Chapter 1
Has Globalization Impacted Science Curricula? An Introduction

Abstract Globalization is a powerful process that exerts an increasing influence on many aspects of society. The impact of globalization on education, and more particularly its impact on the curriculum, is an interesting topic for research, but depends on acquiring comparable data on school curricula from sufficient numbers of countries. The IEA's Trends in Mathematics and Science Study (TIMSS) has collected data on the mathematics and science curricula of participating countries since the 1990s that enables investigation of the national content of science and mathematics curricula over time. Because existing research has tended to focus on mathematics curricula, this study focuses on the evolution of science curricula. TIMSS asks specific questions about the intended curricula, and while the intended curriculum is not necessarily what was implemented or achieved, it has a strong influence on the implemented and achieved curricula of an education system. Many other factors, including local cultural influences, may also contribute; the influence of the international large-scale assessments themselves may lead to countries adopting education reforms and policies that have been successfully implemented by high-performing jurisdictions. Understanding whether and why there have been identifiable global changes resulting in a putative international core curriculum may reveal which strategies and topics countries have recognized as supporting future skills and knowledge.

Keywords Globalization · Science education · Science curriculum
Trends in Mathematics and Science Study (TIMSS)

1.1 Establishing a Framework

Globalization is a topic that is frequently in the news, with the economic and sociopolitical impacts of globalization often receiving a considerable media coverage. By contrast the effects of globalization on education and curricula receive far less attention. Nonetheless, the potential impacts of globalization on education are of international interest, and some have argued that competition between countries

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for labor force, the mobility of people, and the influence of intergovernmental agencies, such as the Organisation for Economic Cooperation and Development (OECD) or the European Union, are promoting increasing similarities among countries' education systems and curricula. Supranational organizations, such as the World Bank, may also exert their influence on educational systems, particularly in developing countries.

But is education around the world really becoming increasingly similar? Does evidence exist to support the notion that the curricula developed by ministries of education and educational practice in schools are increasingly conforming to a set of "international standards" and, if so, is it possible to identify these benchmarks?

Where research studies on the globalization of curricula do exist, they have tended to focus on mathematics curricula as opposed to science curricula (Rutkowski and Rutkowski 2009; Zanini and Benton 2015). Science education is an important subject to investigate from a global curriculum perspective because science has always been an international discipline, with important discoveries and advances being made all over the world, but with the need for a central body of understanding for these to be interpreted and presented as a school curriculum. Therefore, internationalized thinking has long been an influence on the development of science curricula, arguably more so than in subjects such as literature or history, which are more likely influenced by national cultural and historical perspectives.

Many of the topics taught as science in schools are directly influenced by global factors, such as human health and disease, environmental impacts including climate change, and the future of food and energy supplies. It can also be argued that scientific development is the predominant driver of economic growth and quality of life. Consequently, understanding how science is intended to be taught provides insight into how future citizens are taught about the nature and role of scientific advances.

The IEA's Trends in Mathematics and Science Study (TIMSS) has collected extensive data on intended mathematics and science curricula of participating countries since the 1990s (Mullis et al. 2016). While the intended curriculum is not necessarily what was implemented or achieved, it nonetheless has a strong influence on the implemented and achieved curricula of an education system. Twenty years of collected data provides a valuable opportunity to directly explore the effects of globalization on countries' science curricula over time.

Given the global nature of science and science curricula, this study aimed to address three central research questions:

Have there been changes in intended science curricula over the last 20 years?

To answer this question, we conducted a coding exercise in which changes in the intended science curriculum of countries participating in TIMSS were tracked using responses to the TIMSS curriculum questionnaire. This not only enabled the identification of changes in the curriculum but also enabled the nature of changes to

be tracked, for example, if countries were adding new topics to their curriculum or removing topics from the curriculum.

If changes do exist, do they support the hypothesis that science curricula are becoming increasingly similar across countries?

To address this question, we used the outcomes from our coding exercise. We also conducted cluster and discriminant analyses on countries' responses to the TIMSS curriculum questionnaires. This enabled us to identify groups of countries that included similar science content in their curriculum. Finally, for a smaller sample of countries, information on additional features of the science curriculum, such as the mean time spent teaching science per year, was obtained from the TIMSS encyclopedias and TIMSS international results in science reports (for a full list of available TIMSS publications, see https://timssandpirls.bc.edu/isc/publications.html).

Are there groups of countries where curricula are increasingly similar; can the basis of an international core curriculum be identified?

We considered the outcomes of the coding exercise and cluster and discriminant analyses jointly in order to establish whether the intended science curricula of TIMSS countries were becoming increasingly similar. Interpreting the results and outcomes of both approaches enabled us to establish a more complete picture of any emergent international core curriculum.

1.2 Overview of This Book

After this brief introduction, a literature review (Chap. 2) provides background information and context. The literature review has three key aims (1) to identify the factors contributing to the globalization of science education and science curricula; (2) to identify existing evidence for the globalization of science curricula over time; and (3) to identify the methods that have been used previously to investigate the globalization of curricula.

The review establishes potential drivers and mediators for the globalization of science curricula. Different research approaches are identified, ranging from qualitative methods such as interviews, lesson observations and analysis of curriculum documents, through to quantitative methods using statistical approaches such as cluster analysis and latent class analysis.

This literature review informs the different methods we use to investigate the research questions (Chap. 3). Using multiple methodological approaches enables evidence to be collected on different aspects of our three central research questions. Countries participating in TIMSS show considerable variation in terms of the number and nature of changes they made to their science curriculum between 1999 (2003 for Grade 4) and 2015 (Chap. 4), and using this we are able to identify and

highlight topics that were included in the vast majority of participating countries' intended science curricula. Cluster analysis and discriminant analysis provide evidence for convergence or divergence in science curricula over time. In Chap. 5, we examine how the evidence obtained from the analyses and the literature review relate to our three research questions.

Our research contributes to the understanding of globalization in science education and curricula, however, this study is not a measure of the total science curriculum for each country considered, but a measure of the similarity of their intended science curriculum to the TIMSS framework. This research only examined the science curricula of countries that participated in TIMSS, but the same approach could be applied to other international large-scale assessments to assess their impact on national science curricula. We conclude in Chap. 6 by suggesting future areas of research which would complement this study.

References

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