

CHALLENGES IN EDUCATIONAL VALUES AND 4TH INDUSTRIAL REVOLUTION

(Cabaran dalam Nilai-nilai Pendidikan dan Revolusi Industri ke- 4)

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ABSTRACT

The fourth industrial revolution or known as Industrial Revolution 4.0 (IR4.0) or Industry 4.0 and Smart Factory is an improvement from the 3rd Industrial Revolution which is the digital revolution. IR4.0 is the use of automation and data exchange in manufacturing technology that combines physical, digital and biological “cyber-physical systems” to impact all disciplines, economies and industries. Man and technology have emerged since the glory of Islamic civilisation especially in daily life. The impact of technology brought by IR4.0 has penetrated the education sector. Education IR4.0 has always been associated with the human issues that have been overtaken by technology. Therefore, there is a need for an effective strategy to create a concept of education in IR4.0 based on humanitarian values. This paper discusses the challenges of introducing the concept of education 4.0 and the strategies used in designing it. This study used a descriptive qualitative method to acquire literature reviews from journal articles, books and proceedings. Thematic

analysis was applied to analyse this literature review. The results of the study found that the 4.0 education system applies high-tech values in its teaching and learning, while the application of creative and innovative thinking levels is practised in the learning curriculum at all levels of education, together with the inculcation of tawhidic science. This study is a pilot study towards the production of an educational concept book for the IR4.0 era.

Keywords: Industrial revolution, education 4.0, teaching and learning, human values, tawhidic science

ABSTRAK

Revolusi industri keempat atau dikenali sebagai Industrial Revolution 4.0 (IR4.0) atau Industri 4.0 dan Smart Factory adalah peningkatan dari Industrial Revolution 3.0 iaitu revolusi digital. IR4.0 menggunakan automasi dan pertukaran data dalam teknologi pembuatan yang menggabungkan fizikal, digital dan biologi "sistem fizikal siber" untuk memberi impak kepada semua disiplin, ekonomi dan industri. Manusia dan teknologi telah bergabung sejak zaman kegemilangan Tamadun Islam lagi terutamanya dalam kegiatan ekonomi harian. Namun kini, pengaruh teknologi yang dibawa oleh IR4.0 telah meresap ke dalam sektor pendidikan. Pendidikan dalam IR4.0 seringkali dikaitkan dengan isu-isu nilai kemanusiaan yang telah diambil alih oleh teknologi. Maka perlunya strategi yang berkesan dibuat bagi mewujudkan sebuah konsep pendidikan IR4.0 berasaskan nilai-nilai kemanusiaan. Kertas ini membincangkan cabaran dalam memperkenalkan konsep pendidikan 4.0 dan strategi yang digunakan untuk membangunkan konsep ini. Kaedah kualitatif deskriptif digunakan bagi mendapatkan data kepustakaan iaitu daripada makalah jurnal, buku dan kertas seminar. Kaedah analisis tematik digunakan untuk menganalisis data daripada bahan kepustakaan ini. Hasil kajian mendapati pendidikan tinggi di Malaysia menerapkan nilai-nilai berteknologi tinggi dalam pengajaran dan pembelajarannya, manakala penerapan tahap pemikiran kreatif dan inovatif diamalkan dalam kurikulum pembelajaran di pelbagai peringkat bersama juga dengan pendekatan sains tauhidik. Dapatan ini adalah kajian awalkan dalam membentuk sebuah buku konsep mengenai pendidikan era IR4.0.

Kata kunci: *Revolusi industri; pendidikan IR4.0; pengajaran dan pembelajaran, nilai Kemanusiaan, sains tauhidik*

INTRODUCTION

'Revolution' is a term that brings along the meaning of rapid and radical changes. So, upon the Industrial Revolution, there were changes that happened in many aspects, including the economy, business, organisational, social, and many more. The history of changes in the Industrial Revolution has brought many changes to the economic system and social aspects of mankind towards a more structured and well-organized society.

By introducing the *technology of cyber-physical systems*, IR4.0 is known as being based on the *Internet of Things* (IoT) and *networking*, referring to borderless network technology. These made all information received well controlled and organised effectively and efficiently with the approach of automation system application. The expansion of the fourth revolution happened at a glance compared to the previous revolution. It also impacted humanity through their way of life and the way they think (Schwab 2016).

The advancement resulting from IR4.0 can connect billions of people in a network (*web*), and give more facilities to human lives; be it medically, in education, in business and in others too. For instance, the usage of biotechnology, which facilitates medical specialist treatment, initiates effective learning, increases business efficiency, and helps to reestablish the natural environment through better asset management. These cause rapidity in the 4.0 industry based on the fields of robotic and *artificial intelligence* (AI), nanotechnology, quantum computerisation, genetic engineering, biotechnology, and 3D printing (Schwab 2016). IR4.0 comprises ten pillars: automation robots, simulations, system integration, multi-purpose internet, cyber security, public computing, additional material creation, reinforced reality, large data analysis, and system integration (Schwab 2016; Syaidatun et al. 2020).

The emergence of information in many forms, measures, and stages has grown vastly until it has become increasingly overloaded and it has significantly affected the younger generation (Gen-Z). Gen-Z is not only up-to-date in intelligence but also smart and digitally resourceful, whereby they are the computerised genre and have an understanding attitude with special articulation. They are even capable of exploring the internet and innovating computerisation into something imaginative, inventive, and expressive (Majidah, Dian Hasfera & M. Fadli 2019). This development of generation creates challenges in the education world and brings them changes to the new strategy structure of the national education system so that it will be at par with the current generation's progress. Educational values in this paper were based on the Malaysian higher education focus, which is future-ready curriculum, agile governance, talent planning, and research, and innovation, while

the IR4.0 values proposed in this study were based on the tawhidic science which is based on the teaching of Islam in the Qur'an and Sunnah.

HUMAN AND TECHNOLOGY IN HUMAN CIVILISATION

The history of the industrial development revolution has changed human lives towards a more well-arranged and structured one, both economically and socially. Humans first used technology in the agricultural sector when the agrarian revolution happened around 10,000 years ago. Pets were perceived as technology in agriculture in order to increase food production as an effect of increased population and permanent settlement during that time.

In 1784, the first industrial revolution arose, whereby brought up the technology of steam machines which that was the production of machine equipment based on steam and water. In 1870, the second industrial revolution occurred when technology based on electric usage was introduced to generate high production and employees were introduced to work distribution. Revolutionary development progressed well until the third revolution in 1969 when electric usage and information technology (IT) developed and the efficiency of production increased with production automation. The expansion keeps on going when the usage of IT is expanded while intelligence and industries are incorporated into more developed, sophisticated, and advanced intelligence. It was then that the era of the fourth industrial revolution known as IR4.0 came about.

The knowledge of science and technology is capable of optimizing individual intellectuals through objective and rationale. This progress happens due to the application of intellectual elements and the natural human instinct of knowing until it stimulates a sense of getting to know and understanding the properties of nature and the reasons for its creation (Sardar 1984). History has proven that during the golden ages of Islamic civilisation, Muslims built their own traditions upon science and technology which has encouraged the invention and development of modern science and technology in Europe. Islamic science and technology pioneered significant advancements in science fields including astronomy, life, science and architecture between the 7th-century to 16th-century (Alias Azhar 2013). Tawhidic science, which is founded on Islamic teachings in the Qur'an and Sunnah, reminds people that God-fearing (taqwa) is necessary in all aspects of life, including the employment of technology to meet one's requirements in this life (Yusof 2014).

The West also admits the role played by the Islamic civilisation in introducing science to Europe, namely through education institutions in Andalus during the

13th-century AD. It was stated by a Western scholar, Draper, about Europe's intellectual development history (Hassan 2013). According to him, Muslims ruled Islamic countries in Europe for almost 800 years, and it became an example to the Europeans since Spain during those days was highly civilised and knowledgeable. Advancement in the fields of arts, literature, science, and technology could be competed with by any European country. Many assimilators came from France, Germany, and England to get their knowledge made available in Spanish Muslim cities. This is due to the fact that mathematics, astronomy, science and life technology, history, philosophy and law were only dominated by the Spanish (Abdul Wahab Ismail 1989).

This shows the science and technology transfer process from Islamic civilisation through education, studies, translation, and trade. Islam not only encourages exploration and scientific research but in fact, relates it to worshipping. For instance, science and technology education encourages human submission to Allah SWT as contained through the mechanisms of faith (*Iman*), worship, and concern over Islamic values such as caliphate, trust, justice and public interest. The concept of development and advancement within the context of Islamic civilisation is universal as it includes aspects of noble values, morale, spirituality and materiality given that human contentment depends very much on the perfection of faith (Khurshid Ahmad 1979). In fact, the role of science and technology in Islam is to catalyse this goal. It was found that the noble value principles consist of four sub-principles, which are: 1) integrity; 2) accountability; 3) transparency; and 4) objectivity and disinterestedness (Nur Asmadayana et al. 2021).

Within the context of IR4.0, the way humans think and interact with technology must be seen in a different light, not only among humans and devices alone. A man with true and clear values based on universal norms of the Islamic civilisation who understands his role or duty will be driven to interact with justice and appropriateness in the growth of IR4.0 technology. These ways of interacting should be driven by and move along with the values based on the universal norms of Islamic civilisation. For example, today, humans cannot live their lives without their smartphones because they are perceived as important devices. All data, information, and networks are kept on smartphones; trade is done through smartphones; distance communication is simplified and becomes more interactive using all sorts of applications and social media (Humphreys 2010). As a result, the application of creative and inventive thinking levels is practised in all levels of education, along with the instillation of tawhidic science.

Research Method

This research used a qualitative method with systematic literature reviews on IR4.0 and education. Data were collected from archives, library documents, online systems, books, and journals in relation to education and IR4.0. The thematic method has been used to analyse the data. The data management process was carried out through the classification of texts according to themes, materials, or data according to specific themes related to the focus of the study.

IR4.0 EDUCATION CHALLENGES IN EFFECTIVENESS OF TEACHING AND LEARNING

Education in the era of IR4.0 has impacted the education world in Malaysia. Among the main focus elements of higher education in Malaysia are *Future-Ready Curriculum, Agile Governance, Talent Planning, and Research and Innovation*. It begins with the digitilised education system, which requires each element to adapt to the rapid changes in technology that are happening. For instance, the concept of 21st-century skills, the scientific approach, authentic learning, and authentic assessment (Daryanto 2017). Hence, this concept has provided guidance to higher education in developing a more flexible education curriculum. Among the stated challenges are the instillation of Tawhidic science, flexibility in teaching and learning, multi-learning programs, good assessment, the use of technology applications, applications of IR4.0 in education, Internet of Things in infrastructure education; as well as student ownership, peer guidance, and mentorship.

The Inculcation of Tawhidic Science

Malaysian's National Education Policy has outlined the necessity of students' universal potential development based on their belief in God. The general aim of education is to produce a balanced human from the perspectives of physicality, emotion, spirituality and intellect. The National Education Policy is a continuous effort towards enhancing the potential of individuals in a holistic and integrated manner in order to create individuals who are well-equipped intellectually, spiritually, and emotionally. This effort aims to produce knowledgeable, ethical, and responsible citizens who contribute to the harmony and prosperity of the community and nation. Based on the integration of the four elements in the National Education Policy, spiritual intelligence provides the possibility of producing students who can build strong relationships with the Creator (Allah), while intellect, emotional and physical intelligence allows humans to build relationships with other humans and nature. Thus, spiritual intelligence needs to be nurtured in order to build humans who

always do good deeds for Allah in whatever situation, which is the aim of human life in this world (Iksan, Saper & Rashed 2016).

The rapid development of science and technology is a consequence of human glorification of intellectual intelligence, which produces human beings that rely on everything in science. However, Islam basically gives freedom to humans, especially scientists, to study; however, they should realize the intellectual limitations possessed by them. Science is not a science that can explain everything. The opposite, the variety of damage on earth, is the result of human beings helped by the advancement of science (Noor & Mohktar 2021). This is true when no values or revelation guides mankind in their decision-making while using scientific advancement.

Thus, the science of Islam places revelations as the highest source of reference. In other words, in Islam, revelation overrides reason for revelation comes from boundless power, whereas common sense is limited (Noor & Mohktar 2021). In this case, Allah SWT has already stated in Surah al-Jathiyah verse 20, which means: “The Qur’an is an opening guide, the light, and the guidance that bring mercy to those who believe (the truth)” (Qur’an, 45:20).

Flexibility in Teaching and Learning

Higher education, which premiered the traditional model, did not meet the needs of the 21st-century students. Debates were raised to rethink the future of higher education until *Massive Open Online Course* (MOOC) was introduced as a new change in the education field (Daniel 2012; Harden 2013). MOOC is an online learning course that can be accessed by everyone in the entire world for free and accommodate a larger scale of student capacity (Nordin, Norman & Embi 2015). MOOC is seen as a form of information technology that is beneficial and contributes to preparing students for 21st-century learning (Widodo 2015), other than striving for flexible education.

A public university such as the National University of Malaysia has undergone the mentioned changes by adopting more systematic and flexible approaches through the usage of technology in e-learning. E-learning has been using internet applications which may link the educators to the learners in an online learning space (Silahuddin 2015). In spite of that, e-learning benefits well through LSM (*Learning Management System*) and mobile learning acts as a learning medium (Aminudin 2013). Through this method, the ability of the student to analyse, evaluate, elaborate, and create is enhanced, as is the ability to use various thinking strategies creatively through the usage of mind mapping, visual creativity, word association, SWOT analysis, and lateral thinking to meet and deliver new ideas (Kivunja 2014).

Multi-learning Programs

In addition, the introduction of programs with the nature of inter-discipline, multi-discipline and cross-discipline are among the aspects that need to be emphasized in IR4.0 education. This is due to core programs with the nature of inter-discipline, multi-discipline and cross-discipline which produces creative global thinkers (Buzan 2001; De Bono 2000). It also stimulates critical thinking on the why or where question, not only the what and how questions. In relation to the progress in education, the Ministry of Higher Education (MoHE) in one of its minister's statements, suggested that public higher institutions of learning give specific attention to Liberal Studies and multidiscipline study programs. This was also brought up during the launching of the National Dialogue of Country's Education 2012 at Universiti Kebangsaan Malaysia (UKM), which proposed that the national education system must be revalued in order to uphold the country's ability to compete at the international level. The educational system should take the elements of creative, critical, and innovative thinking seriously (Mohamad et al. 2018)

Good Assessment

The role of educators is crucial in providing better evaluation and assessment for students. Through this method, educators get to evaluate the student's ability by using various possibilities for solving problems (Lubart 2010). Learning methods for *Problem-Based Learning* (PBL) through modularly designed programs or projects may expose students to observation methodology and interviews (Dochy et al. 2003). This may create a student's thinking pattern to be more creative in verbal, written, and non-verbal communication in various contexts and forms, encouraging students to be active and effective listeners, exposing students to ways of communicating for various purposes, encouraging students to benefit from various media and technology effectively, and training students to communicate effectively within their environment, including the usage of various languages (Trilling & Fadel 2009).

Usage of Technology Application IR4.0 in Education

Education in the 21st-century requires life and survival skills, learning and innovation skills, and information media and technology skills, which are mentioned as the "21st-century knowledge-skills rainbow" (Trilling & Fadel 2009). The five main domains in education skills of the 21st-century are digital literacy, intensive thinking, effective communication, high productivity, and moral and spiritual value (Osman, Hiong & Vebrianto 2013). Students need to be exposed to the latest technology and application usage. Computer literacy is getting to know how to use and handle

computers related to the usage of software and hardware devices, understanding the usage of various resources, forms, access, and information, knowing how to produce and benefit from information socially, studying and gaining knowledge upon technology usage using information technology, communication ability, information publication, and the ability to evolve the benefits of new technologies (Shapiro & Hughes 1996).

Coding mastery is also important to simplify interaction with the technology. Facebook, was developed by a student by integrating *high-level languages* into a *graphical user interface* (GUI) by using *codes* (Wood et al. 2017). These technologies facilitate long-distance interaction between students and educators. The development of online modules is also increasing, for example, in the development of a module on the love of writing and publishing journals (Zahrin et al. 2022).

The Internet of Things (IoT) provides humans and objects with exclusive identities and the ability to transfer data through networks without requiring two-way interaction between humans and computers (Burange & Misalkar 2015). IoT is the development of knowledge that optimizes life based on sensory intelligence and smart devices connected through internet networks (Keoh, Kumar & Tschofenig 2014). It also connects devices (*things*) to internet infrastructure (wired or wireless) and uses those interactions to monitor or control devices from a distance.

The education field receives IoT technology impact on preserving more effective and efficient education. It began with internet usage at the University of California, Los Angeles (UCLA) in the era of the 60s, IoT in the education world started to evolve. Researchers in the field of technology started to discuss how IoT technology could change the learning environment in higher education. Computing access, high-quality online content, and social media connections can be used to increase the educational experience, and at the same time, students get to complete their coursework using video, activities, evaluation, and conversations related to students and faculty across the globe (Maggie & Max 2010). For example, academic research methodology towards various aspects of IoT has been carried out in most higher learning institutions such as the “life laboratory” at Carnegie Mellon University, whereby it creates platforms that enable sensors, devices, and buildings related to the Internet to communicate with each other.

Internet of Thing in Infrastructure Education

A safe environment at a university enables IoT technology to be practised accordingly. For instance, activating the alarm system, which connects directly to the emergency unit at the police department, fire brigade, and hospitals, may create a safer environment for the instructors and workers, especially students. Having the security system (CCTV) installed in secluded and quiet places may also increase the level of safety. With this technology, the authority and security may receive the information fastest warning during emergency calls, and at the same time, fast action can be taken. Hence, having an efficient and viable education system has a bigger impact on IoT technology usage. Furthermore, learning by using high-quality online content, such as e-learning, enables many facilities and information that benefit students and teachers. This also applies to Technical, Vocational Education and Training (TVET) in Malaysia (Abdul et al. 2023; Cheong & Li 2023).

University infrastructure also needs a high capacity of wireless broadband. Connection upon IoT technology characteristics leads to the connection of wireless networks, known as Wi-Fi, with the purpose of compatibility of internet access and telecommunication. Wi-Fi is the local wireless network through WLAN (*Wireless Local Area Network*), which enables electronic devices to exchange data or connect to the internet by using radio waves. These connections produce an 'Accessibility' network, which is access over a network and 'Compatibility' ability to receive and produce data.

The usage of technology in educational institutions is influenced by the hardware facilities and broadband provided by the institution. For example, a study that has been carried out on the students of UKM found that students did not use the Web 2.0 application since they hardly get an internet connection on campus; they have to find an internet connection in the computer laboratory and also in the library to get their learning materials (Analisa et al. 2015). Hence, the use of complete laboratories with high-technology devices is very important to enhance conducive learning, besides preparing ICT devices and conducting sufficient and recent research in each of the laboratories.

Student Ownership, Peer Guidance and Mentorship

IR4.0 education introduces students to their methods upon determining program structure, which they take (*student ownership*). *Student ownership* is a method whereby students have the right to determine the subjects that they will learn, the methods, and where their learning takes place. This approach gives inner motivation

by having common learning goals, identifying related processes, and producing results (Fletcher 2008). By determining their own program structure, students are tempted to achieve their goals. They will look at and understand how, why, and what is of interest to them in their learning, and the results can be seen through product production, portfolios, and others.

Learning orientations through peers and mentors are also applied in IR4.0 education, whereby this collaborative learning nature directs to metacognitive expansion, concluding better ideas and discussions or debates at a higher order of thinking. Students are given the opportunity to monitor each other, identify each other's mistakes, and learn how to improve their mistakes. By doing so, students may show their ability to work in groups, solve complex problems, and apply knowledge gained in other situations (Barron & Darling-Hammond 2008). Transition realities in economy, technology, and socio-politics emphasised in *Inspiring Education* encourage students to expand efficiency through the discovery process and research that is genuine and valid. Students collaborate to create new knowledge while learning how to think critically and creatively and how to make discoveries through research, reflection, exploration, experimentation and trial and error. Hence, learning may develop critical thinking, flexibility in problem-solving, and skills transition, as well as applying knowledge in new situations (Darling-Hammond 2008).

CONCLUSION

An excellent person with intellect and power but weak spirituality has more disadvantages than benefits. The development of scientific intellectual force without strong spiritual development will develop an unbalanced personality and identity, which will eventually jeopardize the sustainability of civilizational development. The presence of IR4.0 technology has a big influence on the advancement of a race or a nation. In relation to Tawhidic science, man must be able to predict the rapid changes of the future based on the Qur'an and Sunnah. The challenges of educating the new generation must be given serious attention so that this generation will not be left behind and can achieve development on par with the rest of the world. Hence, a few new strategies upon the formulation of the education framework must be implemented soonest so that the current generation not only advances materially but also has humanity values, which include adequacy in moral and spiritual matters.

REFERENCES

- Abdul Ghafur Hanafi, Hanis Hazwani Ahmad, Mohd Fitri Mansor & Wan Azani Mustafa. 2023. An integrated approach in empowering Technical, Vocational Education and Training (TVET) for Malaysian Asnaf in the IR4.0 Era. *Journal of Advanced Research in Applied Sciences and Engineering Technology* 30 (2): 255–271.
- Alias Azhar. 2013. Sains dan teknologi dalam ketamadunan Islam: Analisis epistemologi dan metodologi. *Jurnal Al-Tamaddun* 8(1): 51-66.
- Aminuddin. 2013. *Pengantar Apresiasi Karya Sastra*. Bandung: Sinar Baru Algesindo.
- Analisa Hamdan, Rossemi Din, Siti Zuraida Abdul Manaf, Nor Syazwani Mat Salleh, Intan Farahana Kamsin, Helmi Norman, Nor Mohamad Ismail & Ahmad Syukri Mohamad Zaid. 2015. Pengintegrasian teknologi web 2.0 dalam mencapai pembelajaran bermakna. *Sains Humanika Journal* 5(1): 51–59.
- Barron, B. & Darling-Hammond, L. 2008. Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning. *Powerful Learning: What We Know About Teaching for Understanding*: 11-70. San Francisco, CA: Jossey-Bass.
- Burange, A. W. & Misalkar, H. D. 2015. Review of Internet of Things in development of smart cities with data management & privacy. *International Conference on Advances in Computer Engineering and Applications*, Ghaziabad, 2015: 189-195.
- Buzan, T. 2001. *The Power of Creative Intelligence*. London: Thonrsons.
- Castle, S. & McGuire, C. 2010. An analysis of student self-assessment of online, blended, and faceto-face learning environments: Implications for sustainable education delivery. *International Education Studies*. 3(3): 36-40.
- Cheong, K. C. & Li, R. 2023. The role of TVET in IR4.0 for Malaysia. In R. Rasiah, W. Y. Low & N. Kamaruddin (Eds.), *Digitalization and development: Ecosystems for promoting IR4.0 technologies in Malaysia* (pp. 189-206). Abingdon: Routledge.
- Daniel, J. 2012. Making sense of MOOCs: Musings in a maze of myth, paradox and possibility. *Journal of Interactive Media in Education* 3(18).

- Darling-Hammond, L. 2008. Introduction: Teaching and learning for understanding. *Powerful Learning: What We Know About Teaching for Understanding*: 19. San Francisco, CA: Jossey-Bass.
- Daryanto, Karim, S. 2017. *Pembelajaran Abad 21*. Yogyakarta: Penerbit Gava Media.
- De Bono, E. 2000. *Six Thinking Hats*. Penguin Books: London.
- Dochy, F., Segers, M., Van den Bossche, P. & Gijbels, D. 2003. Effects of problem-based learning: A meta-analysis. *Learning and Instruction* 13: 533-568.
- Fletcher, A. 2008. The Architecture of Ownership. *Educational Leadership*. 66 (3). Retrieved June 10, 2021, from <http://www.ascd.org/publications/educational-leadership/nov08/vol66/num03/The-Architecture-of-Ownership.aspx>.
- Griffin, P. & Care, E. (Eds.). 2014. *Assessment and Teaching of 21st Century Skills: Methods and Approach*. Springer.
- Harden, N. 2013. The end of the university as we know it. *The American Interest* 8 (3): 54-62.
- Hassan, F. 2013. Role reversal: Shared knowledge between Muslims and the West. *Asian Journal of Social Sciences & Humanities* 2 (2): 164-172.
- Humphreys, L. 2010. Mobile social networks and urban public space. *New Media & Society* 12 (5): 763-778.
- Iksan, Z. H., Saper, M. N. & Rashed, Z. N. 2016. Integration of Tawhidic Science through Lesson Study Approach in teaching and learning science or Islamic study. *Tinta Artikulasi Membina Ummah* 2 (1): 40-50.
- Keoh, S., Kumar, S. & Tschofenig, H. 2014. Securing the Internet of Things: A standardization perspective. *IEEE Internet of Things Journal* 1(3): 265-275.
- Khurshid Ahmad. 1979. *Economic Development in an Islamic Framework*. Leicester: Islamic Foundation.
- Kivunja, C. 2014. Innovative pedagogies in higher education to become effective teachers of 21st century skills: Unpacking the learning and innovations skills domain of the new learning paradigm. *International Journal of Higher Education* 3(4): 37.

- Lubart, T.I. 2010. Model of the creative Process? Past, present and future. *Creativity Research Journal*: 37-41.
- Maggie J. & Max S. 2010. Learning to be a software engineer in a complex organization: A case study focusing on apprenticeship/practice-based learning for getting new engineers productive in contributing to the Google codebase. *Journal of Workplace Learning*. 22(3): 180-194.
- Majidah, Dian Hasfera & M. Fadli. 2019. Keterampilan literasi informasi mahasiswa dalam menghadapi revolusi industry 4.0. *Shout al-Maktabah: Jurnal Perpustakaan, Arsip dan Dokumentasi* 11(1): 1-11.
- Mohamad Mohsin Mohamad Said, Syaidatun Nazirah Abu Zahrin, Maznah Ibrahim, Abdul Salam Yusof & Jamsari Alias. 2018. Creative thinking skills for a 21st century Muslim educational system. *MALIM: Jurnal Pengajian Umum Asia Tenggara* 19: 85-97.
- Mohd Yusof Othman. 2014. *Pengenalan Sains Tauhidik*. Kuala Lumpur: Dewan Bahasa & Pustaka.
- Noor, A. Y. M. & Mokhtar, A. M. 2021. Sains tauhidik: Kolaborasi ilmu antara Al-Qur'an dan sains moden. *Akademika* 91(2): 167-176.
- Nordin, N., Norman, H. & Embi, M. 2015. Technology acceptance of massive open online courses in Malaysia. *Malaysian Journal of Distance Education* 17(2): 1-16.
- Nur Asmadayana Hasim, Latifah Amin, Ahmad Fazil Ellias, Zurina Mahadi & Mashitoh Yaacob. 2021. Noble values principle and indicators as ethical guiding principles for modern biotechnology in Malaysia. *Jurnal Hadhari* 13 (2): 271-279.
- Osman, K., Hiong, L. C. & Vebrianto, R. 2013. 21st Century biology: An interdisciplinary approach of biology, technology, engineering and mathematics education. *Procedia-Social and Behavioral Sciences* 102: 188-194.
- Sardar, M. Husain 1984. Science and Islam: Is There a Conflict, In Ziauddin Sardar. The Touch of Midas. Manchester: Manchester University Press.*
- Silahuddin. 2015. Penerapan e-learning dalam inovasi pendidikan. *Jurnal Ilmiah Circuit*. 1(1): 48-59.

- Schwab, K. 2016. The Forth Industrial Revolution. *World Economic Forum, 2016*. Geneva.
- Shapiro, J. J. & Hughes, S. K. 1996. Information literacy as a liberal art: Enlightenment proposals for new curriculum. *Educom Review*. 31(2).
- Siemens, G. 2005. Connectivism: Learning as network-creation. *ASTD Learning News, 10(1)*, 1-28.
- Syaidatun Nazirah Abu Zahrin, Rezki Perdani Sawai, Joki Perdani Sawai & Che Sulaila Che Harun. 2022. Muslim psychologists in facing challenges of the 4.0 industrial revolution. *Islamiyyat: International Journal of Islamic Studies* 44 (1): 145-156.
- Trilling, B & Fadel, C. 2009. *21st Century Skills, Learning for Life in Our Times*. San Fransisco: Jossey-Bass.
- Widodo, Slamet dkk. 2015. Membangun Kelas Literat Berbasis Pendidikan Lingkungan Hidup Untuk Melatihkan Kemampuan Literasi Siswa Di Sekolah Dasar. *Prosiding Seminar Nasional Pendidikan* (Retrieved 12 June 2020).
- Wood, J., Nguyen, T., Sharda, S. & Schlosser, A. 2017. ASEAN 4.0: What does the Fourth Industrial Revolution mean for regional economic integration? *White paper: World Economic Forum and the Asian Development Bank (ADB)*.
- Zahrin, S. N. A, Mahmud, M. I. & Azman, N. 2022. Development of the Love for Writing and Publishing Journal (LWPJ) Module for Higher Education International. *Journal of Learning, Teaching and Educational Research* 21(3): 434-447.