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Preparing Science Teachers Across the World

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Abstract
The aim of this study is to examine the professional identities of the academic staff of the faculties of education in Turkey. The study employed the Q methodology, in which both quantitative and qualitative data can be used. The qualitative data were collected and analysed by interviewing seven academics working in the faculty of education in the first stage of the study, which was conducted in two sequential stages. The analysis of the qualitative data showed that the academic staff of the faculty of education defined their professional identities as a "Practitioner", "Researcher", "Instructor", "Coach", "Counsellor" and a "Preparer". In the second stage of the study, the Q measurement tool was developed by the researchers based on the specified definitions for professional identities. The quantitative data were collected from 21 academics working in the faculty of education and analysed with the Q measurement tool. According to the analysis of the quantitative data, the academic staff of the faculties of education were seen to adopt six professional identities defined in general. In addition, the professional identity as a "Researcher" was found to be the most preferred, while the professional identity as a "Preparer" was the least preferred of the given identities. According to the findings obtained in the study, it was concluded that the educational experience of the academic staff of education faculties significantly differentiate the preferences and attitudes towards professional identities. Based on the findings and results obtained in this study, it is highly recommended to examine the role of the educational experience of the academic staff of education faculties in the change and transformation of their professional identities.

Key Words: Faculty of education, academic staff, professional identity, Q methodology

Introduction

Teacher quality has been a global issue for many years. For example, in 2005 the Organization for Economic Cooperation and Development (OECD) called for a focus on teacher quality so that student achievement and literacy could increase. All countries seek to improve their schools' and students' abilities and knowledge "to respond better to higher social and economic expectations" (OECD, 2005, p.1). This report concludes that the efficiency, quality, and equity of schools and education are dependent upon the quality of the teachers. The OECD (2018) reaffirmed the importance of teachers in 2018 when they stated that all teachers were the most important resource in education.

Within the broader field of teacher education, teacher quality has been discussed as consisting of content knowledge, content pedagogy, and teaching experience (Dar-

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ling-Hammond, 2017). Ultimately, teacher quality starts with teacher preparation programs and the knowledge and experiences they gain. Within science, technology, engineering, and mathematics (STEM) education, there are growing pressures to improve the quality of K-12 STEM education for countries to become more competitive in the global economy. For example, in the United States, the National Research Council (2007) and the President's Council of Advisors on Science and Technology (PACAST) (2012) have made calls for the improvement of STEM education for science literacy and economic gain. Teacher quality based on initial teacher education, as one factor, has been showed to improve mathematics performance in the developing country of Kenya (Barasa, 2020). The pressure is consistent with market-driven neoliberal government policies. One metric that has influenced countries to improve their economy and international competitiveness is through performance on international assessments of student leaning in STEM, such as the Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS). For example, Ingvarson and Rowley (2017) found that 17 countries with strong policies for assuring quality teachers also had students who performed strongly on international mathematics tests. As such, governments are starting to realize the importance of teacher preparation, and especially in STEM related fields, as these areas of education are often viewed from a neoliberal perspective as the gateway to a better society and economy (National Academy of Engineering and National Research Council, 2014). Research provides support for a neoliberal perspective for teacher education that is driving competition and comparisons among educational systems, including teacher preparation programs (Craig, 2016). For example, Lay and Chandrasegaran (2018) found that eighth grade student scores on TIMSS were positively related to how well science teachers were prepared. This article specifically explores the policies and influences on science teacher preparation (STP) in different countries around the world and how neoliberalism has influenced STP programs.

The impetus for this study originated in prior work as part of a joint task force of the National Science Teaching Association (NSTA) and the Association for Science Teacher Education (ASTE) that was charged with redrafting the 2012 Science Standards for Teacher Preparation (Veal & Allan, 2014) in the United States. The resulting 2020 Science Teacher Preparation Standards (Morrell, Pyle, Park Rogers, Roehrig, & Veal, 2018a; Morrell, et al., 2018b) were purposefully aligned with the Framework for K-12 Science Education (NRC, 2012) and resultant Next Generation Science Standards (NGSS) (NGSS Lead States, 2013). These two documents dramatically expanded the scope of science teaching to a three-dimensional framework of disciplinary core ideas, science and engineering practices, and cross-cutting concepts. The new standards for STP clearly address the need to effectively prepare future science teachers to implement the goals of the Framework (NRC, 2012) and support state agencies and external accreditation bodies in the accreditation and evaluation of STP programs

across the United States. The resulting 2020 Science Teacher Preparation Standards (Morrell, et al., 2018a; Morrell, et al., 2018b) needed to be responsive to local, state, and national policies and expectations, as well as aligning with existing accreditation processes. Prominent policy drivers were workforce preparation, increased scientific literacy, and global competition (e.g., Bronson & Merryman, 2010; Freeman, Marginson, & Tytler, 2014; PCAST, 2012).

This study is driven by questions about the nature of secondary STP accreditation outside of the United States and curiosity about how secondary STP in other countries are influenced by the aforementioned driving forces, and in particular the need for global competitiveness and STEM workforce development. The following questions guided our work: a) Are STP programs accredited, and if so, how; b) Do teacher preparation standards exist, and if so, who determined these and are they general and/or science-specific; c) Who are the governing bodies deciding what is included in a STP program; and d) How might a country's economic standing influence STP? In addition, the team also looked for other potential impacts such as historical influences (e.g., colonialism and religious impacts). Considering these questions and other potential impacts, ultimately the aim of this paper was refined to examine the policies and influences on STP in different countries for the purpose of understanding the state of STP more globally.

Theoretical framework

Given the focus of K-12 science standards on workforce readiness across the globe, comparisons among international science test scores, and publicly ranking schools based upon science assessment scores (e.g., Carter, 2017; Guerrero & Farruggio, 2012), neoliberalism, a construct embodied in each of these factors, was selected as the theoretical lens through which to frame the study. Indeed, the conflation of science education and STP with a nation's global identity in the economic arena is a driving factor for the preparation of science teachers and development of scientific literacy in K-12 education. Research suggests that science teaching is designed to serve the needs of industry in science and technology (Smith, 2011).

There is an abundance of definitions for neoliberalism. The term grew out of the Walter Lippmann Colloquium in France in 1938 as an exercise to rethink liberalism after the Great Depression. Neoliberalism developed out of the need for a better society and economic situations. The ideology states that markets, not governments, can solve most of society's problems using personal responsibility and competition. Neoliberalism is the "deliberate intervention by the government to encourage particular types of entrepreneurial, competitive and commercial behavior in its citizens with the market as the regulatory mechanism" (Carter 2016, p. 33). As such, the promotion of a free-market economy directs how governments manage issues of social programs (Greenblatt 2018). In the 1970's, the common ideas implemented and fostered were

small government, the rights of individuals, personal responsibility, free trade, and an interconnected world economy. However, the implementation of neoliberal ideas in education in some instances has been problematic. For example, in Chile, the dictatorship government of Pinochet "restructured education based on the principles of efficiency and competition" that led to the "clean-up" of the programs' curricula due to the dangerous "controversial issues" that were against the government agenda (Fernandez, 2018, p. 4).

Other potential problematic acts of neoliberalism in education have been found under the guise of educational reforms which are, "enacted in the form of standardization, individualism, outcome-based accountability, and free-market policies" (Greenblatt, 2018, p. 805). Sharma (2017) stated that stricter standards of accountability have increased pressure on teacher quality measures based upon a neoliberal perspective. Within the United States, the No Child Left Behind Act of 2002 mandated standardized testing which was used as both a school and teacher accountability mechanism (Greenblatt, 2018; Jenlink, 2017a). This placed schools in competition (Guerrero & Farruggio, 2012) resulting in school choice policies that have resulted in the proliferation of charter schools (Ozmantar & Karatasoglu, 2019), which are often privately run, in alignment with the neoliberal view that private is superior to public (Lipman, 2013). In turn neoliberal policies impact institutes of higher education (Al-Haija & Mahamid, 2021; Johnson, 2018) and teacher education programs (Jenlink, 2017b) and de-professionalizes teacher educators (de Saxe, Bucknovitz, & Mahoney-Mosedale, 2020). Several scholars describe the rapid growth of alternative pathways to teaching over the past two decades as part of "the broader neoliberal assault on public and teacher education" (e.g., Nygreen Madeloni, & Cannon, 2015, p. 107).

The global embrace of neoliberalism means that these issues are not unique to developed countries and the western world. Within the developing world, the social value placed on education is being "seriously challenged by a market-driven neoliberal agenda" (Guerrero & Farruggio, 2012, p. 554) and "the corporate model of market competition" (Rahm & Brandt, 2016, p. 183). Promoting access to education is seen as a mechanism to increase economic growth (Tarabini, 2010); however, neoliberal globalization has focused government attention on competitiveness and economic reforms (Tarabini, 2010). Consequently, the public school system in many developing countries is underfunded resulting in a rise in private school enrollment and increases in inequality gaps (Ogamba, 2020; Tarabini, 2010). The distinction between private and public is also found at the university level and how teachers are prepared in some countries (e.g., Fernandez, 2018). This view is promoted through the economic and techno-determinist paradigm of the International Monetary Fund, the World Bank, and the Organization for Economic Co-operation and Development with the result that higher education is aligned to the demands of neoliberal globalization in almost every country across the world (Banya, 2010). The substantial aid offered through entities

such as the World Bank represent "the exportation not only of resources and technologies, but of Western thought" (Calderone & Rhoads, 2010, p. 8).

Western/Eurocentric standards are exported primarily with the expectation of leveling economies and productivity but directs "blame" towards those that cannot "keep up" with more competitive economies. This process that is designed to promote economic integration on a global scale also tends to create greater divides and polarization of wealth. As a result, the goalpost of market competitiveness for those countries viewed as "lagging" becomes less attainable. There is a tendency by policymakers to see education solely as a means to the end of closing the competitiveness gap (Coxon, 2002). On the world stage, the OECD and World Bank have supported the "scientific and technical rationality of educational reforms" (Diniz-Pereira, 2002, 381) which employ student performance as the tool of teacher accountability (Christou, 2010) and thus teacher preparation. As a result, teacher education is driven to more conservative and homogenous reforms, particularly in those countries deemed as "behind" and thus market non-competitive. In the neoliberal aim of empowering labor (e.g., teachers) to be more highly qualified and thus able to move to better "market" conditions, if realized would only come at the expense of local or national education traditions (Humes, 2008). The very bureaucracies designed to ensure conformity have the net effect of diminishing market competitiveness, meaning that such countries will never be able to catch up.

The use of comparative studies has become useful for policy making and reform efforts in education. The global understanding of the importance of education entices educators to learn from one another and apply knowledge to their own contexts. As Adamson (2012) stated, "The predominance of neo-liberal discourses in education [have] increased the uniformity of policy goals, reinforced by international measures of student performance such as PISA and IEA" (p. 641). The forces of globalization have forced countries to alter their STP programs to accommodate neoliberal and national policies (e.g., Fasching-Varner, et al., 2020). Education has become an economic goal and outcome for the good of the country with concepts from business infiltrating educational policy (e.g., accountability, standards for quality assurance, and competitiveness).

Methodology

The goal of this study was to explore secondary STP programs across different countries and the factors that dictate STP practices. Thus, the research design is a multiple case study (Yin, 2009), with each case representing a single country and their policies and practices related to secondary STP. The data sources included interviews with a key informant in each country and relevant policy documents. This allowed new insights and interpretations to be derived (Adamson, 2012). This study focused on an a priori research perspective that included an interpretive approach, a unit of analysis

being the secondary STP, and data that included interviews with STP faculty, government policy documents, and the research literature surrounding STP.

The research team decided to look broadly at countries around the globe to understand the driving forces behind secondary STP. In doing so, the process originally started with a geographical approach. After reading the literature on comparative education, the research team decided a systematic approach to trying to discover common themes across countries in different geographical regions. Classification based upon economic and income classification from the United Nations report "World Economic Situation and Prospects" (United Nations [UN], 2020) was used to find countries that were both similar to and different from each other based upon economic and income characteristics. The economic classification is a composite grouping based on "basic economic conditions," which includes the growth of Gross Domestic Product. The income classification is based upon the country's "per capita GNI [gross national income], a human assets index and an economic vulnerability index" (UN, 2020, p. 164). Table 1 contains the economic and income classifications for the countries used in this analysis of STP driving forces/processes. Once the regions were selected, the specific selection of countries was purposeful and focused on those countries with whom the research team members had contacts with key informants working with secondary STP.

Table 1.
Listing of Countries Analyzed and their World Economic and Income Classification

Developing		Geographic Region	Country
	High Income	Asia	
			Republic of South Korea
			Israel
			Oman
		South America	
			Chile
	Upper Middle	Africa	
			South Africa
		Asia	
			Thailand
		South America	
			Brazil
	Lower Middle	Africa	
			Egypt
			Zimbabwe
		Asia	
			Pakistan
			Indonesia
Developed			
	High Income	Europe	
			Ireland
			Spain
			Sweden
		North America	
			Canada
			United States
		Pacific	
			Australia

Data collection

Data collection was achieved using multiple data sources. Within each country, the key informants were mostly academics in a STP program since these people would most likely understand the practical implementation of STP practices and policies. Informant interviews were recorded and either transcribed or summarized by the researcher, with each interview lasting approximately 60 minutes. The interview focused

on understanding the teaching profession; general influences on STP (e.g., historical, cultural, international assessments/competition, religious, etc.); pathways and responsibilities of teacher certification; accreditation processes for higher education programs; differences among primary and secondary STP; external influences of policies impacting STP (e.g., national curriculum, teacher assessments, employment hurdles, economics, etc.); and the autonomy permitted under policies and accreditation procedures. Each informant was asked to share relevant policy documents for supplementary analysis. Additional documents were added by the research team; for example, the Teaching Council of Ireland's 'Initial Teacher Education: Criteria and Guidelines for Programme Providers (2017), the Zimbabwe National Qualifications Framework (2018), the National Qualifications Framework Act in South Africa (2008), the Chilean 'Evaluation Criteria for the Education Career' [translated] (2009), Korean Science Education Standards (2019), and The Australian Professional Standards for Teachers (2011). Research articles and book chapters on teacher education and science teacher education (e.g., Al-Balushi, et al., 2020; Hali, Zhang, Al-Qadri, & Bakar, 2020; and the *International Handbook of Teacher Education World-wide: Issues and Challenges* (Karras & Wolhuter, 2010) and the International Handbook of Teacher Education (Karras & Wolhuter, 2019) were also included as additional data sources.

Data analysis

The informant interviews were initially coded using a *priori* themes identified from the literature review: competition, government influence, teacher education standards, certification of programs, and economic mobilization. All of the videos, transcribed notes, and policy documents were available for all researchers to confirm understanding of the findings. Trustworthiness was achieved through the agreement of all researchers on the emergent themes and by triangulating the interview data, policy documents, and published scholarly work. Thick description was accomplished by developing a table of data aligned with all the research questions. Data analysis produced emergent themes (science-specific teacher preparation standards, influences by Western thought, accreditation, autonomy, and competition) that complemented the existing themes (Appendix). Complementary document analysis (Bowen, 2009) was conducted on the various policy documents to further understand the goals, structures, and processes of STP. Following the coding of each individual case, a cross-case analysis was conducted to look for broad themes across the different countries. The following section contains the qualitative themes from this cross-case analysis.

Findings and Discussion

As previously noted, the aim of this paper was to examine the policies and influences on secondary STP in different countries for the purpose of understanding the state of STP more globally. The cross-case analysis led to the identification of five

major themes influencing secondary STP: science-specific teaching standards, local autonomy, accreditation, Westernization, and competition. Each of these are described below, followed by illustrative case studies that elucidate the theme.

Science-specific standards for teacher preparation

All the countries in this study had accreditation standards for teacher preparation, however, only Israel, Oman, Chile and the U.S had science-specific standards for the accreditation of STPs. Interestingly, these science-specific accreditation standards were often similar to those within the U.S. For example, Israel adopted science-specific standards similar to the previous 2012 Science Standards for Teacher Preparation from NSTA that focus on content, classroom environment, teaching methods, and support. These are applied mainly in the professional development of teacher leaders rather than preservice teachers. While Oman has its own national science-specific standards for secondary science teachers, at least one private university in Oman modeled their accreditation system from the Council of Accreditation of Education Programs of the U.S., which also included NSTA's former 2012 science-specific standards.

Independent of the U.S. model, Chile's Ministry of Education developed science-specific standards for teacher preparation. The standards are based upon a set of performance-based statements for each content area (e.g., physics, biology, and chemistry) that can be observed and a "level" that must be achieved by a future science teacher. The science-specific standards were developed so that preservice teachers know the specific K-12 science curriculum, understand how students learn science, can plan and implement learning experiences, and reflect on student learning achievements. Additionally, this initiated a voluntary diagnostic assessment program (INICIA) that allowed the government to collect data on program quality. As of 2016, the government uses the data for accreditation purposes by comparing the achievement of the students coming from the programs with the K-12 student test scores. Low correlations may lead to decreased funding.

In the absence of science-specific standards for teacher preparation, other policy structures exist to monitor STP programs. For example, in South Korea secondary teachers are trained in undergraduate and graduate programs of education and licensed by the Minister of Education. Students wishing to teach science are subjected to science-specific testing with a focus on both content and pedagogy. In effect, the licensing exam serves as a gatekeeper to becoming a licensed teacher. After the licensing exam, candidates must also undergo a screening process at the local, provincial offices. The Metropolitan and Provincial Offices of Education may also require a science skills test for secondary science teacher candidates. Licensing exams and science skills tests are the de facto science-specific standards for teacher preparation, as exemplified in South Korea and in other countries (e.g., Egypt, Ireland, Spain, and Sweden), although they may vary by their administration (civil service examination in Spain; quasi-gov-

ernmental governing board as in Ireland).

In most cases, regardless of the economic and income classifications, STP programs were heavily influenced by the K-12 science standards and nationally approved K-12 science curriculum. If the preservice standards were not science-specific, then most secondary preservice teachers were trained to teach to the K-12 science curriculum, which reflected 'educational reform' in the sciences and the de facto science-specific standards (e.g., Egypt, Pakistan, Thailand). For example, Zimbabwe added STEM courses to the K-12 curriculum with the goal of preparing a literate workforce in STEM fields. This resulted in the STP programs creating additional methods courses with a STEM focus to reflect the neoliberal framework of the government.

Local autonomy

Part of the neoliberal application in education is the determination of who or what makes decisions with self-autonomy reflecting a neoliberal position. In some countries (e.g., Thailand) there are national science K-12 science standards and preservice teachers must learn the content and pedagogies to teach them. In some instances (i.e., Ireland), there is an assumption that attainment of a science degree confers appropriate content competency to new teachers. However, in other countries, the decisions of what students are to learn K-12 are determined at regional/provincial/state levels, such as in Brazil, Canada, and the United States. This more local level of autonomy affords classroom science teachers, and similarly STP programs, the opportunity to focus on critical issues in science, such as the climate change, and the impacts on their particular regions. For example, in Canada some provinces have shifted focus away from traditional Eurocentric views of science to establish goals for science instruction that include understanding science for addressing environmental impacts (e.g., Climate Science) or to provide a more native perspective through the use of an Indigenous Knowledge Systems (IKS) framework (Baker & Heller, 2019). Examples of such provinces making local decisions to consider IKS in the teaching (and thus preparation of teachers) are Saskatchewan and Manitoba (key informant, personal communication, July 16, 2020).

When a country takes a region-by-region approach to deciding what to teach in science, teachers are also exposed to the same criteria in their teacher preparation. This can create some discrepancies, as shown in the United States and Brazil, where not all students are evidence-based perspectives on climate change or evolution. This issue is of particular concern currently in Brazil as there has been a growing religious movement against the teaching of evolution at the secondary level, and many with this particular view have started to enter the political arena in different regions of the country. As such, talks have started to occur about the proposal of laws that would require teaching creationism as a viable theory alongside or in place of evolution (key informant, personal communication, August 12, 2020). If such laws were to succeed, it

would have a significant impact on how secondary life science teachers are prepared to teach evolution. Therefore, while local autonomy can have some benefits for students to gain an understanding of the purpose of science with respect to explaining everyday phenomena in their daily life, as well as impacts on their daily living, it can also create bias or divisiveness with respect to the questions, "Whose knowledge is of most worth?", "What should be taught in schools?", and "How should it be taught?" (Baker & Heller, 2019).

Accreditation

In all countries examined, a government accreditation system existed to provide quality assurance in university programs that reflected the neoliberal position on accountability and competition. Note that this is different to ascertaining an individual's ability to teach (e.g., teacher licensing, registration, or certification, depending on the system). Accreditation of programs and universities were based upon government mandated standards that were pedagogical in nature. In some countries, the university was accredited (e.g., Australia, Brazil, Egypt, Spain, Sweden, Thailand, Zimbabwe); while in others, specific programs of study were accredited (e.g., Ireland, Pakistan, Canada, Chile, Israel, South Africa). Some countries have both a program and university level of accreditation that are based upon generic pedagogical standards (e.g., Indonesia, South Korea, United States). In these cases, colleges and programs were accredited together. Accreditation in most countries studied is based upon recommendations made by the national government on developing a workforce to promote the economy and international standing. These recommendations are then interpreted and applied in the development of K-12 standards and curriculum at state or provincial levels.

Accreditation in some countries is reflected in the approval of the K-12 curriculum, the syllabi used by science methods instructors, and the theoretical framework that guides STP. One example of this is Canada, where each province determines their own requirements for certifying a teacher and universities have some autonomy in what they require in their programs to meet these certification requirements, and thus what they present for accreditation to their governing bodies. However, a common thread across the provinces and territories is a focus on candidates demonstrating in their courses a knowledge of and the ability to teach the K-12 science curriculum. In another example, accreditation is implemented by an accrediting body for the syllabi of the science methods courses (e.g., Malaysia, Egypt, and Zimbabwe). The guiding principle in Zimbabwe for the science teaching methods curriculum is to promote STEM, which is a government initiative in the K-12 schools and assessed by a government agency. Thus, STP places a focus on integrated STEM preparation. Going even a step further, in Israel and Egypt there is a mandatory curriculum for teacher methods courses that reflects the K-12 curriculum. Lastly, using a slightly different approach, in Sweden, pedagogical content knowledge is the accepted theoretical framework for

training secondary science teachers. Therefore, all teacher preparation programs integrate pedagogy and science content into their methods courses but again the content is in line with what is expected for teachers to teach in the secondary science curriculum.

The need for initial or continuing accreditation of programs also varies among countries. In the case of Egypt and Pakistan, there is a process for national accreditation but not all universities have yet undergone a review or been accredited. In Israel, an initial decision is made concerning accreditation by the Council for Higher Education, and there is some follow-up for continuing accreditation. Conversely, in Australia, a program is accredited for a period of time (generally two to five years), but an annual report must be compiled and filed with the accrediting agency and any major changes to a program of study needs prior approval by the accrediting body. The existence of and the power of accrediting bodies, and thus their oversight of program implementation, is inconsistent across the countries studied regardless of economic standing.

In all countries, accreditation is based upon a set of standards that the programs or universities must meet. In several countries, the rationale for developing the standards and evaluating programs and universities using government accrediting agencies is to assure the policymakers that the citizens are being prepared to be part of a competitive workforce. The impact of program accreditation resonates with keeping STP comparable globally and competitive nationally, which are hallmarks of neoliberalism. For example, the outcomes of the accreditation process, in all instances, impact either the continuation of the program or the program funding. This has economic consequences for the university and often creates an air of competition among ITE programs. For example, in the United States, if an educational program is not accredited, the teacher licensing bodies will not recognize the program, and thus graduates of the institution will not be eligible for certification to teach.

Westernization of science teacher preparation

All of the countries studied had a similar approach to secondary STP. Secondary science teachers are required to have degrees or the equivalent of a major in a science discipline, as well as a minimum number of credits in education and pedagogy coursework. This pedagogical coursework routinely included practicum experience and student teaching. It was notable that within developing countries, the program of study, courses, and guiding theory for STP programs were aligned with western perspectives.

A pattern was found in some of the developing economies (e.g., Egypt, Pakistan, Indonesia, Thailand, Zimbabwe), of professors who earned education PhDs in countries with western perspectives and returned to their home countries to begin their academic careers. For example, in Thailand, both key informants had completed their PhDs in the U.S., and they also mentioned many of their colleagues had completed similar graduate level education in the U.S. or United Kingdom. Having received

training in countries holding western perspectives resulted in an infusion of western reforms, such as the ideas described in the Framework for K-12 Science Education (NRC, 2012), and the globalization of reforms such as a STEM approach to science teaching. In Thailand, this globalization of education reforms resulted in a push for STEM specific courses in STP, as well as teacher re-training provided by the Institute for the Promotion of Science Teaching, an autonomous agency under Thailand's Ministry of Education. While funding to support the graduate education and improvement of universities is sometimes provided by the national government, other international organizations (e.g., USAID, World Bank, and Fulbright) have also promoted the exchange and education of students. While one intention of globalization of education is to aid less well-developed countries (by Eurocentric standards), it can come at the cost of local or national distinctiveness (Humes, 2008).

It is important to note that these countries, which are former colonies of various western nations, are still in the process of building a system to develop their own PhD granting programs. The developing economy countries in this study gained independence in the 1940s and 1950s. Access to free education was used as a mechanism for growth. For example, in Egypt, President Nasser (1956-1970) established a free education system with the expectation that all students were to complete at least elementary school. The need to educate more and more students who were enrolling in the free educational system created a massive demand for teachers which resulted in the hiring of untrained teachers and the implementation of lecture-based classroom practices as Egypt struggled to fulfil the growing need for teachers (El-Deghaidy, 2010). In the past two decades, developing countries have mandated more rigorous education teacher preparation. For example, in Egypt in the early 2000s laws were passed requiring that teachers formally complete an education program. At the same time, the national strategy to enhance the education system in Egypt called for quality assurance and accreditation in higher education. This initiative was funded by the World Bank and utilized the international Quality Assurance and Accreditation in Higher Education (QAAHE). International accreditation of institutes for higher education is considered necessary to compete globally and ensure the ability of graduates to enter advanced degrees across the world. Similarly, in 2010 USAID supported significant changes in Pakistan's teacher education system to require a four-year Bachelor in Education degree for teachers instead of the prior one-year program.

Competition

A hallmark of neoliberalism is market competitiveness. Within teacher preparation, this is realized through the ability of governments to use teacher accreditation and associated measures, such as scores on teacher license exams and performance assessments, to draw comparisons across STP programs and thus determine their contribution to market advantage. As described in section 4.3, accreditation systems are

used to control teacher preparation programs and potentially remove the authority to prepare teachers. However, in some countries, accreditation and test scores are used to determine funding and future STP enrollment. For example, in South Korea, the outcomes of accreditation determine the enrollment cap set for the university programs, thus creating competition amongst STP programs.

In spite of the existence of standards for teacher preparation, it was noted that in several countries' policy decisions were made to subvert these standards and make it easier to enter into the teaching profession, especially to address a perceived shortage of secondary science teachers. Examples of alternative teacher pathway programs are Teach for America and Teach for Australia. Teacher education programs are forced to compete for students from these alternative programs which often yields negative consequences for the quality of teacher education programs (Nygreen et al., 2015). These 'teach for' programs are fast-tracked, with the teacher candidates generally receiving less than two months of formal preparation before being placed in a classroom as the teacher of record, generally in a high needs school. These alternative certification programs vary in terms of how much teaching is required, the amount of supervision, and the existence of an in-school mentor. These programs lead to a focus on more general teacher preparation, even at that secondary level, and less focus on discipline specific training. Although they provide competition to standard teacher education programs, these alternative pathways tend to be costly, and the resultant teachers tend not to stay in the field (e.g., Clark, Isenberg, Liu, Makowsky, & Zukiewicz, 2017; Glazerman, Mayer, & Decker, 2006). In response to these fast-tracked models of teacher preparation, university STP programs may feel a need to compete for students resulting in the creation of more efficient models further eroding the quality of STP by decreasing coursework and preparation for teaching (Nygreen et al., 2015).

Similarly, policy decisions made for the economic advancement of a country have also resulted in the privatization of K-12 schools and institutions of higher education, magnifying rather than suppressing economic disparities (Papastephanou, Christou, & Gregoriou, 2013). For example, public schools in Pakistan struggled to cope with the rapid influx of students which led to the proliferation of private schools (Khamis, 2010). Teachers in private schools are not held to the same levels of accountability of those in public schools and in developing countries they are less qualified and rarely required to be licensed (UNESCO, 2014), thus creating another loophole in policies related to STP. Indeed, in countries such as Egypt and Pakistan, the primary requirement for private school teachers is English language proficiency rather than teacher certification.

Conclusions and Implications

The quality of education and student achievement is directly tied to the quality of the teacher and thus the quality of the teacher preparation program (Bales, 2015).

Results indicate that governments can control science teacher preparation through direct and indirect means through policy and accreditation standards. In most countries studies, the implementation of policy and accreditation standards were to improve the teacher preparation programs and teachers so that ultimately students would develop into meaningful participants in a national and global economy. In order to advance a neoliberal agenda, all countries instituted standards for teacher preparation that reflect the characteristics of preparing a competent workforce, competing economically on a global scale, and instituting accountability through accreditation. Other countries in this study (e.g., Ireland, Spain, Thailand, Indonesia, Israel, Chile, Brazil, and Zimbabwe) implemented policy initiatives at the national level that governed standards at the university level. In analyzing the policies and influences on STP programs across the globe in 17 countries, we found more similarities than differences, reflective of a globalist-based homogenization. While few countries had science-specific teacher preparation standards (Israel, Oman, Chile, and the United States), all countries had some kind of teacher standards and an accreditation program in place to help ensure teacher quality. What was included in teacher preparation programs (content course requirements, pedagogical courses, educational theory courses, and practicum experiences) was similar and reflected a Western perspective, though different areas were stressed in different countries. Generally speaking, however, there was a greater emphasis on the science content at the secondary level and a lesser focus on pedagogy. Additionally, the K-12 science curriculum is deemed as a driving force for how science teachers are prepared, and the K-12 curriculum can often be heavily influenced by the need for workforce readiness (Rahm & Brandt, 2016). While the teacher preparation standards are general in nature, most education programs and science methods courses had the autonomy to implement their interpretation of the standards. In many cases, the developing countries were highly influenced by Western thought and training.

Recognition of structural inequalities will aid a government's ability to develop the human capital of all citizens to increase the economic stability of the country. Regardless of geographic location, economic status, historical and cultural influences, all countries were ultimately driven by a neoliberal view to enhance and expand the STEM workforce. An indirect global influence was the western ideas on teacher education program structure and courses and the importing of theoretical and philosophical ideas from teacher education professors who were educated at the doctorate level in westernized countries.

Globalization was established through the education and preparation of human capital that could advance the free markets and international trade of each country. However, this vision has yet to be realized in an economically or philosophically meaningful way within the policies influencing teacher preparation. Therefore, if nations continue to adopt conservative policies viewed as most likely to retain market competitiveness, globalization will not come to fruition.

Social justice was not something raised in discussions, noted in the documents reviewed, nor part of the structural questions in the protocol. Social justice was a pivotal point that could have emerged from the interviews or the documents but was mostly a side note to the discussions. Currently, the use of the social justice framework is almost exclusively used in education, but rarely in international comparative articles and studies due to the fact that many countries have not adopted its tenets (McDonald & Zeichner, 2009). Future comparative articles and studies using a neoliberal framework, which promotes personal responsibility and competitiveness, need to investigate the presence of social justice within the teacher education program. Specifically, Fernandez (2018) suggested that teacher education for social justice (Sleeter, 2008), the theory of teacher education for social justice (Cochran-Smith, 2010), and social justice teacher education (McDonald & Zeichner, 2009) should be integrated into all teacher education programs due to the recognition of diversity and culture. Within STP there were two examples of this starting to occur. The first is Australia, where accreditation of teacher preparation programs must ensure that graduates meet the Professional Teaching Standards 2.4 and 1.4: "understand and respect Aboriginal and Torres Strait Islander people to promote reconciliation between Indigenous and non-Indigenous Australians" and Strategies for teaching Aboriginal and Torres Strait Islander learners (Australian Institute of Teaching and School Leadership, 2017). The second example is Canada, where some provinces are taking an Indigenous Knowledge Systems framework to better understand the changes in the environment and the effects of this on populations with strong connections to Earth's natural resources.

The recent COVID pandemic has had an influence on the international preparation of science teacher educators. The closing of borders, restrictions on some international travel, curtailing of issuing of student visas, and hindrances to acceptance of international students have led to a change in patterns of international student education. Similarly, changes in political alliances among countries may also influence a move away from promoting a degree from a Western university to more of a home-grown approach. Regardless, it is unlikely the push for global competition in the marketplace will cease to influence science education and hence science teacher preparation.

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Appendix
A priori and emergent themes with data*

Theme	Country: Data Example
Government Influence	Zimbabwe: Developed teacher education standards for the purpose of economic development. Egypt: Government oversight is also ensured by the fact that "a representative of the Ministry of Higher Education has to sit on the board of each new private university in order to report back on the university's activities." Brazil: Theoretically, the Ministry of Education should warrant the standards of teaching. In practical terms, things are or course different. Ex. --- Northeast Brazil is the lowest economically and the institutions are the lowest ranked. In the Southeast you have the wealthiest states and the best universities. Teachers in these two areas assess/judge the teaching of each other. The system is built so the status quo is kept. Inequities remain. Curriculum (national or not) as a driving force [is it taking a neoliberal view]--- There seems to not be teacher standards -- but teachers are prepared to show evidence that they are capable of teaching the K-12 science standards. Chile: Military government took a neoliberal approach - more capitalist and privatizing of education. Oman: "High quality teachers were needed to build society so that individuals or learners could benefit, excel, and be as innovative and creative to make a stride toward economic, social and political growth"
Teacher Education Standards	University Level: Brazil, Egypt, Spain, Sweden, Thailand, Zimbabwe Program Level: Ireland, Pakistan, Canada, Chile, Israel, South Africa Zimbabwe uses standards from one university which is mandated to be the official developer of standards for the country. National Level: Australia follows the Australian Professional Standards for Teachers
Certification of Programs	Sweden: National Agency for Education Spain: National government using European Union standards. Ireland: The Teaching Council Israel: Each university does it using national standards. Egypt: Each university by default using national standards. Thailand: Thailand Education Council accredits the schools/faculty of education specifically. Australia: State level College of Teachers accredits the university teacher education programs.
Economic Mobilization	The labor force is neoliberal, and the accreditation process is based on trust. Shift to free market capitalism. If markets make decisions, the push for accreditation is necessary but there are loopholes with engineers who can teach with little training. Business model in that citizens and existing teachers can get "upgrades" and "certificates" to be certified to teach. Brazil: Textbook companies were powerful in making shift to more national curriculum in 2021. Indonesia: Minister of Education is a businessperson who has introduced business terms, experiences (e.g., internships), and outcomes in education. Ireland: The lack of native industry drives interest in direct foreign investment in STEM and related professions.

	Pakistan: From the accreditation website, "In the backdrop of globalization, knowledge economy, technological advancements as part of fourth industrial revolution, teaching has become highly complex and demanding.
Competition	Australia: Competitive, Universities strive for strong Excellence for Research for Australia (ERA) ratings, rankings are important, PISA scores are monitored, national science priorities exist. "Participate in TIMMS and PERLS but don't do well, Human Sciences Research Council wants better results." Canada: Participates in PISA and rank 10th or higher typically, but this does not seem to drive anything with what happens in Sci Ed for the country. Egypt: Changes in laws and standards are responses to competition, raising PISA scores. South Korea: "Students score well on PISA on their own, MOE displeased with a drop in rankings. STEM is a big push from MOE and parents"
Science-specific Teacher Preparation Standards	Australia: National teaching standards that are general. Chile: Develop some science-specific by themselves. United States: NSTA science teacher preparation standards (2012 & 2020) Oman uses NSTA science teacher preparation standards (2012) Israel developed their own science-specific ones. Thailand: Teachers are prepared Grades 1-12 by subject. They graduate from a "science teacher preparation program" and all are prepared for the possibility of teaching science at primary or secondary level. Science coursework was necessary, so this dictated the science content of these teachers. (South Africa, Zimbabwe, Canada, Australia, South Korea, Spain, Indonesia, Egypt, Pakistan, Chile)
Influences by Western Thought	The faculty in these more transitioning less Westernized countries receive their PhDs and how long ago to see the influence the High income/advanced countries are having on preparing faculty of education....which trickles down to preparing teachers. Egypt: "Lots of international influence – e.g., USAID involved in teacher training."
Accreditation is General	University Level: Brazil, Egypt, Spain, Sweden, Thailand, Zimbabwe Program Level: Australia, Ireland, Pakistan, Canada, Chile, Israel, South Africa University and Program Level Standards for Accreditation: Indonesia, South Korea, United States. Indonesia: The accreditation process conducted by National Accreditation Agency of Higher Education [BAN PT (Badan Akreditasi Nasional)]. BAN-PT adopts two accreditation models, i.e., study program accreditation, and institution accreditation. Korea: National government accreditation; site evaluation conducted by a team from the Ministry of Education, Science and Technology (MEST) No national curriculum in some countries. In some countries, preservice teacher education is based upon what the teachers need to know and be able to do.
Autonomy in Decision Making	Syllabi of methods courses: Malaysia, Egypt, and Zimbabwe Egypt: Deans from colleges meet and approve syllabi to use in courses. Canada: It is more important that teachers can teach the K-12 science standards that they will use in the classroom. These are the curriculum standards and by default the science teacher preparation standards.

*Note: All quotes are from the informant from the specified country.