Fostering Global Citizenship in Statistics Education

By: Ms. Gusti Ayu Russasmita Sri Padmi
Ms. Ummy Salmah
Ms. Pasttita Ayu Laksmiwati
Research and Development, Capacity Building, and Training Specialists
SEAQIM

Abstract

GCED has been a primary theme of educational goals and policies for the past few years. In a society where data has become pervasive, data literacy has become crucial to support global citizenship. Yet very little effort has been exerted to incorporate global citizenship into statistics education. Statistics education often does not go beyond memorising formulas and procedures and so fails to promote global citizenship. This article reports on the development and implementation of a cross-border lesson on statistics in the context of energy conservation that aims to promote global citizenship through data literacy. Thirty-two English-speaking eighth-grade students each from Indonesia and Thailand participated in the lesson via the WebEx video-conferencing platform. Data was collected based on video recordings and students' written work. Data analysis revealed that the use of real-life data, meaningful context, and cross-border collaboration in statistics has great potential to increase student engagement and nurture their sense of global citizenship.

Introduction

In the 21st century, data has become inseparable from daily activities. Statistics lessons in school offer ample potential to help students become data-literate citizens. However, such lessons often do not transcend the confinement of classrooms and textbooks, at least in Indonesia. Bakker (2007) told an interesting story about a student citing statistics as "mean-median-mode," clearly thinking of it as only being about formulas to apply to a bunch of numbers, completely void of purpose and meaning.

Amidst an increasingly globalised and interconnected world, it is important for people to not only see themselves as part of their own tribe, but also as global citizens. Global citizenship has been widely discussed with regard to educational goals and policies in the past few years.

GCED refers to a framework that aims to develop students' sense of global citizenship. It can take either a curricular or an extracurricular approach. The curricular approach often offers global citizenship as a stand-alone subject or embeds related concepts in subjects such as ethics, civics, or religion (UNESCO, 2014). Very few studies have reported attempts to embed GCED into mathematics, especially statistics.

Statistics has a lot of potential to help students develop a sense of global citizenship. To become a global citizen, one needs to be aware of issues from around the world and communicate and cooperate with others to resolve them. Because numerical data largely comprises information these days, data literacy has become increasingly important. Strong data literacy can thus enhance GCED but efforts to improve data literacy need to start by innovating statistics lessons.

This article describes the development and implementation of a statistics lesson that aims to foster global citizenship through data literacy. Students were tasked to analyse and critically think about given data then use it in an argument. To engage the students, tasks need to be made exciting, meaningful, and worth doing. We attempted to achieve this by incorporating genuine, real-life data, meaningful contexts, and cross-border collaboration into the lesson.

Literature Review

Data Literacy to Support Global Citizenship

Data literacy is defined as the ability to derive meaningful information from numbers, including accessing, assessing, manipulating, summarising, and presenting information (Schield, 2004). In the field of statistics education, data literacy may not be as well-known as statistical literacy—the ability to critically digest statistical information in daily life and use it as evidence in arguments (Schield, 1999).

People often interchange data literacy with statistical literacy, which is understandable because the two are interrelated. Analysing data, especially big data, can be quite complex and requires a strong foundation in mathematics and statistics. Note though that statistics summarises data and so demands sufficient ability to work with numerical information. Seeing that most information today uses data and statistics, data literacy has become inseparable from statistical literacy (Schield, 2004 and Prado and Marzal, 2013).

To improve data literacy, classroom activities need to be inclusive, use data that is relevant to learners, and offer many possibilities for unexpected outputs (Bhargava and D'Ignazio, 2015). They need to let students use their ability to explore complex issues and construct their own understanding.

GCED, meanwhile, hopes to give students a better sense of belonging to a broader community and a common humanity (UNESCO, 2013). As opposed to the administrative nature people often associate with citizenship, global citizenship refers more to a holistic perspective on what it means to be a global individual. This notion is increasingly gaining relevance as the world increasingly becomes globalised, interdependent, and interconnected.

GCED requires practices that nurture the said perspectives in students. It comprises three core conceptual dimensions—cognitive, socio-emotional, and behavioural (UNESCO, 2015).

Table 10: Core Conceptual Dimensions of GCED

Cognitive	Socio-Emotional	Behavioural
To gain knowledge and understanding of and critically think about global, regional, national, and local issues, along with the interconnectedness and interdependency of different countries and populations	To foster a sense of belonging to a common humanity, sharing values and responsibilities, empathy, solidarity, and respect for differences and diversity	To act effectively and responsibly at the local, national, and global levels for a more peaceful and sustainable world

GCED aims to encourage learners to critically analyse real-life global issues and identify possible creative and innovative solutions for them while empowering them to develop sense of agency and take an active role in solving global challenges on a local or global scale (UNESCO, 2013). It can take a curricular or an extracurricular approach. In the curricular approach, it takes the form of a stand-alone subject or is embedded in an existing subject (UNESCO, 2013).

GCED is part of the SDGs (UNESCO, 2017), a set of 17 goals formulated by UN hailed as necessary for collective humanity to achieve by 2030. The goals encompass social and economic issues that affect humanity on a global scale. Amongst these is partnership, which is necessary if we are to solve global issues and reach global goals.

GCED strongly emphasises engaging students in real-life global issues. They need to be aware of and understand important issues that affect the world and communicate and cooperate with people from different cultures to solve problems. As data comprises most information today, the ability to handle and communicate said data has become crucial for students to fully understand global issues. As such, students need to develop strong data literacy if they are to truly and successfully become global citizens.

Previous research in mathematics education reported attempts to enhance awareness of and develop a sense of agency about significant and noteworthy real-life issues. Gutstein and Chicago (2003) reported how math lessons helped students in an urban Latino school build their knowledge and understanding of social justice. Lesser (2007), meanwhile, described the potential of statistics to incorporate issues related to social justice.

Real-Life Data Sets in Meaningful Contexts

Real-life data is acquired from real-life situations. This includes archival data, data collected from research, and classroom-generated data (Neumann, Hood, and Neumann, 2013). Consequently, real-life data is often messy, unfriendly, and comprises big numbers, which can be intimidating and difficult for students to manipulate. Teachers often avoid using real-life data in lessons and opt instead for artificial data. As opposed to real-life data, artificial data is collected through simulations or generated by teachers based on hypothetical situations. Teachers can design this kind of data to be easily decipherable for students.

To make statistics more meaningful, classroom instruction needs to be made as similar to real-world situations as possible. One way to do this is to put real-life data sets in the learners' context (Bidgood, 2010). This will make learning richer and more challenging and motivating for students who may already be struggling with statistical techniques (Libam, 2010). The numbers used should be easy to manipulate so working with data is no longer procedural, but instead requires critical thinking and reasoning.

Data essentially refers to numbers with context as opposed to artificial data, which requires teachers to create contexts for. Though real-life data already has context, teachers still need to ensure student engagement. As such, complex problems that contradict the students' prior beliefs (Ben-zvi, Gil, and Apel, 2007), along with contexts that combine perspectives from different disciplines, should be avoided.

Many studies have reported positive results on using real-life data in statistics. The "Guidelines for Assessment and Instruction in Statistics Education" (GAISE) (Franklin, et al., 2007) states that using real-life data can contribute to more successful statistics lessons. Hourigan and Leavy (2015) also reported that fifth-grade students were better engaged in describing and comparing likelihoods in activities that used real-life data. Libam (2010) and Neumann, et al. (2013) found the same thing.

Students can even collect real-life data on their own using different methods. If this is, however, too time-consuming, various reliable online databases are available at no cost. Many international institutions such as UN, OECD, and WB provide such kind data for free online.

Cross-Border Collaboration

Technological developments offer endless possibilities to mathematics classrooms. Software, apps, and animation are just some of the latest technologies that can help teachers deliver more attractive, engaging, and livelier math lessons. In our research, we used synchronous communication technology.

Synchronous communication technology enables real-time communication. It includes text messaging, chat rooms, audio and/or video conferencing, and shared white boards (Chiu, Yang, Liang, and Chen, 2008). These have become pervasive in distance education. Software such as Adobe Connect, Blackboard Collaborate, and WebEx are some of the most widely used in education.

The rationale behind incorporating synchronous technology use in teaching stems from putting global issues in a local context. Global issues do not concern only one country or community; they transcend cultural and geopolitical boundaries. As such, students should discuss them with people from different countries, which supports the goal of GCED, especially with regard to the socio-emotional and behavioural domains.

International communication through synchronous technology use is also known as cross-border collaboration. This allows students from different countries, cultures, and time zones to participate in the same math lesson via a video-conferencing technology, for instance.

Research

Research Setting

This project is part of the Asia-Pacific Economic Cooperation (APEC) Lesson Study Project initiated by the University of Tsukuba and Khon Kaen University in 2006, which aims to develop more innovative teaching practices in mathematics.

The "Cross-Border Lesson Study" began in 2016 and continued on until 2017. In it, members were grouped in pairs to design and conduct cross-border lessons. Indonesia was paired with Thailand. A team of academics from SEAQIM in Indonesia and Khon Kaen University in Thailand worked together to design a statistical task that was implemented as a cross-border lesson.

Some 32 English-speaking eighth-grade students each from Indonesia and Thailand participated in the lesson. One math teacher from each country acted as model teachers. The lesson was taught in two meetings, the first of which was run separately in Indonesia and Thailand. A week after, the second meeting, which used WebEx, was conducted with all of the participants from both countries.

The Lesson Taught

The lesson featured data from the APEC energy database, which contained information on the energy production and consumption of member countries and economies, available at no cost from http://www.egeda.ewg.apec.org/.

The context given was that energy use had to do with electricity consumption and carbon-dioxide emission. Though the students would easily relate to using electricity, the same cannot be said about carbon-dioxide emission. As such the concept of carbon footprint was discussed.

Energy conservation is a global issue that transcends geopolitical borders and cultural boundaries, making it a suitable topic for promoting global citizenship. The task involved using data from several countries—Indonesia, Thailand, the U.S., and the PRC. Adding the U.S. and the PRC, which were extreme cases, to the list made it easier for students to see patterns and relationships.

The lesson aimed to teach students to represent energy-related data in chart form, interpret data in the context of energy conservation, and explain the correlation between energy consumption and carbon-dioxide emission.

During the first meeting, the students worked on electricity consumption data from Indonesia and Thailand. They were asked to present the data in chart form then describe and explain trends shown in the graph. The numbers were left in kiloton of oil equivalent (KTOE), a unit representing the energy generated by burning 1,000 tons of crude oil. They referred to country-level consumption rates and so the students had to work with large numbers, something they did not normally do in statistics lessons.

After creating charts, the students were asked to discuss their work in groups. They were, however, limited to form a group with peers from the same country as theirs. They were asked to determine the correlation between electricity consumption and population. They produced charts similar to Figure 10 below.

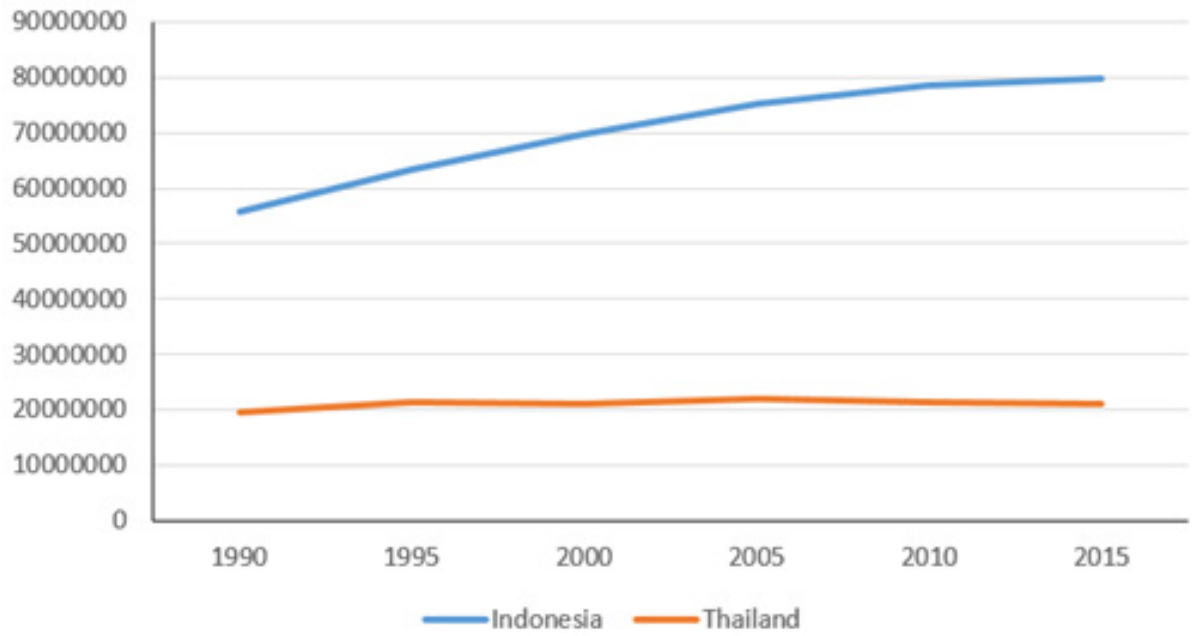

Figure 10: Comparison of the population of Indonesia and Thailand

During the second meeting, the students from Indonesia and Thailand were asked to communicate with one another using synchronous communication technology, specifically via a WebEx video conference.

They were first shown two line charts (see Figure 11)—one comparing the electricity consumption of Indonesia and Thailand while the other showed their carbon-dioxide emission levels. At a glance, the charts looked to share the same trend, which implied a direct correlation between energy consumption and carbon-dioxide emission.

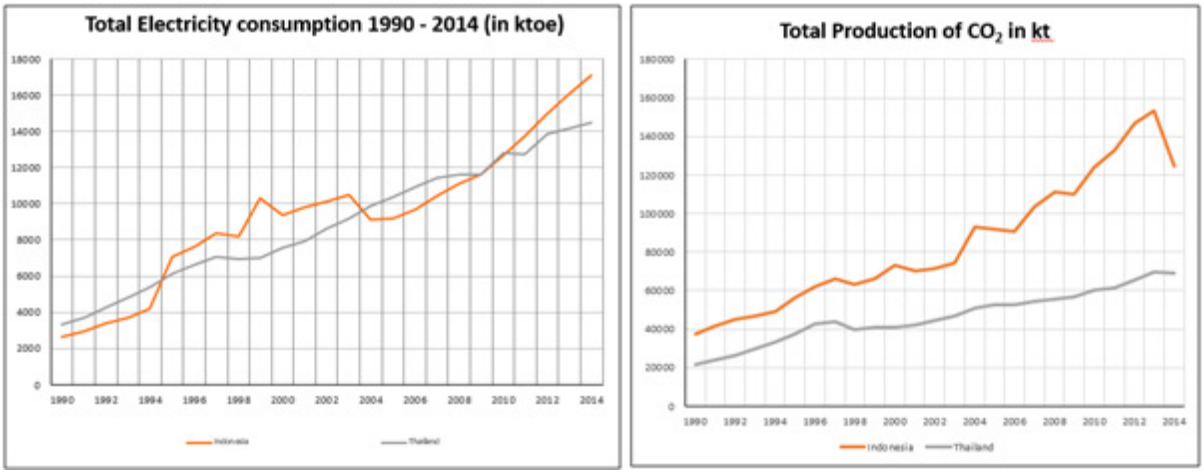

Figure 11: (Right) Comparison of the electricity consumption in Indonesia and Thailand; (left) comparison of the carbon-dioxide emission levels in the same countries

The teacher then challenged the students' initial assumption. To explore possible relationships between the two variables, the students were asked to look at four more charts (see Figure 12) showing Indonesia, Thailand, the U.S., and the PRC's total electricity consumption, sources of electrical energy, coal consumption, and carbon-dioxide emission levels.

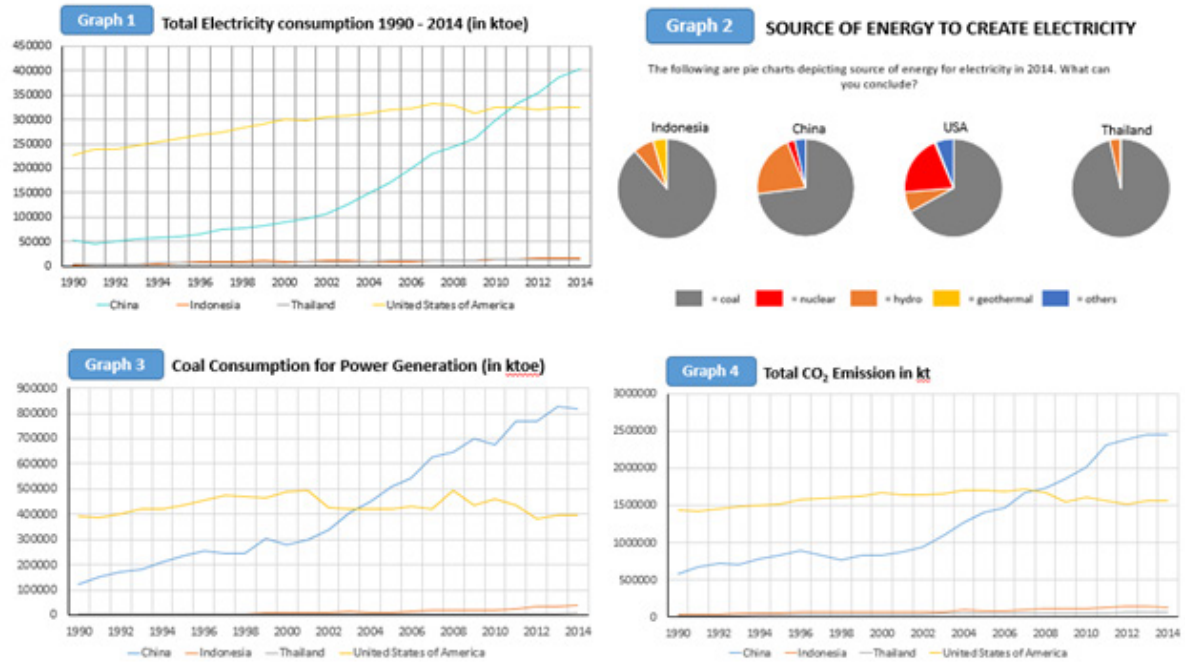

Figure 12: Additional charts comparing Indonesia, Thailand, the U.S., and the PRC

The students were asked to analyse the charts visually then discuss their thoughts with peers. They were then asked to present their findings to the whole class and even share their learnings with friends from other countries.

Research Results and Findings

The first lesson started by showing the students an image depicting the pollution on earth represented by lights (taken from http://blue-marble.de/nightlights/2012), zooming in to Indonesia and Thailand. It showed that Thailand was significantly brighter than Indonesia, except Sumatra and Java. It should be noted though that Indonesia covered a bigger area than Thailand. They were then asked which country consumed more electricity and what factors affected their electricity consumption.

Answers were then discussed. The students exchanged views with their peers. Most thought Indonesia consumed more electricity because Sumatra and Java were brighter than Thailand. They equated the number of lights to population. In general, they believed that a country's population was directly proportional to its electricity consumption.

The teacher reminded them that no matter how sound their arguments were, their answers were merely assumptions and need to be backed up by data. Afterwards, the teacher gave the students a worksheet that showed how much electricity Indonesia and Thailand actually consumed from 1990 to 2014 (see Figure 13). The students were then asked to plot a line chart using the data they received then answer the same questions they were asked earlier.

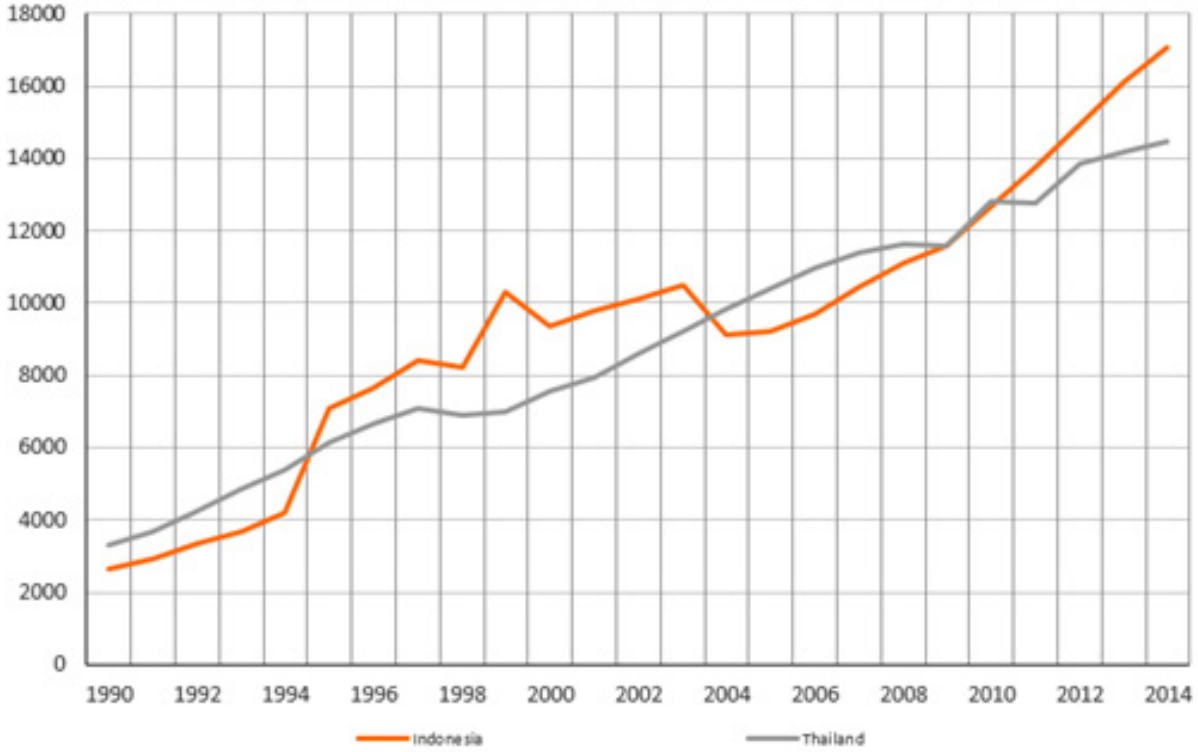

Figure 13: Comparison of electricity consumption in Indonesia and Thailand

The chart showed that Thailand and Indonesia consumed roughly the same amount of electricity. As the students struggled to match the new information with their initial assumption, the teacher showed them the chart comparing the countries' population (see Figure 10). It showed that Indonesia's population far exceeded that of Thailand. Again, this did not match their initial assumption—electricity consumption was not directly proportional to population. A heated discussion of unseen factors then ensued. They worked together to find out why the facts did not meet their expectations.

At the end of the lesson, the students concluded that electricity consumption was not proportional to population because not every individual consumed the same amount of electricity. Developing countries with more successful industries and better access to technology will consume more electricity even if they had a tiny population.

The second meeting started with a review of the events that transpired during the first one. Since the students from both countries worked on the same data, it was more interesting to note how they shared their thoughts and communicated with others.

They were then asked if electricity consumption was related to carbon-dioxide emission. Most students did not think so. This could be due to prior knowledge from their science classes. Some were, however, unsure because the related charts in Figure 12 seemed to show some level of correlation.

The teacher asked the students if they foresee any unexposed variables before asking them to look more closely at the charts in Figure 12. The students mainly performed exploratory data analysis, that is, looked at data to identify trends and form hypotheses.

The students found that the electricity consumption of the U.S. and the PRC followed a similar trend just like data from Indonesia and Thailand showed likenesses. A notable dip in the U.S.'s carbon-dioxide emission level was seen near 2014, which may have something to do with the increase in its coal consumption. To confirm, they looked at the country's source of electrical energy, which indicated a shift towards clean energy (hydro and nuclear). This prompted the students to conclude that the volume of electricity consumed by a country did not affect its carbon-dioxide emission, what mattered more was where they obtained the energy to create electricity.

Apart from the charts, the students were also given a worksheet to complete so they can form their own conclusions about the correlation between electricity consumption and carbon dioxide emission. The students concluded that the PRC used more coal than the U.S. and so it had a higher carbon-dioxide-emission level. Additional data (from the U.S. and the PRC) and guidance helped the students better notice trends and relationships between countries and the factors they were scored on.

In sum, the lesson helped the teacher better explain how important data literacy was in understanding the world around us while building strong and sound arguments. Most of the students appreciated the fact that the problem they were given in class was an important global issue because they were able to share their thoughts with people from a different country in hopes that they can work together to resolve the issue.

Conclusion

Data literacy is crucial to support GCED. Yet very little effort has been exerted to incorporate GCED into statistics education. Statistics education mostly focuses on memorising formulas and learning the procedural way of handling data. To develop students' data literacy and, in turn, foster global citizenship, statistics needs to be enhanced by using real-life data set in meaningful contexts and using cross-border collaboration.

Data literacy is the ability to derive meaningful insights from data, including accessing, assessing, manipulating, summarising, and presenting information (Schield, 2004). Students need to be able to relate to given data if they are to derive meaningful insights off it. Using real-life data in lessons not only challenges students, but also makes them care more about solving the problem. They are more invested in working on a data-driven problem that can affect their lives.

Applying the right context to data is also important. In the sample lesson, energy conservation was the global issue used because it goes beyond geographical and jurisdictional borders. Through cross-border collaboration, the students became aware that energy issues affected everyone worldwide and as global citizens, they can become agents of change to solve the problem.

Teachers can explore other core dimensions of global citizenship and use other global issues for their lessons. They are also encouraged to explore other data sources and methods to conduct statistical investigations. Cross-border collaboration in school can also open more opportunities for teachers and students alike to work with their peers in other countries.

The findings presented in this article were limited to conducting one lesson. We did not have the luxury of time to test our thesis in other topics or subjects. Challenges due to a language barrier were also encountered but successfully managed.

Note: The authors would like to express their deepest gratitude to the teachers, students, and schools who participated in this endeavour.

References

1. Arthur Bakker. (16 April 2007). "Diagrammatic Reasoning and Hypostatic Abstraction in Statistics Education." Retrieved from https://www.degruyter.com/view/j/semi.2007.2007.issue-164/sem.2007.017/sem.2007.017.xml.

2. C. H. Chiu, H. Y. Yang, T. H. Liang, and H. P. Chen. (24 July 2008). "Elementary Students' Participation Style in Synchronous Online Communication and Collaboration." Retrieved from https://www.tandfonline.com/doi/abs/10.1080/01449291003686195.

3. David L. Neumann, Michelle Hood, and Michelle M. Neumann. (November 2013). "Using Real-Life Data When Teaching Statistics: Student Perceptions of This Strategy in an Introductory Statistics Course." Retrieved from https://iase-web.org/documents/SERJ/SERJ12(2)_Neumann.pdf.

4. D. Ben-zvi, E. Gil, and N. Apel. (2007). "What Is Hidden Beyond the Data 1? Young Students Reason and Argue About Some Wider Universe 2 Working Version."

5. Eric Gutstein. (January 2003). "Teaching and Learning Mathematics for Social Justice in an Urban, Latino School." Retrieved from https://www.jstor.org/stable/30034699?seq=1#page_scan_tab_contents.

6. Javier Calzada Prado and Dr. Miguel Ángel Marzal. (31 May 2013). "Incorporating Data Literacy into Information Literacy Programmes: Core Competencies and Contents." Retrieved from https://www.degruyter.com/view/j/libr.2013.63.issue-2/libri-2013-0010/libri-2013-0010.xml.

7. Lawrence M. Lesser. (7 August 2007). "Critical Values and Transforming Data: Teaching Statistics with Social Justice." Retrieved from https://www.tandfonline.com/doi/full/10.1080/10691898.2007.11889454.

8. Mairéad Hourigan and Aisling Leavy. (24 July 2015). "What Do the Stats Tell Us? Engaging Elementary Children in Probabilistic Reasoning Based on Data Analysis." Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/test.12084.

9. Milo Schield. (1999). "Statistical Literacy: Thinking Critically About Statistics." Retrieved from http://web.augsburg.edu/~schield/MiloPapers/984StatisticalLiteracy6.pdf.

10. Milo Schield. (2004). "Information Literacy, Statistical Literacy, and Data Literacy." Retrieved from http://www.iassistdata.org/sites/default/files/iqvol282_3shields.pdf.

11. Penelope Bidgood. (25 March 2010). "Relating Assessment to the Real World." Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1002/9780470710470.ch12.

12. R. Bhargava and C. D'Ignazio. (April 2015). "Designing Tools and Activities for Data Literacy Learners." Retrieved from https://www.media.mit.edu/publications/designing-tools-and-activities-for-data-literacy-learners/.

13. UNESCO. (2 December 2013). "Global Citizenship Education: Preparing Learners for the Challenges of the 21st Century." Retrieved from http://unesdoc.unesco.org/images/0022/002277/227729e.pdf.

14. UNESCO. (2015). "Global Citizenship Education: Topics and Learning Objectives." Retrieved from http://unesdoc.unesco.org/images/0023/002329/232993e.pdf.

15. UNESCO. (2017). "Education for SDGs: Learning Objectives." Retrieved from http://unesdoc.unesco.org/images/0024/002474/247444e.pdf.

16. Zipora Libman. (March–June 2010). "Alternative Assessment in Higher Education: An Experience in Descriptive Statistics." Retrieved from https://www.sciencedirect.com/science/article/pii/S0191491X10000039?via%3Dihub.