INDONESIAN STUDENTS' EXPERIENCE WITH REAL-LIFE DATA AND CROSS-BORDER COLLABORATION: WHAT DOES THE GRAPH SAY?

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Statistics has been advocated as a way for students to make sense of the world. However, statistics instructions in schools mainly focus on number and formulas, thus fail to serve the aforementioned purpose. Existing research have proposed various perspectives on effective statistics instructions in the classroom, as well as the role of lesson study in the innovation of teaching and learning. To contribute to this area of study, we developed a statistics lesson for secondary school through Lesson Study, featuring the use of real-life data and cross-border collaboration. In this study, 32 students each in Indonesia and Thailand deduced the link between coal consumption and CO_2 emission using data from APEC database. This paper describes the lesson from the perspective of Indonesia.

INTRODUCTION

In an increasingly information-laden civilization, the ability to deal with statistical information becomes essential for a well-functioning member of society. This ability is what known as statistical literacy, i.e. "the ability to understand and critically evaluate statistical results that permeate our daily lives-coupled with the ability to appreciate the contributions that statistical thinking can make in public and private, professional, and personal decisions" (Wallman, 1993).

Educational institutions are responsible for better statistical literacy (Ferligoj, 2015), therefore reforming statistics education becomes one of the long term goals. However, the way statistics being taught in school often does not serve this goal justice. Statistics classroom instruction in school usually revolves around rote memorization of formulas and procedures. Bakker (2004) storytelling about *meanmedianmode*, for example, provides insight into how students view statistics as a set of procedures applied to random numbers, totally void of meaning and thus needs no reasoning.

Zooming in to Indonesia, the education scene shows similar trends. The syllabus document mentions 'making decision with data' and 'making prediction with data' (Kemendikbud, 2016), yet judging from the content of the textbook (Kemendikbud, 2014), statistics are taught in old, familiar ways. Most problems are procedural, with occasional contextual problem set in hypothetical situation with made-up data.

Recent research in statistics education have confirmed that instead of focusing on statistical skills, procedures, and computations, statistics education in school needs to foster the students' ability to think and reason statistically using real data set in an appropriate context (Bakker, 2004; McGatha, Cobb, & McClain, 2002). In order to produce innovative and groundbreaking best practices in statistics education, classroom instructions need to undergo continuous reform.

LITERATURE REVIEW

What constitutes an effective classroom instruction for statistics is still a continuous debate. We propose three features, all are relatively novel to the landscape of statistics education in Indonesia: the use of real data, meaningful context, and cross-border collaboration. All these features are incorporated in a set of learning material developed through lesson study.

Real-life data

In a pursuit to make our statistics education serves the goal of the future generation's statistical literacy, classroom instructions need to be made as relatable as possible to the real world. This can be achieved through two measures: 1) imitating some part of a professional or academic statistician's working life, or 2) using genuine data in context (Bidgood, 2010). In line with this notion, the last fifteen years have seen an increasing preference in active learning, the use of real-life data in the classroom, and innovative use of technology to help the students learn statistics (Chance & Garfield, 2002).

Real-life data is data taken from archival data, data collected in research projects, and classroom-generated data (Neumann et al., 2013), as opposed to artificial data, which are conjured

through simulations or based on hypothetical situations. Real-life data can be collected by the students themselves through different methods of data collection. However if actual data collection is deemed too time-consuming, a plethora of accountable online database are available out there that provides credible and trustworthy real-life data at no cost

The use of real-life data has many advantages. The integration of real-life data makes learning activity a complex, rich, and challenging one (Libman, 2010). The numbers are not purposely made to be kids-friendly and easy to manipulate, hence dealing with data is no longer done in an automatic way and instead becomes a venue for critical thinking and reasoning. Real-life data motivate the students since it provides ground for students to grapple with statistical techniques used in real life (Diamond & Sztendur, 2002).

Real-life data has been advocated and mentioned by many researchers and institutions in statistics education. Hourigan and Leavy (2015) used real-life data in engaging fifth grade students in 'describing and comparing likelihood' activity. Libman (2010) and Neumann et al. (2013) both discovered that the use of real-life data increases the students' engagement and encourages the students to take more active role in the classroom. This is also underlined by Guidelines for Assessment and Instruction in Statistics Education (Franklin et al, 2007), which states that successful statistics courses can be achieved through, among others, the use of real-life data.

Many international institutions have provided their data for free online, which can be accessed and used by everyone. Most notable institutions for example UN, OECD, and World Bank.

Meaningful context

The ability to interpret statistical result in context is one of the goal of statistics education (Franklin et al, 2007). The students will have to look beyond mere procedures and be able to uncover meaningful information from the resulting numbers. They also have to be critical, either in questioning the information they acquire from others as well as defending their own argument. In order to do that, it is essential for the students to be interested and engaged in the problems.

It has been stated before that real-life data, by default, are set in a context of its own, as opposed to artificial numbers for which the teachers might have to struggle to find suitable context for a bunch of numbers they have available. Nevertheless, our job is not done yet. In order to ensure the students' engagement, the choice of context is really important. Surprising and complex problem situations that contradict their prior beliefs are recommended (Ben-Zvi et al., 2007), as well as contexts that open possibilities for interdisciplinary learning (Selmer et al., 2014).

Cross-border collaboration

Collaboration, along with critical thinking and creativity, are the notions that constitute 21st century skills. It is a term commonly mentioned in today's discussion on education and its policies, referring to a set of skills a person need to posses in order to be able to compete in an increasingly connected and globalized world (Rotherham & Willingham, 2010).

In education, collaborative learning is an approach to classroom activity where students are expected to work together in solving a problem or completing an assignment. In addition to achieving the goal of 21st century skills, working with other people also makes the students to be more engaged and active in the classroom, thus achieving higher in assessment (Giraud, 1997). Therefore, collaboration is added as one more feature to the classroom instruction we envisioned, in the form of cross-border collaboration.

The phrase cross-border here is taken from the notion of cross-border education, which is a term that refers to the movement of education across national jurisdictional or geographic borders (Knight, 2006). Hence, cross-border collaboration in this research refers to classroom discourse involving students from different countries and nationalities working together.

Cross-border collaboration in this case is made possible by synchronous technology, which is technology that enables real-time communication, which includes text chat rooms, audio/video conferencing, and shared whiteboards (Chiu, Yang, Liang, & Chen, 2010). Software such as Adobe Connect, Blackboard Collaborate, and WebEx are among the most widely used in education. With the help of synchronous technology, the students in Indonesia will collaborate and learn together with students from other country.

Lesson Study

All of those features above are then incorporated into a set of learning materials, developed through lesson study. A well-known approach to teachers' professional development, lesson study is arguably Japan's most famous export in pedagogy. In Japan, it is known as *jugyou kenkyou* which literally translates as "lesson research/study". The idea was first conceived and brought into realization in the end of 19th century, but the form of lesson study we currently know did not take part until the start of 20th century. Since then, lesson study has been an inseparable part of Japan's pre-service and in-service teacher training and professional development. It reflects the culture among Japanese educators, who prizes thirst for knowledge and self-betterment (Lewis, 2000). The success of Japan in Science and Mathematic is also largely contributed to this practice.

The idea lesson study built on is simple: teachers come together to discuss a shared question regarding the students' learning, collaboratively plan a lesson incorporating their joint knowledge, conduct the lesson and observe how the lesson proceed, then review and discuss what they did for possible improvement (Murata, 2011). Lesson study typically follows an iterative cycle comprising 4 consequent phases: 1) studying curriculum and identify long term goals for student learning and development, 2) lesson planning, in which teachers set the lesson objectives and develop lesson plan and materials in accordance; 3) lesson presentation/observation, in which the prepared lesson is implemented while being observed by a group of teachers; and 4) lesson reflection, in which the model teachers and the observers sit together and discuss the possible improvement for the lesson (Murata, 2011). However, the practice of lesson study commonly known in Indonesia consists only of steps 2, 3, and 4, also popularly jargonized as the Plan-Do-See step.

The first step is what marks the difference between lesson study and classroom action research. Lesson study does not have to be started by the need to fix an urgent problem classroom; it can be driven simply by a teacher envisioning better teaching and learning environment for their student. Therefore, lesson study is a suitable means to improve classroom instructions. Several characteristics of lesson study have been pointed out as the driving force of instructional improvement, such as development of teachers' knowledge, strengthening of professional community, and the improved lesson task and plan (Lewis, Perry & Hurd, 2009).

Various research have reported the success of improving classroom instruction of lesson study. The case from statistics education, among others, are the experience of Hourigan and Leavy (2015) with fifth-grade students learning about describing likelihood, and Chong et al. (2017) with twelfth-grade students learning conditional probability.

THE RESEARCH

The lesson

In this research, Thailand is the partner country, thus an appropriate context for both countries was chosen for the learning activity. The two countries would be connected through live video conference. The students would join forces together despite the barrier of distance and cultures, to work on an issue that transcends both nations: energy.

Two contexts are used in this research: 1) the electricity consumption of Thailand and Indonesia, and 2) the connection between electricity consumption and CO_2 emission. The first context was coupled with data about population count and the students were asked whether electricity consumption of a country is determined by how many people living in it. The second context was started by what seemed like a positive correlation between the two data, contradicting the students' prior knowledge that electricity consumption does not, at least directly, affect CO_2 emission.

The data we used for this research is from Asia-Pacific Economic Cooperation (APEC) energy database, which is a comprehensive database providing energy-related information on APEC member countries (Asia-Pacific Economic Cooperation, 2018).

All the ideas above are combined together in designing the lesson, which extended two meetings set approximately a week apart. The first meeting was carried out separately in Indonesia and Thailand, while the second meeting was conducted simultaneously in both countries and connected via live video conference. In accordance to the topic of this paper, the discussion will be limited to the second meeting.

The meeting was opened with line graphs of electricity consumption of Thailand and Indonesia, followed by a question whether or not electricity consumption causes CO_2 emission due

to the seemingly correlating data as shown by the line graphs. As predicted, the students were conflicted between their previous knowledge that electricity consumption does not affect CO_2 emission and the information presented in the graph.

In order to solve the problems, the students were assigned worksheet that they have to do in groups of four or five students. The worksheet features four graphs: 1) electricity consumption, 2) sources of energy to generate electricity (coal, nuclear, hydro, geothermal, and others), 3) the consumption of coal, and 4) CO_2 emission– each from Indonesia, Thailand, USA, and China. All data were taken from APEC energy database. These graphs as shown in figure 1.
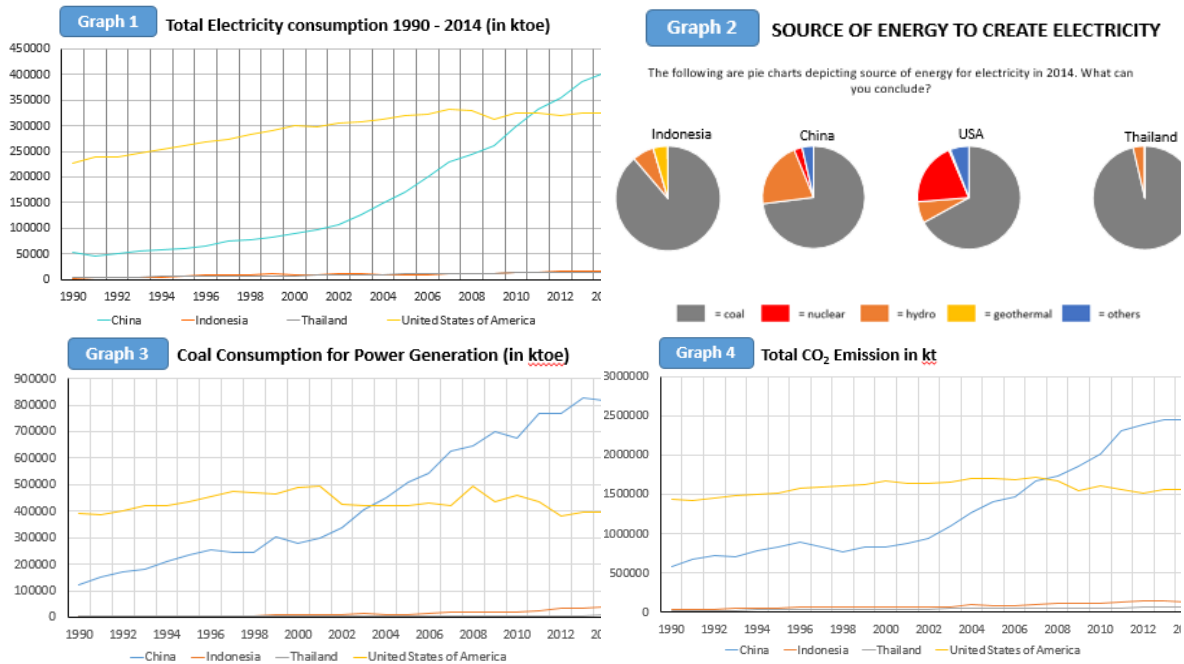
Figure 1. The graphs used in the worksheet

The discussion was centered around two questions: 1) *Observe graph 1. For China and USA, their electricity consumption is going up. However in graph 4, CO2 emission of China is going up while for the case of USA, is going down. What do you think is the cause behind these phenomenon? Explain your answer. Use the graph to support your reasoning*; and 2) *Does higher electricity consumption cause higher CO2 emission? Explain your answer.*

It is evident that this worksheet relies heavily on exploratory data analysis. Both tasks require the students to visually analyze the data, put it in context, and use the graphs to defend their arguments.

The lesson study cycle

The planning phase was conducted over the course of three months between researchers in SEAMEO QITEP in Mathematics, Indonesia and Khon Kaen University, Thailand. The result of the planning phase was the final version of the learning materials and technical matters regarding the implementation of the lesson.

The implementation and the observation phase was conducted in a lower secondary school in Yogyakarta, Indonesia and a laboratory school of Khon Kaen University, Thailand. The model teachers were selected from the school itself, who prior to the lesson was also actively involved in the designing of the teaching materials. The participants consisted of 32 English-speaking eight grade students each in Indonesia and Thailand. During the lesson, the students were given the time to discuss the answer with their assigned group, before proceeding to a question-and-answer session with their Thailand friends.

The implementation phase was then followed by reflection between the model teacher and the observer about the obstacles faced during the lesson and possible improvement. The result of the discussion were then used to refine the worksheet and lesson plan.

The results

Through visual analysis and group discussion, the students were able to conclude the answers for both questions. Below are the excerpt of the Indonesian students' answers respectively for questions 1 and 2, that they explained during Q&A sessions with their Thailand friends.

> *... and [the CO_2 production of] USA is going down. I think the CO_2 production depends on the source of energy [to create electricity] but based on the data China uses more coal than USA. It causes the production of CO_2 in China increase.*

> *[explaining USA] and use more alternative source of energy to create electricity than any other country. [CO_2] production depends on which source of energy the country use to create electricity.*

The students showed significant engagement during the lesson. Being able to talk with students of their age from other country definitely added an element of novelty to their statistics lesson, as shown by their curiosity and enthusiasm during the discussion. They were also able to appreciate the fact that they can understand a world larger than what they usually see everyday, through investigating real-life data from reliable sources. However, due to technical problems with internet connection and the inability of the microphones to record the sound of the room, the discussion did not flow as smoothly as expected. Students often experienced difficulty in understanding what the students from the other side of the screen were saying.

The reflection phase revealed some rooms for improvement which can serve as guidelines for future researchers who are interested to conduct similar projects. Most important points regarding technical matters can be summarized as follows:

- Internet connection. We strongly recommend to use LAN/cable connection instead of wireless.
- Sound recording. Instead of placing microphones at the center of the room to record the sounds of the entire class, the microphone should be transmitted directly to the other country via internet.
- This lesson opens another possibility for the use of ICT which is quite new to the world of Indonesian education: connectivity. Teachers are encouraged to maximize this by employing it not only in classroom discussion but also projects, assignment, etc.

CONCLUSION

Reforming statistics education to adhere to the goal of statistical literacy needs to start from classroom instructions. We propose to contribute to the improvement of classroom instruction in statistic through the development of lesson through lesson study, which incorporates the following features:

- The use of real-life data.
- Meaningful context.
- Cross-border collaborations.

Due to time restriction from the school, this lesson study could only be conducted in one cycle. Future research are encouraged to explore more into the three features - other sources of data, other contexts, and other countries. This research is hoped to provide more insight into designing innovative and effective classroom instructions in statistics.

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