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Disruptive innovative technologies in higher education

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Abstract
Rapid advancement of information and communication technologies has brought about various changes in education and the structure of colleges and universities. The education system is undergoing dynamic changes. These dynamic changes can be explained from the perspective of theory of disruptive innovation which basically explained that existing organizations were displaced from their industries because of their inertia towards the adoption of new innovation. This study is meant to give readers, especially practitioners in education sector a way of understanding the nature of disruptive innovation and how disruptive innovation is influencing the education landscape.
This paper analyses the role of ‘‘disruptive’’ innovative technologies in higher education. In Most of Countries, Higher Education Institutions (HEIs) have invested significant sums in learning technologies, but these technologies have not been universally adopted and used by students and staff. Instead, other technologies not owned or controlled by HEIs are widely used to support learning and teaching. According to Christensen’s theory of Disruptive Innovation, these disruptive technologies are not designed explicitly to support learning and teaching in higher education but have educational potential. This study uses Activity Theory and Expansive Learning to analyse data regarding the impact of disruptive technologies. This study identifies a contradiction between learning technologies made available by HEIs, and technologies used in practice. There is no evidence to suggest that a wide range of technologies is being used to support learning and teaching. Instead, a small range of technologies is being used for a wide range of tasks. Students and lecturers are not dependent on their HEIs to support learning and teaching. Instead, they self-select technologies, with use weighted towards established brands. The use of technologies outside HEIs has implications for the monitoring of learning and teaching, and for the role of HEIs, which are no longer the gatekeepers to knowledge.

Keywords: disruptive technology, online learning, disruptive innovation, MOOCS

Introduction
Currently, higher education is fundamentally being disrupted by various new tools and online environment. Rapid advancement of information and communication technologies has brought about various changes in education and the structure of colleges and universities. Colleges and universities are "...moving up the quality chain and losing touch with the mainstream..." (Christensen, 2008, p. 43) [18]. Colleges and universities are undergoing a sort of “disruptive innovation and catalytic change” (Christensen, 2008, p. 43) [18]. It has been noted that "The theory of disruptive innovation has significant explanatory power in thinking through the challenges and changes confronting higher education" (Christensen, Horn, Caldera, & Soares, 2011, p. 2) [23]. It is predicted that by 2019, 50% of "high school classes will be taught over the Internet" (Trotter, 2008, p. 1) [20]. Therefore the purposes of this study are (1) to provide a review of the theory of disruptive innovation, and (2) to examine the implications of disruptive innovation on the Malaysian distance education scene. introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.
A number of researchers have anticipated that the use of technologies in learning and teaching would disrupt learning and teaching practices in higher education (e.g., Blin and Munro 2008; Sharples 2003). However, digital technologies have, in practice, largely reproduced, rather than transformed and disrupted, existing pedagogical approaches (Fry and Love 2011; Margaryan, Littlejohn, and Vojt 2011). It is therefore appropriate to explore how non-institutional technologies contribute to learning and teaching in higher education. In order to address this issue, this paper investigates the role of ‘‘disruptive technologies’’ (Christensen 1997) [18] in higher education.

Disruptive technology in Higher Education
In 2009, Milan Zeleny described high technology as disruptive technology and raised the question of what is being disrupted. The answer, according to Zeleny, is the *support network* of high technology [20]. For example, introducing electric cars disrupts the support network for gasoline cars (network of gas and service stations). Such disruption is fully expected and therefore effectively resisted by support net owners. In the long run, high (disruptive) technology bypasses, upgrades, or replaces the outdated support network. Questioning the concept of a disruptive technology, Haxell (2012) questions how such technologies get named and framed, pointing out that this is a positioned and retrospective act.
Technology, being a form of social relationship always evolves. No technology remains fixed. Technology starts, develops, persists, mutates, stagnates, and declines, just like living organisms. The evolutionary life cycle occurs in the use and development of any technology. A new high-technology core emerges and challenges existing technology support nets (TSNs), which are thus forced to coevolve with it. New versions of the core are designed and fitted into an increasingly appropriate TSN, with smaller and smaller high-

technology effects. High technology becomes regular technology, with more efficient versions fitting the same support net. Finally, even the efficiency gains diminish, emphasis shifts to product tertiary attributes (appearance, style), and technology becomes TSN-preserving appropriate technology. This technological equilibrium state becomes established and fixated, resisting being interrupted by a technological mutation; then new high technology appears and the cycle is repeated.

Regarding this evolving process of technology, Christensen said:

The technological changes that damage established companies are usually not radically new or difficult from a technological point of view. They do, however, have two important characteristics: First, they typically present a different package of performance attributes—ones that, at least at the outset, are not valued by existing customers. Second, the performance attributes that existing customers do value improve at such a rapid rate that the new technology can later invade those established markets.

When the technology that has the potential for revolutionizing an industry emerges, established companies typically see it as unattractive: it's not something their mainstream customers want, and its projected profit margins aren't sufficient to cover big-company cost structure. As a result, the new technology tends to get ignored in favor of what's currently popular with the best customers. But then another company steps in to bring the innovation to a new market. Once the disruptive technology becomes established there, smaller-scale innovation rapidly raise the technology's performance on attributes that mainstream customers' value.

For example, the automobile was high technology with respect to the horse carriage; however, it evolved into technology and finally into appropriate technology with a stable, unchanging TSN. The main high-technology advance in the offing is some form of electric car—whether the energy source is the sun, hydrogen, water, air pressure, or traditional charging outlet. Electric cars preceded the gasoline automobile by many decades and are now returning to replace the traditional gasoline automobile. The printing press was a development that changed the way that information was stored, transmitted, and replicated. This allowed empowered authors but it also promoted censorship and information overload in writing technology.

Milan Zeleny described the above phenomenon. He also wrote that:

Implementing high technology is often resisted. This resistance is well understood on the part of active participants in the requisite TSN. The electric car will be resisted by gas-station operators in the same way automated teller machines (ATMs) were resisted by bank tellers and automobiles by horsewhip makers. Technology does not qualitatively restructure the TSN and therefore will not be resisted and never has been resisted. Middle management resists business process reengineering because BPR represents a direct assault on the support net (coordinative hierarchy) they thrive on. Teamwork and multi-functionality is resisted by those whose TSN provides the comfort of narrow specialization and command-driven work.

Social media could be considered a disruptive innovation within sports. More specifically, the way that news in sports circulates nowadays versus the pre-internet era where sports news was mainly on T.V., radio, and newspapers. Social media has created a new market for sports that was not around before in the sense that players and fans have instant access to information related to sports.

Innovation in Higher Education

Innovation is by no means different from invention. Henry Chesbrough (2003) stated that innovation means invention implemented and taken to the market. Where beyond the innovation lies disruptive innovation, which actually changes social practices –the way we live, work and learn. For a successful disruptive innovation, the first challenge is technological breakthrough in terms of the products it enables, and how are they shaping the social practices if they are having huge payoffs, both to the innovator and to society. Another challenge is that a successful innovation usually needs an innovative business model and also demands an innovative product offering. (Brown, and Seely 2006.) Christensen (2008) [18] mentions that disruption is a two-stage process, where the first phase is that the innovator makes a product substitute to the existing product more affordable and easier to use. To be noted that making and building the new product is more expensive and complicated. In the second stage of disruption is called modular design, it is the shortcut to building and upgrading the products in a simple and inexpensive way. (Christensen 2008) [18]. Lectures are held as production of knowledge, the delivery methods in-class are being transformed from spoken lectures to showing various forms of information such as multimedia. The interactions between students and teacher has increased, also peer-to-peer interactions enabled. The learning journey has developed into a collaboration between these factors of participations. The aim to allow school ICT strategy development and support decision making, and the use of using portable ICT device per learner is rapidly becoming a trend in many education and training sessions in higher education. Schools deploy laptops, smart phones or tablets to support teaching and learning both online and offline lectures. The capital investment may burden the budget by schools and funders. Depending on various approaches to implement bring 7 your own device (BYOD) concept, participants are encouraged to bring their personal electronic devices to the lectures to take advantage of enhance teaching and learning. (Attewell 2015.) While the dominant age of television transfers to the future of digital data which presents on personal owned machines such data that are unlimited by its content. The descendants of TV viewers are moving to the digital platform where one could order certain types of content one want, determining the time of the arrival time and even the form of the content. Gilder also concluded that the technical changes would affect institutional changes among with negation of mass media such as broadcasting stations and centralized telephone system to client-server networks and networks for individual uses. (Gilder 1993, 95.)

Digital revolution

Among the big three Information revolutions, beside Gutenberg Revolution and scientific revolution is the digital evolution in our era. Digital revolution is a combination of digital transmission, digital processing and digital storage. The revolution is being defined due to its nature of impacting society and the economy; it transferred the management of records by from organizations to businesses. Thus, the bureaucracies are no longer dependent on concrete files and space for storing data. The significance of completing communication via world wide web in 1989, and electronic

mail, which was already mature in 1993. In the other words, the digital transmission was originally dated back in 1906. When tele printers and the telex network was developed in 1930s, the development was fast and furious in the 80s. (Moodie 2016, 9.) It is predicted to be overtaken by quantum computation and communication mentioned by Wiseman (2012).

On the other hand, the digital revolution in one case had proposed libraries to focus on information literacy development for the information age of society (Castells 1996). Anderson (2004) observes the internet enables suppliers to aggregate from the whole world the long tail of demand from customers which has a small demand within any city or region. Thus, information literacy is made available and reachable for everyone.

This all was presented by Bush in 1945 when he suggests that a future device for individual use, a sort of library like mechanical and private thing. The device was given a name 'memex' which is a device where an individual could insert and store all forms of information. All these are mechanized so that it may be consulted with exceeding speed and flexibility – to supplement his memory capacity. (Bush 1945)

Artificial intelligence

The two approaches which are ITS and ILEs, to project possibilities for artificial intelligence and knowledge-based systems in education. The diversity of application of AI in education is profoundly interesting objects of two different aspects proposing the fact that ILEs is completely student-controlled and the other tutor-controlled ITS whereas teachers play a role of a guide in the field. (MacArthur, Lewis., and Bishary 2005).

Throughout the time, educators have looked to educational technology to increase productivity of students and teachers in a straightforward way. Past technologies including CAI systems and most ITS, have already offered such set of tools for educational uses, it is to be noted that most of the applications only changed the way the content is delivered. It is to be predicted that AI applications may follow the previous route, however in the future new information 9 technologies are redefining how professionals do their jobs and what are those jobs. (MacArthur, Lewis and Bishary. 2005.)

While implementations required when integrating ITSs in classrooms as well as ILEs for reaching out new goals and methods deliverable. Proportionally it requires more effort, as technology continues to transform the methods for learning and teaching. These tasks are mentioned by MacArthur, Lewis and Bishary (2005): -

The demand of new curricula –

New methods and instruments as well as for assessing the outcomes

New teaching practices and professional standards

Continues training for teachers

Similarly, the main point is that artificial intelligence and knowledge-based systems neither support 'instructionist' or 'constructionist' views of teaching. Future mixed-initiative technologies will be predicted to strongly control the learning interaction. Regardless of how rigid the procedures of drill-and-practice or lectures are; AI will expand to represent models of subtle reasoning skills. The final destination for AI is not to replace teachers and peers in the classroom but more likely to change their roles. (MacArthur, Lewis and Bishary. 2005.)

Artificial intelligence, has the potential to enhance online learning, adaptive learning software, and research processes in ways that more intuitively respond to and engage with the students.

The MOOCs society

There will always be new disruptive threats emerging. Education institutions need to be aware of any disruptive threats and must be able to respond to those threats successfully. It is possible to assess those threats in just three steps (Christensen & Armstrong, 1998) [18]. First step is to ask the right questions about the importance of disruptive approaches to their institution. A second step is to draw a trajectories map as sample depicted in Figure 1. By looking at the trajectory map, it is possible to judge the quality and content of disruptive programs in an institution.

Third and final step, administrators of the institution need face decide if disruptive technology is beginning to penetrate the mainstream market, would they be willing to kill their own existing programs with disruptive programs of our own or should others kill their programs?

Changes are bound to take place. How and when those changes will take place is still unknown. The best is for the changes to be initiated through internal forces rather than through external pressure from competitors. As one of the best example, Harvard University, doesn't derive its world-leading reputation from endowment or gifted faculty but through its tradition of change (Christensen & Eyring, 2012) [18]. That tradition of change is what other institution should emulate.

MOOCs are shortened from Massive Opening Online Course, which is standing for unlimited participation and open access via the web worldwide. It was first introduced as a platform for students who are learning from distance and in which the pedagogical material is planned and prepared by educational institutions, who also offer licensed courses for completions. (Kaplan Andreas M., Haenlein M. 2016) [1].

The MOOCs are having this special mission of expanding access to education worldwide, also pursuing the innovation of educating people online along with their partners. (President Rafael Reif. MITx on edX (MOOCs)) However, the scepticisms of whether MOOCs are leading to educational changes or misleading people purchasing courses that are near-impossible to fail and that are said to be correspondence colleges. (Shea, Michael. 2015).

10 However, there are some future brightening offerings about online courses. Daphne Koller, who formed the Coursera is aiming for an education, that is the best quality to the number of people possible. With the best instructors at the best universities, are completely free. Online courses have made many opportunities for people who had not have the chance to afford it. (Koller 2012)

Disruptive Education Technologies Poised to Change Higher Learning

Digital technology disrupted our everyday lives and now it's coming for Higher Education. The most promising innovations aren't mainstream yet. But they will revolutionize the very fabric of learning. They will not only change education contents and the student experience. They will also influence student attraction and student retention. Things are about to get *very* interesting. These are four disruptive digital technologies poised to disrupt higher learning.

1. Virtual Reality (VR)

So far VR is about gaming and entertainment. But it combines the best of in-person and online education in an immersive experience.This is a *very* realistic and cheap way to visit unthinkable scenarios. Think the inside of a star, the mechanisms of a complex machine or the streets of a lost city.

For example Microsoft's Hololens is already being used by medicine schools. It allows students to visualize the *functioning* human body in 3D.

Apps like VRChat are also being used to teach virtual classes.

For now the penetration of these tools in Higher Education is still low. Even in the US, the birth ground of these technologies, few classrooms have VR tools.

But this will soon change. Some forward-thinking universities are already experimenting with this technology. Click here to read an interview with Georgia State University academics on the potential of VR for Higher Education.

Fig 1: A GSU teacher guides students on a virtual tour of Rome.

2. Collaboration Platforms

Videos, presentations and forums integrate education materials from different sources in different formats. This makes learning easier and social.

As a result these platforms are fueling collaboration among Higher Education centers.

Education and innovation consortium NMC's 2015 Higher Education report points to this trend. A growing number of institutions collaborating in technology, research and shared values.

Fig 2

They do this by forming local and international strategic alliances and consortia. But these partnerships have to be relevant and beneficial for all participants.

The report mentions Open Cloud Consortium (OCC) as a successful example of this. This entity enables professors and researchers to share vast amounts of data.

An NMC report shows a growing number of universities forging collaborative strategic alliances

The departments at the university are in constant consultation, and the head of the faculty monitors changes in workload and evaluates its impact, while the staff discusses concerning workloads and reports any difficulties and variations.

This faces deans and academic directors with important challenges. On one hand collaboration is key for benefitting students trough innovation. And at the same time they need to collaborate to nurture local academic ecosystems.

The internet is the great facilitator of collaboration in Higher Education. The reason? It eliminates geographic boundaries hindering local and international collaboration between students and teachers.

They aren't mainstream yet, but several platforms are making student collaboration easier:

That is why the workload of teachers is constantly revised and recorded to ensure that the staff is neither over nor underworked. It is important for universities to run curriculum and syllabi consultation processes with permanent and non-permanent faculty members, to assess both the student and the teacher's workload.

The Higher Education Funding Council for England funded a study on improving managing academic workloads. They concluded that consensual agreed initiatives improve the process both for the academic staff and the heads of school in several ways:

- Google Docs enables remote document creation, commenting and revision
- ePals creates a global classroom for learning
- Emaze is a collaborative platform for creating presentations
- Wikispaces, Genius, ChalkUp and Google Hangouts are other examples

3. Augmented Reality (AR)

AR also has enormous potential to inject value in the educational process. It uses mobile devices to add a layer of information to physical reality.

The Google Glass are the perfect example of how AR works. Let's suppose you walk into a store. These glasses will show you product info "layered on" the item you're seeing. Like it's "floating" above it.

Fig 3

This gadget didn't have commercial success due to privacy and development issues. But Pokemon Go made the potential of AR crystal clear.
In the classroom AR lets you scan an equation and find possible solutions or tutorials. Museums and historical exhibitions use it to enhance their exhibition experience.

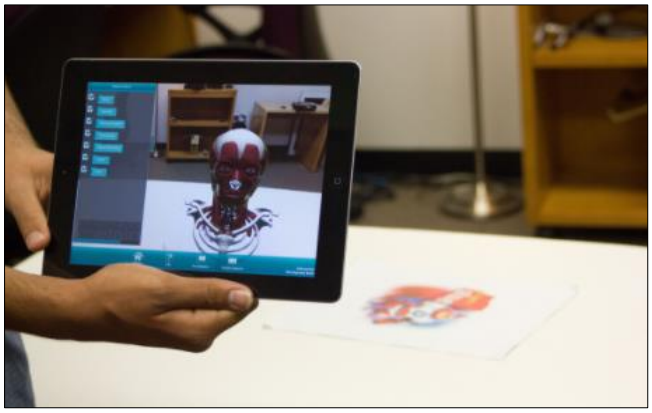

Fig 4

The great part is you don't need to spend big on equipment. All you need is a mobile device like a smartphone or tablet.
This is why many researchers are betting on AR to drive learning.

4. Artificial Intelligence (AI)
Do you know Jill Watson? She's an assistant professor at Georgia Tech, answering student's questions and emailing reminders.
Few of them know Jill is an artificial intelligence.
Some say IBM is behind it but it's not clear. In any case NMC says AI will revolutionize Higher Education.
In fact it's already making headway in the learning industry.
Some computer systems are already doing personalized tutoring. They can also moderate discussions and alter context to stimulate learning.
AI uses algorithms to personalize the student experience. In fact, *it learns your way of learning*. At the same time it generates data to analyze the needs of individual students and the classroom as a whole.
As AI gets smarter and more intuitive it will start complementing human educators. One day it will be able to teach and interact with students.
This opens fascinating possibilities about how we learn and teach.

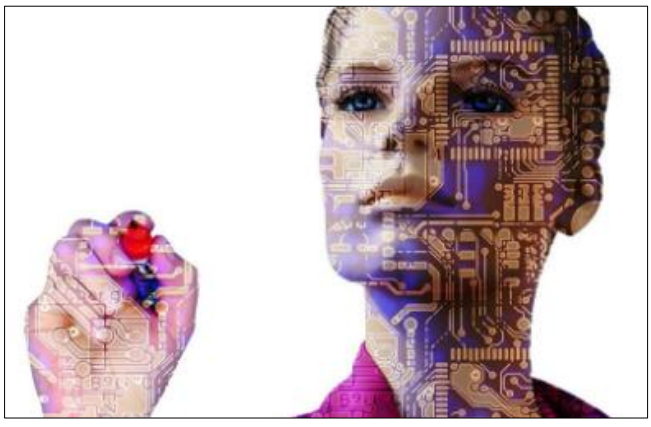

Fig 5

A 2016 study by British education company Pearson identifies two AI applications that will have massive impact on education.
Pearson predicts AI will give students instant feedback on their learning process. But there's more. It will also assess their level of knowledge and even their mood. This will end the need to interrupt learning to take standardized tests.
Very soon including AI in academic curricula will be key to attract and keep students.
But the most fascinating prediction is the rise of "lifelong learning companions".
This virtual tutor will make questions, offer suggestions and curate educational resources. It will also counsel and encourage students when they run into difficulties.
In time this companion will "learn" what you know, what interests you and how you learn. All your data –*your* data– will be in the cloud and follow your process from kinder to postgraduate ed and beyond.
For now nothing can replace human interaction in the learning experience. But soon including AI in academic curricula will affect student attraction and student retention in higher education.
Research and Markets says AI will grow 48% in the next four years. The WEF predicts automation will kill five million jobs worldwide by 2020.
This means universities *already* need to update their curricula around AI competences.

Conclusion
It is important to recognize the nature of disruptive innovation in education. According to the person who developed the theory of disruptive innovation, professor Clayton Christensen, "...disruption are now occurring in the world of education..." (Lagace, 2008, p. 1) and "...school as they are now...cannot do it..' (Trotter, 2008, p. 1) [20]. Furthermore, school should "... create the new architecture for the curriculum in a new space..." so that "...the school can truly transform itself..." (Trotter, 2008, p. 4) [20]. Thus, a challenge for educators and researchers is to always observe and identify innovation or invention that might disrupt the education landscape. Latin America has a long way to go when it comes to innovating with technology for education. The good news is that many of these disruptive technology will be within anyone's reach in the short- to mid- term. Soon it will no longer necessary to be an elite university or academy to get ahead of the curve. But the time to innovate and create relevant educational offers *now*

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