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Science Teacher's Knowledge, Understanding and Readiness in Dealing with the Education Transformation of the 4th Industrial Revolution

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The purpose of this study is to identify the level of science teacher's knowledge, understanding and readiness in dealing with the education transformation in the 4th Industrial Revolution (4IR). This study was conducted on 151 secondary school science teachers. Data were analysed by descriptive (mean, percentage & standard deviation) and inference (MANOVA & Pearson Correlation) analysis using Statistical Package for Social Sciences. Descriptive findings indicated that the level of teacher's knowledge, understanding and readiness in dealing with 4IR is at a moderate level. MANOVA analysis found no significant differences in teacher's knowledge, understanding and readiness in terms of gender and teaching experience. Pearson Correlation also found that there was no significant relationship between teaching experience and gender on their level of knowledge, understanding and readiness in dealing with the 4IR. In conclusion, this study proposes that exposures to the 4IR should be made more widely available to ensure that every teacher is able to cope with this increasingly challenging educational transformation.

Key words: *4th Industrial Revolution (4IR), Education 4.0, Science teacher.*

Introduction

The development of the Industrial Revolution 4.0 has had a direct impact on many fields including education; in particular, which is fundamental to the workforce. This is because the Industrial Revolution 4.0 requires a new set of skills. As a result, this training and education

system will grow as we provide industries with skilled workers who can support the growth of today's industry. According to former Higher Education Minister, Datuk Seri Idris Jusoh, the education sector especially higher education institutions (HEIs) in Malaysia need to change the teaching and learning (T&L) processes to meet the challenges of the Industrial Revolution 4.0. These changes include aspects of the learning space, teaching methods, a more dynamic curriculum and the use of the latest technology. This will lead to new methods such as studying without lectures outside of the classroom and no more examination-based assessment (Norman, Nordin, Embi, Zaini, & Ally, 2018).

The changes that result from this Industry 4.0 phenomenon require a highly knowledgeable and highly skilled human resource in order to be competitive. The current human resource are the people that will lead the country in the future. Today's reality shows that human resource development is a major focus of organisations in addressing environmental change. This is closely related to the demands of Industry 4.0 based on computer technology and automation. Human resources need to be exposed to the need to complement their individual capabilities in addressing Industry 4.0 demands. Hasnah et al. (2009) explains that education and human resource development are key to increasing the national competitiveness of each country.

Human resource development policies, especially in education and training, are increasingly important as the Malaysian economy shifts from labour intensive to capital and technology intensive. Therefore, in order to achieve this goal, schools need quality, knowledgeable teachers and those capable of being agents of change for students by helping students to process the knowledge gained to great things (Wesch, 2008). Therefore, the level of knowledge, understanding and readiness of teachers in dealing with educational transformation in the 4th Industrial Revolution needs to be studied first in order to provide educators who are capable of producing a workforce that meets Industry 4.0 demands.

Statement of the Problems

Current educational systems are increasingly exposed to the world of digital technologies such as cloud computing, the internet, and social media with the development of the Industrial Revolution 4.0, until the emergence of the term Education 4.0. Undeniably, the teaching and learning process that takes place in the classroom is the key indicator that can accurately measure a country's future. Malaysian Education Blueprint (2013 - 2025) stated that to meet today's global economic competition, a country's success depends on the knowledge, skills and competencies of its people (Malaysia Ministry of Education, 2013). A teacher's knowledge, understanding and readiness must also align with current economic needs in order to produce a workforce that meets the demands of globalisation today (Razak, Alakrash, & Sahboun, 2018; Nordin & Norman, 2018). However, in the context of this study, the public understanding of the Industrial Revolution 4.0, with no exception among

academics, remain unclear on this matter (UniMAP Bulletin, 2018). A study conducted by Hoedi and Wahyudi (2017) found that the Industrial Revolution 4.0 is a new term and may not be widely known and understood by the public. Anealka (2018) questioned whether educators really understood both the terms of the Industrial Revolution 4.0 (IR4.0) and Education 4.0 or did they just follow what others do. To ensure that the community, especially educators, understand the Industrial Revolution 4.0 and Education 4.0, universities and industries need to play a role in educating and cultivating understanding of IR4.0 and Education 4.0 to ensure that they are ready for the ever-changing world.

It is the responsibility of teachers to diversify their teaching and learning approaches to produce a quality generation (Malaysia Ministry of Education, 2015). This is supported by findings from a study conducted by the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2011) that shows that teachers teach only to meet exam requirements. The teaching and learning process that emphasises the exam focuses on students' ability to recall facts and indirectly influences teachers' teaching patterns to give more facts, memorisation activities and encourages students to think less about the facts learned (Desimone, Smith, & Phillips, 2013). As a result, students do not have the time to develop their talents, abilities and potential in any field as they tend to memorise what their teachers say for the purpose of getting good grades in the examination.

Hussain (2014) stated that teachers prefer and use the methods of lectures and 'drill and practice' to prepare students for the examination. However, even though students have achieved excellent results in examinations as a result of lectures and 'drill and practice' approach it affects the generic skills of students' who are said to be still in lower level (Soh, Osman, Arsad, 2012). In the Industrial Revolution 4.0, just being smart is not enough. A good worker should not only be skilled in his actions and be honest in his words, but also be smart in his emotions. Emotional intelligence is the ability to identify and manage one's own emotions and those of others with three main factors: awareness, networking and emotional control. Emotional intelligence is the key to successful social and professional relationships. In this regard as educators, teachers should be prepared to take steps to improve themselves and to change their teaching and learning approaches as technology advances and their current career needs to meet the demands of a future career workforce.

Dunwill (2016) says that technological advances are constantly changing and consequentially will change the teaching method and the setting in the learning process. Some of the most common changes made by higher institutions include lecturers submitting online grades and assignments, students using software / applications to complete group assignments, students completing their assignments online and uploading them to online classroom portals or learning management systems, high levels of dependency by students on cloud storage to store their work and communication among students, parents, lecturers and administrators

through social media platforms. Dunwill (2016) also predicts how the average classroom will look in the next five to seven years where: a) the layout of the classroom will change immensely; b) virtual and augmented reality will change the educational landscape; c) flexible assignments will accommodate multiple learning styles; and d) MOOCs and other online learning options will impact formal education.

A similar transformation has taken place in higher education in Malaysia. The layout of the classroom is gradually changing from neat rows and chairs to a flexible seating arrangement that allows for individual and collaborative work space. Student assignments are no longer in the form of constructive or selective impressions. Alternative assessments have been introduced to accommodate different learning styles. Portfolios, project papers, demonstrations of skills and rating scales are among the alternative assessment practices today in higher education. In addition to classroom layout changes and assessment types, tertiary education has begun to use Massive Open Online Classrooms (MOOC) and other online learning platforms for teaching and learning. Most MOOCs offered by prestigious academic institutions in Malaysia are free. Students can choose any course they are interested in. Many courses are standalone, allowing students to learn the course anytime, anywhere with the ease of use of the device of their choice. The last prediction by Dunwill (2016) of the 4th Industrial Revolution on education systems are related to the use of Virtual Reality (VR) and Augmented Reality (AR) in teaching and learning which seem new to many educators in higher education in Malaysia. The emergence of user-friendly VR and AR applications has helped educators integrate virtual reality and improvements in their teaching and learning.

The above points require a change in the role of teachers as educators and the need to know the level of knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution. To make a country capable of producing a workforce that meets the demands of the industry, human resources must be prepared first. In preparing this human resource, teachers must first be aware of the changes that are going on around the world and understand the role and approach of teaching and learning that needs to be improved to realise the dream of becoming a competitive country in Industry 4.0. In addition, with the rapid growth of the global economy and industry, educators are encouraged to equip themselves with information and communication technology (ICT) knowledge, thus enabling them to meet the challenges of the Industrial Revolution 4.0. Teachers need to have a clear understanding of the latest technology, especially to enhance teaching and learning sessions in the classroom (Berita Harian, 2018). Teachers must also be prepared with a wide range of skills and an ability thinking ahead. Thus, to respond to the government's call and move in line with the education revolution of the Industrial Revolution 4.0, this study will focus on the level of knowledge, understanding and readiness of teachers in dealing with the education transformation in the 4th Industrial Revolution, as teachers are the determinants of the

effectiveness of educational change. Teachers who are not ready for innovation will face problems and be a burden to teachers in implementing educational paradigm change.

Research Objective

Specifically, the objectives of this study are to;

i. to examine the level of teacher's knowledge, understanding and readiness in dealing with the Industrial Revolution 4.0 and Education 4.0.
ii. to examine the differences in the level of teacher's knowledge, understanding and readiness in dealing with education transformation in the Industrial Revolution 4.0 by gender and teaching experience.
iii. to examine the relationship between the level of teacher's knowledge, understanding and readiness in dealing with education transformation in the Industrial Revolution 4.0 by gender and teaching experience.

Industrial Revolution and the Current Needs

The first-generation revolution brought history when man and animal were replaced by the emergence of machines. The first revolution began in Britain. In the late 18th century, machines were invented to simplify human labour and increase productivity. The Industrial Revolution 1.0 was marked by the creation of engines using steam engine power (Schwab, 2016). This was followed by the wave of the Industrial Revolution 2.0 that began in the mid-19th century with the introduction of electricity use. The use of electricity has led to several new inventions such as telephones, radio waves transmitters and car inventions. The discovery of the emergence of power plants and combustion engines triggered the emergence of high-tech devices such as phones, cars, aircraft and other heavy machinery that significantly changed the face of the world (Saucedo et al., 2018). The Industrial Revolution 3.0, however, occurred during the mid-20th century. This third wave of the Industrial Revolution is also known as the digital age. The Industrial Revolution 3.0 occurred with the advent of computers and the Internet. Communication and information technologies are evolving, and data is one of the key assets. The digital age is booming with everything we can see today. In addition to the development of digital systems and computer technology, the engineering field has also expanded with various inventions such as robots and other automation systems. In this era, most people still control machines.

The so-called fourth Industrial Revolution involves cyber-physical systems (CPSs) taking over much of the work currently being done around the world (Gleason, 2018). The fourth Industrial Revolution (4IR) or Industry 4.0 is the transition from the digital age to the physical era of the 21st century. The revolution takes place with the advent of

supercomputers, smart robots, driverless vehicles, genetic modifications and the development of neurotechnology that enable humans to further optimise brain function (Guangli et al., 2018; Ciolacu et al., 2018; Fuchs, 2018). In Industry 4.0, all human everyday tasks will be shared with robots designed specifically to optimise human needs and comfort (Sousa et al., 2018). Although these technologies are still in the global testing phase, many applications that have been used today are the result of the Industrial Revolution 4.0. Uber and Grab are a small example of how cyber technology has affected taxi drivers in the country.

In terms of education, the Industrial Revolution 4.0 will see more and more use of laptops in schools. Hologram technology, social media and artificial intelligence will also be key aspects of teaching aids. Perhaps in the future, students can only study at home because the lecture is presented in video form (Salleh, 2017). The Industrial Revolution 4.0 also led to the emergence of the term Education 4.0. According to Campanella (2018) in today's rapidly changing world of work, the jobs in most demand in the future will be data scientists, application developers, or cloud computing specialists, one of the few jobs that never existed five or ten years ago.

Therefore, it is undeniable that the development of Industry 4.0 will impact the country's education system to provide the workforce of the future. Head of Education Specialist, Francisco Marmolejo (Berita Harian, 2017) said the global higher education system will undergo changes based on the Industrial Revolution 4.0. The concept of transhumanism is linked to Industry 4.0, where the era of artificial intelligence and human skills was carried out by robots using the enhanced Artificial Intelligence (AI) technology. Accordingly, the emergence of the cyber-physical system that is hitting the world will result in 60 per cent of existing jobs, disappearing by 2050 (Datuk Seri Idris Jusoh, Minister of Higher Education (Berita Harian, 2017). As the Digital Era to the Cyber Age, the new field will dominate the world and will focus more on the dominant areas emphasised in Industry 4.0, mostly focused on Science, Technology, Engineering and Mathematics (STEM). Are the levels of teacher's knowledge, understanding and readiness important agents in dealing with education transformation in the 4th Industrial Revolution? Are they already at a satisfactory level?

In line with the wave of the Industrial Revolution 4.0, the future generation must be knowledgeable and highly skilled in dealing and coping with the increasingly complex technology challenges. STEM education is therefore a platform to formally integrate the core fields of Science, Technology, Engineering and Mathematics. It connects students with every challenge of the Industrial Revolution 4.0. Efforts to make STEM an area of specialisation must begin from early childhood to the tertiary level. The interest and enthusiasm for STEM among students needs to be nurtured consistently to promote better discipline of science. In fact, community and industry involvement is also needed to ensure this important agenda is successful. The challenges of the Industrial Revolution 4.0 need to be aligned with education.

Technological innovation is becoming more sophisticated and the job offer perspective is different from the existing one. By having students master STEM well, it becomes a first step in addressing the challenges of the Industrial Revolution 4.0. The gap between STEM and the Industrial Revolution 4.0 needs to be bridged. As such, the transdisciplinary element in STEM needs to be strengthened through the proactive role of educators not limited to the classroom only. Initiatives to promote the importance of STEM and awareness of the importance of the Industrial Revolution 4.0 should also be intensified to prevent future generations from falling behind; with rapid changes in technology. Mastering STEM and science in particular, helps to prepare the next generation to meet the needs of the Industrial Revolution 4.0. Therefore, this study was conducted to identify the level of knowledge, understanding and readiness of teachers in dealing with the education transformation of the 4th Industrial Revolution.

Research Methods

Research design

This study was designed quantitatively using a survey method and by randomly conducting surveys of Science teachers in the Kuantan district.

Population and study sample

This study was conducted on Science teachers in secondary schools in the Kuantan district, Pahang. To obtain the total number of samples used in this study, the Krejcie and Morgan's sample size determination table was utilised (Krejcie & Morgan, 1970). The population of government secondary school science teachers in the Kuantan district is 344 with a breakdown of 143 core Science teachers, 53 physics teachers, 78 chemistry teachers and 70 Biology teachers. According to the sample size by Krejcie and Morgan (1970), a total of 181 Science teachers in the Kuantan area will be involved in this study. However, during the questionnaire retrieval process, only 151 questionnaires were received with a response rate of 83.4%.

Research instruments

The instrument for this study was the questionnaire form. The development of the questionnaire involved the three-stage approach. Stage 1 began with identification, definition and scope of knowledge, understanding and readiness in dealing with 4th Industrial Revolution in the research context. Stage 2 involved the writing of individual items within the scales. Finally, stage 3 involved the field-testing items followed by an item analysis and validation procedures.

The questionnaire was divided into four sections, sections A, B, C and D. Section A was the background information of the respondents with 10 items. Part B was the aspects of teacher knowledge of the Industrial Revolution 4.0 and Education 4.0 with 10 items. Part C was the aspects of teachers' understanding of the Industrial Revolution 4.0 and Education 4.0, while Part D was the level of teacher readiness in dealing with educational transformation in the 4th Industrial Revolution which consists of 15 items. A questionnaire with five-point agreement of Likert-type response was distributed to the samples. Scale 1 and scale 2 indicated low level, scale 3 and 4 indicated medium level and scale 5 indicated high level (altogether there were three levels of interpretation of mean score in this study). Data were collected and analysed to test the reliability and validity of the instrument. The questionnaire was validated by a specialist teacher and senior lecturer at a private university as well as a pilot study was conducted in the earlier stages of research.

Thirty science teachers who were not involved in the actual study were used as the sample for the pilot study. This pilot study is intended to test the reliability of a measuring instrument or instrument to be used before distributing it to a real study sample. Cronbach's alpha obtained through analysis using SPSS software was used as a reference to look at instrument reliability. The Cronbach's alpha coefficient was 0.93. According to Chua (2014), the Cronbach's alpha coefficient of 0.65 to 0.95 is satisfactory and indicates that the instrument has an acceptable reliability. This means that the instruments used by the researchers have high reliability and acceptability. After obtaining the data for the pilot study, the questionnaire was administered to other science teachers. Researchers allocated one week for the study sample to respond to the questionnaire distributed. A total of 181 questionnaires was sent to the selected respondents but only 151 of them returned the questionnaire with a satisfactory response rate of 83.4%.

Analysis of data

Using Statistical Package for the Social Science (SPSS) version 22 software, the data were analysed by descriptive and inference. Descriptive analysis was used to obtain mean scores as well as standard deviation values. The interpretation of mean scores used is as in Table 1 below. The range determined is based on the calculation of the formula and as used by Azmi (2016). The formulas used to get a range of levels are as follows:

Range = (Max – Min) / Level of Mean Score = (5 – 1) / 3= 1.33.

Table 1: Mean score interpretation of the level of science teacher's knowledge, understanding and readiness for the 4th Industrial Revolution

Mean score	Interpretation of mean score
1.00 to 2.33	Low
2.34 to 3.66	Medium
3.67 to 5.00	High

In order to see the relationships between variables, inference analysis was also performed. The MANOVA test was performed to see whether there was a difference in the level of knowledge, understanding and readiness in dealing with educational transformation in the 4th Industrial Revolution by gender and a teacher's teaching experience. The independent variables in this study were demographic factors such as gender and teaching experience while the dependent variables were level of knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution. Pearson Correlation Analysis was also conducted to examine the relationship between the level of science teacher's knowledge, understanding and readiness in dealing with the education transformation in the 4th Industrial Revolution by gender and teaching experience. The interpretation of the strength of the relationship as suggest by Cohen (1988, pp.79-81) as; i) small= r=.10 to .29; ii) medium=r=.3 to .49; and iii) large=r=.50 to 1.0.

Findings

Respondents' profile

Table 2: Profile of respondents by gender and teaching experience

Profile		Frequency	Percentage (%)
Gender	Male	21	13.9
	Female	130	86.1
Teaching experience	1-5 years	10	6.7
	6-10 years	47	31.1
	11-15 years	47	31.1
	16-20 years	47	31.1

Table 2 shows the profile of 151 science teachers who answered the questionnaire. In terms of gender, 21 (13.9 percent) were male teachers and the remaining 130 (86.1 percent) were female teachers. In terms of teaching experience, 10 teachers (6.7 percent) had one to five years teaching experience, while 47 teachers (31.1 percent) had teaching experience between six and 10, 11 to 15 and 16 to 20 years.

i) The level of teacher's knowledge, understanding and readiness in dealing with Industrial Revolution 4.0 and Education 4.0.

Table 3: Mean score for the level of teacher's knowledge, understanding and readiness in dealing with 4th Industrial Revolution and Education 4.0

No	Construct	Mean	Standard deviation (Sd)	The level of interpretation of mean score
1	Teacher's Knowledge of the Industrial Revolution 4.0 and Education 4.0.	2.88	.86	Medium
2	Teacher's Understanding of the Industrial Revolution 4.0 and Education 4.0.	3.44	.74	Medium
3	Teacher's Readiness in dealing with education transformation in the Industrial Revolution 4.0.	3.32	.43	Medium
Total		**3.23**	**0.51**	**Medium**

Table 3 shows that the mean value of the first aspect studied was the level of teacher knowledge of the Industrial Revolution 4.0 and Education 4.0 is 2.88. These values indicate that the level of knowledge of science teachers on this aspect is at a moderate level. The second aspect of the teachers' understanding of the Industrial Revolution 4.0 & Education 4.0 is 3.44. These values also indicate that the level of readiness of science teachers is at a moderate level. For the third aspect of science teachers' readiness for the educational transformation of IR4.0, the mean value was 3.32. These values also indicate that teachers are still in the early stages of the educational revolution of the IR4.0. Overall, the level of teachers' knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution is at a moderate level of 3.23 mean score.

ii) The significant difference of teacher's knowledge, understanding and readiness in dealing with education transformation in the Industrial Revolution 4.0 by gender and teaching experience

The MANOVA analysis was conducted to examine the differences in the level of knowledge, understanding and readiness of teachers in dealing with education transformation in the 4th Industrial Revolution based on gender and teaching experience. The variance covariance homogeneity matrix test was first determined before the MANOVA analysis can be proceed,

using Box's M test and Levene test. Tables 4 and 5 show the findings of the Box's M and Levene tests.

Table 4: Box's M test based in gender and teaching experience

Independent variable	**Box's M**	**F-value**	**df1**	**df2**	**p**
Gender	3.076	.48	6	7052.60	.82
Teaching experience	12.59	.81	18	5163.88	.69

df=degree of freedom

Table 5: Levene test based on gender and teaching experience

Independent variable	**Dependent variable**	**F-value**	**df1**	**df2**	**p**
Gender	Knowledge	1.38	1	149	.24
	Understanding	.01	1	149	.94
	Readiness	1.55	1	149	.22
Teaching experience	Knowledge	1.39	3	147	.25
	Understanding	.60	3	147	.61
	Readiness	1.18	3	147	.32

df=degree of freedom

Table 4 shows the results of the Box's M test performed on gender that showed that there were no variants covariance differences between dependent variables and independent variables (F =.48, p =.82) (p>.05). For teacher teaching experience, there was no significant variants covariance difference between dependent variables and independent variables (F =.81, p =.69) (p>.05). This proves that variants and covariates are homogeneous across independent variables; gender and teacher teaching experiences. The results of the Levene test as shown in Table 5 prove that the variance and covariance of all variables are the same. Observed power (p) showed that all variables were significant (p>.05). Thus, all the variables were complying with the conditions for the MANOVA test to be performed (Pallant, 2005).

Table 6: MANOVA analysis to identify differences based on gender and teaching experience

Effect		N	Pillai's Trace	F	df between group	df within group	p
Gender	Male	21	.43	2.23	1	149	.09
	Female	130					
Teaching experience	1-5 years	10	.07	1.13	3	147	.34
	6-10 years	47					
	11-15 years	47					
	16-20 years	47					

Table 6 shows the results of the MANOVA test performed to determine whether there is a significant difference in knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution by gender (with Pillai's Trace = .43, F = 2.23 and p = .09 > .05) and teacher teaching experience (with Pillai's Trace = .07, F = 1.13 and p = .34>.05). The results of the MANOVA test clearly showed that there were no significant differences between the four groups of teacher teaching experiences of 1 to 5 years, 6 to 10 years, 11 to 15 years and 16 to 20 years in terms of knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution and between gender (male and female) as the p-value> .05. This means that there is no significant difference in the level of knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution with gender and teaching experience. Indirectly it can be concluded that gender and teaching experience do not influence the level of knowledge, understanding and readiness of teachers to realise the education transformation in the Industrial Revolution 4.0.

iii) Relationship between the level of knowledge, understanding and teacher's readiness in dealing with education transformation in the Industrial Revolution 4.0 by gender and teaching experience.

Pearson correlation analysis was conducted to examine the relationship between the level of knowledge, understanding and readiness of teachers in dealing with education transformation in the 4th Industrial Revolution based on gender and teaching experience.

Table 7 presents the findings of Pearson's correlation analysis between gender and teaching experience with the level of knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution. For gender variables, the finding that the correlation coefficient for knowledge was r = .07 (probability value (p = .43) was

found to be greater than significant level (p>.05), understanding, r = .11 (probability value (p = .17) was significantly greater than the significant level (p>.05), thus, there were no significant relationship between teacher's knowledge and understanding by gender in dealing with education transformation in the 4th Industrial Revolution. Whereas, in terms of teacher readiness, the correlation value also showed a very low correlation (r =.21), but the probability value of p = .01 was less than significant (p <.05). This is always the case when the sample size is large, as large sample sizes can detect small correlations significantly. Thus, the findings indicate that there is a significant but weak relationship between gender and the level of teacher readiness in dealing with education transformation in the 4th Industrial Revolution. Overall, the findings show that the level of knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution has no significant relationship with the gender of teachers.

Table 7: Pearson correlation analysis between the level of knowledge, understanding and teacher's readiness in dealing with education transformation in the Industrial Revolution 4.0 by gender and teaching experience.

Independent variable	**Dependent variable**	**r**	**p**	**Strength of the relationship**
Gender	Knowledge	.07	.43	Small
	Understanding	.11	.17	Small
	Readiness	.21	.01	Small
Teaching experience	Knowledge	-.16	.06	Small
	Understanding	-.05	.52	Small
	Readiness	.01	.87	Small

N=151

For teacher teaching experience, the negative correlation co-efficient value of knowledge was r =−.16 (probability value (p=.06) was greater than the mean level (p> .05)) and understanding, r = -.05 (probability value (p=.52) was found to be significantly greater than the significance level (p> .05)). Therefore, the findings show that there is no significant relationship between teaching experience and the level of knowledge and understanding of teachers in dealing with education transformation in the 4th Industrial Revolution. This means that, in terms of teachers' knowledge and understanding, the longer the teaching service in the school, the level of teacher knowledge and understanding in dealing with education transformation in the 4th Industrial Revolution is inversely proportional. This means that if the teacher is a novice teacher, they have the level of knowledge and understanding to handle the teaching and learning with relate to 4th Industrial Revolution environment more

efficiently. However, for the level of teacher readiness based on teaching experience, the correlation value was positive, but the value was very small, r =.01. Overall, the findings show that the level of knowledge, understanding and readiness in dealing with education transformation in the 4th Industrial Revolution has no significant relationship with a teacher's teaching experience.

Discussion and Implications of the Research

Overall, the findings of the study prove that the knowledge, understanding and readiness of science teachers in the Kuantan area in dealing with education transformation in the 4th Industrial Revolution is at a moderate level. The findings of this study are in line with the study of Sharita et al. (2018) and Kamaruddin and Che Aleha (2018) who stated that the level of knowledge regarding Industrial Revolution 4.0 in their samples studied is at a moderate level. Based on the statements in the questionnaire, the study found that although teachers were not very knowledgeable about Industrial Revolution 4.0 (IR4.0) and education 4.0, they were still trying to prepare for the coming changes.

This study also shows that teacher readiness in dealing with education transformation is crucial in contributing to the generation of workforce that will meet the demands of industry 4.0 in line with the country's development in education. As the dominant areas in IR4.0 involve the fields of Science, Technology, Engineering and Mathematics (STEM), the responsibility to realise the nation's dream of producing a workforce that meets the demands of industry 4.0 lies on the shoulders of Science teachers in particular.

The importance of knowing and understanding the IR4.0 & Education 4.0 should be practiced by every teacher. Teachers who understand the importance of IR4.0 and Education 4.0 will often be prepared to meet the challenges of today's educational transformation. However, there is no doubt that some teachers are ready and able to respond to the challenges of IR4.0 and Education 4.0 even though their knowledge and understanding of IR4.0 and Education 4.0 are at a moderate level.

This study has enabled teachers to be more prepared for the increasingly challenging transformation in the education world which requires teachers to be prepared from the technological and digital aspects of building a thriving and creative society while not forgetting their soft skills. This study also provides a new platform for teachers to increase their knowledge of the Industrial Revolution and Education 4.0 as well as link it with careers in science while improving their teaching practices to fit the current challenging state of the education system.

On the other hand, the findings of this study provide an overview of the current level and quality of teachers in their understanding of the Industrial Revolution 4.0 and Education 4.0 while helping management and administration to design internal courses for teachers to have greater exposure to the IR4.0 and Education 4.0. Teachers' training programs across institutions need to be updated to address this new revolution. At the highest level the Ministry of Education Malaysia can also be strengthened with the curriculum framework to be formulated in line with this new Revolution. In addition, this study will also supplement the literature for other researchers who wish to study the same aspects of the Industrial Revolution 4.0 and Education 4.0 discussed.

Conclusion

The results of this study achieved the set objectives and were able to provide answers to some of the research objectives that have been generated. The findings show that secondary school science teachers in the Kuantan area have a moderate level of knowledge and understanding but positively strive to be prepared to cope with any changes in this increasingly challenging world of education. In the face of increasingly complex environments, teachers need to reinforce their knowledge and skills especially in the areas of the Industrial Revolution 4.0 (IR4.0), the STEM field for teaching and learning as required in the Industrial Revolution and Education 4.0. As such, it is hoped that these teachers will become better teachers and be able to produce excellent students in the future as work demands are increasingly challenging. As a recommendation for further research, other researchers can use different populations and different kinds of measures related to the Industrial Revolution and Education 4.0 by using different measurement tools or better questionnaires.

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