Technology Foresight In The Virtual Learning Environment in Malaysia

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Abstract. The government has adopted the Virtual Learning Environment (VLE) into the primary and secondary education system via the 1BestariNet project. Since this project is expected to consume more than RM 4 billion, it is vital to do technology foresight to identify the emerging technologies which can be integrated to the VLE system. Besides, the emerging technologies must also be ranked accordingly so that the government can be made aware from the most practical technologies to the least for future study or procurement processes. This will indirectly help to identify technologies which are becoming obsolete or not relevant in the digital education field. This will certainly help the government to budget wisely and avoid any wastage or ill-spending.

Keywords— Virtual Learning Environment (VLE), Virtual Learning Classroom (VLC) 1BestariNet, emerging technologies, Delphi-ranking method.

1. Introduction

Malaysia is moving ahead by setting targets for the year 2050 through the National Transformation Plan 2050. The vision is crucial for the nation as it paves the way for new visions in order to make Malaysia as a robust and resilient country. The future education system needs to be build based on holistic approach. Today’s technological progress has made it possible by connecting all the stakeholders for children’s education without a time limit or geographical barrier. A structured and well-planned technology monitoring system needs to be established in order to support the nation to make strategic decisions. Digital learning experience is the new trend which is being used in schools around the world. By introducing Virtual Learning Environment (VLE) or Virtual Learning Classroom (VLC) to the school children, the stakeholders such as the student, teachers, parents, school authorities and education ministry can connect together in a single digital platform remotely. Reports, programmes, emails and learning modules are uploaded to VLE system and integrated for easy access. This unified communication system enables optimum information sharing and communications among the stakeholders with minimum cost [1].

The Malaysian Ministry of Education (MOE) launched a cloud-based education platform in the year 2011. The project was known as the 1BestariNet (1Bestari) aimed to equip 10,000 primary and secondary schools in Malaysia with 4G internet connectivity. Besides, a unified VLE platform which was known as the Frog VLE was also made available for the students [2]. By preparing necessary infrastructure and competent human capital, MOE planned to establish a whole new teaching and learning experience for the school children in tandem with developed countries. The 1BestariNet in Malaysia has been implemented for seven years without any technology foresight initiative. The project
which was divided into three phases has been running for the past 7 years and has consumed more than RM663 million. According to the original blueprint, the government needs to budget RM3.802 billion for the phase 2 and phase 3 which will complete in the year 2026. Thus, upon completing all the three phases of 1BestariNet, the nation will witness the full transformation of digital learning system besides being one of the biggest digital education projects in Malaysia.

Throughout the implementation of the programme, it is necessary for the government to review the blueprint as much as possible. This is because the original blueprint established in the year 2010 might not include the latest technologies invented at least for the past 3 years. Besides, as the modern technologies might disrupt the older ones, Malaysia needs to be careful in doing procurements as the cost for changing the classroom concept from the “chalk and talk” to “digital and virtual” is very high. The government needs to do thorough technology foresight to anticipate future educational technologies which can be merged with the current VLE so that our children can be exposed to the current education system in tandem with global trends. This research could help the government to foresight the next generation of VLE in Malaysia. By identifying the emerging technologies, the government could plan to invest smartly and remain confident that the procurements will remain significant and relevant for another few years. Any technologies which identified as becoming obsolete can also be identified and avoided for procurement. This will certainly help the government to budget wisely and avoid any wastage or ill-spending. Creative teaching methods can be introduced by integrating various technologies for the students to learn according to their pace and skills. Since there had been never a foresight research done in educational technologies in regard to VLE, this study is aimed to foresight the emerging technologies which can be merged with VLE in the public primary and secondary schools.

2. Technology Foresight

Technology foresight brings multiple meaning. Ben Martin’s famous definition for technology foresight is “the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefits” [3]. The term technology foresight has long been used to describe structured approach for setting priorities technology resource allocation. [4]. The objective of technology foresight is to bring together expectations of diverse actors of a technology and establish for future development. There are various options to choose to foresight emerging technologies, thus, choosing the wrong method might not give desired nor accurate analysis result. Technology Foresight analysis (TFA) is used as the method to foresight buyer’s acceptance rate for any new technological products [5]. Besides the corporate sectors, it is necessary for the government to adopt TFA to assess any new policy, product or services before being introduced to the public. This process is vital because some technological products may give big scale impact to the external environment especially in economy, social, legal and environment. As it carries big impact, various nations have setup foresight division at the national level to scan for emerging technologies which will influence the national landscape [6]. Saritas [7]mentioned that foresight is a process which involves four (4) main stakeholders which are scientific researchers, civil society, private sectors and public policymakers. The roles of the experts participating in any forecasting effort are to gather and analyse relevant information, stimulate new ideas of the future possibilities and suggestion practical actions as a way forward to materialise the bright sides of forecasted ideas. Mishra, Deshmukh & Vrat [8] suggested that the characteristics of any technology need to be rated by the subject matter experts along with a list of assessing methods. Bakouros [9] proposed seven (7) steps methodology to find areas for improvement which are work Team Establishment, Selection or Rejection, Identification of Area for additional information, Comparison of new information, Assessment, Terminate or Proceed and Detailed Evaluation.

2.1. E-Learning: Virtual Learning Environment

The e-learning is an innovative approach method introduced to enhance the efficiency of learning and teaching by using electronic information. Besides, it is also an approach to learn particular content or information by using the Internet [9]. Shee & Wang [10] explained that e-learning can come in various forms such as virtual classrooms learning, digital collaboration learning, course-learning, web-based learning and online learning. Goodyear [11] in his article The VLE also is a virtual space with explicit
educational information space ranging from text model to 3D immersive virtual mediums to enrich classroom activities in real time. By incorporating multiple pedagogical and heterogeneous technologies approaches, students could experience overlapping environments between the physical and digital space. This enables the students to become active and able to co-construct the virtual space by themselves. The National Education Technology Plan [12] highlighted that a flexible and robust learning environment is vital to materialise technological applications in the schools. The report mentioned that efficient educational technology can only be diffused in school when a number criteria are met such as ubiquitous connectivity, high-quality digital learning content and powerful learning devices.

2.2 Virtual Learning Environment in Malaysia
Since the year 1972, Malaysia has been looking into initiatives to develop e-learning platform and models for the school children. The first step to materialise the aspiration was when the Ministry of Education (MOE) established Educational Technology Division. The division worked in tandem with various government agencies and corporate companies to build the necessary infrastructure and modules in order to prepare the school children in tandem with other students in the developed countries. The government has allocated millions in the budget every year to make sure the development of e-learning in public school progress smoothly [13]. The MOE introduced the application of Information Communication and Technology (ICT) in schools via SchoolNet project. Through this project, the government equipped all the schools with basic ICT infrastructure such computers, printers, educational CDs and other learning materials. Since the internet infrastructures were not made available in the schools, SchoolNet remained as education initiative [14]. The big leap in the education sector came in the year 2011 when MOE introduced the 1BestariNet Service Portal (1BestariNet). As a continuation of SchoolNet project, the new initiative made the breakthrough by allowing the students, teachers, parents and the education authorities to be grouped in a single online digital platform called Frog Virtual Learning Environment (Frog VLE). The 4G enabled platform was set to promote the students to innovate, learn and share materials such as education modules, videos and applications throughout the nation at ease [15]. The 1BestariNet project is an ambitious project to connect six million school children from 10,000 schools all over Malaysia to the high-speed 4G Frog VLE. The project was awarded to YTL Communications through the FrogAsia company and the platform configuration was done as shown as the Figure 1. Additionally, MOE has also introduced many ICT programmes such as Computer in Education and Computer Literacy Project to encourage the usage of computer in the classrooms. Kaur & Hussein [16] have reported that teachers’ inadequacy to master the usage of VLE has contributed negatively to the effectiveness of the system. Their research on a Frog VLE Champion School revealed many teachers does not have adequate skills nor readiness to access the Frog VLE system. The situation was observed critical because the school was directly trained and monitored by FrogAsia. The study found that teacher’s attitude towards the training given does not determine the success of VLE. However, the duration of training, teachers’ focus to prepare the students for public examinations, inefficient internet access and high consumption of time to prepare the digital online material are the factors which contribute negatively towards the success of Frog VLE in the schools.

3. Delphi Method
The Delphi method is used in this research by interrogating a group of experts by acquiring data or feedback on a particular subject. With that, a total of 15 experts from various bodies, such as the government agencies, non-governmental organizations, corporate companies, teachers and researchers were selected. For this research, experts were selected based on a number of criteria such as knowledge and experience in the educational technology or emerging technologies, years of experience in the related field, availability and readiness to participate in the research. The questionnaires were circulated to the experts individually and they were asked to list the emerging technologies in regard to VLE. The brainstorming phase in the ranking type Delphi method was used and known as the first round which requires the experts to respond to question. The experts were asked to list out as many technologies which might be suitable to be integrated with current VLE system in Malaysia. The ranking phase was the final phase where the experts were expected to do the ranking on the items and reach consensus.
4. Result and discussion
The data which was obtained from 15 experts were gathered and analyzed.

4.1 Delphi process: Round 1
The experts collectively suggested 20 emerging technologies which could be integrated into the current VLE system. From the total list, five technologies were already existed and commonly being used by the students. Nevertheless, the experts feel the potential and further development of the technology will play a significant role in the coming 10 years. The 20 technologies which have potential to be implemented in the schools are as follows;

4.1.1 Open content
Open content has become a common technology which enables people from the virtual community to contribute to improving and redistributing content which is produced without any interest on an immediate monetary reward. Open contents such as blogs, online discussion forums, online references, websites, digital books and other open educational sources on the internet help the students to collaborate and comprehend any area of interest.

4.1.2 Cloud computing
The Frog VLE is a cloud computing service which is being used by the government schools nationwide. This technology is ranked second next to open content as it involves monetary implication. Nevertheless, the potential of cloud computing is huge because another type of technologies could be merged to the cloud computing. Experts believe the Frog VLE service could be further expanded to disseminate and retrieve a huge amount of data as it has been readily being used by the school community today. Examination, marks analysis, characters assessments and much more can be done using the cloud computing in the future.

4.1.3 Coding
The experts feel that the skill need to be learned by the students from the early age and this can be done by merging coding subject to the Frog VLE. Learning to code has become vital because research has shown that a new type of digital divide which has emerged is the disparity between the students which use the technology to build, explore, collaborate, build and design technology and those who use the technology only to consume media passively [17]. Thus, in order to bridge the gap, coding is suggested as one the ways for the children to learn and get used in the next coming years.

4.1.4 Electronic books
The electronic book or e-book is industry worth billions of dollars. China has recorded e-book sales of RM6.7 billion whereas Japan has recorded sales of RM2.3 billion in the year 2011. Korea, on the other hand, records annual sales of RM8 billion since the year 2007. In tandem with that, experts feel that this industry will flourish in Malaysia as more children have access to the internet and devices. Experts expressed their opinion that laptops or tablets will be distributed in stages so that the school children could access the reading materials even after school time. This facility was opinionated to be merged to Frog VLE so that children could have vast array of access to digital books for reading.

4.1.5 Mobile computing
Mobile computing is a common term used to refer to various devices to access digital data from any location. The mobile devices could be smartphones, laptops, tablets, wearable computers or any similar future devices. Although the device is just a precursor, the important aspect of mobile computing is the connection of the devices to the internet via local area network (LAN) or wireless local area network (WLAN). With the government’s effort to provide VLE to the schools, the children need ways to utilise the facility remotely after the school time. Considering Malaysia as a developing country, many children might not have the privilege of owning the device due to their family financial situation. Thus, experts feel that research and development which is done to curb such problem will hugely benefit the children. The government has pledged to finance YTL comm to disseminate Google Chromebook (laptop) to all
the 10000 schools where each school will receive 41 laptops. This number is still insufficient to make sure all the students to have the remote devices to access the Frog VLE.

4.1.6. Visual data analysis

Visual data analysis is defined as advanced computational methods with sophisticated graphics engines to tap the extraordinary ability of the human to see patterns and structure in even the most complex visual presentations. Experts believe that this approach will be widely used in the schools not only by the teachers for teaching or analysis purposes but also by the students to present their findings or information. By introducing the techniques to the teachers, students will also slowly expose to visual data analysis before applying it in their assignments and school works. Students will know the suitable software to use to extract digital information and summarise into an infographic. Experts admit that this skill is crucial to prepare the students for the future workforce.

4.1.7. Analytic technologies

Experts also anticipate that analytic technologies especially the software will flood the market. Students will be thought to retrieve data and do analysis using software so that they can learn about identifying trends, relationship and patterns. This can be then used to train the children to do strategic prediction from various angles. Experts believe this skill will be in demand in the future job market and the education system will be forced to adopt this skill to be taught to the school children.

4.1.8. Gesture-based computing

Gesture-based computing technology has huge potentials to be integrated into the VLE concept and we are already moving towards it. The mobile devices have been shifted from using the clicks on the keyboards to swiping and tapping on the screen. This technological shift has been further enhanced by companies by producing Nintendo Wii and Microsoft Kinect system which uses arms and body movements as input. This technology enables students to engage in virtual activities using body movements similar to the real world. This will be a unique approach for the students to control software programs which dedicated for teaching and learning purposes. Gamification concept could also adopt gesture-based computing to encourage the children to gain knowledge in fun way. Besides, physically challenged children will also benefit from this technology. Sign language recognition, rehabilitation therapies, assistive options and simulations can be programmed in gesture-based computing to help the needy. Thus, this attribute complements well with VLE concept.

4.1.9. Artificial intelligence

Artificial intelligence has become one of the crucial technologies which focus on creating intelligent machines which can think, work and react like humans. This advanced technology can be used in developing adaptive learning, games and software programmes for educational purposes. The technology could assess children for weak areas which they have not mastered and run suitable training or modules for them to learn. Teachers, on the other hand, can take the role as a guide or coach whereas the technology tutors the students. Other than that, teachers and the school authorities could use the data gathered by artificial intelligence to monitor students’ progress, interests, weaknesses and future planning. Artificial intelligence also could compile and suggest ways of mitigating challenges in educating the children. It can suggest the best approach to guide any student provided it had enough time to gather the information about the student digitally.

4.1.10 Biometric technologies

The physiological characteristic includes fingerprint, voice, iris or retinal pattern and hand geometry whereas behavioural characteristics are dynamics of signatures and keystrokes. This technology can be used to detect physiological changes which can give information about students’ health, character, behavioural changes and interests. Teachers and school authorities could use this technology to monitor sub-conscious changes on students which might need to be addressed. For example, biometric technologies could detect the arrival (attendance), participation (activeness), health (fit for classroom or outdoor activities) and aggressive behavioural which need to be addressed. This technology might not
be seen as directly involved in educating the children however it monitors the soft aspects and external factors which are also crucial to create a healthy environment for the children.

4.2 Delphi process: Round 2

In round 2, the experts were presented with all the 20 identified technologies in the first round collectively and asked to do ranking from the “most expected technology” to the “least expected”. The experts have ranked the 20 technologies as below:

| Rank | Technologies       | Rank | Technologies                  |
|------|--------------------|------|--------------------------------|
| 1    | Open content       | 11   | Wearable Technologies          |
| 2    | Cloud computing    | 12   | Augmented Reality              |
| 3    | Coding             | 13   | Virtual and Remote Laboratories|
| 4    | Electronic books   | 14   | Internet of Things             |
| 5    | Mobile computing   | 15   | Big Data                       |
| 6    | Robotics           | 16   | Visual data analysis           |
| 7    | Virtual reality    | 17   | Analytics Technologies         |
| 8    | Games/ gamification| 18   | Gesture-based computing        |
| 9    | 3D printing        | 19   | Artificial intelligence        |
| 10   | Drone              | 20   | Biometric technologies         |

Based on the Round 2 Delphi process, technologies which attained at least 50 percentage of vote for any rank were filtered out. The technologies which ranked according to the mean rank were compared to the highest frequency rank with at least 50% consensus among the experts. There are factors which were taken into consideration when the ranking was done by the experts. The factors are the market availability, cost and affordability, suitability and acceptance and infrastructure preparedness.

4.2.1 Market availability

The experts mentioned that they ranked the technologies according to the market availability. For example, the top six technologies (open content, cloud computing, coding, electronic books, mobile computing and robotics) have become common in today’s world but has not being utilised fully in schools. In another word, they call it as the “low hanging fruits” which can be reaped easily compare to the rest of the technologies which still low in terms of market availability. Technologies which ranked seventh until eleventh are the technologies which already available in the market but not common to the national education system. Teaching and learning modules could be established by the authorities to run in pilot schools so that the teachers and students will be exposed. The outcome of the new strategies should be assessed before the new educational technology strategies can be scaled to nationwide. Technologies which ranked from the twelfth to twentieth are the emerging technologies which still young, being developed and enhanced in the market. These technologies still have not utilised by the developed countries fully and the potentials are still unknown. Thus, compared to all the other technologies, these will be adopted into the school system very later.

4.2.2 Cost and affordability

Technologies such as robotics, virtual reality, gamification, 3D printing, drone technologies and wearable technologies require the government to allocate and spend big budgets for asset procurement, infrastructure and training. These technologies and gadgets are not common devices which used in the daily life of the children. For the technologies ranked from twelfth to twenty (augmented reality, virtual and remote laboratories, internet of things, big data, visual data, analytics technologies, gesture-based computing, artificial intelligence and biometric), the government would require spending even more for
research and development. Thus, experts opinionated that the higher the cost to adopt the technology, the lesser the chance for it to hit the government schools in Malaysia.

4.2.3 Suitability and acceptance into the Malaysian education system
Experts mentioned that the government will only adopt a technology if it is found suitable and will be practical for the Malaysian education system. Since Malaysia is a developing country, the social economy level throughout the nation is very different and the divergence in the social class. Besides, any new technology which needs to be introduced to the children will need to be done systematically in stages so that no child will be left out in comprehending the usage of the technology. The experts have ranked the 20 technologies according to the potential level of exposure. The first five technologies are the technologies which are common to the children and it begins to become less common throughout the ranked list in terms of exposure. The aspect is important because the level of exposure is expected to determine the level of acceptance by the students. Besides, the teachers are also required to be trained so that they will be well versed in using the technologies and guiding the students for the betterment.

4.2.4 Infrastructure preparedness
The experts mentioned that the government must ensure the availability of infrastructures before any technology adopted for the education system. For example, the government has invested hugely in setting up infrastructures for the 1BestariNet programme so that all the schools will have accessibility to the 4G internet. However, the Auditor General Report in the year 2013 reported that more than 800 schools failed to be equipped by the facilities due to various reasons such as poor telecommunication signal and no telecommunication signal tower available in the areas. Due to this, the affected schools could not use the Frog VLE platform as the other children and left out from the mainstream digital initiatives. Learning from this, any technology which does not need new infrastructures will be adopted easily to the education system.

5. Conclusion and future recommendation
There are many technologies which could emerge and be destructive in the next few years. So, by implementing foresight techniques and strategic planning, Malaysia’s digital education agenda must always be in tandem with the global educational technology improvements. For that, the government must spearhead initiatives to detect innovation or destructive technologies which may cause significant implication to the local education system. The government must always be clear that education is about educating and preparing the future workforce. Thus, adopting any technology must be done correctly with proper due diligence assessment and cost-benefit analysis. Since this research includes 15 experts, the government or any interested party could further research on this study so that more details could be gathered and used to prepare for the future. Future foresight may not show the exact situation of the future but it can improve preparedness for future developments. Implementation and execution of technological programmes could be done in small scale first before expanding it to larger scale. This can detect the advantages and weaknesses of introducing new technologies to the school children. With the emergence of the new technologies, the teachers must also be prepared to adopt, adapt and accommodate the transition.

Acknowledgments
We would also like to show our gratitude to all the participants (experts) for sharing their pearls of wisdom with us during the implementation of this research, and we would like to thank the “anonymous” reviewers for their so-called insights.

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