

STATISTICS EDUCATION RESEARCH JOURNAL

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STATISTICS EDUCATION RESEARCH JOURNAL

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STATISTICS EDUCATION RESEARCH JOURNAL 19(1), 2020

SPECIAL ISSUE ON “BUILDING FUTURE GENERATIONS OF STATISTICIANS”

Special-Issues Editor: Manfred Borovcnik
Guest Editors: Ayşe Bilgin and Peter Howley

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NOTE FROM THE EDITOR FOR REGULAR PAPERS

Welcome to the first issue of SERJ for 2020. Regular readers may be surprised by the February issue date, but starting in 2020, SERJ will publish three Issues per year: two with Regular papers and one Special Issue. Typically, the Special Issue will be published in June, with the Regular Issues coming out in February and October. For 2020, this Special Issue, *Building Future Generations of Statisticians*, is being released in February, and the Regular Issues in June and October. The change in publication dates underscores the growth of the statistics education community in general, and of the number of high-quality manuscripts submitted to SERJ in particular. It is a very exciting time for our research field!

Please join me in thanking the leadership team responsible for the February 2020 Special Issue of SERJ: guest editors Ayse Bilgin and Peter Howley, and the SERJ Editor for Special Issues, Manfred Borovcnik. This team has worked tirelessly to produce the issue with such an important focus for our field. In addition, a special thank you to Manfred, for whom this Issue represents his last as Editor. Manfred's dedication to SERJ and attention to detail will be missed by the SERJ Production Team. New to the position of SERJ Editor of Special Issues is Daniel Frischemeier, who will oversee the publication of the June 2021 Special Issue of SERJ, *Statistics Education Research from a Latin American Perspective*, as his first Issue. The Editorial Board of SERJ is looking forward to working with Daniel and we welcome him to the leadership team of SERJ.

JENNIFER J. KAPLAN

EDITORIAL FROM THE SPECIAL-ISSUES CO-EDITOR OF SERJ

The central theme of the present special issue is 'initiatives in developing future statisticians'. The main focus was laid on the surrounding 'outreach' initiatives and supporting mechanisms for increased engagement in the field of statistics. We wanted to collect details about activities that arouse interest from the wider community and schools and increase the numbers of individuals engaging with statistics. Activities that let the next generation recognise the value of statistics and wanting to be part of a statistics movement. Our call for papers was not very specific, we asked for collaboration between stakeholders, innovative approaches to develop a love of statistics and to overcome statistical anxiety, success and failure stories. It is vital to accompany such activities by research in order to draw evidence-based conclusions from the experience. Yet, in practice such research is missing.

To evaluate such outreach programmes is a difficult task: the problem is open, not clearly stated (criteria are missing somehow; the target group is not well-defined), and the programmes are not initiated by researchers who primarily are from the community of statistics research, but are carried out by singular persons or institutions who want to spread the ideas of statistics. The focus is on inventing something that works and attracts attention. We are in some justification dilemma: Either we acknowledge the various attempts and programmes by other standards than used in research or, we miss opportunities. There are no or not well-organised accompanying research activities when creativity is in flux and programmes are developed. Yet, in practice, it becomes often rapidly clear that some ideas will work and others will not. When we are facing the revolution of statistics by data science, for statistics as a discipline, we are in need to change our attitudes, our conceptions what are feasible statistical methods (the role of assumptions), what are the relevant criteria for success of statistics, and what are the relevant problems to solve. For teaching statistics, what are feasible and viable solutions to teach such a revised statistics, and who will be able to teach them. The situation, in a sense, is analogue to the "conflict" between statistics as an applied discipline and data science as an innovative field.

There are different paradigms behind statistics and data science: Statistics is seeking for an “optimal” model of the situation with a best solution. That requires to have appropriated data or to produce appropriate data that fulfil the necessary assumptions of the used model. Data science is seeking for a comparably small improvement of the current situation using data and models in an exploratory way, often created out of dirty data. The comparison hits also the heart of the future of statistics as with the traditional attitude, statistics will ever decrease in relative importance to data science.

Statistics could give way to the new community of data science. That would neither help nor clarify the relative roles of traditional statistics based on narrow assumptions and data science (anything goes). That means the relation between statistics and data science has to be reorganised with an active and pro-active role of the traditional statisticians. Data-science people would see – in face of their relative success – no reason to go back to traditional statistics. Data science would also use Bayesian ideas more freely than traditional statisticians would do. Surely, this is another source for their success. Yet, Trevor Hastie in his keynote at the WSC 2017 in Marrakech did state in the discussion: We still are hoping that the statisticians will be able to explain why our algorithms really do work.

We did not structure the call for papers for the special issue; yet, we have seen the intelligence of the crowd in action. With hindsight, we can identify the problems for statistics education to build the next generation of statisticians clearly.

Invited Essays First, we have to make clear that statistics – as it is involved anywhere – opens a future for the next generation to have an interesting and challenging work (Bilgin, Bulger, & Fung). Second, we should not forget that we have to teach an interesting and memorable statistics that means we have also to focus on meta strategies of teaching to clarify the details of what we learn at the moment (Sowey). Third, we have to think beyond the traditional school environment by integrating the practice of statistics into the class, which asks for a change of view of schools beyond teaching, exams, and certificates (Howley & Roberts).

Beginning early and developing the ideas and concepts spirally Let the ideas grow and change in the learners’ minds by suitable contexts and meaningful activities. It is amazing what young primary students can learn and how it is possible to enthuse them about comparing two groups by statistical methods with the help of an intuitive software (Frischemeier). Apart from statistical activities to solve problems in a context, games are still a challenge for developing probabilistic ideas in young students. Interestingly, not only playing games but changing the rules of games is a trick to engage the students and to foster their cognitive development (Malaspina & Malaspina). Learning within a project in the paradigm of creative insubordination, working on a task that comes from the young students, enables the learners – with the suitable and sensitive support of the teacher – to work collaboratively and develop skills that go far beyond using data (Oliveira Souza, Lopes, & Fitzallen).

Learning to teach statistics That means, to recognise that it does not help for teaching once teachers have learned the mathematics behind the subject. We all know that the teachers (mostly mathematics teachers teach statistics) are all but well educated in statistics. Yet, their education does not cover anything like learning to teach statistics, which is completely different from knowing the technical details. Working groups and workshop-initiated learning for teachers may support teachers to learn to teach statistics. A workshop conference for teachers in connection to the introduction of data analysis and an individual project into the Welsh Baccalaureate has been initiated by school authorities and is analysed here by an “insider” (Jones). A series of workshops was organised as teacher training over several years by university staff to close the gap between formal (non-)education in statistics and teaching statistics (Pérez et al.). We have to work with in-service teachers to immediately improve the situation in building the next generation of statisticians. Such activities are needed worldwide and it seems important to see what works elsewhere and how to catch the interest of teachers who might have other daily needs.

Involving the wider society in activities around statistical literacy It takes all parts of the society to educate the next generation: the parents, the teachers, ..., the statisticians, and several institutions also beyond the school system, such as statistical societies. The *International Statistical Literacy Project* (ISLP) is an initiative originally founded by the *International Statistical Institute* (ISI) that involves schools, their students, their teachers, and all stakeholders that have an interest in promoting statistical literacy and attracts many posters in their national and international poster competitions. On the international level, the analysis of the activities is impressive (Helenius, D'Amelio, Campos, & MacFeely). Interestingly, the competition in Russia goes beyond a poster competition but involves also statistical quizzes and attracts quite a large public interest and is also backed up by official scholarships for the future students (Ponomarenko & Svirina).

Helping students and early researchers to understand and use statistics Students have great problems in learning statistics, which is a prerequisite in many studies and they do not use the traditional support systems. A system of support that is immediate, anonymous, and offered by peers who work as tutors is an innovative idea, which seems quite successful (Intepe & Shearman). A quasi-internship at a company accompanied by the support in the traditional course at the university might help to overcome the gap between the theoretical knowledge acquired at the university and the qualifications needed at the later workplace (Rodríguez Silva & Sánchez Aguilar). A capacity-building initiative as support for young researchers who have to apply statistics in their research work (and not yet understand the relevance of the methods and do not master the technical details, and would not be able to interpret the results accordingly) might improve the image of statistics in young researchers and improve the quality of their research, and increase chances that their papers are accepted by research journals (Reston & Poliquit).

Big Data and innovative approaches to deal with data Finally, with the huge changes in the applications by the tsunami of Big Data, we have to take care about the new skills and take this as opportunity rather than a challenge to resume data science and techniques of the kind, which makes a complete new approach necessary. We have seen a theoretical work on big-data literacy as amending statistical literacy (François, Monteiro, & Allo) in our special issue. The advent of new data sources (as from satellites) will help to amend missing data, especially in African countries. The need for substituting innovative forms of data is also an opportunity for such countries as there are quite a few skills needed to make use of the then Big Data to calibrate and handle them, i.e., also to attribute them to locations (Stern et al.). African countries seem to be very creative in using novel ways of data acquisition but also online-quizzes and examinations to amend their lack of capacity in qualified staff, which in turn allows for a much faster and more direct feedback for the learners, a substantive element for success for students (Sidi Zakari). Epidemiological concepts are analysed for their potential to foster a paradigm change in teaching statistics that embraces the applications of statistics and the approach of Big Data. A comparison between traditional statistics and Big Data is overdue; an attempt to do that and identify the challenges but also the potential from the need to reorganise statistics education for the next generation of statisticians is completing this special issue (Hassad).

Coming back to the purpose and the specific advantage of special issues over regular issues with papers submitted by authors from the community about their ongoing research, the purpose, challenge, and potential of special issues might be seen in the following points:

- To involve larger parts of the statistics-education community with greater responsibility.
- To identify larger problem fields of statistics-education research and to contribute to progress by a joint effort.
- To focus on specific topics and elaborate the topic to some extent to cover the prominent views and problems.
- To accompany as guest editors the process of working on the common theme and interact with the authors (and the reviewers).
- To encourage innovative ways of research exchange, especially as invited essays, or seminal paper – discussion – rejoinder (we had none in the present special issue).

- To allow for the development of conference papers on a specific topic. Revisit, refine, and revise some ideas that have already been completed, may boost the insight and the value of the presentation and understanding of the results of studies even with hindsight.

Guest editors have a more active role than journal editors. They are not neutral. They accompany the authors and synthesise the ideas presented. If appropriate, they look for additional discussion papers. It is like working on a monograph with a specific research topic. To summarise: The potential of special issues is to synthesise the ideas of the papers that are written specifically around a common theme by the guest editors to make clear where the problems lie and where the special issue has arrived at contributing.

MANFRED BOROVCNIK

EDITORIAL: BUILDING FUTURE GENERATIONS OF STATISTICIANS – WHO CARES?

INTRODUCTION

For many, the theme of this special issue has been a perennial focus, discussed at national and international fora but perhaps lacking a consolidated emphasis in the literature. Indeed, there have been pioneers in this area; many of whom have led and contributed to international collaborations and research, or assumed executive roles in statistical societies and associated initiatives – too many to name without inadvertently overlooking someone but such should at least be collectively acknowledged.

The field of statistics is increasingly being challenged by competitors, or those purporting to reduce the need for statistics and all that underpins the discipline. Ironically, the global need for statisticians has never been more greatly recognised by employers and governments than over the past decade. So why is there such a misalignment between supply and demand and, significantly, how may we draw a line in the sand and arrest this? How do we ensure that we will not be having these same conversations in another decade, assuming the discipline of statistics has survived!

The aim for this issue was to provide a consolidated platform for sharing the many and varied international initiatives operating towards building future generations of statisticians. It is not expected that this special issue necessarily provides all the answers; however, to solve a problem, one needs to acknowledge that the problem exists, postulate, collaborate, investigate, and take action! Whatever your views on this issue's articles, whether you feel heartened by new and appealing approaches to engage people with statistics, or consider the ideas inadequate or antiquated, the outcome from the focus of this special issue needs to be the same – we, as an international statistical society need to view the education system holistically, recognise the need and our ability to proactively address and contribute to the system and ultimately increase the supply chain, lest the field of statistics otherwise becomes the diamond of disciplines; highly prized but beyond the reach of many and thus cast aside as impractical and unnecessary – or worse, a legend of a bygone age.

The collection of papers in this issue brings together academics from widespread geographical locations and different perspectives on a common theme. You will be able to read how to enthuse young children about statistics via games or software tools and capacity-building practices for teachers and academics within the discipline of statistics and beyond. Many papers document coordinated activities to nurture entry into statistics through competitions, workshops, or conferences. One wonders how long the goodwill of the relatively few academics who engage in outreach activities can continue under the “publish or perish” nostrum and requirements to secure grants along with pressures from other disciplines working to exclude statistics from Big-Data initiatives. The future of statistics and statistics education is

going to be as bright as we are willing to make it. The hope is that the collection of papers in this issue will be useful for many to adopt, adapt or otherwise be inspired to unite, conduct their own outreach activities and engage in surrounding research towards fulfilling the societal need in the era of Big Data.

BACKGROUND

Statistics and the interpretation of data are ubiquitous in the knowledge society and, consequently, statistical literacy is assuming an increasingly prevalent role in education at all levels. However, the perceptions and general appeal of statistics require methods to overcome initial hurdles to gain student interest and keep them interested (Howley, 2008). Statistics has a branding or image problem; often perceived as simply descriptive statistics or mathematics, missing the more interesting experimental, inferential, investigative, and creative aspects.

Further, statistical anxiety is increasingly a major issue, an impediment for young people to access and succeed in university degrees (Chew & Dillon, 2014; Onwuegbuzie & Wilson, 2003; Siew, McCartney, & Vitevitch, 2019; Williams, 2010) with cross-country comparisons indicating that this is not unique to any country (Chiesi, Primi, & Carmona, 2011). Statistics is seen as a beast, it is our duty to reveal the beauty.

It has been a decade since Google's chief economist, Hal Varian, first publicly referred to statistician as the sexy job of the next decade, identifying how Google was building their numbers of statisticians and statistics-oriented employees. There have since been significant reports identifying the predicted shortfall of adequately skilled individuals for the new Big-Data age (Manyika et al., 2011; Puang-Ngern, Bilgin, & Kyng, 2017), a crescendo of discussion, and national and international initiatives surrounding the need to address this shortfall.

Students need to engage with and become more greatly interested in the analytical, statistical and machine learning aspects needed to fill the increasing need for such Big-Data skills. Although universities are introducing new degree programs to address this issue (Kyng, Bilgin, & Puang-Ngern, 2016), earlier appreciation of and engagement with statistics is lacking.

It would seem the perfect opportunity for statistics to thrive – statistics is all about data. What is preventing interest and engagement?

School teachers have rarely if ever experienced statistics in practice, nor do they understand the varied and wide reach of statistical thinking, the techniques and applications, and its importance to study design and inference. Their knowledge about the practicing statistician is at best limited, their focus has been on the many other topics and aspects of teaching. When it comes to teaching statistics, teachers usually concentrate on the theory but not on interesting applications of statistics; supposedly it is easier to teach and assess the theory compared to practical aspects and applications of statistics.

Internationally, initiatives have commenced towards engaging schools, tapping into the supply chain of potential undergraduates, incorporating industry, academics and a multitude of resources and support. The aims of such activity include showing the beauty of statistics in everyday life, creating a comfort zone to deal with data, killing the statisticophobia beast (Dillon, 1982), and finally encouraging new generations to be confident and skilled in data analysis. But what are those activities? Have they been successful? What have we learnt from such attempts, past and present, and where should this lead us?

This special issue brings the spotlight to such activities internationally in an attempt to consolidate existing experiences, resources, and knowledge towards ensuring the diversity of skills, and efforts; outcomes are recognised and utilised that might help to develop increased and potentially more focussed collaborations and successes. We aim to enable educators across primary, secondary and tertiary sectors, and industry and national societies to learn from one another's experiences and potentially reduce the unnecessary duplication of efforts, rather supporting the higher-level learning as a first stage of engagement for creation of increasingly innovative and successful initiatives.

FINAL REFLECTIONS AND CHALLENGE

Why were we drawn to statistics? Was it due to our mathematical abilities or some other reason? Is the work we are performing as we expected it to be when we began our studies?

As you read through this issue we ask you to reflect upon whether we, those who carry the statistics torch, are possibly our own worst enemies? Do we espouse how globally important statistics is, and how it can take you anywhere, to our own detriment? This lack of specific outcomes and career options is exemplified and perpetuated by job advertisements rarely stating ‘statistician’. Should we be better connecting the dots for people? People study accounting with the image they may become an accountant; similarly, medicine with thoughts of becoming a doctor, and engineering to construct planes, ships, or buildings. These are of course somewhat trite and inept descriptions of reality; however, the point is that there is an existing connection made between the field of study and the perceived career outcome or job. Are the opportunities from studying statistics so broad and pervasive that without clarification the field seems of little value alone – does it get lost amongst the breadth?

The publications in this special issue address varying elements along the statistics pathway, which may be characterized as focusing on early intervention, supporting the teaching fraternity, support systems for students and early researchers, and Big-Data coordinated approaches. We shall leave it for you to connect the dots on this one.

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