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Theorising the Possibilities of Stem Education in the 21st Century

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INTRODUCTION

Significant socio-economic transitions are characterised by a rise in change when, from one generation to the next, people work and live differently than they used to and, daily life becomes radically different (Miller, 2001). These transitions are induced by different inventions, leading to major changes in how people live and relate with one another. The first industrial revolution recorded the introduction of the steam engine which transformed industries, while the second revolution was associated with the use of electricity to operate new technologies for manufacturing. This era was based on combustion engines and, the development of transport, communications and high-tech industries. This was followed by the third revolution which saw a shift from a society based on conventional fossil fuel to one based on renewable energy. This revolution is widely known to have being inspired by information technology. Since the beginning of the 21st century, the fourth industrial revolution has been in progress and it presents the possibilities of unprecedented inventions and emerging breakthroughs in technology (Gordon, 2016; Lee et al. 2018; Aggarwal, 2019).

Widely known as the knowledge age, the 21st century is an age where growth and progress is a function of knowledge and ideas. New patterns of work have been developed and as a result, new kinds of workers with new and different skills are required. According to Khalil & Osman (2017, p.1), "the shift in this current world economy from a manufacturing-based to a knowledge-based economy, scientific innovation, augmented globalisation and advances in communication and information technology (ICT) have changed the job market in this modernised era". This implies that this century is focused on innovations which is largely driven by advances in Science, Technology, Engineering, and Mathematics (STEM) fields. The generation of innovation in science and technology has become key towards development in this era thereby driving the need for professionals in the fields of science, technology,

engineering and mathematics (STEM). Foundational efforts are being made to prepare students to meet emerging 21st century realities and STEM education has been identified as priority as it is at the heart of our fast-moving technology-driven world (Gordon, 2016).

STEM AND STEM EDUCATION IN THE 21ST CENTURY

Advances in the disciplines of Science, Technology, Engineering, and Mathematics (STEM) largely drives innovation and, this explains the rationale behind the prioritization of these fields by different societies in this century. These are fields that improve human understanding of the physical environment, support research and experimentation, in order to gain knowledge and skills needed for the real world. These fields are individually significant and can be taught in isolation, but when collectively applied can deepen understanding and solve real-world problems (McDonald, 2016). STEM education blurs the boundaries amongst these disciplines, presenting an integrated approach to solving problems, using interdisciplinary or cross-disciplinary knowledge and skills. The separation of subjects in education have become less relevant in the 21st century as students are no longer taught along the lines of memorization, but are trained to imbibe 21st century skills, develop 21st century approaches and, strategies to solving real-life problems(Khalil& Osman, 2017).

STEM education is the purposeful integration of Science, Technology, Engineering and Mathematics disciplines with the objective of expanding student's abilities by supporting technical and scientific education with a strong emphasis on critical and creative-thinking skills (Xie et al. 2015; Siekmann & Korbel, 2016). Quality education can only be provided if classes and schools are structured towards 21st century skills and knowledge needed for survival in the current global economy, and this has made the need for STEM education vital to today's society. This is a society projected to be driven by technological innovations such as renewable energy, advanced materials, 3D printing, energy storage, genomics, advanced oil and gas exploration, internet of things (IoT), cloud, advanced robotics and autonomous vehicles (Fisk, 2017). This implies that the future marketplace will experience a radical change and education systems should adapt and respond to these changes. Learners should be equipped with the skills needed for this future and this involves training them to exercise higher level thinking skills by investigating, creating, debating and synthesizing knowledge (Shaer et al. 2019).

Further highlighting skills crucial to education in the 21st century, Shaer et al. (2019) insists that there should be a shift from knowledge content-based education to education that focuses more on knowledge use and synthesis, building useful skills and positive character qualities. Some of these needed 21st century skills are creativity skills, critical thinking skills, communication skills and collaboration skills. Popularly called the "4C's", these skills have become important considering the volatility, uncertainty,

complexity and ambiguity that dominates this century and the future (Shaer et al. 2019; Bob, 2014). Creativity is the ability to produce new and useful ideas, it is the ability to use imagination to create something valuable. A creative student is one that perceives a situation in a novel way by finding not-so-visible patterns and making connections between intricate facts or phenomena. Such deep-thinking skill is important for students in the 21st century as they begin to think outside the box, and proffer solutions on their own to real life problems (Soo, 2019; Sen et al. 2018).

The best solutions are rarely produced in isolation but mostly through joint efforts. Collaboration skills are therefore vital and, STEM education supports the conglomeration of multiple perspectives in problem solving. This fundamental skill supports teamwork and shared responsibilities to achieve shared goals. According to Borrego et al. (2013), STEM education encourages students to work together as a team to present innovative designs and ideas. Collaboration involves continuous interaction and as such, effective communication is vital. Communication skills are not usually natural and needs to be developed as each task requires participation and expression of ideas (Shaer et al., 2019; Sen et al., 2018; Soo, 2019).

STEM EDUCATION AND THE FUTURE

STEM education is picking up steam as governments and schools continue to look at the possibilities it presents. Baffes et al. (2015) argue that STEM education is now being integrated into global economies in the bid to encourage diversification, drive economic growth, and compete in global markets. The world is embarking on a period of unparalleled technological advancement which will present both significant challenges and opportunities within the next 5 to 20 years (Schwab, 2018). For individuals and nations with the right knowledge and skills, this era will be liberating, but those who are unprepared will face vulnerable and insecure life without prospects. The 21st century has seen globalisation posing a major challenge for countries in the world as the independence of a country is directly dependent on its economic strength. Times have changed and according to Schilero (2013), economies based on finite natural resources will no longer take the lead. Focusing on developing a knowledge-based economy is a much safer investment for building a healthy economy.

A knowledge-based economy is one that relies on the limitless creativity and talents of its people to generate economic value. This kind of economy requires innovators, educators, researchers, and leaders who possess new skills, new ideas, and a high level of creativity to solve the most pressing challenges facing their nations (Henry, 2016; Schilero, 2013). STEM education therefore presents the possibility of grooming a knowledge-based and technologically driven race. It will ensure the growth of a STEM-capable global citizenry where individuals on the average have knowledge, conceptual understandings, and critical thinking skills that come from studying STEM subjects. Sahin (2016) postulates that STEM education holds the key to sustenance of economic

and innovative leadership in the global economy. The production of innovative economic leadership is dependent on training STEM professionals who will develop inventions and innovations in all areas of the economy.

The possibilities of STEM education do not just involve the development of skills vital for living in the 21st century, it also helps us understand the environment we live in (Wallace-Wells, 2017). For one, new technologies provide solutions to environmental threats abound in our society. One of these threats is the increasing world population as statistics show that by 2050, the world's population will be about 10 billion as opposed to the population of 7.3 million recorded in 2017. This implies that available resources become stretched and food may become insufficient due to the loss of arable land (Schwab, 2015). STEM education related knowledge can encourage the development of ground-breaking new sources of food production using technology. The spread of these technologies to agriculture will lead to increased yields, lower costs, and reduce the environmental impacts of these predicted global changes.

Environmental threats also arise from Co2 build up and build-up from other greenhouse gasses from the many factories that will sprout up. This will affect climate change and create the need for innovative ideas to help preserve the natural environment. Wallace-Wells (2017) predicts that global warming could make the earth uninhabitable, leading to crop failures, heat exhaustion and even death. Global warming will not only affect agricultural productivity by as much as 15% for every degree of warming, it will increase global precipitation, cause sea levels to rise, cause ocean water to become acidic and disrupt its currents, and alter biological systems and the global carbon cycle (UCAR, 2011). New technologies inspired by STEM education could attenuate global warming by absorbing excess carbon dioxide using bio engineered organisms, and new materials within buildings (Wallace-Wells, 2017).

The Schwab (2018) in its future of job report reveals the top five trends that will impact growth throughout 2022 as, increasing adoption of new technology, increasing the availability of big data, advances in mobile internet, advances in artificial intelligence, and advances in cloud technology. It is worthy to note that all five trends are technology-related and as such implies that, there will be an increase in the demand for technologically inclined employees in the near future. This report further states that by 2022, the top five technologies companies plan to adopt are, user and big data analytics, app-and web-enabled markets, internet of things, machine learning and, cloud computing. These companies will therefore demand for creative employees grounded in STEM disciplines, with analytical thinking and, innovative skills, who can optimise these technologies.

Over the next 10 to 20 years, 14% of jobs are at high risk of being fully automated, while another 32% at risk of significant change. Machines will learn to analyse, communicate and interact, thereby taking over jobs thought to need human thinking. By 2022, 75million jobs could be displaced but, these new technologies will create

about 133million new jobs for people trained to work with machines data. Lastly, 65% of children entering primary school today will work at jobs that do not currently exist. These predictions clearly show that the future belongs to technologically inclined individuals (Schwab, 2018). In order to meet the demands of the future workforce, students should be equipped with 21st century skills and technological knowhow needed to thrive in this era. STEM education is therefore training today's students to occupy tomorrows' workplaces.

These STEM fields and those who work in them are critical engines of innovation and growth as these are areas that will drive global development and advancement. It is important that education systems fully integrate STEM as it is the formula for career certainties in a future workforce that is predicted to be STEM based. The benefits of an adaptable future workforce are quite clear, ranging from industrial and economic growth, to innovations that would benefit the planet, STEM education presents the possibility of a successful, competitive, and progressive global economy.

CONCLUSION

Education in the 21st century has recorded a paradigm shift from content-based education, to an education based on knowledge use and synthesis, building useful skills such as creativity, critical thinking, communication and, collaborative skills. This is as a result of the fact that STEM education has been tasked to prepare students to thrive in a future which has been predicted to be technologically driven, and knowledge based. STEM education presents the possibilities of creating a global knowledge-based economy, grooming a capable global citizenry and innovative leadership that possess the right skills, new ideas and, a high level of creativity to solve real life problems. STEM related knowledge can also encourage the development of ground-breaking technologies to tackle the unavailability of adequate resources, such as food due to increased population and loss of arable lands. Experts have also predicted damaging environmental threats to our society such as global warming and its adverse effects on human life. STEM education will also train experts that will create innovative ideas to help preserve our natural environment. In conclusion, educating today's students in STEM fields is a strategic driver for economic growth and global competitiveness. The future workplace has been predicted to be technologically driven and as such, education should prepare today's students to take over tomorrow's workplaces.

REFERENCES

[1] Aggarwal, M. (2019). History of the Industrial Revolution. Accessed on the 30 October 2019, From: http://www.historydiscussion.net

[2] Baffes, J., Kose, M.A., Ohnsorge, F., & Stocker, M. (2015). The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses. Washington DC: World Bank Group.

[3] Bob, C. (2014). Teaching 21st Century Skills Through an Integrated STEM Approach. The Elementary STEM journal, 18(4), 1-13.

[4] Boon, N. (2019). Exploring STEM Competences for the 21st Century. In Progress Reflection NO. 30 On Current and Critical Issues in Curriculum, Learning and Assessment. Geneva: UNESCO International Bureau of Education.

[5] Borrego, M., Karlin, J., McNair, L.D., & Beddoes, K. (2013). Team Effectiveness Theory from Industrial and Organisational Psychology Applied to Engineering Student Project Teams: A Research Review. Journal of Engineering Education, 102(4), 472-512.

[6] Fisk, P. (2017). The Fourth Industrial Revolution... How 12 Disruptive Technologies Will Reshape Our World...and Their Opportunities for Your Business. Retrieved on the 30 October 2019, from http//www.geniusworks.com

[7] Gordon, R.J. (2016). The Rise and Fall of American Growth: The US Standard of Living Since the Civil War. Princeton: Princeton University Press.

[8] Henry, P. (2016). Enhancing STEM education for Global Leadership. Mimio Classroom Technology Blog Published 7 December 2016. Retrieved on the 3 November 2019, From: http://www.blog.mimio.com

[9] Khalil, N.M., & Osman, K. (2017). STEM- 21cs Module: Fostering 21st Century Skills Through Integrated STEM. K-12 STEM Education, 3(3): 225-233.

[10] Lee, M., Yun, J.J., & Pyka, A. (2018). "How to Respond to the Fourth Industrial Revolution, or the Second Information Technology Revolution? Dynamic New Combinations between Technology, Market, and Society through Open Innovation," Journal of Open Innovation: Technology, Market, and Complexity, 4(3), 1-24.

[11] McDonald, C.V. (2016). STEM Education: A review of the Contribution of the Disciplines of Science, Technology, Engineering and Mathematics. Science Education International, 27(4): 530-569

[12] Miller, R. (2001). 21st Century Transitions: Opportunities, Risks and Strategies for Governments and Schools. What Schools for the Future? Schooling for Tomorrow. Paris: OECD.

[13] Sahin, A. (2016). STEM education and Why it is Important For Countries' Global Leadership. The Fountain Magazine, Issue 112, Published July 1, 2016. Accessed on the 3 November 2019, from https://fountainmagazine.com/2016/issue-112-july-august-2016/stem-education-and-why-it-is-important-for-countries-global-leadership

[14] Schilero, D. (2013). Diversification and Development of the UAE's Economy. Munich Personal RePEc Archive, Paper No. 47089. Accessed on the 5

November 2019, from https://mpra.ub.uni-muenchen.de/47089/1/MPRA_paper_47089.pdf

[15] Sen, C., Ay, Z.S., & Kiray, S. (2018). STEM Skills in the 21st Century Education. In Book: Research Highlights in STEM Education. In M. Shelley & S. Kiray, Research Highlights in STEM Education pp.81-101. Iowa: ISRES Publishing.

[16] Shaer, S., Zakzak, L., & Shibl, E. (2019). The STEAM Dilemma: Advancing Sciences in UAE Schools the Case of Dubai. Dubai: Mohammed Bin Rashid School of Government.

[17] Siekmann, G., & Korbel, P. (2016). Defining 'STEM' Skills: Review and Synthesis of the Literature. Adelaide: NCVER.

[18] Schwab, K. (2018). The Future of Jobs Report 2018. Geneva: World Economic Forum.

[19] Xie, Y., Fang, M., & Shauman, K. (2015). STEM Education. The Annual Review of Sociology, 41(19): 1-19