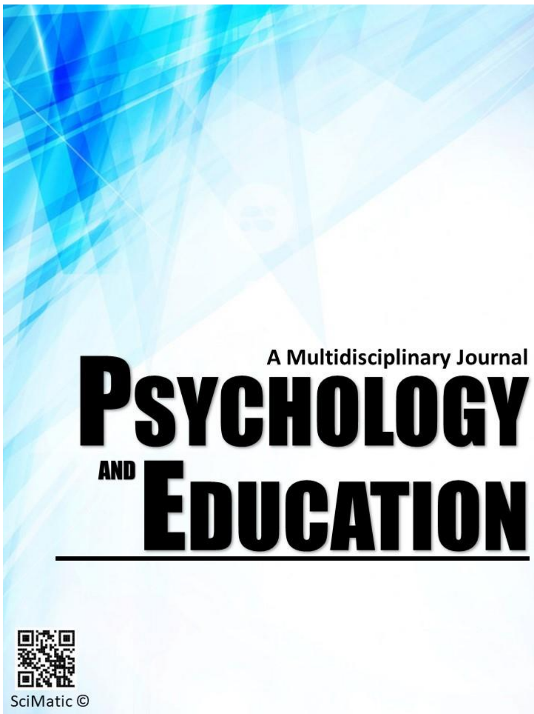
SCRUTINIZING LITERATURE ON THE GLOBALIZATION OF THE SCIENCE CURRICULUM IN THE CONTEXT OF EDUCATION: A REVIEW PAPER



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Research Article

Scrutinizing Literature on the Globalization of the Science Curriculum in the Context of Education: A Review Paper

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Abstract

In a competitive, interdependent world where economic production and educational achievement are intertwined, there has been a constant shift toward standards-based scientific education. Numerous countries are making new or recurrent efforts to raise the bar for student learning achievements in order to compete in the global market. This review paper aimed to scrutinize the literature on the globalization of the science curriculum in the context of education. With the main goals, to determine and investigate the causes of globalization in science curricula in the context of education; to look into the research supporting the evolution of science education globally; and to evaluate the methodologies and techniques applied in earlier research studies. Studies examined the data proving diverse local, national, and international influences on science curricula. Although policymakers are under pressure to globalize their intended curricula, these studies demonstrate that there are local cultural restrictions at work at the implementation and realization levels that may offer some resistance to this globalizing effect.

Keywords: *education, review, literature, background, science curriculum*

Introduction

The process of globalization has wide-ranging effects on a variety of fields, including education. Although it is a broad concept, globalization can be summed up as pertaining to "reforms and institutions that transcend national borders" (Astiz et al., 2002; Stacey et al., 2014). There has been a continual shift toward standards-based scientific education in an increasingly interdependent, competitive world that is interdependent on both economic production and educational proficiency. In order to keep up with the global competition, several nations are adopting either fresh or repeated attempts to raise the threshold for student learning achievements. This tendency is partially driven by global comparisons of students' performance on science examinations and the idea that a country's economic prosperity is correlated with its educational accomplishment, particularly in technical subjects. Additionally, it is believed that better learning would result by defining student learning objectives and holding them accountable through evaluation. Although there is considerable opposition to this paradigm at the local level, global policymakers typically seem to accept it without question (Carter, 2005; DeBoer, 2011; Mahusay & Herrera, 2019).

The analyses of student achievement on international assessments like the Programme for International Student Assessment (PISA) and the Trends in Mathematics and Science Study are among the movement's most important catalysts since they have shown the relative success of children around the world (TIMSS). The Organization for Economic Cooperation and Development (OECD) developed PISA, which was first used in 1997. The reading, math, and science exams are given every three years. In the majority of nations, it is taken by students at the age of 15, near the conclusion of their compulsory education, during which time they have typically studied a broad common curriculum (DeBoer, 2011). The primary domain assessed in 2006 was science literacy, followed by reading literacy in 2009 and mathematics in 2012. PISA was taken part in by 57 nations in 2006 and 67 nations in 2009. The International Association for the Evaluation of Educational Achievement established TIMSS, a global examination of fourth- and eighth-grade students' understanding of mathematics and science. TIMSS is given every four years and was first administered in 1995. In 2007, there were 48 participating nations.

The difference between PISA and TIMSS, which will be discussed in further depth later in the review paper analysis, is that TIMSS places more emphasis on students' curricular knowledge than PISA does on their capacity to apply their science knowledge in practical settings. Both PISA and TIMSS were developed with the hope that the findings would encourage policymakers to reevaluate the goals they set for their students and identify strategies to raise the standard of scientific education in their individual nations. PISA and TIMSS offer the chance for improved national accountability, monitoring, and regulation at the same time (Apple, 1999, 2000; Carter, 2005; Bennett et al., 2006; Stacey, 2014). The way that many nations see science education is being influenced by these international tests. For instance, half of the countries explicitly referenced the results of TIMSS or PISA in discussions of their nation's approach to science standards in the book Making It Comparable: Standards in Science Education, which examines the development of science standards in a group of countries from various parts of the world but primarily from northern Europe. Many of these nations are creating more intricate student outcome statements in response to the TIMSS and PISA test results in an effort to enhance scientific learning and performance (Waddington et al., 2007).

The use of contexts and applications of science as a means of increasing scientific understanding has become one of the most obvious trends in the development of science curricula over the past two decades in a number of countries. This method of instruction is frequently referred to as a context-based or STS (science-technology-society) approach. From elementary to university level, there is a tendency toward the use of context-based/STS techniques, but materials created for use in the secondary age range show this trend the most clearly. Globalization's potential impact on national education policy and school science curricula in the field of education could be extensive. While there are specific consequences of globalization on education, it's crucial to remember that this cannot be separated from broader economic and cultural globalization.

Autumn (2016) had seen the completion of a literature search. They did not aim to offer a thorough analysis of all published publications linked to the globalization of curricula due to the abundance of articles that have been published on globalization in education as well as the resources that were available for this study. Instead, they used a very targeted search approach. The purpose of the literature search was to locate research that showed evidence of nations that had revised or altered their scientific curricula to more closely resemble high-performing jurisdictions or the substance of the TIMSS framework (curriculum). The literature search also looked for research that have already examined the globalization of curricula using TIMSS data.

Within those limitations, the search method was devised to increase the likelihood of finding the most relevant literature. The period range was restricted to current evidence (2010 and later) on problems with global alignment/globalization of science curricula. To find studies that had used TIMSS data to investigate issues related to global alignment/globalization of scientific curricula, the date parameters were, however, extended to 1995. (The influential Third International Mathematics and Science Study, the first cycle of what later became known as TIMSS, was administered in 1995). This made sure that the literature evaluation didn't overlook any important research that used the data from the 1995 study.

There were 25 research articles retrieved in the literature search. Three researchers reviewed the abstracts of each of these papers to determine which ones would be most pertinent to include in the literature review. The article's relevance to the literature review was determined by applying a number of quality criteria. Articles that looked at the curricula and educational systems of multiple nations, those published in peer-reviewed journals, those that concentrated on science curricula (as opposed to other subject curricula), empirical studies, and studies that used data from TIMSS and other large-scale international assessments received priority consideration. The evaluation of the articles found during the literature search was done using a series of questions.

This literature review's research highlighted variables that are promoting and accelerating globalization in science education and science curriculum as well as forces that are restraining or balancing it.

This literature review had three main objectives due to the variety of ways in which globalization might affect education and science curricula:

1. To determine and investigate the causes of globalization in science curricula in the context of education;
2. To look into the research supporting the evolution of science education globally; and
3. To evaluate the methodologies and techniques applied in earlier research studies.

Literature Review

Globalization of Science Education and Science Curriculum Factors

Density and speed of information transmission are two key components of globalization. As a result, one could feel as though they are a part of a single world, or, as McLuhan puts it, a global village, due to the strong ties that exist between its residents and the confines of their local communities. Everyone will soon be aware of what occurs at a specific location, and its effects may be felt throughout the entire town

(Ghalyoun and Amin, 2002; Durib, 2014).

Globalization is being pushed by a variety of factors that Spring (2008) highlighted as being active in education more broadly. The importance of education as a driver of economic development is one of these drivers, along with multinational enterprises, intergovernmental, governmental, and international non-governmental organizations, information technology, and large-scale international assessments.

These factors are also affecting and having an impact on the globalization of science education and science curriculum, in addition to how globalization in education is generally shaped by these factors. Below is a breakdown of how each of these forces has an affect specifically. Even while each force is presented independently, it's vital to understand that they interact and shape the process of globalization in science education rather than existing in isolation.

The Role of Education in Economic Growth

Political agendas with regard to education have become more convergent in the twenty-first century, especially in the developed countries. One of the key drivers of the globalization of education and curricula, according to Spring (2008), is the idea of the information economy. There is a critical need for nations to prepare their young people for active involvement in these international markets as countries throughout the world become more involved in the globalized economy (Sellar and Lingard 2014).

Additionally, when nations work to create information-based economies, this has an immediate impact on education and school curricula as policymakers work to provide students with the knowledge and abilities necessary to prosper in the global market. The concentration on the knowledge economy is affecting school curricula as policymakers try to diversify these states' economies away from their current hydrocarbon-based ones, according to Weber (2011), who noticed this phenomenon in the Gulf states. The competitive landscape is related to the rising emphasis on education's role in fostering economic progress in many nations. As a result, schools in many nations now concentrate a larger emphasis on helping children improve their workplace skills and competences and get ready for life after school. As nations modify their curricula to concentrate on scientific areas that have the greatest potential to support future economic growth, this could ultimately result in convergence in science curricula.

Since many of the most globalized economic sectors have a technological or scientific foundation that calls for particular scientific knowledge and abilities, globalization and its economic effects are particularly relevant to science education and curricula. Some of the most globally integrated economic sectors are computer and mobile technology, medicines and biotechnologies, petrochemicals, and emerging sustainable energy technologies. Therefore, as a medium- to long-term approach for successful involvement in these sectors, countries wanting to promote economic engagement in these areas may propose reforms to science curricula.

Organizations, Both Intergovernmental and Nongovernmental

A few intergovernmental and nongovernmental organizations are significant players in the globalization of education, in addition to the knowledge economy and economic globalization. Intergovernmental institutions, like the World Bank and the Organization for Economic Cooperation and Development (OECD), for instance, have a significant impact on the discourse around education as well as the educational agenda in many nations. Both groups see education's value from an economic vantage point and see it as a means of promoting the expansion of the economy. For instance, Sellar and Lingard (2014) hypothesized that "the economization of education policy is linked to the rise of the OECD's education work." According to these groups, one of the main functions of schools is to train students to be successful members of the knowledge economy (OECD 1996).

International large-scale assessments, multinational corporations, and information technology

The development of international large-scale science assessments like TIMSS and the Programme for International Student Assessment (PISA) is one of the most influential factors influencing globalization in science education and science curricula (PISA). According to one statement, the PISA test "plays a major role in the standardization of education" (Spring 2008). Their influence is expanding with more nations taking part in international assessments. Large-scale assessment plays a variety of roles in the globalization of science education and curricula.

The International Association for the Evaluation of Educational Achievement established TIMSS, a global examination of fourth- and eighth-grade students' understanding of mathematics and science. TIMSS is given every four years and was first administered in

1995. In 2007, there were 48 participating nations.

The importance that TIMSS 1995 played in the redesign of national scientific curricula and the subsequent integration of science curricula across several nations was noted in an evaluation of the effects of TIMSS 1995 on teaching and learning in 29 different countries (Robitaille et al. 2000). After TIMSS 1995, a few of the participating nations started making significant changes to their scientific curricula, such as modifying the science content taught (as in Kuwait) or the skill areas prioritized therein.

The premise that international surveys and the content they evaluate can encourage the convergence and globalization of science curricula is supported by evidence from Israel (Klieger, 2015). The Israeli Ministry of Education decided to change its science curriculum in order to make it more consistent with the TIMSS science topic domains after receiving subpar TIMSS results in both 2003 and 2007. As a result, at least in certain nations, national scientific curricula have been directly impacted by the TIMSS evaluations. Interviews with specialists in scientific education in Australia, a nation that has always done well in TIMSS and PISA, however, indicate that the international exams have not had a significant impact on the curriculum (Aubusson 2011). These interviews did, though, indicate the importance of TIMSS and PISA, and there was a definite desire among Australian policymakers and the science education sector to make sure that standards on these exams were upheld throughout time (Klieger, 2015; Aubusson, 2011).

The impact of TIMSS on the science curriculum had only been marginal for some nations, such as Japan, according to Robitaille et al. (2000). International large-scale assessments have a different impact on different nations' curriculum, which indicates that each participating country has "its own unique set of incentives for participating, and each of them has their own set of expectations for the study" (Robitaille et al. 2000).

Table 1. *The Significant Responses, Description, and Involved Countries to the TIMSS Science Education Findings*

Items	*Significant Responses*	*Description*	*Involved Countries*
1	Changes and its impact to science assessment in the context of education.	Modifications to science exams to include TIMSS items and move away from sampling assessments to full cluster testing.	Philippines
2	Modifying some procedural tasks and changing some of the content in the science curriculum.	The scientific curriculum has been expanded with new themes, such as the addition of environmental science, a change from learning to apply information to real-world situations, and a stronger focus on problem-solving and practical abilities.	Kuwait and Iran
3	Alterations to the science curriculum's organization and structure, as well as curriculum adjustments to address student attitudes.	In order to address students' misguided beliefs about science and the implementation of an integrated science curriculum in the elementary stage of education, the science curriculum has been modified.	Romania, Canada, Korea
4	Adaptations to teacher development, training, and status of science education.	Increased attention is dedicated to teaching science, especially to young students in primary grades. There is greater assistance and training for pre-secondary school teachers to boost their science expertise.	Norway
5	There are no major changes to the science curriculum and education.	TIMSS-related alterations were either nonexistent or extremely slight.	Japan and Netherlands

Globalization in science education has been significantly impacted by the expanding significance of information technology and the internet. This is primarily attributable to how quickly and easily information can be accessed and distributed (OECD 1996). Universities and educational institutions, as well as international companies that offer educational services and curriculum resources to schools and education ministries around the world, could all have an impact on how quickly scientific information and ideas are shared across borders.

Science education and the curriculum have already undergone significant changes because to information and communications technology (ICT), for instance by "increasing the locations, methods, and times for its propagation" (Cornali and Tirocchi 2012). ICT has improved science teaching materials with new features like animations and multimedia content. This has had an impact on scientific education since it allows for the simulation of experiments that would not be possible in a typical classroom science lab.

ICT proliferation has significantly expanded the amount and accessibility of learning resources, making personalized learning tailored to the needs of each individual student more practical and affordable. Additionally, ICT has made it possible for learners to communicate with one another across greater geographical distances and share knowledge and information instantly. With the replacement of traditional science curricula based on factual information with more open science curricula centered on the acquisition of specialized skills, the impact of ICT on science education and curricula is anticipated to continue to grow in the future (Cornali & Tirocchi 2012).

Standardization of Policies

Astiz et al. (2002) characterized the global trend towards a larger emphasis on standardization, accomplishment, and evaluation in scientific and mathematics curricula in addition to policy borrowing and international large-scale evaluations. This has been accomplished by employing tactics that increase school accountability while also encouraging a broader global convergence of educational goals. Nevertheless, despite the numerous forces propelling it, there are other factors that are limiting or balancing the rate of globalization in science education and curricula. One of the most important mitigating factors is local culture. For instance, research comparing the teaching of science in Grade 6 classes in Australia and China highlighted the cultural influences on these countries' curricula and instructional strategies (Tao et al. 2013).

The study discovered that the divergent cultures and educational philosophies in Australia and China had an effect on both classroom procedures and the implementation of educational changes. The research identified resistance to these reforms, for instance, with traditional teaching methods (such as memorization of facts, reading from books, and observing teachers conduct experiments) still the predominant approach to science teaching in many schools in China, despite changes to the curriculum that were made to place a greater emphasis on constructivist approaches. It is obvious that even though the intended science curricula in various nations or jurisdictions may be getting more globalized, this does not imply that the implemented science curricula that students experience grow more closely matched. This implies that pupils will interpret the same curriculum differently depending on where they live.

Factors that Oppose the Globalization of Science Curricula in the Context of Education

The distribution of teachers and class time among the various topics served as a gauge for the effectiveness of the adopted curriculum. The teaching of science as separate courses (such as biology, chemistry, physics, and earth sciences) complicates the picture in terms of teaching time because no single science topic was taught by more than 70% of all science teachers (compared to an average of 90% of all teachers for mathematics topics). A statistical analysis of the proportion of teachers who teach particular courses in various nations revealed wide differences, which led to a distinct picture. Regional cultural effects have been found by other studies. Using item responses from TIMSS 2003 science questions, Kjaernsli and Lie (2008) developed a cluster analysis approach and identified a number of nations that tended to group together primarily along geographic or linguistic lines. For instance, the study found clusters for Arabic, English-speaking, and South Eastern European populations. This study offers some supporting data regarding the geographic and cultural alignment and convergence of science curricula.

The study's findings demonstrated that science instruction in the United States exposed pupils to a wide range of pedagogical strategies and subject matter, in contrast to instruction in other nations that was more consistently content-focused (Roth et al. 2006). The learning cultures of the various nations varied significantly, even within this common approach. For example, the Czech Republic prioritized whole-class discussion, Australia and Japan focused on connecting ideas through data and inquiry, and the Netherlands used independent textbook-centered reading and writing activities. Due to cultural differences, each nation had a unique strategy to teaching science, giving pupils a variety of possibilities to learn the subject and diverse ideas about what it meant to comprehend science.

A number of nations' comparatively subpar results in TIMSS 1995 served as a direct impetus to implement significant modifications to their science curricula in an effort to perform better on upcoming international comparison examinations. The TIMSS framework itself was adopted as a curriculum model in Iceland as a result of the country's dismal TIMSS 1995 score, which prompted a curriculum review process and increased the prominence of science and mathematics instruction there. Similar to Iran, where bad TIMSS 1995 findings prompted adjustments to the curriculum based on the TIMSS framework, low TIMSS 1995 results in Iran identified factors that required additional attention in the curriculum. This broadened the curriculum, raised the curriculum's cognitive demands, and emphasized scientific skills.

For many nations, defining educational standards in terms of student results is still a novel concept. Several nations, especially those in Europe, have previously prioritized the quality of educational inputs while determining their standards. Curriculum, teaching aids, and pedagogical techniques are only a few examples of inputs. Prior to 2003, for instance, each state's course syllabus in Germany's 16 federal states provided instructors with guidelines on what to teach (Schecker & Parchmann, 2007). These course syllabuses instructed teachers on which subjects to cover but did not specify the goals for their students' learning. The German Educational Standards are now outlined in the form of common result standards that are to be used by all 16 federal states.

In the United States, there is currently a new initiative happening to create universal standards that all 50 states can freely choose to follow in order to further the determination of learning goals for students in science. English language arts and mathematics have already undergone a comparable endeavor to establish common core standards, and the majority of states have volunteered to employ these common core standards (Common Core, 2010). The strategy also allows decision-makers more power over what is taught and more possibilities to keep an eye on systemic elements like students, teachers, and schools. Given the long history of local authority and teacher autonomy in the US, it is currently unknown how successful the common core project will be. As they acclimate to a system in which what is taught will be controlled far more centrally than ever before, different regions of the country, with varied traditions of local control over education, will most certainly react differently.

Conclusion

Studies looked at the evidence supporting various global, regional, and cultural influences on scientific curricula. These studies suggest that, while policymakers are under pressure to globalize their intended curricula, there are also local cultural constraints at work at the implementation and realization levels that may offer some resistance to this globalizing influence.

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