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Towards Data-driven Education with Learning Analytics for Educator 4.0

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Abstract. Learning analytics has not been extensively used yet as necessary tools in the management and operation of public universities in Malaysia. Massive amount of data been created and collected on students at the faculty but mostly remain dark and unexplored. Generating many reports, having lots of alerts or dashboards does not make a faculty data-driven. To be smart, a faculty must utilize technology to enable and support better planning and decision-making, and to be data-driven, a faculty must have analytics to drive actions for value. This paper intends to explore the impact of IR 4.0 in the field of education and research into the possibility on how a university or a faculty can adapt to IR 4.0 and function in the big data environment. It will present the concept of Education 4.0, data-driven education and learning analytics. To transform, universities must rethink the current teaching practices and then redesign learning to suit future demand. This is discuss next. Finally, it summarizes the roles that educators 4.0 should play in Education 4.0.

1. Introduction

Life as a whole is very different in the volatile, uncertain, complex and ambiguous (VUCA) world today [1]. Rapid change is the norm today and it is dramatic and constant. Advances in technology is transforming humanity in both positive and negative ways and its increasing pervasiveness in the big data environment and fourth industrial revolution (IR 4.0) has become a reality whereby no one can ignore but adapt to unprecedented change in which Covey [2] referred as the emerging era of wisdom. IR 4.0 emerge with revolutionary change that occurs when information technology proliferates in all industries and caused disruptive effects on economy, business, governments and countries, society and individuals. Schwab [3] characterized this revolution as a fusion of technologies that is blurring the lines between the physical, digital and biological spheres through connectivity. The concept of smart organization is adapted from smart factory, the heart of IR 4.0. Its technological basis is smart automation of cyber-physical systems with decentralized control and advanced connectivity (IoT functionalities) [4].

Data generation, collection and storage have changed resulting in digital data explosion growing at exponential rate. From cyberspace googling, emails, online transactions, blogs to social media postings of photos, audio and video, human are creating torrents of unstructured and binary data. While machines are producing semi-structured data in the forms of weblogs, machine logs, RFID chip readings, GPS system output and environmental sensor readings. As the world is now instrumented,



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data generation has become a default [5], and every firm today is a data firm. Accepting the notion of “data as an asset”, many forward-thinking business organizations race aggressively looking for opportunities to leverage their data to extract significant valuable insights for their business. Data and analytics are already changing the shape of many industries, and more and more companies are adopting data-driven approach. Digital denial organizations that are not harnessing their data and not using it to their advantage are suffering from “dark data” syndrome [6]. If such condition is left untackled, they will soon disappear into oblivion. Data denial or data resistant organizations are advised to combat the inertia and explore their data to unleash its power. Figure 1 shows the stages of evolution to become a data-driven organization.

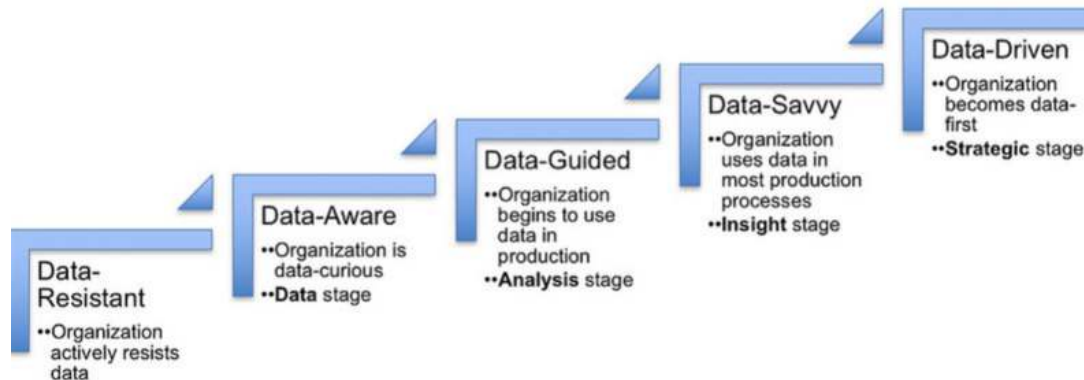


Figure 1. Evolution of the data-driven organization [7]

This paper intends to explore the impact of IR 4.0 in the field of education and research into the possibility on how a university or a faculty can adapt to IR 4.0 and function in the big data environment. It will present the concept of Education 4.0, data-driven education and learning analytics. To transform, universities must rethink the current teaching practices and then redesign learning to suit future demand. This is discussed next. Finally, it summarizes the roles that educators 4.0 should play in Education 4.0.

2. Education 4.0

In today’s technology-fueled and data-fueled world, academicians too are equally involved to react to the call of IR 4.0. Education 4.0 emerges in response to the IR 4.0. It is the impetus, global trendsetter for educational transformation and future education system, whereby human and machine / technology form partnership to enable smart teaching and learning. Education 4.0, as explained by Harkin [8], is the personalization of the learning process, where the learner has complete flexibility to be the architect of his or her own learning path and has the freedom to aspire for, approach and achieve personal goals by choice. Table 1 depicts characteristics of Education 4.0 as compared to the earlier three in order to shed some clarity on the topic.

Table 1. The Difference between Education 1.0, 2.0, 3.0 and 4.0 [9]

Characteristics	Education 1.0	Education 2.0	Education 3.0	Education 4.0
Institutional arrangements	Campus-based with fixed boundaries between institution	Increasing collaboration between universities; still one-to-one affiliation between students and universities	Loose institutional affiliations and relations	Jukebox Ala Carte Do it yourself (DIY) courses
Location of institutions	In a building; Brick & mortar	In a building plus online; Brick & click	Everywhere in the “creative society” (thoroughly infused	Anytime, Anywhere Anydevice, Anyplatform,

			into society: cafes, bowling alleys, workplaces, etc.)	replacing the classroom
Content arrangements	Traditional copyright materials	Copyright and free/open educational resources <i>for</i> students within discipline	Free/open educational resources created and reused <i>by</i> students	User-generated content; DIY content; Personalize
Technology	Unheard of	Cautiously “adopted”	Ubiquitous	IoT, AI, VR, AR, MR, Simulations, Robotics, Block Chain
e-Learning	Computer-aided Learning	Blended Learning	Mobile Learning	Open Distributed Learning, Virtual Immersive Learning, Gamification
Hardware & Software	Are purchased at great cost and ignored	Are open source and available at lower cost	Are available at low cost and are used purposively	Software-as-a-Service (SaaS), Platform-as-a-service (PaaS)
Curriculum structure	Rigid and fixed	Just-in-case	Just-in-time; Just-for-me; Just-enough	Fluid and organic
Gadgets	Confiscated at the classroom door	Cautiously adopted	Bring Your Own Device (BYOD)	BYOD, Cloud-based, Gadgets on body
Learning orientation	Teacher-centered	Learner-centered	Learning-centered; PBL Experiential learning, Action learning	Challenge-based learning, Passion-based learning
Teaching & Learning mode	Pedagogy	Andragogy	Heutagogy	Cybergogy Peeragogy
Learning theory	Instructivism, behaviorism	Cognitivism	Constructivism	Connectivism
Primary role of professor	Source of knowledge	Guide and source of knowledge	Orchestrator of collaborative knowledge creation	Learning experience designer (LED) Resource expert
Primary role of student	Largely passive absorptive	Passive to active, emerging sense of ownership of the education process	Active, strong sense of ownership of own education, co-creation of resources and opportunities, active choice	“Digital natives” Creator of knowledge Self-explorer

3. Data driven education

Vast “digital ocean” of data about learners are generated at universities that if analysed can provide valuable insights. Treating data as an asset and becoming a data-driven organization has become necessary for universities in the big-data era. The advantage is, the universities will have the means to improve productivity, make operations more efficient and change the way decisions are made, from opinion-based to fact-based, where they can make better, more informed decisions.

Data-driven education enables universities to leverage educational data to get insights about teaching-learning process and to make data-driven educational decisions based on student needs [10]. Data-driven decision-making involves making use of data, such as the sort provided in virtual learning environments or Learning Management Systems (LMS), to inform teaching decisions [11]. Values underlying learning analytics are to analyse student-learning data and its contexts in order to better understand and personalize student-learning experiences [12,13]. Figure 2 shows categories of data that educational institutions need to justify actions, guide actions and prescribe actions [14].

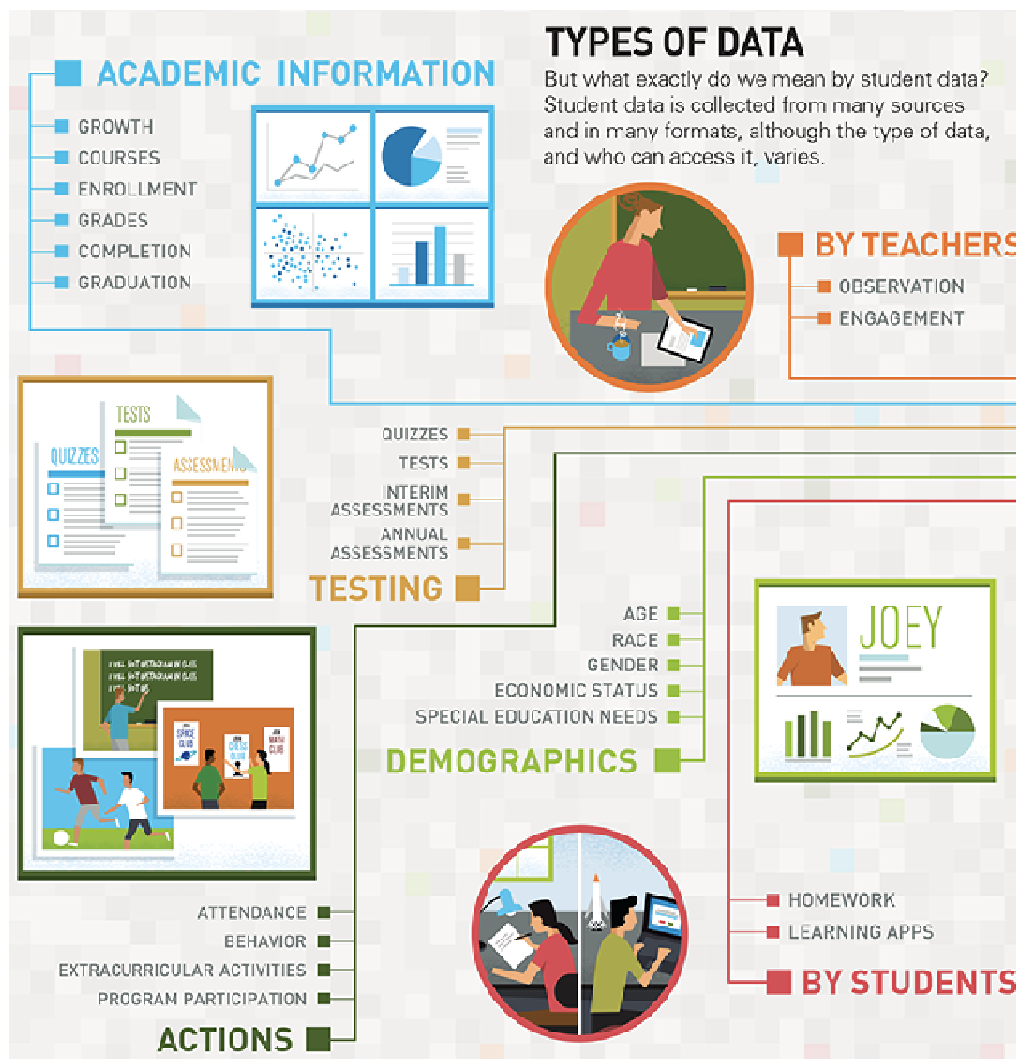


Figure 2. Types of Students Data [15]

According to Burbano [16], universities need to establish their goals, based on the data they collect and the analysis made on it, showing what has been achieved and what progress is necessary in their data-driven endeavour. To be smart, a faculty must utilize technology to enable and support better planning and decision-making, and to be data-driven, a faculty must have analytics to drive actions for value. Prerequisite for this endeavour is to foster a culture that acts on data in the organization [14].

4. Learning analytics

Learning analytics has not been widely used yet, as necessary tools in the management and operation of public universities in Malaysia. Massive amount of data been created and collected on students at the faculty but mostly remain dark and unexplored. Small percentage of the data are usually used to

generate reports, alerts or dashboards, which does not make a faculty data-driven. Answering the “what happened” question is merely doing descriptive analytics. To be data-driven, three other types of questions should also be considered:

- “Why is it happening?” (Diagnostic analytics),
- “What could happen?” (Predictive analytics) and
- “What should I do next?” (Prescriptive analytics).

Vital aims of analytics is value. Dykes [17] describes the data-driven stages as a series of dominoes: (data > reporting > analysis > decision > action > value). If one domino is removed, it can be more difficult or impossible to achieve the desired value.

Examining Chatti’s [18] learning analytics reference model in Figure 3, there are four dimensions to look into which includes: types of data available, purpose of doing it, the analyst and beneficiaries involved and applying data science works to carry it out.

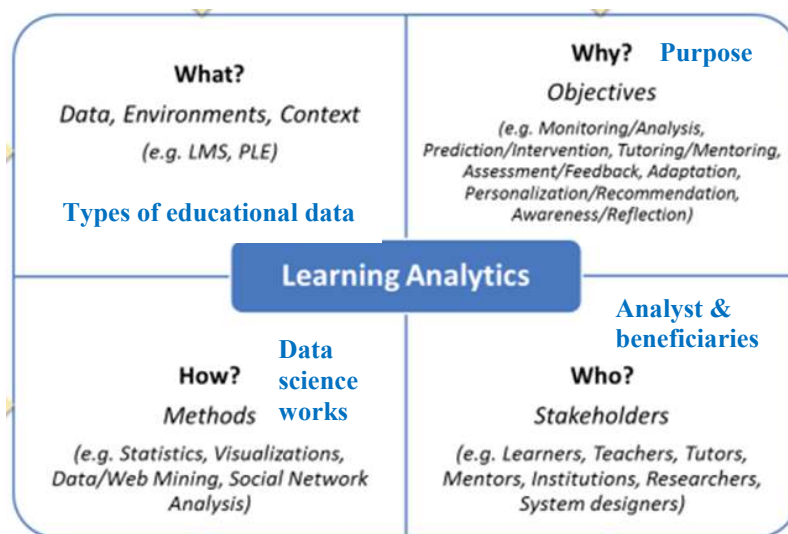


Figure 3. Learning Analytics Reference Model (modified from [18])

5. Rethinking teaching and redesigning learnings

University of the future is emerging and does teaching, research and service differently to augment human talent and learning capacity. To transform, this future university utilize advance technology for significant task redesign and creation of new tasks, previously not possible. Referring to SAMR Model [19], these technological transformations happen at modification and redefinition level.

Current practices of most universities are at Education 2.0. The universities need to break away from the process driven, technology supported mass teaching systems to a new approach of education that appreciates the personalization of learning. To shift from present state to Education 4.0, universities need first to reflect about how they are operating today, before leapfrogging through innovative, time and cost saving means [8]. Dealing with the digital natives students, universities need to rethink on the effectiveness of present-day teaching, minimize passive teaching and maximize interactive teaching using technologies. Then redesign learning approach following active learning method that encourage engagement, participation and collaboration.

In order to position current Malaysian public universities in the era of IR 4.0, Ministry of Higher Education suggest to focus on these four principal aspects [20]:

- i. Redesigning of learning spaces
- ii. Incorporation of 21st century pedagogies
- iii. Applying a fluid and organic curriculum, responding to innovations & new areas of knowledge
- iv. Incorporation of the latest T & L technologies

Ernst & Young [21] reported that social media, mobile, analytics and cloud computing (SMAC) are emerging technologies that are also affecting all areas of higher education. Analytics should be the fifth additional part to focus as one of the Malaysian higher education principal aspects. Universities capture a wide range of data that can be used to improve performance and productivity with the application of learning analytics.

Unlike private sectors, the pace of change and adoption of new method by universities is incredibly slow. This key innovation message, “Think big, start small and scale fast” can be the guide to initiate the change. In this matter, change can transpire at three levels: micro (individual lecturer and department level), meso (at faculty level) and macro (at university level). Driven by the vision to become Educator 4.0, a faculty member can start the initiative and upon successful can share the results at the faculty level then with considerable effort communicate to the whole university.

6. Educator 4.0

Educators today has to be future-oriented and be adaptable to new methods to catch up with the changes happening in the digital age of wisdom. This is where educator 4.0 must play a role and innovate the way teachings are done using emerging technologies. Teaching should be interactive, creative, engaging, effective with greater emphasis on digital age skills development, and less on memorising content. Among the innovative teaching strategies discussed in the workshop [9] include flipped classroom, gamification, real world experiential learning, maker learning, Open learning with MOOC and Open educational resources (OER). Educator 4.0 need to explore, try out diverse learning tools and experiment these tools during class session with the digital natives’ students. Students should be active learners, creator of knowledge and self-explorer. Cybergogy and peeragogy become the mode of teaching and learning, with connectivism as the new learning theory. Content-wise mostly digitalized, are user-generated with Web 2.0 applications and machine-generated, driven by data through Web 3.0 applications [22]. Learning orientation is towards student-centred, peer-to-peer, challenge-based, competency-based, personalised and deep learning approach. Time and space is no longer a barrier for learning. Educator 4.0 shall be the resource expert, learning experience designer and facilitator. When data is treated as an asset, learning analytics can be used to monitor, evaluate, and improve the learning process. With this regard, a new role for educator 4.0 as learning analyst appear.

7. Conclusion

Human, technological, teaching & learning related matters and data are four educational aspects to focus in the changing VUCA world of the 21st century. Education 4.0 emerges in response to the IR 4.0 as the impetus, global trendsetter for educational transformation towards future education system. A rethinking and reassessing of traditional teaching is required to educate learners with new technologies. This needs imagination and vision besides technical expertise. Teaching philosophy should be the basis to reinvent teachings and redesign learnings that correspond to the needs of students, the demands of the discipline, and the resources available. Educator 4.0 plays a proactive role to make learning happens in the digital age, as they are the resource expert, learning experience designer, facilitator and learning analyst that utilised data to informed teaching and learning.

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