Exploring the Teaching and Learning Indicators towards Education 4.0 in MTUN, Malaysia

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***Abstract*—MTUN has been given responsibility for producing skilled TVET workforces in the industrial sectors. Therefore, the education structure in MTUN is gradually making a transition to Education 4.0 to integrate the existing education structure with the discovery of the 4th Industrial Revolution new technologies. The impact of this shift demands changes in the implementation of teaching towards Education 4.0. Teaching towards Education 4.0 is a phenomenon in moving the change of MTUN to a higher level. However, there is an issue of a mismatch of skills between the industry's needs and graduates' quality to face the 4th Industrial Revolution in Malaysia. Therefore, this study explores how to implement Education 4.0 to produce quality and technologically skilled graduates required by the industry. Thus, this study aims to determine the indicators and elements of teaching towards Education 4.0 for Engineering Technology in MTUN. The study involved seven experts in instructional design technology and in Technical Vocational Education and Training (TVET). The interview data collections were analysed using thematic analysis to explain the subject matter of this study. Eight elements were identified to implement teaching towards Education 4.0. These include Industry 4.0 elements, courses design, projects, practical, simulation, educator readiness, up-skilling and re-skilling training, and industrial experience. These elements may be viewed in two mains constructs which are essential to implement in the Engineering Technology programme in MTUN. There are curriculum and educator professional development. Further studies, which take these variables into account will need to be undertaken.**

***Index Terms*—Education 4.0, engineering technology, curriculum, educator professional development.**

I. Introduction

4th Industrial Revolution (4IR) technology rising demands new skills and created new opportunities and challenges for Technical and Vocational Education and Training, TVET institutions. The effects of the revolution lead to changes in work patterns in the industrial manufacturing sectors [1]-[3]. Thus, the work field needs new skills to fit in a new type of work pattern. The primary objective of TVET education is to prepare students to enter the workforce that focuses on various skills to meet industry demand continuously. Also, TVET education aims to enhance education's image and quality to uplift Malaysia towards World Class Education. In that case, what students learn today will possibly become obsolete after they are graduated. It is a challenge for educators to prepare students to enter rapidly changing employment, and it is an alarm call for educators to schedule themselves first [4], [5]. Educators need to equip students with the ability to transform the skills that students possess to fit in new work pattern demands. Teaching and Learning (T&L) in TVET institutions should be improvised due to the rapidly changing work patterns.

Based on the Eleventh Malaysia Plan (11MP), the government has transformed an education system that focuses on four areas, which are improving the labour market efficiency to boost economic growth, transforming TVET to meet industry demand, strengthening lifelong learning to enhance skills, and system quality education for better student understanding and industry excellence. Transforming TVET in this era of 4IR is challenging because there are challenges that need to be overcome. TVET is positioned to create talented human capital with updated skills demanded by Industry 4.0. The higher institution of TVET is known as Malaysia Technical University Network (MTUN). MTUN is a combination of 4 technical-based universities, Universiti Tun Hussein Onn Malaysia (UTHM), Universiti Teknikal Malaysia Melaka (UTeM), Universiti Malaysia Pahang (UMP) and Universiti Malaysia Perlis (UniMAP). Its mission is to develop highly competent technical for human capital to support the nation's sustainable development and competitive edge through synergistic and strategic ties with industries [6]. The government has implemented various initiatives to improve education quality and effectiveness to help educational institutions move towards Education 4.0. As reported in many papers, the response to the Education 4.0 has necessitated a rethinking of traditional practices [7]-[12]. It required the adoption of a new reformation of education towards the Education 4.0 vision. This paper is structured in few sections. In section 2, the researchers explained the issues to reform current education towards Education 4.0 followed by the summary of related work in section 3. In section 4, the method involved in this study are explained. Next, the results of this study are presented and researchers have drawn some correlations in the discussion. Lastly, researchers provided a conclusion based on the outcomes of this study.

II. The Issues to Reform Current Education towards Education 4.0

The main issue outlined in this study is the issue of a technological skills mismatch between industry needs and the output of higher education institutions being a significant barrier to 4IR requirements [13]-[15]. This skill mismatch is faced by TVET graduates where they are not equipped with job skills such as problem-solving skills, decision-making

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skills, lifelong learning, and competencies among graduates required by the industry and consequently, they are not ready to work in the sector [16]. A series of skills mismatches will cause unemployment among graduates, and the cause is due to lack of experience, lack of job market information, and lack of employability skills such as communication skills as well as new skills that have not been found to align with future job market demand [17]. Furthermore, the challenges faced by the industry as a result of the revolution are the lack of digital culture and lack of training, and context-based knowledge of Industry 4.0 [7], [18]. All the issues need to be considered and focus on technological-oriented education. The current Teaching and Learning (T&L) model is becoming obsolete and should be tossed out and moving with teaching and learning needs [19], [20]. The gap needs to be close by bridging up a new teaching and learning format with the challenges presented by 4IR. A new structure of education can contribute didactically to industries' needs.

Therefore, this study focuses on discovering significant indicators as a base reference for educators that would be implemented for new teaching and learning format towards Education 4.0. As TVET is considered as the driving force for sustainable labour market demand for industrial sectors. TVET institutions should have a tool to measure how educators comply with standards to train students to be skilled workforces. The finding of this study would be used as a benchmark for educators aligned with standard skills demanded by the 4IR.

III. Related Work

There are ways to transform education according to the principles of 4IR. It seems adaptation of education to the 4IR demands has been new practical concepts in recent years. Education shaped in the context of the 4th Industrial Revolution is known as Education 4.0. Along with time when the revolution becomes mature, the manufacturing environment becomes smart and autonomous that can analyse and handle themselves and the environment autonomously according to their analysis. Students must have hands-on experience with industrial applications while still studying to understand the challenges in implementing Industry 4.0 applications. In this context of study, Engineering Technology students must have knowledge, skills and attitudes in using technologies born from the revolution. What kind of preparation should educators, universities, and industry be prepared? Furthermore, how can the preparation be applied?

A. Preparing the Educators

The role of educators is crucial in preparing students for the world of work. Educators need to equip them with the knowledge, skills, and attitude demanded from the 4IR to be well-equipped workers. It is a challenge that educators can control upon the changes brought by the Fourth Industrial Revolution. Educators should refer to the existing theoretical and empirical data from literature reviews to guess the actions to support students to become highly engaged and independent learners.

B. Transition to New Pedagogy for New Demanded Skill

The rise of digital industrial technologies provoking changes in skills requirement. Students should have new soft skills, hard skills, technical skills, and digital skills [21], [22]. All these skills would be an essential requirement to ensure the employability of working people. According to [13], reformation of education is required to allow future workforces to work in a flexible and digitalised working environment. Students need to have well-developed skills for them to adapt and make sense of this changing phenomena. It seems like an opportunity for educators to consider new ways to adopt innovative approaches to teaching and learning and to re-conceptualise the nature of Engineering Technology programmes.

C. TVET Approach to Meet Education 4.0

MTUN needs to prepare TVET students to utilise technology in their learning experiences. The new teaching and learning approach will impact students' hard skills and softs skills in the future. Technical and Vocational Education and Training or Technical Vocational Education and Training (TVET) is a competency-based dual vocational training system related to industry needs [23]. TVET is an educational stream that provides a highly skilled workforce, i.e. k-worker (knowledge worker), by applying the competencies needed to meet the industry's demands in the 21st century [24]. The provision of the TVET workforce in the industrial sector has become the responsibility of MTUN in producing skilled graduates. Therefore, the education structure in MTUN is increasingly making the transition to Education 4.0 to integrate the existing education structure with the discovery of new technologies born from Industry 4.0. The impact of this shift demands changes in the education sector to Education 4.0. The implementation of teaching towards Education 4.0 is described as a phenomenon in moving the change of higher education institutions in MTUN to a higher level.

IV. Methodology

This study used a qualitative approach using a semi-structured interview. This interview session was conducted through two methods: a face-to-face interview and an online interview using Zoom. The interview involved seven experts in instructional design technology and TVET. The interviews were conducted in Bahasa Malaysia. This study was focused on gathering and analysing data from 7 experts. This research used a qualitative approach using the interview to understand how to implementing teaching towards Education 4.0 for Engineering Technology programme directly from 7 selected experts who have knowledge, understanding and thought for this study. The data were analysed using thematic analysis. This study's data were obtained by an in-depth interview with seven experts from MTUN. Before the face-to-face interview meetings, the researcher previously called and sent an official letter to explain the interview's purpose. The interview protocol was developed from literature review and document analysis based on a review from [25]. The interview protocol consists of a list of semi-structured questions. After the interview, the

results were written in an interview transcript according to the recording's exact words. The data were analysed using thematic analysis.

V. Results

The findings of this study were analysed, and the results have shown eight elements to implement teaching towards Education 4.0. These elements may be viewed in two leading indicators, which are curriculum and educator professional development. Fig. 1 presents an overview of elements that have been classified in their related indicators of teaching towards Education 4.0.

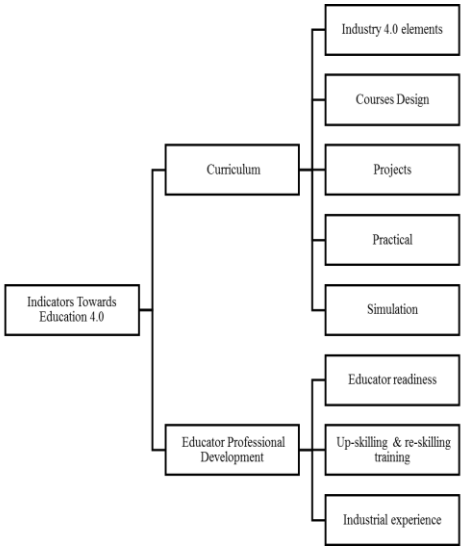

Fig. 1. Indicators and elements of teaching towards education 4.0.

Curriculum

The curriculum is an essential indicator in teaching towards Education 4.0. The elements related to the curriculum indicator are Industry 4.0 elements, courses design, projects, practical and simulations. The results of discussions with the experts found that all the experts agreed that each program should have Industry 4.0 elements embedded in the Engineering Technology courses. One of the experts suggested selecting one or two elements of Industry 4.0 to be embedded in the Engineering Technology courses. It emphasises that educators can deliver lessons aligned with the 4th Industrial revolution.

> "… I'm not mistaken…not later than 2 years ago..maybe in a year or more..that's where in the program there should be an element of 4.0 .. there are subjects that it gives that have something to do with IR4.0..so far that is relevant with the program is that..there is a change in the curriculum where the subject is mapped to IR4.0 ..."

> "…to achieve level 4.0 just now..we looked in terms of the content of the course or the subject just now..right .. so the word 4.0 is not that we provide facilities…provide equipment aaa..towards 4.0. but we see how the content of the course was adapted to element 4.0…"

Next, courses design are elements that need to be emphasised so that the educators can deliver lessons based on the changes that have taken place in the industry sector. Four experts had a consensus on the Engineering Technology courses where the courses should be improvised aligned with the revolution.

> "…most of the courses we offer are more to IR4.0 for example science data, big data,..so there are courses we offer in the form of aaa… IR4.0 .."

> "..so courses or subjects related to analytical data should be given to students .. maybe at the moment it is not very comprehensive in terms of the courses involved, the need to create an analytical data course is important...that is my view…"

The next element is a project. The element involves students psychomotor that encourage students to fully utilise their skills in project coursework. The experts encourage students to propose projects related to the industrial project for their final year assessment. Besides, the experts suggested students learn about programming related to Industry 4.0 as knowledge of troubleshooting.

> "…we get a lot of opinions and views and also from the industry which we also encourage projects based industrial project..just imagine a project like Integrated Design Project so the project involve a lot in the industry…"

> "…there are 6 months of final year projects which are based on projects in the industry…"

> "…programming project..look there are some ambiguous 3..there are 2..3 I put 3..3 programming subjects to make sure he has the basics of programming..ahaa..every student..and that is mandatory…"

Practical is an element that involves a lot of students' psychomotor aspect. Talking about this issue, an expert said students must have skills in operating machines through real touch and needs to be in physical existence in the laboratory. Another expert said practice involves the use of software can and should be delivered online. There were some suggestions that educators need to review on the virtual reality and augmented reality software for the use of T&L in the laboratory.

> "…even if it's virtual, it has to feel..it has to be real .. at the end of the day, when you want a project, you have to do it right..so there are times when virtual reality may be as far as basic, for him to understand what virtual reality can do …."

> "…self-skill and hands-on really need to be offline practical..can't do it online...but if only theoretical learning, it is ok...so practical needs to

be face to face and do it in the lab not swift to online ….”

“...practical learning must be face-to-face in the lab…”

“…the lab can be held as an alternative, for example, people do simulations using software…”

Only a small number of experts indicated that practical learning could be conducted using simulation. Some participants expressed the belief that the simulation learning method needs to be reviewed whether this method can reach the psychomotor level. Another commented that simulation is suitable to apply to courses that use software such as AutoCAD and SolidWORK as well as theoretical courses.

“…the lab, there are several approaches that are used, among them…among them using simulation….”

“...maybe there is a simulator or simulation that we want to do to reach the psychomotor level….”

“…The form of simulation is, for example like a machining process...there is a software website that is given a simulation of how the process takes place, so the lecturer uses the simulation to give exposure to the students…”

Educator Professional Development

The second indicator is educator professional development. It is an indicator that the educators' competencies can be maximised, preferably to educate students to become skilled human capital when they graduate. Therefore, the elements related to the educators' professional development are educator readiness, up-skilling and re-skilling training, and industrial experience. Educators readiness is an element required by educators to willingly share their expertise and conduct teaching with minimum supervision.

“…we have existing staff..new staff who expertise in it..that is the strategy that we will create….”

“…our staffs will enrol on professional certification related to Industry 4.0....not specific but related to Industry 4.0.. that's where the role of the lecturers or the teaching staffs, whose implement their expertise related to 4.0 elements in the course…aaa, and not just show it in the course but we implement…do it practically….”

Plus, educators should attend up-skilling and re-skilling training to improvise their competencies. Talking about this element, an expert said the educators need to attend up-skilling and re-skilling training related to Industry 4.0.

“…go to industrial training and so on so that when she/he comes back, he/she can teach that subject...so it is very important how we design the curriculum…we see the necessary needs in the curriculum….”

“…from time to time lecturers will be given training in series…used for projects such as upskilling..re-skilling..training….”

“…the lecturers attend upskilling..reskilling to improve and improvise their competencies...competencies on handling machine..equipment..software….”

“…We have started sending staffs for training for them to get the certification…staffs must be certified first before they can provide the training to students….”

Despite this, educators who never have industrial experience should be undergoing attachment in the industry for six months to a year. Most of the experts' consensus is that educators must have at least five years of industrial experience to be qualified as Engineering Technology educators.

“…teaching staffs whose do not have industry experience are in a small number in the faculty..we will send them to undergo industrial programs for six months to a year...”

“…lecturers must have five years of experience in the industry …”

“…also encourage staffs to go..aaa..attachment in the industry in certain areas..attachment a year, just now we have sent staffs to make an attachment for a year …”

VI. Discussion

The indicators towards Education 4.0 for Engineering Technology consists of curriculum and educator professional development. Education should have a strategy to reform the curriculum to adapt to market needs. According to [26], the Framing Malaysia Education 4.0 is launched as a remark for the curriculum to be redesigned to meet the demands. Thus, an educational programme must be based on innovative teaching techniques [27]. The result from the interview has shown that the characteristic of Industry 4.0 must be embedded in the Engineering Technology programme. It helps students to be trained on how to use applications of Industry 4.0 technologies. According to [28], three aspects that need to be emphasised to celebrate the arrival of the 4IR are systems and infrastructure, organisational structure, and organisational citizens. In this context, educators are the drivers of change in the education system. The educators' quality will determine the quality of the graduates after they graduate from university to meet the requirements of revolution. Besides, the ministry of education has entrusted

educators to educate students to produce human capital with integrity and competitiveness because they are the generation that will serve the country. In this point of view, educators should attend an up-skilling and re-skilling training related to Industry 4.0 elements as one of the initiatives to strengthen educators competencies as Engineering Technology Educators. Research by [29] states up-skilling and re-skilling workers with industry experts using the train the trainer approach is one of the initiatives to expose workers with new skills and technology to meet the latest skillset. In this context, educators should up-skilling and re-skilling themselves to meet the demand of future students. According to [10], educators should be prepared themselves with digital tools because next-generation students are revolutionised by technology. In this case, educators should be breaking out of their comfort zone by developing their skills and competencies to adapt and utilise technology efficiently [30]. As educators, they should have good character and personality and a high value of competence in terms of professional and social [31] because the impact of educators competence in T&L sessions on student achievement is high [31] then educators should have guidelines in conducting quality T&L to enhance their competencies in line with technological changes and the addition of new information towards Education 4.0.

Educators need to gain exposure to the real-practice situation in the industry. Educators should gradually be looking for opportunities to enrich their self-qualities in line with the industry's needs. This kind of exposure suited the best for those with limited work experience. Educators would get opportunities to learn how the industry works. Interestingly, it would allow the educators to expand their knowledge beyond the written journals and books. Instead, the educators would have chances to share their experience with their students and elevate teaching delivery quality.

VII. Conclusion

The findings of this study provide insight into a need for educators to recognise and implement the outcomes of this study in teaching towards Education 4.0. Educators' self-qualities are key to ensuring students' excellence as a whole. Educators should be equipped with knowledge and skills to handle the advanced 4IR technology so their knowledge and skills could be used to assist students exploring these technologies in T&L. It is crucial needs to break the traditional curriculum to focus on individual's potential development. Students can explore and engage in a dynamic technological environment to develop their individual potential. Therefore, MTUN must provide adequate facilities and equipment for educators and students to utilise effectively. In addition, MTUN should have highly skilled professionals that always fulfill the demand of industries. The highly skilled professionals not only focus on preparing students but also educators. Thus, links between MTUN and industry need to be strengthened for educators to attend up-skilling and re-skilling training to improvise their competencies. The outcomes of this study do not mean to redesign the whole MTUN system but to encourage to change and adopt approaches as new cultures towards Education 4.0.

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Conflict of Interest

We certify that there is no actual or potential conflict of interest in relation to this article).

Author Contribution

All authors have contributed equally to this manuscript. All authors have agreed to the final version

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