Amsterdam, 23 March 2018

CALL FOR PROPOSALS

Call no. IEA 08/03-2018

Thematic report using IEA TIMSS data: Using "wrong" answers to understand common misconceptions in mathematics and science

1. Introduction

The International Association for the Evaluation of Educational Achievement (IEA) invites proposals for creating a report based on secondary analysis of IEA data. The general theme for this report is to use TIMSS data to understand whether discernible patterns of incorrect answers can be used to understand misconceptions in mathematics and science. The deliverable for this project will be an 80- to 150-page report that includes, in addition to the main text, an executive summary, tables, graphs, and cited references.

2. Study background and objectives

In general, classical and modern methods of modeling educational achievement place an emphasis on *correct* answers, which are used for scoring, reporting, and cross-country and cross-educational system comparisons. Less-tapped resources are the *incorrect* answers. To that end, a small, but important sub-field of educational measurement concerns understanding the basis for incorrect answers on tests of achievement. Much of the work in this area is done under the cognitive diagnostic modeling (CDM) framework (Birenbaum & Tatsuoka, 1993) and may be referred to as "distractor-driven" analyses. A recent innovation in this area includes the scaling individuals and classifying misconceptions (SICM) model (Bradshaw & Templin, 2014). Under the SICM approach, categorical latent variables represent measured skills that students have not yet mastered. Understanding patterns of incorrect answers can provide an important foundation for improving instruction, and allows for a deeper understanding of student learning. Modeling systematic incorrect responses is also a useful method for validating intended scores use and for future test development (Shear & Roussos, 2017).

As a common test of mathematics and science, administered across dozens of countries and educational systems, TIMSS offers a rich data source for investigating patterns of incorrect responses across languages, cultures, and geographies. Establishing patterns of incorrect answers, within or

across educational systems, may offer opportunities for understanding not only what students know and can do but also common misconceptions across content and cognitive domains.

Although CDM in general and SICM in particular are fruitful ways to quantify and model potential misconceptions in tests such as TIMSS, other descriptive and graphical means exist and these can also provide valuable insights. Examples include simple tables of proportions or histograms. Given a wealth of basic and advanced methods for looking more deeply into incorrect responses in mathematics and science internationally, the IEA invites proposals for an in-depth thematic report on the topic of analyzing and reporting on misconceptions in mathematics and science. In particular, proposals should address methods for modeling and describing incorrect answers and underlying misconceptions in TIMSS. The exemplar methods described here are by no means the only approaches. Applicants are encouraged to pursue approaches most suited to their expertise and research interests. Competitive proposals should clearly describe and demonstrate innovative methods using TIMSS data. In particular, the IEA welcomes proposals that feature a didactic aspect. Proposals that also address a relevant, well-defined substantive theme are encouraged. Successful teams are expected to provide exemplar syntax and data, so that readers can replicate and extend the analyses presented in the report. Preference will be given to proposals that capitalize on the full 20-year span of TIMSS data.

3. Possible substantive topics

Interesting aspects that could be explored in the report may include, but are not limited to:

- Are there international patterns of math and science misconceptions?
- Are there cultural, regional, or linguistic patterns in math and science misconceptions?
- Do misconceptions depend on group demographics, such as student sex, socioeconomic status, or interest in the topic?
- Are there international patterns regarding changes in misconceptions over time?
- Do international patterns depend systematically on policy-relevant characteristics, such as immigration patterns, economic changes, or technological innovation?

4. Data

IEA's Trends in International Mathematics and Science Study (TIMSS) has assessed student achievement at grades 4 and 8 in mathematics and science at four-year intervals since 1995. In 2015, nationally representative samples of students from 57 countries and seven benchmarking entities (regional jurisdictions of countries, such as states) participated in the study. In total, more than 600,000 students took part in TIMSS 2015. The various international reports on TIMSS provide a detailed overview of the study's results (see for example Martin et al., 2012, 2016; Mullis et al., 2012, 2016).

TIMSS not only collects achievement data, but, additionally, the TIMSS database encompasses rich background information from students, their teachers, and principals. Since IEA studies are based on a curriculum model where the intended, implemented and achieved curriculum are considered, TIMSS also includes information on the intended curriculum in participating countries from national centers and what is implemented in the schools from teachers, principals and students. Over the 20-year span of data collection, more than 2.5 million students from about 100,000 schools worldwide have participated, making the total database a rich source for examining system-level change over time.

5. General guidelines for proposal submission

Proposals must be submitted in English.

Please ensure the proposal demonstrates familiarity with the proposed research by including a sound literature review. Ensure that the contribution of the proposed thematic report to this literature is explicit, especially in terms of its potential to expand the current state of research and knowledge.

When preparing a proposal, please clearly specify the research relevance and the policy relevance of the research questions and methods selected. This specification needs to expand on and add to the ideas set out in this call for proposals.

The proposal must furthermore describe the general analytical framework that will guide not only analyses of the IEA data, but also interpretation of the results of those analyses. The description of the framework must be such that it clearly shows how the proposed analysis will address the policy-relevant research questions. The description should therefore identify:

(i) which IEA data (study, questionnaire items, indices, or constructs from questionnaires) you intend to use,

(ii) any non-IEA data sources that will be included, and

(iii) any additional data collection that is deemed necessary (such as system-level characteristics).

Please make sure that a brief description of the types of statistical analyses to be used is included.

In addition, the proposal must include a detailed timeline for all analyses and report-writing activities, and a well-considered budget proposal to complete the project.

When developing timelines, assume a start date of 1 July 2018 and an end date of 1 July 2019; the final manuscript of the report must be supplied to IEA for print production by {1 March 2019}. Although there may be a certain degree of flexibility in the timeline, it must make provision for (i) submission of a complete draft report by 10 December 2018 for review by IEA, and (ii) subsequent revision and language editing of the report. The corresponding author must be available for consultation with Springer Publishers during the print production period.

Budgets must include the expected number of work days needed to complete each activity related to the project and a total budget in euros or US dollars. The total budget should not exceed 25,000 euros.

The call is open to all researchers, excluding teams from IEA International Study Centers. For the latter, direct assignments are possible.

The proposal should be no more than 10 pages in length[1]. Please also provide a short (500-word maximum) biographical note on each person in the team tendering for the project. Please highlight the relevance of each person's experience to the proposed activities.

IEA will review all proposals according to their methodological quality, research and policy relevance, and budget. All tenderers will be informed of the outcome of these deliberations by 1 June 2018.

Proposals may be submitted by post, courier, or email.

The deadline for proposals is 1:00 p.m., 4 May 2018.

Send the proposal by post to:

International Association for the Evaluation of Educational Achievement, Keizersgracht 311, 1016 EE Amsterdam, The Netherlands

or by email to secretariat@iea.nl.

[1] Times New Roman, Arial or similar, 12 point type, double spaced.

References

Birenbaum, M., & Tatsuoka, K. K. (1993). Applying an IRT-based cognitive diagnostic model to diagnose students' knowledge states in multiplication and division with exponents. *Applied Measurement in Education*, *6*(4), 255–268. https://doi.org/10.1207/s15324818ame0604_1

Bradshaw, L., & Templin, J. (2014). Combining item response theory and diagnostic classification models: A psychometric model for scaling ability and diagnosing misconceptions. *Psychometrika*, *79*(3), 403–425. https://doi.org/10.1007/s11336-013-9350-4

Martin, M.O., Mullis, I.V.S., Foy, P., & Hooper, M. (2016). *TIMSS 2015 international results in science*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College. Retrieved from: http://timssandpirls.bc.edu/timss2015/international-results/

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