UNDERSTANDINGS OF SCIENTIFIC INQUIRY: AN INTERNATIONAL COLLABORATIVE INVESTIGATION OF SEVENTH GRADE STUDENTS

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Although understandings of scientific inquiry (as opposed to conducting inquiry) is included in science education reform documents around the world, little is known about what students have learned about inquiry during their primary school years. This is partially due to the lack of any assessment instrument to measure understandings about scientific inquiry. However, a valid and reliable assessment has recently been developed and published, Views About Scientific Inquiry (VASI) (Lederman J. et. al., 2014). The purpose of this large scale (i.e., 19 countries spanning six continents and including 2,960 students) international project was to get the first baseline data on what grade students have learned. The participating countries were: Australia, Brazil, Canada, Chile, China, Egypt, England, Finland, France, Germany, Israel, New Zealand, Nigeria, South Africa, Spain, Sweden, United States, Taiwan, and Turkey. In many countries, science is not formally taught until middle school, which is the rationale for choosing seventh grade students for this investigation. This baseline data will simultaneously provide information on what, if anything, students learn about inquiry in primary school, as well as their beginning knowledge as they enter secondary school.

Keywords: Scientific Inquiry, International

INTRODUCTION

Scientific inquiry has been a perennial focus of science education for the past century and it generally refers to the combination of general science process skills with traditional science content, creativity, and critical thinking to develop scientific knowledge (Lederman, 2009). Recent reform documents have emphasized that students should develop the abilities necessary to do inquiry as well as have an understanding about inquiry (e.g., *Benchmarks for Science Literacy*, AAAS, 1993; *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, National Research Council [NRC], 2011), and the National Science Education Standards (NRC, 2000) were most explicit in their differentiation between the abilities to do inquiry and knowledge about scientific inquiry. Distinctions are becoming more prominent in reform documents throughout the world. Quite simply, it seems logical that students will improve their ability to do inquiry if they have an understanding about what they are doing, and this knowledge combined with knowledge of science will enable students to make more informed decisions about scientifically based personal and societal decisions.

The intent of this collaborative project is to report on students' understandings of SI across the globe. Now that a valid and reliable assessment tool is available, we can begin to see what students of the same grade levels know about SI in various countries. The purpose is not to focus on comparisons across countries (especially since instruction, curricula, and cultures vary widely across nations), but rather to develop a baseline of understandings worldwide.

KNOWLEDGE ABOUT SCIENTIFIC INQUIRY

The aspects of scientific inquiry that follow are considered appropriate in the context of K-12 science education. Specifically, students should develop an informed understanding that: scientific investigations all begin with a question but do not necessarily test a hypothesis; there is no single set or sequence of steps followed in all investigations (i.e. there is no single scientific method); inquiry procedures are guided by the question(s) asked; all scientists performing the same procedures may not get the same results; inquiry procedures can influence results; research conclusions must be consistent with the data collected; scientific data are not the same as scientific evidence; and explanations are developed from a combination of collected data and what is already known. It is important to note that the aspects of inquiry noted are not meant to be a definitive list of outcomes with respect to inquiry. However, there is little debate about the importance of these aspects of inquiry and research has shown they are accessible to precollege students within the context of existing curricula (Lederman, J. et. al., 2014).

STATEMENT OF PROBLEM

Although the teaching of scientific inquiry is valued around the world, there has never been an international assessment of what students actually know. This study sought to examine grade seven students' understandings, at the beginning of the school year, of SI in various countries worldwide. This baseline study will give us data on what, if anything, students learn about inquiry in elementary school, as well as their beginning SI knowledge as they enter secondary school. It will provide the global science education community a starting point from which instructional, curricula, and policy decisions can be made.

SAMPLE AND METHOD

There were approximately 100 seventh grade students sampled from each continent around the world, with the exception of Antarctica. The research sites were North America: USA (n=208), Canada (n=222), South America: Chile (n=142) and Brazil (n= 102); Africa: South Africa (n=106), Nigeria (n=102) and Egypt (n=100); Europe: Sweden (n=126), Germany (n=136), England (n=103), Spain (n=159), France (n=109), and Finland (n=149); Asia: China (n=350), Turkey (n=268), Taiwan (n=282), Israel (n=102) and Australia/New Zealand (n=108 and n=86). The total sample size of grade seven students was 2,960 students. The students who were selected for this study were representative for their region; their selection was based on average academic ability, representative diversity of the region and socioeconomic background.

There was a total of 19 primary contact people participating in this study, one contact person in each country, who almost always worked with a team of colleagues. The contact people across the six continents were responsible for; completion of training in the coding of the VASI, language translation/back translation for VASI validity, selection of a representative, sample, data collection (including paper and pencil assessments and individual interviews), data analysis, and the writing of location specific aspects of the results.

Each student was given a VASI to complete in a 60 minute time period. The VASI was given in the students' language of science instruction. When the language spoken was not English, the instrument was translated and then back translated to verify the accuracy of the translation. After administration of the VASI, the responses were coded by the primary contact person (and colleagues) in each country. Each student was given a code of; No Response, Naïve, Mixed or Informed for each aspect of SI. At least 20% of the students were interviewed to ensure that the coding of the VASI was accurate. This insured face validity for the questionnaire. The interviews were recorded and transcribed. The inter rater reliability of the VASI was 80% or better for each site.

RESULTS

Frequency data were used for each aspect of SI for each country. Due to lack of space and the amount of data for this study only one aspect is shown below. Each aspect of SI has its own data table containing a list of the participating countries. In parentheses after each country's name is the reliability for that aspects' data. All of the numbers for each category (naïve, mixed and informed) are percentages. Not all of the percentages add up to 100 due to the fact that students left some of the questions on the VASI blank, therefore we could not categorize their answers.

Procedures are guided by the question asked			
Country	Naïve	Adequate	Informed
USA (.97)	54	26	10
Canada (1.0)	50	8	20
Chile (1.0)	67	23	3
Brazil (,95)	75	7	1
South Africa (.80)	53	15	30
Nigeria (.90)	14	22	50
Egypt (.86)	10	65	35
Sweden (1.0)	42	3	28
Germany (.95)	14	22	55
England (.97)	38	9	36
Spain (.87)	54	9	32
France (.83)	24	54	7
Finland (.96)	50	8	30
China (.95)	14	26	57
Turkey (.95)	72	10	9
Taiwan (.86)	16	50	30
Israel (.95)	16	32	43
Australia (1.0)	23	20	50
New Zealand (.86)	51	21	25

CONCLUSIONS AND IMPLICATIONS

Overwhelmingly, the results from this study show that students around the world have an overall naïve view of scientific inquiry although there were instances in which students in a country did better than "naïve" on a particular aspect of SI. This is consistent with the studies that have been done with secondary students, pre service and in service teachers. The findings are not surprising since students are rarely taught understandings of inquiry in an explicit, reflective manner. Science is often taught by lecture and with students simply doing inquiry activities, with little reflection on what was done and why. It is clear that no matter where students live worldwide that understandings of inquiry are not cultivated. It is important to note that no statistical comparisons were made among the countries as the purpose here was just to get a baseline of beginning middle school students' understandings. Statistical comparisons across countries would be inappropriate.

During the workshop attendees will have the opportunity to speak with representatives from each site about their specific data and trends. In this study we found that students do not understand SI. Our inference is that SI is not taught in an explicit/reflective manner. These understandings are consistently naïve around the world. This study provides evidence to pre service and in service educators that they need to explicitly teach about scientific inquiry and how such understandings can be facilitated in their students.

References

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