

Oliver Stacey, Giulia De Lazzari, Hilary Grayson, Hazel Griffin, Emily Jones, Amanda Taylor & David Thomas (2018). *The globalization of science curricula* (IEA Research for Education, vol. 3).

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This publication examines the extent to which large-scale international assessments have been shaping science curricula globally in the last 20 years at both primary and secondary level. This open access book offers an important addition to science education literature for researchers, science educators, curriculum designers and policy makers. The authors draw on the TIMSS encyclopedias and questionnaire data to identify changes in science curricula, through both qualitative and quantitative methods. The book illustrates how the fundamental aspects of international large-scale assessments are infiltrating science curricula and causing what the authors call ‘a globalisation of science curricula’. It is structured into six chapters and each chapter begins with an abstract and keywords section to help the reader distinguish what is discussed. Chapter one outlines the research questions, the literature review is charted in chapter two, chapter three detailed their methodological and analytical approaches, chapter four provides their results, the answers to the research questions are presented in chapter five and chapter six suggests future directions and further research

topics. The offerings in each chapter are summarised below.

Chapter one comprises of only four pages and outlines the direction and research questions that guide the authors. These address the changes in the intended science curricula over the last 20 years, and if changes do exist, do they support the hypothesis that science curricula are becoming increasingly similar across countries? And finally are there groups of countries where curricula are increasingly similar and can the basis of an international core curriculum be identified?

This chapter too, identifies the purpose of the literature review that makes up chapter two. The three main themes include investigating the contributing and existing factors for the globalisation of science education and the methods used previously in other studies to investigate this.

Chapter two then provides this themed literature review. Applying themed parameters to their search within various data bases, 76 articles were identified. A set of questions (found in appendix A) was used to evaluate the abstracts in order to assess the most relevant. These questions assess aspects such as article type, peer-review, curriculum/education aspects and use of large-scale assessment data, amongst others. Once this assessment was complete, a subsequent template relating to the research questions (located in the appendix B) was used to evaluate the ten most relevant articles. From these

articles the authors were able to outline other elements than international large-scale assessments that have contributed to the globalisation of science education. Those include policy borrowing, the intergovernmental (world-bank) and non-governmental organisations (OECD), as well as the increasing role of information technology and improved internet access in schools. It only briefly states in the text that multinational corporations shape curriculums by providing educational and curriculum resources across the world. It would be useful to expand on this with some examples for the reader. The chapter presents strong evidence that changes to certain countries' curricula are occurring. Included in this evidence is perhaps the Israeli case study, which characterises how governments take notice of international large-scale assessments and instruct their teachers to implement content from these large scale tests in their teaching prior to any official curricular changes. The literature provides a rationale and justification for the methods implemented in their study in chapter three.

Chapter three deals with the three methodological and analytical approaches used to answer the research questions, the results of which are discussed in chapter five. Their methods describe the comprehensive analysis carried out. These involved (i) capturing the changes identified in the TIMSS curriculum questionnaires, (ii) cluster and discriminant analysis, and (iii)

analysis of the TIMSS encyclopedias and TIMSS teacher questionnaires.

The first method was used to answer the first research question and identifies the nature of the curriculum changes in the curricula examined in a mapping exercise. The TIMSS curriculum questionnaires were used in this mapping exercise and not the curriculums themselves. A quantitative coding table was developed by applying it to qualitative data. The responses of individual countries for each TIMSS cycle were obtained from the IEA data repository where it was determined if a topic was removed, reduced, or added. The coding range was -2, -1, 0, 1 and 2, where -2 was applied if a science topic had been removed and 2 was applied if a science topic had been introduced to the curriculum. It is a useful contribution for other researchers conducting similar exercises.

The second method applied cluster and discriminant analysis to the curriculum questionnaire which details the science topics included in the intended curriculum. Cluster analysis was applied in the first TIMSS cycles (1999 for Grade 8 and 2003 for Grade 4) in order to identify clusters or groups of countries that were similar in terms of their intended science curricula. Discriminant analysis was performed to produce a model that was then used to classify countries in the subsequent times cycles and this analysis, like the cluster analysis, was executed on the first TIMSS cycle. The advantage of

this two-step approach is that all countries who participated in TIMSS in any of the three cycles could be included and not just the countries that participated in all three cycles.

The third method used the TIMSS encyclopedias and TIMSS teacher questionnaires to obtain information on additional features of the implemented science curricula. These included details such as the average time spent teaching science and the percentage of students taught the TIMSS science topics. The authors did highlight the difficulties in drawing meaningful comparisons due to the inconsistencies in the way this information was collected and presented across different TIMSS cycles. The complications included selecting countries for consistency that would reflect the geographic scope of TIMSS and represent the full range of achievement on the TIMSS assessment.

The final section of this chapter systematically outlines the various limitations of the above analysis and consideration needed when interpreting the results. These include many assumptions such as accuracy of the reported data on the TIMSS questionnaire and over representation of developed countries in the data set. This is useful caveat for various investors (i.e. policy makers, curriculum developers, teachers, researchers etc.) to consider when they are interpreting the results outlined in chapter four.

Chapter four provides their results and presents evidence to suggest a

globalisation of science curricula. By using the TIMSS encyclopedias, teacher questionnaire and additional data from the TIMSS curriculum questionnaire, they built up a robust image of aspects of science curricula for their selected countries. The analysis of these items found the variety and nature of changes made to science curricula between 1999 (2003 for Grade 4) and 2015 varied considerably amongst countries. The cluster and discriminant analysis revealed which science topics were most discriminative in predicting which group a country would fit, i.e. grouping countries based on the TIMSS science topics included in their intended science curricula. Two groups emerged which they simply call Group 1 and Group 2. General trends in their analysis showed that countries in Group 1 tended to have a more focused curriculum and were shown to be more balanced between the sciences, whereas countries in Group 2 tended to have more curriculum topics and these were more skewed towards life science topics and less towards the physical sciences. Their analysis showed that although there were a similar amount of countries placed in both Group 1 and Group 2 in 1999, by 2015 many of the countries that were classed as Group 1 transitioned into Group 2. This analysis produced evidence for convergence in science curricula over time for both Grade 8 and Grade 4, but this was seen more at Grade 8. The authors are quick to warn the reader that the results

should be interpreted with caution as more countries participated in the 2015 TIMSS survey than in 1999. The TIMSS teacher questionnaire responses were used to examine the implemented science curriculum of 15 countries in more depth. Due to difficulties in obtaining robust comparable data for countries across the different TIMSS cycles, significant caveats have been applied by the authors to any conclusions drawn from these analyses. Subsequently they were able to determine how stable or changeable their curriculum is on the basis of the number of changes a country has made to their curriculum. The average number of curriculum changes at Grades 4 and 8 for each TIMSS cycle and the topics common to the vast majority of participating countries' intended science curricula were calculated. Their results showed that on the whole, changes to a countries' science curriculum was more likely to lead to an increase, rather than a decrease in the number of science topics from the TIMSS framework.

Chapter five presents the answers to the research questions outlined in chapter one. It explores the study's findings, such that all countries studied had made changes to their intended science curricula, although the extent of these curricular alterations varied considerably between the countries. The authors further discuss how a TIMSS science topic is more likely to be added to national curricula than removed, indicating that countries under review tended to con-

verge in their science curricula and grow in similarity. Although, the authors note that they do not take into account differences in the *intended* verses the *implemented curriculum* in the classrooms.

In the three pages that comprise chapter six, it suggests future directions and further research topics. They discuss how this builds on other research on globalised curricula but is novel in its approach by focusing on science rather than the usual focus of mathematics. The chapter discusses the impact of a globalised science education in terms of preparing a nation's students for employment in a rapidly changing world. A very welcoming addition in this chapter of the book is the table which summarised the key findings. It is a useful concluding feature of the book and reminds the reader of its content.

Overall, this publication is a valuable resource to those interested in science assessment, curriculum studies and education policy. The book succeeded in answering their particular research questions and reporting what it sets out to measure i.e. assessing the similarity of counties intended science curriculum participating in TIMSS against the TIMSS framework. One criticism is perhaps the narrow lens on which they are substantiating their claims. To validate their claims further research is necessary, which the authors do remark on in the final chapter. Comparing curriculum content of countries which have or have not participat-

ed in TIMSS would help to validate these claims as it would show if changes are truly global in nature. Then identifying why countries have added these topics to their curriculums would help to detect why these reforms have occurred. Comparing the results of other large-scale international assessments, such as Programme for International Student Assessment (PISA) or the Relevance of Science Education (ROSE) would widen the lens to present a boarder picture of influencing factors in science curriculum reform.

Some critiques I would make are raised by the authors, such that the findings supporting their arguments stem from a relatively short period and a longer spread of historic data may be necessary to provide a more accurate picture. Additionally, as research in science education evolves, benefits of particular teaching strategies such as problem-solving and inquiry based learning are being noticed by political leaders and governments. In order to obtain a more accurate reflection of what is driving science curricula reform around the world, it would be useful to investigate the curricula for not only science topics, but education strategies such as those above. Another area of research which the author did not discuss, would be to examine the importance of countries having common science education content in their schooling due to the internationalisation of science and scientific industries. Nevertheless, the evidence in the book

presents a strong case which indicates how large-scale international assessments such as TIMSS are powerful in standardising science curricula around the world. As well it provided a bank of research that cater for science education on this topic rather than the usual focus of mathematics. One assumes that large-scale international assessments are influencing factors on science curricular reform as many governments change their assessments and

curriculum depending on their ranking on these tests. But, this book provides rich empirical evidence in support of this based on analysis that even novices to these kind of studies would be able to interpret and understand. This is not easy when one considers the scope and volume of data being presented.

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