attempts to simplify the process by laying out the fundamental considerations to a systematic educational innovation project. Between technological advancements, pedagogical consideration, and scopes of application, there are opportunities for educators to develop new innovative educational products and services that are of value and relevant to both their practice and to the needs of the target market(s).

Ultimately, educational innovation initiatives should take into account the perceived value of those innovations (and its contents) on learners, the incorporation of learner-centric pedagogical designs and its experience, the readiness of learners, educators, and technologies, and the alignment of these considerations onto the institutional missions and strategies.

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