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The Practice of STEM Education in Higher Education Context: China and USA

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Abstract: *This report focuses on education policies across two nations, focusing specifically on STEM higher education, and more specifically on the two nations' efforts to increase the number of students in STEM-related fields. The main goal of increasing the number of students in STEM-related subjects in higher education has been to create an ecology of STEM education, something which has been established by one of the nations in this report, the USA. Through years of development, the USA has left an ecological footprint of STEM education which fits into the cultural, historical, political, and economic context of the USA. However, this context also has limitations, in particular low percentages of female and minority students, and low accessibility for students from lower socioeconomic backgrounds and certain states. The second country, China, has also been working on building up an ecology of STEM education, and considers actively improving the number of students in STEM higher education to be a strategic national movement, launching a series of educational policies and implementations, which could be considered as a process of policy borrowing, the main factor associated with which has been globalisation. This brings us to the main point of this report: globalisation has a fundamental influence on the education system, and sometimes can even offer opportunities to reform a nation's education system. Besides globalisation, some ideas associated with neoliberalism have also been linked with the challenges that global STEM education is facing.*

Keywords: *STEM Education; Ecology of STEM Education; Policy Borrowing; Globalisation and Neoliberalism*

1. Introduction

STEM (Science, Technology, Engineering, and Mathematics) education as a concept originated from the US, and has increasingly received focus globally in the past two decades [1, 2]. Because the role of STEM education has been considered to be 'a vehicle for future economic prosperity' [3]. And universities are considered to be vital settings of STEM education. As such, STEM education has arguably become the key focus of curriculum change internationally, and many nations are working on improving student numbers in higher education [4]. What's more, nations are, overall, increasing the proportion of their GDP that they invest in higher education [4], although despite these increases, there are still some differences between higher education policies among different countries. This report aims to explore the policies and practices of STEM education in China and the USA in particular. To do this, this report has been divided into 4 parts. The first section will introduce the format of STEM education within the context of higher education. The second part will talk about the development of STEM education in the USA by explaining some relevant key policies and acts. A description of the current STEM education environment will follow. After this, the limitations of STEM education in the USA will also be discussed. The third section will focus on the development of STEM education in China, and will highlight the benefits and challenges that Chinese STEM education is facing. After that, I will argue that, although China has borrowed some STEM educational frameworks from the States, it still needs a localisation process to achieve its desired effects. As such, STEM education in China and its limitations will be discussed through applying Steiner-Khamsi's policy borrowing theory, which will also situate those policies and practices within a global landscape to evaluate sustainable evolution. The final part will discuss the global challenges for STEM education under a globalising environment.

2. STEM education and STEM education in the higher education context

Teaching and learning in STEM education take on various forms. Higher education, as one such form, has high return rates from market and non-market perspectives [4], because higher education is always

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intimately connected with innovations, patronage, productivity, and technological change [5, 6]. As such, governments nowadays pay more attention to higher education. Moreover, STEM education has also been associated with innovations and technological changes, which makes STEM subjects in higher education especially important. As such, nations are working on improving enrollment in higher education, especially in STEM subjects.

Studying STEM-related subjects not only requires students to specialise in particular areas, but also involves research-based learning [7]. Those areas are considered as collections of centred principles of science, technology, engineering, and mathematics, and expect students to apply information and solve real world problems [8]. As such, STEM projects normally involve student-centred learning [7]. Moreover, innovation and problem-solving are required for STEM projects, and students are also expected to have aptitudes such as collaboration, critical thinking, journaling, and design thinking [9].

The progression to STEM higher education, when compared to pre-college settings, involves greater instructors' autonomy, less government involvement, and less reliance on standardised tests [10, 11]. This progression reflects a more neoliberal outlook, because, in neoliberalism, nations try to create or find individuals who are well-suited to enterprise and competition [12], although neoliberalism as an economic philosophy term refers to the valuing of individual freedom, free markets, and limitations on governments' control [13].

3. STEM education in the United States

Over the past few decades, STEM education has been transformed from only focusing on the improvement of science and mathematics as isolated disciplines into an applied process of using current tools and technologies to solve real-world problems [14, 15]. To engage students in a high quality and quantity of STEM education, the US has established an integrated STEM education model based on the entire society, and national economics, politics, and culture [15], which has also reformed higher education. Since the publication of 'Task Committee on Undergraduate Science, & Engineering Education' in 1986, which is often believed to be the start of STEM education as such in the USA, and which set the direction for the subsequent decade of STEM education in the USA. After that, the 'American competitiveness initiative' was published in 2006, which raised investment in STEM education and research, which was a great opportunity for American STEM education. Meanwhile, the number of instructors in STEM fields also increased. In 2007, the first act concerning STEM education was named the America COMPETES Act (America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education， and Science Act), which clearly defined requirements for STEM teachers and lecturers by improving current teachers' skills and providing more opportunities for students who are studying STEM subjects. For example, the ED provides scholarships for existing STEM teachers and for students in STEM to provide opportunities to get teacher certifications [16]. This shows that the United States was facing a challenge in 2007, concerning the quality and quantity of STEM teachers. Soon, the US education department also identified the problem of coherence in terms of STEM education. In other words, the previous education acts only focused on pre-college STEM education (K-12), paying no attention to the coherence of pre-college and undergraduate education. As such, this also makes the America COMPETES Act the first act that focused on the interface between undergraduate education and K-12, in other words, the coordinated development of K-12 education and undergraduate education [17].

After years of development, STEM education in the USA came to be considered as employing an 'all-hands-on-deck approach', prioritising training teachers in those particular areas to encourage students as much as possible [18]. After this, all states put efforts into STEM education. For example, the California Department of Education issued [19] the California Assessment of Student Performance and Progress, which aimed to help teachers and educators to access the latest training resources and information, to prepare teachers in STEM areas. Through all of the efforts the government put in, the number of students who were awarded bachelor's degrees and above (e.g. master's and doctoral degrees) increased from 343,691 in 2008 to 612,693 in 2021 [20]. However, some states in the USA also noticed a gender gap in the graduate demographics.

For example, the California Department of Education in 2015 [19] published 'Engaging Girls in STEM', which aims to fix the gender issue within Californian education in general and increase the number of female graduates. In 2018, 'Charting a Course for Success: America's Strategy for STEM Education' was published, which indicated that there was a need for associations among schools, families, communities, companies, and industries in the States to make it a "North Star" in STEM education. Since then, the USA has generally formed a STEM education system that includes involvement of families, schools, colleges, and social organisations as an ecosystem [21].

4. Ecology of STEM education

The National Research Council [22] distinguishes between formal and informal engagement in STEM education. ‘Formal’ STEM education refers to sessions within institutions [23]. In contrast, informal STEM education extends beyond institutions, and includes social organisations, social encounters, and public media engagement [24, 25]. However, it is believed that only relying on formal STEM education limits the engagement of adults in STEM education, considering their different cognitive capacities and needs [26, 27]. As such, it is also essential to facilitate informal education, considering that it can effectively increase individuals’ interest and willingness to participate in formal STEM education [23].

In other words, to build up an ecosystem of STEM education could cover individuals’ formal and informal STEM learning which could potentially or directly encourage children and adults to participate in STEM education [23]. And, evidently, the similar interests and struggles of building up an ecology of STEM education are a global problem [23, 28, 29].

5. Limitations of STEM education in the USA

STEM education in the USA has undergone a transformation from its traditional form of mathematics- and science-focused to an integration of mathematics and science education with engineering and technology [30]. And the focus of US STEM education has pivoted away from traditional efforts to improve the inclusiveness of STEM education. For example, a national coordinating conference hosted in Washington named ‘YOU Belong in STEM’, as the key initiative of the Biden-Harris administration, indicated that, considering the gender and race gap of STEM education, the data indicate that, although there is an increasing rate of female graduation in core STEM subjects, the percentage is still considerably low at 24% [20]. Moreover, minority groups, as a proportionally increasing group in the States, only represented 9.1% of the areas of science and engineering [20]. According to Cindy Marten, deputy secretary of education, STEM education should be more inclusive. Although efforts have been made in increasing the diversity of STEM education in the USA, it is still white- and male-dominated [31, 32].

Meanwhile, the accessibility of STEM education in the USA has also been criticised. Although it is believed that the ecology of STEM education increases the possibilities of individuals to participate in STEM higher education, different regions and communities have different levels of access to STEM education. In other words, the equipment and well-trained teachers are often allocated to urban areas [3]. Moreover, there is still a lack of trained teachers in some subjects in urban areas, for instance technology and engineering [33].

6. STEM education in China

STEM education in China is a concept that was introduced from the USA [34, 35]. And the ecology of STEM education from the United States has been considered as the main positive feature of STEM education in the USA [35]. To investigate developing STEM education’s ecology in China, a report conducted by Zhu and Kong (2008) explored the developmental strategies of STEM education in America and, since then, the Chinese government has continued to explore practical means by which STEM education can respond to national needs and social demands [36, 37]. Through analysing the method of building up the ecology environment of STEM in the USA, the Chinese government first encourages higher education institutions to collaborate with local corporations and other institutions to improve students’ abilities by involving them in practical experiences of innovation and science research (UNESCO, 2010). Meanwhile, higher education institutions need to improve their social service abilities for citizens from society by providing continuing education services (UNESCO, 2010). Through this process, society should have a basic understanding of the nature of STEM education [38].

After that, the Education Management Information Center of the Ministry of Education [35] published the ‘Report on the Development of STEAM Education in China’, which analysed global STEM education trends. After That, the National Institute of Education Sciences (NIES) issued ‘China STEM Education White Paper’, which included the chapter ‘China STEM Education 2029 Innovation Action Plan’, in 2017. The aim of this chapter was to establish the expected version of Chinese STEM education’ ecology in the subsequent decades, considering national political, economic and cultural conditions [39].

Economically, the major goal of developing STEM education in higher education contexts was generally to improve the 'labour quality', and to transform 'made in China' into 'created in China' by raising productivity (13th Five Year Plan for Education, 2016-2022). Arguably, starting with the issuing of 'The 13th Fifth Year Plan for Education in the Information Age', the practice of STEM education in China has always been associated with entrepreneurship. Besides entrepreneurship, STEM higher education also has been considered as the essential tool to improve Chinese manufacturing power, because STEM students are convinced to help build a qualified workforce for the future [40]. As such, the Chinese government has issued a National Strategy for Medium and Long-Term Education Reform and Development (2010-2020), which aimed to focus on increasing the amount of STEM subject graduates in higher education. And it is believed that building an ecology of STEM education is the most effective way to increase the number of students in STEM-related fields [35]. Thus, the Chinese government has promoted improving students' number in STEM higher education as a strategic national movement and launched a series of educational policies and implementations which are considered as a policy issue geared towards economic ends [41].

7. The strengths of STEM education in China

STEM education has been considered as a movement in China which offers opportunities to educators and experts to rethink current forms of taught education, school education, and the aim of education for students' future [30]. STEM education has also been used as a tool to inspire students' critical thinking and innovation skills [42]. And Chinese students have always been criticised for their lack of critical thinking and innovation abilities [7]. Furthermore, STEM education focuses on individual achievements. This could be a challenge for the Chinese education system and individuals within it because, as a collectivist country, individuals are required to prioritise group welfare and value more highly the contribution of individuals to the group [40, 43].

Moreover, because of the nature of STEM education in China, which improves Chinese manufacturing power, STEM education is market-driven. As such, students have opportunities to develop skills that are valued in the marketplace [34]. This also reflects the neoliberal belief that the market is the most efficient way to allocate resources, and that individuals should be responsible for their own success. Moreover, the practice of STEM education in China has always been associated with entrepreneurship and creation, as mentioned earlier [40, 41]. This not only refers to economy-driven policies, but also reflects neoliberalism, in which emphasis on entrepreneurship and innovation are the drivers of economic growth and prosperity [44]. And the organisations and companies which are interested in STEM-related activities and education also are likely to contribute in this area [45]. Some of them could be global and could therefore enhance communication between nations.

8. The weakness of STEM education policies in China

Although the meanings of STEM education have drawn much attention from Chinese policymaker and practices, the conceptualization of what STEM means in terms of curriculums has received less interest from populations, as STEM education in China demands only "practices based on instrumental effectiveness and better assessment performance" [46]. This could be associated with cultural conflict. Because education in China is still exam-dominated, and the main factor for introducing STEM education in the higher education context is to improve labour quality [47], which makes STEM education an instrument of improving the economy in China. This could be potentially damaging in terms of the sustainability of Chinese STEM education [40]. And, because of the impacts of Confucian culture on education, Chinese education is teacher-centred and assessment-centred compared to student-centred education in the USA [48]. Furthermore, STEM education entails an integration of subjects, while education in China is also normally single-subject-centred [42]. In other words, STEM education in China lacks a framework or scaffold to integrate subjects and assess the effectiveness of the subjects [49]. As such, importing the STEM education system from the USA wholesale could cause some problems, which means STEM education needs to be localised to fit with Chinese culture. This will be explained in detail in the following section.

Moreover, it is argued that the development of STEM education needs to be enmeshed with the development of technology [50]. However, STEM education in China has been viewed as the solution to underdevelopment of technology [30]. In other words, the integration of STEM in education needs to be triggered by the practice of STEM; however, the development of technology has stagnated, which has caused the development of STEM education to become stagnated.

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It is also worth noting the existing gap between numbers of male and female participants in terms of STEM education. The PISA test (OECD, 2019), which investigated career expectations in Beijing, Shanghai, Jiangsu, and Zhejiang, found out that only 9.1% of girls intended to participate in STEM-related careers, which is a considerably low rate. Under these circumstances, improving the inclusiveness of STEM education might require support at the national level.

Furthermore, it is believed that there is no consensus term for STEM education in China. A related term that refers to 'new engineering' has been mentioned by the Ministry of Education of China [51] to describe STEM education in China. Additionally, there is no actual and specific policy to lead STEM education, just encouragement for local universities to practise, which might lead to misunderstandings or misuse of the term.

9. Globalisation and indigenisation of STEM education

As mentioned above, STEM education in China, as a concept, is borrowed from America, which has an established STEM education model, considering features of economics, politics, and culture. This could be considered as an educational policy borrowing. 'Policy borrowing' refers to a process of comparatively learning successful experiences or policies from other countries [52]. Policy borrowing is a complicated process, which, according to Steiner-Khamsi, consists of two main stages, reception and translation. 'Reception' refers to the reason why a certain policy has been selected, the aims of the introduced policy, and the attraction of that policy. 'Translation' refers to the localisation of an education policy.

The main factor that pushed the development of STEM education in China was the process of globalisation. Arguably, STEM education has been taken as a solution by the Chinese government in responding to the global interests of the STEM concept [34, 53]. In other words, the current context of Chinese STEM education can be linked with global trends, global markets and globalisation [54], which have jointly facilitated the development of STEM education in China. Globalisation has been defined as 'tendencies to a world-wide reach, impact, or connectedness of social phenomena' [13]. Because of globalisation, many STEM-related educational multinational companies, such as Modular Robotics and Orbotix are coming into the Chinese STEM education market [35], which could benefit STEM education in China, as this promotes cross-national and cultural collaboration between students, teachers, and educators [55]. A general understanding of STEM education has also developed within Chinese society; this could be considered as another factor of policy borrowing, in responding to social needs towards STEM education [56]. This sharing process could not only enhance the development of STEM education, but also help individuals who are in STEM-related areas to get in touch with different perspectives on STEM education [54]. And, because of these global trends and interests, individuals in STEM fields have more career opportunities [54, 57]. As such, to develop the economy and solve employment issues in China, the ecology of STEM education from the USA has been introduced to China.

However, policy borrowing is not the same as transferring policies or practices wholesale from one country to another [58]. Especially in the context of education, transplanting a successful educational practice or policy, without critical analysis, from one culture to another has a high likelihood of creating problems [59]. Education systems are unique and reflect the history, politics, and economy of certain 'national characters', which also could be defined as culture. Different nations' cultures could shape the role of education in their respective society; in the meantime, education also adjusts to adapt to different environments. In other words, culture plays a central role in education policy transfer [59]. As such, copying STEM education policies from the USA is actually an expense of globalisation, because the STEM education system in China has been criticised as copying education ideology from Western countries and ignoring local conditions [58]. This means that the STEM education system in China is the reflection of the hegemonic discourse of Western nation states that are consequences of unbalanced developments of technology [55]. This has been criticised as denying local cultures and traditions' value and reinterpretation globally [54, 55]. Based on that, China not only needs a certain local term to define STEM education, but also needs to be adjusted to fit into the Chinese cultural environment [53]. Because, according to the timeline and development of STEM education in the states, it is clear that STEM education is socially constructed, which means that STEM education needs to be integrated with cultural backgrounds, social structures, and the nation's indigenous ideology, in the process globalising education.

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10. Challenges for STEM education

Although this section will discuss the challenges that STEM education faces under the globalising background in general, it still will cover some challenges that arise from the concern of neoliberalism. Because neoliberalism is not a main driver of globalisation, but also the direction that globalisation moves towards [13].

Even though STEM education has been considered as a global trend, it still raises some challenges. First, it is believed that STEM education has offered more opportunities to teachers and students, and yet it still faces visible issues of education inequality in terms of gender and race. Moreover, it is also essential to think about inequality from a socio-economic status and race perspective. Evidently, individuals who get a higher level of education are typically white males from 'higher social classes'. As such, inequality will increase through the globalisation of STEM higher education.

Moreover, although it is argued there has always been a mutually beneficial relationship between economics and STEM-related fields, this still raises some problems. Because the transformation of STEM subjects from free, open, and interest-oriented to capitalism-led by raising interests and investment of governments, knowledge will, as a consequence, be tied to national economic interests and global markets and trends. Neoliberalism nowadays treats knowledge as a capital, which is damaging in terms of sustainability of STEM education. Under these circumstances, individuals may seek success by going where the capital is and define unsuccessful as being where the capital is not. In other words, education should not be intimately linked with the social version and market. Moreover, to protect the unique and scarcity-defying nature of this kind of capital, intellectual property rights are increasingly focused on by national governments, which could limit international communications across cultures and countries. And, moreover, this will cause asymmetries of information. In other words, although the protection of knowledge responds to neoliberalism, education policy makers and educators need to rethink education forms in terms of involving knowledge creation, acquisition, transmission, and organisation.

11. Conclusion

In conclusion, through years' efforts, the USA has established an ecology of STEM education, which could increase individuals' willingness to participate in higher education. However, there are still existing gaps in terms of gender and race. Although the government has already issued policies, and some states have also been working on addressing this, female and minority group participants in STEM higher education are considerably badly represented. Although STEM education in China was introduced from the USA and the government, this was led more by the economy. And introducing STEM education from the USA has not achieved the desired effects in China. Through analysing the process of policy borrowing by applying Steiner-Khamsi's theory, which includes two key stages, reception and translation, reception refers to the reasons for policy borrowing - in this case the process of globalisation and social needs that are caused by globalisation in Chinese society- and translation means adopting an introductory theory to fit in local historical, cultural and economic context, for which STEM education of China has been criticised in this stage because it has the possibility to cope with the ecology of STEM education from the USA instead of developing it within its own culture, history, and economy. Under the globalising circumstances, this is considered as the hegemonic discourse of Western nation states, in that this ignores and denies its own culture. And, from a globalisation and neoliberalism perspective, although STEM education does provide opportunities for individuals and nations to communicate and gain knowledge and skills, it is still important to be aware of its potential to reflect neoliberal values and reinforce inequalities. By recognizing the limitations, educators and policymakers can work to ensure that STEM education is equitably accessible to all students and reflects a broader vision of social and economic justice.

References

[1] Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated stem education. International Journal of STEM Education, 3(1), 11.
[2] Tytler, R. (2020). Stem education for the twenty-first century. In J. Anderson & Y. Li (Eds.), Integrated approaches to stem education: An international perspective (pp. 21-43). Springer International Publishing.
[3] Huderson, B., & Huderson, A. (2019). Urban stem education: A vehicle for broadening participation

in stem. In J. L. Wendt & D. L. Apugo (Eds.), K-12 stem education in urban learning environments (pp. 1-24). IGI Global.

[4] Gehrke, S., & Kezar, A. (2017). The roles of stem faculty communities of practice in institutional and departmental reform in higher education. American Educational Research Journal, 54(5), 803-833.

[5] Leslie, L. L., & Brinkman, P. T. (1988). The economic value of higher education. Macmillan Publishing.

[6] Krabec, T., & Čižinská, R. (2020). Value of branded education. Financial Internet Quarterly, 16(4), 42-46.

[7] Loyalka, P., Liu, O. L., Li, G., Kardanova, E., Chirikov, I., Hu, S.. Beteille, T. (2021). Skill levels and gains in university stem education in china, india, russia and the united states. Nature human behaviour, 5(7), 892-904.

[8] Blackburn, H. (2017). The status of women in stem in higher education: A review of the literature 2007–2017. Science & Technology Libraries, 36(3), 235-273.

[9] Briggs, C. (2017). The policy of stem diversity: Diversifying stem programs in higher education. Journal of STEM Education, 17(4), 5-7.

[10] Hargreaves, A., Lieberman, A., Fullan, M., & Hopkins, D. (2010). Second international handbook of educational change (Vol. 23). Springer Science & Business Media.

[11] Sykes, G., Schneider, B., & Plank, D. N. (2012). Handbook of education policy research. Routledge.

[12] Apple, M. W. (2017). What is present and absent in critical analyses of neoliberalism in education. Peabody Journal of Education, 92(1), 148-153.

[13] Wikan, V. (2015, March 21). What is 'neoliberalism', and how does it relate to globalization. E-International Relations Students. https://www.e-ir.info/2015/03/21/what-is-neoliberalism-and-how-does-it-relate-to-globalization/

[14] Borrego, M., & Henderson, C. (2014). Increasing the use of evidence-based teaching in stem higher education: A comparison of eight change strategies. Journal of Engineering Education, 103(2), 220-252.

[15] Hoeg, D. G., & Bencze, J. L. (2017). Values underpinning stem education in the USA: An analysis of the next generation science standards. Science Education, 101(2), 278-301.

[16] The United States Congress. (2007). The america creating opportunities to meaningfully promote excellence in technology, education, and science act of 2007. https://www.congress.gov/110/plaws/publ69/PLAW-110publ69.pdf

[17] Yee, K. (2015). America competes act's effect on nasa's education and public outreach programs. Space Policy, 31, 27-30.

[18] White House. (2013). Educate to innovate. https://www.whitehouse.gov/priorities/

[19] California Department of Education. (2015). Engaging girls in stem. https://www.cde.ca.gov/pd/ca/sc/engaginggirlsinstem.asp

[20] National Center for Education Statistics. (2022). Number and percentage distribution of science, technology, engineering, and mathematics (stem) degrees/certificates conferred by postsecondary institutions, by race/ ethnicity, level of degree/certificate, and sex of student: Academic years 2011-12 through 2020-21. https://nces.ed.gov/programs/digest/d22/tables/dt22_318.45.asp

[21] Macisaac, D. (2019). U.S. Government releases charting a course for success: America's strategy for stem education, report guiding federal agencies that offer stem funding opportunities. Physcis Teacher, 57(2), 126-126.

[22] National Research Council. (2009). Learning science in informal environments: People, places, and pursuits. National Academies Press.

[23] Gupta, R., Voiklis, J., Rank, S. J., Dwyer, J. d. l. T., Fraser, J., Flinner, K., & Nock, K. (2020). Public perceptions of the stem learning ecology–perspectives from a national sample in the US. International Journal of Science Education, Part B, 10(2), 112-126.

[24] Allen, S., & Peterman, K. (2019). Evaluating informal stem education: Issues and challenges in context. New Directions for Evaluation, 2019(161), 17-33.

[25] Gupta, R., Fraser, J., Rank, S. J., Brucker, J. L., & Flinner, K. (2019). Multi-site case studies about zoo and aquarium visitors' perceptions of the stem learning ecology. Visitor Studies, 22(2), 127-146.

[26] United States Department of Education. (2016). Stem 2026: A vision for innovation in stem education. https://www.air.org/resource/report/stem-2026-vision-innovation-stem-education

[27] Zouda, M. (2018). Issues of power and control in stem education: A reading through the postmodern condition. Cultural Studies of Science Education, 13(4), 1109-1128.

[28] Tal, T., & Dierking, L. D. (2014). Learning science in everyday life. In (Vol. 51, pp. 251-259).

[29] Basham, J. D., Israel, M., & Maynard, K. (2010). An ecological model of stem education: Operationalizing stem for all. Journal of Special Education Technology, 25(3), 9-19.

[30] Li, Y. (2018). Journal for stem education research – promoting the development of interdisciplinary research in stem education. Journal for STEM Education Research, 1(1), 1-6.

[31] Vakil, S., & Ayers, R. (2019). The racial politics of stem education in the USA: Interrogations and explorations. In (Vol. 22, pp. 449-458): Taylor & Francis.
[32] McGee, E. O. (2020). Interrogating structural racism in stem higher education. Educational Researcher, 49(9), 633-644.
[33] Gross, J., & Ouyang, Y. (2021). Types of urbanization and economic growth. International Journal of Urban Sciences, 25(1), 71-85.
[34] Quan, G. (2020). Tracking stem education development in china: National, regional, and local influences. In C. Zintgraff, S. C. Suh, B. Kellison, & P. E. Resta (Eds.), Stem in the technopolis: The power of stem education in regional technology policy (pp. 251-283). Springer International Publishing.
[35] Education Management Information Center of the Ministry of Education. (2017). Report on the development of steam education in china. http://ifastdata.com/data/upload/ueditor/20221117/6376182646b98.pdf
[36] Dong, Y., Wang, J., Yang, Y., & Kurup, P. M. (2020). Understanding intrinsic challenges to stem instructional practices for Chinese teachers based on their beliefs and knowledge base. International Journal of STEM Education, 7(1), 1-12.
[37] Li, Y. (2020). Six years of development in promoting identity formation of stem education as a distinct field. International Journal of STEM Education, 7(1), 59.
[38] Zeng, N., Zhang, B. H., & Wang, Q. (2019). Stem fever: Science educators' opportunities and challenges. AIP Conference Proceedings, 2081(1), 020003.
[39] National Institute of Education Sciences. (2017). White paper on stem education in china. https://www.doc88.com/p-86416995822344
[40] Ma, Y. (2021). Reconceptualizing stem education in china as praxis: A curriculum turn. Sustainability, 13(9), 4961.
[41] Meng, N., Yang, Y., Zhou, X., & Dong, Y. (2022). Stem education in mainland china. In M. M. H. Cheng, C. Buntting, & A. Jones (Eds.), Concepts and practices of stem education in asia (pp. 43-62). Springer Nature Singapore.
[42] Zhou, C., & Li, Y. (2021). The focus and trend of stem education research in china—visual analysis based on citespace. Open Journal of Social Sciences, 9(7), 168-180.
[43] Qu, X. (2019). Rethinking norms and collectivism in china's inclusive education–moving teachers' understanding beyond integration. Journal of Research in Special Educational Needs, 19(4), 353-361.
[44] Freeman, B., Marginson, S., & Tytler, R. (2019). An international view of stem education. In A. Sahin & M. J. Mohr-Schroeder (Eds.), Stem education 2.0 (pp. 350-363). Brill.
[45] Larsen, M. A. (2016). Globalisation and internationalisation of teacher education: A comparative case study of Canada and greater china. Teaching Education, 27(4), 396-409.
[46] Colomer, J., Serra, L., Cañabate, D., & Serra, T. (2018). Evaluating knowledge and assessment-centered reflective-based learning approaches. Sustainability, 10(9), 3122.
[47] Gao, Y. (2014). An emerging giant of science: Achievements and challenges of stem education in china. In B. Freeman, S. Marginson, & R. Tytler (Eds.), The age of stem (pp. 47-66). Routledge.
[48] Atkinson, R. D., & Mayo, M. J. (2010). Refueling the US innovation economy: Fresh approaches to science, technology, engineering and mathematics (stem) education. The Information Technology & Innovation Foundation. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1722822
[49] Zhong, B., Liu, X., Zhan, Z., Ke, Q., & Wang, F. (2022). What should a Chinese top-level design in stem education look like? Humanities and Social Sciences Communications, 9(1), 1-8.
[50] Aziz, A. A. A., & Rowland, S. (2018). The entrepreneurship skills that biotechnology graduates need: Findings from entrepreneurial employees in a developing economy. Entrepreneurship Education, 1(1), 61-83.
[51] Ministry of Education of China. (2016). The 13th five-year plan for educational informatization. http://www.moe.gov.cn/srcsite/A16/s3342/201606/t20160622_269367.html
[52] Steiner-Khamsi, G. (2014). Cross-national policy borrowing: Understanding reception and translation. Asia Pacific Journal of Education, 34(2), 153-167.
[53] Tan, C. (2016). Educational policy borrowing in china: Looking west or looking east? Routledge.
[54] Klikauer, T. (2019). Stem--education for the global economy. Australian Universities' Review, 61(2), 93-97.
[55] Yamada, A. (2021). Globalisation in higher education: Bridging global and local education. In J. Zajda (Ed.), Third international handbook of globalisation, education and policy research (pp. 269-284). Springer International Publishing.
[56] Tan, C. (2015). Education policy borrowing and cultural scripts for teaching in china. Comparative Education, 51(2), 196-211.
[57] Steiner-Khamsi, G., Silova, I., & Johnson, E. M. (2013). Neoliberalism liberally applied: Educational policy borrowing in central asia. In J. Ozga, T. Seddon, & T. S. Popkewitz (Eds.), World

ISSN 2663-8169 Vol. 5, Issue 22: 17-25, DOI: 10.25236/IJNDE.2023.052204

yearbook of education 2006 (pp. 217-245). Routledge.
[58] Burdett, N., & O'Donnell, S. (2016). Lost in translation? The challenges of educational policy borrowing. In (Vol. 58, pp. 113-120): Taylor & Francis.
[59] Steiner-Khamsi, G., & Waldow, F. (2012). World yearbook of education 2012: Policy borrowing and lending in education. Routledge.