14th International Congress in Mathematics Education

TSG-12 Agenda

TSG 12 : TEACHING AND LEARNING STATISTICS

Class: B

Session 1. 19:30-21:00 Beijing time, July 13th (Tuesday)

Session Moderator: Gail Burrill, Michigan State University, U.S.A.

1. **Time: 19:30 – 20:00**

   Title of the Paper: DESIGNING EMBODIED TASKS IN STATISTICS EDUCATION FOR GRADE 10-12

   Author: Lonneke Boels

   Institution and Country: Utrecht University/ Christelijk Lyceum Delft, The Netherlands

   Short abstract of the paper:

   Students persistently misinterpret histograms. In our previous work we unraveled why. In this paper I discuss the next step: How can literature—on misinterpreting histograms and on embodiment—in combination with results from an eye-tracking study inform embodied task design in statistics education? The findings applied in task design can be summarized in three main characteristics of the tasks: 1) sensory-motor actions evoked by the design are purposefully designed, 2) dotplots and dotplots with histograms overlays are used to support students' understanding of univariate data in histograms, and 3) the concept of data is made very explicit.

2. **Time: 20:00- 20:15**

   Title of the Paper**:** TEACHING STATISTICS AND SUSTAINABLE LEARNING

   Author : Hanan Innabi
   Institution and Country: University of Gothenburg, Sweden
   Short abstract of the paper:

   This paper aims to bring the attention to an important idea related to teaching statistics and sustainable learning. We claim that teaching statistics by considering variation in data and distribution might help students to strengthening their generic learning and to sustain it. Sustainable learning is used in the meaning of the generative learning that continue and prepare students for the future. The variation theory of learning is used as a framework of this paper.

3. **Time: 20:15- 20:30**

Title of the Paper**:** READING AND INTERPRETING DISTRIBUTIONS OF NUMERICAL DATA IN PRIMARY SCHOOL

Author : Daniel Frischemeier,

Institution and Country: University of Paderborn, Germany

Short abstract of the paper:

The ability of reading and interpreting distributions is a cornerstone when analyzing data. In primary school, this ability is often limited to reading and interpreting categorical data displayed in tallies, pie charts and bar graphs. In this paper, we report on a teaching-learning arrangement which has the aim to support primary school students (age 10-11) when extracting information of graphs displaying numerical data.

4. **Time: 20:30- 20:45**

Title of the Paper**:** STATISTICAL LITERACY AS CENTRAL COMPETENCE TO CRITICALLY UNDERSTAND BIG DATA

Authors : **Carlos Monteiro**[1] and Karen François[2]

Institution and Country:

[1]Universidade Federal de Pernambuco / The Federal University of Pernambuco (UFPE) – Brazil

[2]Vrije Universiteit Brussel / Free University Brussels (VUB) - Belgium

Short abstract of the paper:

Big Data are massive data sets which are generated continuously in many contemporary social practices. Big Data has potential and limits which need to be understood, therefore it is a challenge to develop Big Data Literacy to support the needs of constructive, concerned, and reflective citizens. In this paper, we problematize the conceptualizations of mathematics and statistical literacy and we will highlight the need to integrate the new challenges and critical issues from data-science associated with Big Data, including e.g. ethics, integrity, misconduct, agency, and mathwashing. These reflections remark the needs to develop school and teacher education curricula which comprise learning and teaching processes associated with a literacy that enable learners to understand Big Data in daily life.

5. Time 20: 45 – 21:00

Title of Paper: STUDENTS BELIEFS ABOUT STATISTICS AND THEIR
INFLUENCE ON THE STUDENTS´ ATTITUDES TOWARD STATISTICS
IN INTRODUCTORY COURSES

Authors: **Florian Berens[1]**, Kelly Findley[2] and Sebastian Hobert[3]
Institution: [1]University of Goettingen, Germany, [2]University of Illinois –Urbana-Champaign,
USA, [3]University of Goettingen, Germany
Short Abstract of the Paper:

Negative attitudes of students toward statistics in introductory courses are a widespread phenomenon. The reasons for this lie first and foremost in their experience with mathematics, but they are also more diverse than just that. In addition to known reasons, this paper proposes that the personal definition of statistics also has an influence on the attitudes of students towards statistics. Students´ beliefs about statistics are therefore described as a cause that influences students´ (negative) attitudes. The presented paper has therefore surveyed 471 students of social sciences in a German university. It builds on a preliminary stage of a survey on beliefs about statistics two of the authors developed and on SATS 36. An overview of the survey development is given and a connection to attitudes is established. Findings show slight influences of the different beliefs of the students on their attitudes towards statistics. Especially rules-based beliefs about statistics have negative impacts on the students´ attitudes, investigative perspectives on statistics have positive impact on all dimensions of attitudes.

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Session 2 19:30-21:00 Beijing time, July 14th (Wednesday)

Session Moderator: Adam Molnar, Oklahoma State University, U.S.A.

1. Time: 19:30-20:00

Title of the Paper: INTERDISCIPLINARY DATA WORKSHOPS

Authors: **Danny Parsons,** David Stern, Balázs Szendrői, Elizabeth Dávid-Barrett
Institutions and Country: IDEMS International, University of Oxford, University of Sussex, United Kingdom

Short abstract of the paper:

An approach to interdisciplinary data workshops has been developed that brings together mathematical science students and practitioners to work on problems with real data in the practitioners' area of expertise. The approach was conceived through collaborative research projects aimed at tackling development challenges in Africa using data-based approaches to corruption in public procurement and farmer experimentation in agriculture. Implementation of the approach in four workshops in three African countries is presented. The workshops provided important learning outcomes both for students, experiencing a problem-solving approach to working with real data in a genuine context, and for practitioners to gain data awareness, literacy and skills.

2. Time: 20:00 -20:15

Title of the Paper: DISTINCTIVE ASPECTS OF REASONING IN STATISTICS AND MATHEMATICS: IMPLICATIONS FOR CLASSROOM ARGUMENTS

Authors: **Anna Marie Conner**[1] and Susan A. Peters[2]
Institutions and Country: University of Georgia[1] , University of Louisville[2] , U.S.A

Short abstract of the paper:

Reasoning plays an important role in mathematics and statistics, but the kinds of reasoning used to establish results differ between mathematics and statistics. In general, we see more probabilistic and contextual reasoning in statistics, while in algebra, as in other areas of mathematics, results rely on deductive reasoning, perhaps after inductive or abductive reasoning is used to examine patterns. Secondary school teachers are expected to teach topics from both mathematics and statistics, and they are asked to use collective argumentation in their teaching. It is important for teachers to support their students in

making arguments that use appropriate reasoning for the subject in which they are engaged. In this paper, we discuss distinctions between reasoning in statistics and mathematics and use diagrams of argumentation to illustrate these differences in practice.

3. Time: 20:15 – 20:30

Title of the Paper: A SCHOOL EXPERIMENT FOR INTRODUCTORY INFERENTIAL STATISTICS IN HUNGARIAN SECONDARY SCHOOLS

Author: **Péter Fejes Tóth[1],** Ödön Vancsó [2]

Institution and Country: Szent István University[1], Eötvös Loránd University[2], Hungary

Short abstract of the paper:

This paper deals with a possible concept and a school experiment based on it, both aiming to introduce the main ideas of inferential statistics in Hungarian secondary schools. Following a brief historical introduction, the main goals and the theoretical base of our experiment will be discussed. We will conclude our presentation with a comprehensive report of the pilot tests, complimented with results of feedback from students and teachers participating.

4. Time: 20:30- 20:45

Title of the Paper: AN INFORMAL STATISTICAL INFERENTIAL REASONING EXPERIENCE WITH SEVENTH GRADERS: A LESSON STUDY

Author: **Soledad Estrella**, Maritza Méndez-Reina, Tamara Rojas, and Rodrigo Salinas

Institution and Country: Pontificia Universidad Católica de Valparaíso, Chile

Short abstract of the paper:

Statistical thinking is fundamental for citizens to be able to make decisions in situations of uncertainty, allowing them to overcome the fallibility of intuition and to analyze with skepticism and greater precision the behavior of data. In this paper we present the results of the implementation of a learning sequence designed by a Lesson Study Group, with the purpose of promoting informal inferential reasoning of seventh graders' (12- to 13-year-olds). The results show that students' responses express the coordination of their informal knowledge about the context and data of the problem and outline statements beyond the data they possess. However, some cases give evidence of difficulties in making inferences with expressions denoting uncertainty. It is concluded that the learning sequence implemented in online teaching, enables the progressive development of some components of informal statistical inference.

5. 20: 45 – 21:00

Title of the Paper: RESEARCH ON TEACHING STRATEGIES OF MEAN FROM THE PERSPECTIVE OF STATISTICAL LITERACY

Author: **Wu Jiaqi** and Yu Yao
Institution and Country: Beijing Normal University
Short abstract of the paper:

In the era of big data, statistical literacy is a necessary ability of citizens, and mathematics classes in primary and secondary schools are an important place to cultivate statistical literacy.Mean is an important part of statistics teaching in primary schools. Students are confronted with the following problems when learning mean: they can calculate but cannot apply and cannot deal with extreme values in different situations.To solve these puzzles of students, it is necessary to understand the historical development of mean, analyze the essence of mean, and figure out the relationship between mean and other statistics.In order to cultivate the statistical literacy of students and combine with the puzzles encountered in their learning, the teaching needs to be improved from the following three aspects: introducing the mean in two ways, presenting a variety of methods for analyzing data, feeling the relevance of statistics, and appropriately handling extreme values.

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Session 3. 21:30-23:00 Beijing time, July 16th (Friday)

Session Moderator : Leandro de Oliveira Souza
                          Universidade Federal de Uberlândia, Brazil

1. **Time: 21:30-22:05**

Title of the Paper: MARGIN OF ERROR: CONNECTING CHANCE TO PLAUSIBLE

Author: Gail Burrill

Institution and Country: Michigan State University, U.S.A.

Short abstract of the paper:

An intriguing question in statistics: how it is possible to know about a population using only information from a sample? This paper describes a simulation-based formula-free approach to answering the question used in a course for elementary preservice teachers. Applet-like dynamically linked documents allowed them to build "movie clips" of the features of key statistical ideas to support their developing understanding. The live visualizations of simulated sampling distributions of "chance" behavior enabled students to see that patterns of variation

in the aggregate are quite predictable and can be used to reason about what might be likely or "plausible" for a given sample statistic. The discussion includes a brief overview of a learning trajectory leading to margin of error, summarizes a key lesson in the development, describes how the ideas are extended, and concludes with a brief analysis of student understanding after the course.

2. **Time: 22:05- 22:20**

Title of the Paper: CRITICAL CITIZENSHIP IN STATISTICS TEACHER EDUCATION

Authors: Cindy Alejandra Martínez-Castro[1], **Lucía Zapata-Cardona[2]** & Gloria Lynn Jones[3]
Institutions and Country: University of Antioquia, Colombia[1, 2], University of Georgia[3], USA

Short abstract of the paper:

This research analyzes the contributions of the statistical investigations to the development of critical citizenship of prospective teachers. Critical citizenship is a quality of thought that promotes environmentally, socially, politically and economically conscious citizens and develops critical dispositions towards the world in which they live. The participants were 10 prospective teachers pursuing a degree in Mathematics Education in a well-known public university in northwestern Colombia. The prospective teachers voluntarily participated in the research in which they carried out four classroom statistical investigations related to social crises. The main sources of information came from discussions in eight lessons where prospective teachers studied empirically crisis of society using statistical tools. Supplementary information included ideograms, autobiographies, and narratives. The results show that statistical investigations promote statistical thinking and encourage the development of the sense of agency.

3. **Time: 22:20- 22:35**

Title of the paper: MATHEMATICS ABILITY AND OTHER FACTORS ASSOCIATED WITH SUCCESS IN INTRODUCTORY STATISTICS

Authors: **Adam Molnar** and Shiteng Yang
Institution(s) and Country: Oklahoma State University, U.S.A.

Short Abstract of Paper:

Determining controllable factors associated with performance in introductory statistics would improve course quality and student success rates. This paper describes the construction of a brief 19 question diagnostic on mathematics needed for general introductory statistics. Multivariate models were constructed to predict student performance based on math diagnostic score and 13 other available variables. The most

predictive variables, in order, were general college GPA, mathematics ability, highest prior mathematics completed, and instructor effect.

4. **Time: 22:35- 22:50**

Title of the paper: ELEMENTARY STUDENTS' RESPONSES TO QUANTITATIVE DATA

Authors: **Karoline Smucker** and Azita Manouchehri

Institution and Country: The Ohio State University, U.S.A

Short Abstract of Paper:

In this work, relying on a teaching experiment methodology, we examined development of statistical thinking surrounding the creation of graphical displays amongst a cohort of elementary students. Students showed flexibility in adapting techniques from categorical data to create displays which took into account various wingspans of class members, though for some class members it was difficult to separate graphing from the "rules" which had been encountered in prior instruction.
20:50 – 21:00 General Discussion

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Session 4. 14:30-16:30 Beijing time, July 17th (Saturday)

Session Moderator: Enriqueta Reston, University of San Carlos, Philippines

1.   **Time: 14:30-14:50**

Title of the Paper: IMPLEMENTATION OF A COURSE ON TIDYVERSE IN PAKISTAN UNDER THE ASA EDUCATIONAL AMBASSADOR PROGRAM

Author: Saleha Naghmi Habibullah
Institution and Country: Kinnaird College for Women, Lahore, Pakistan

Short abstract of the paper:

The relatively new collection of R packages known as Tidyverse is not yet much known in developing countries such as Pakistan. This paper presents an account of a six-day course on Tidyverse that was rendered by the author and her team at the Bureau of Statistics (BoS), Punjab twice during the summer of 2019. This was the outcome of the Educational Ambassador Program of the American Statistical Association under the auspices of which the author had attended the Joint Statistical Meetings (JSM 2018) held in Vancouver,

Canada. The paper elucidates the various stages of preparation and implementation of the course at the Bureau as well as the feedback obtained from participants. Experiences gained provide important insights for the optimization of similar courses to be conducted in the future.

2. **Time: 14:50-15:10**

Title of the Paper: YOUNG LEARNERS' REASONING WITH INFORMAL STATISTICAL MODELS AND MODELING

Author: **Michal Dvir** and Dani Ben-Zvi
Institution: University of Haifa, Israel

Short abstract of the paper:

Statistical modeling as a pedagogical paradigm to developing learners' statistical reasoning has been the subject of a growing interest in the statistics education community. Therefore, various pedagogical adaptations of the formal statistical modeling practice have been explored as means of introducing novices to the culture of statistics. With regard to young learners in particular, these are typically void of the formal mathematical and probabilistic procedures, and are intended to have students explore informally the meaning of various statistical notions. Our study is part of this global trend, with a particular interest in showcasing the potential of young students' emergent informal reasoning. We report here on a particular type of representation students invent and refine, which we refer to as Informal Statistical Model (ISM) – a purposeful representation of the process by which observed variability was generated that includes both deterministic and stochastic components. The goal of this article is to illustrate, based on three case studies of pairs of 11-12-years-old students, how young learners can gradually create ISMs and elucidate the reasoning that accompanies their informal statistical modeling process.

3. **Time: 15:10 – 15:30**

Title of the Paper: THE BINOMIAL MODEL: COIN TOSSES OR CLAY POTS?
Author: Von Bing Yap
Institution and Country: National University of Singapore, Singapore

Short abstract of the paper:

The binomial distribution has a clear mathematical description, but in applications, it can arise in two ways or scenarios: coin tosses and sampling clay pots. It is shown that in a number of authentic applied questions, the second scenario fits better than the first. Beyond sharpening such questions, the teaching of applied probability at all levels should make a careful distinction between the two scenarios and their domains of applicability. Since the binomial distribution is ubiquitous in the analysis of many statistical studies, the

proposed reform could enhance the quality of media reports on various surveys and epidemiological studies, and thus positively impact public numeracy.

4. **Time: 15:30-15:45**

Title of the Paper: VARIABILITY MODELING AND DATA-DRIVEN DECISION-MAKING USING SOCIALLY OPEN-ENDED PROBLEMS: A COMPARATIVE STUDY OF HIGH SCHOOL STUDENTS IN THAILAND, BRUNEI AND ZAMBIA

Author: Orlando González
Institution and Country: Assumption University, Thailand

Short abstract of the paper:

The purpose of this article is to describe the features and instructional potential of the "Darts game" task (González & Chitmun, 2017), a socially open-ended problem through which students could be challenged to acknowledge, structure and model variability, in order to assess performance and develop data-driven decision-making skills. The results and key issues of implementing this task on Grade 12 classrooms in Thailand, Brunei and Zambia are discussed, and a quantitative statistical comparison is made of relevant findings emerging from students' answers among the three groups.

5. **Time: 15:45 – 16:00**

Title of the Paper: ALGEBRAIZATION LEVELS OF STATISTICAL TABLES IN SECONDARY TEXTBOOKS

Authors: **Mara Magdalena Gea,** Jocelyn D. Pallauta, Pedro Arteaga, Carmen Batanero
Institution and Country: University of Granada, Spain

Short abstract of the paper :

The aim of this paper is to analyze the algebraization levels involved in the mathematical activity linked to statistical tables in a sample of 18 Spanish secondary school textbooks (12-15- year-old students) from three different publishers. We performed a content analysis based on the classification of the statistical tables suggested by Lahanier-Reuter and the levels of algebraic reasoning described by Godino and his collaborators. The results show the increase the algebraization levels required to apply both statistical and arithmetic knowledge and algebraic reasoning with school level. The distribution of the types of statistical tables in the textbooks selected shows differences between the selected publishers as the school year progresses, which may go unnoticed by the teacher.

6. **Time: 16:00 -16:15**

Title of the Paper: DATA MODELLING WITH YOUNG LEARNERS AS EXPERIENCES OF *ALLGEMEINGBILDUNG*

Author: Stine Gerster Johansen
Institutions and Country: Danish School of Education, Aarhus University & University College Copenhagen, Denmark

Short abstract of the paper:

This paper indicates how young learners can make experiences of Allgemeinbildung through data modelling. A teaching experiment was conducted in a Danish 3rd grade (aged 9-10) where students performed all parts of the data modelling process. Video recordings were made and afterwards transcribed. This is a presentation of empirical data, which shows examples of essential statistical reasoning. It includes posing questions relevant for data modelling, reasoning about how to structure data and reasoning about how the data modelling shed new light on the chosen topic. It is discussed how students' experiences can be a potential for Allgemeinbildung.

7. **Time: 16: 15 -16:30**

Title of the Paper: INVESTIGATING MATHEMATICS TEACHER EDUCATORS' CONCEPTIONS FOR INFORMAL LINE OF BEST FIT

Author: **Jale Gunbak Hatil**, Gulseren Karagoz Akar
Institution and Country: Bogazici University, Turkey

Short abstract of the paper

In this study, I examined eleven mathematics teacher educators' conceptions for informal line of best fit. Basic qualitative research design was used in this study. I conducted approximately one hour long task-based interviews to understand teacher educators' conceptualizations. Results showed that five of the teacher educators had representer, four had predictor and two had signal as their dominant conceptions. The results implied for the informal line of best fit that signal conception reflect and include the ideas of both representer and predictor conceptions.

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TSG-12 POSTER PRESENTATIONS

1. ID N0.530
DOES CLIMATE CHANGE REALLY EXIST? HIGH SCHOOL STUDENTS DISCOVER
STATISTICAL METHODS BY SOLVING A MODELING PROBLEM

Author(s): Maren Hattebuhr, Martin Frank
Institution : Karlsruhe Institute of Technology (KIT), DE

2. ID No. 548
DO STUDENTS IN GRADE 10 GENERATE IDEAS OF STATISTICAL HYPOTHESIS
TESTING SPONTANEOUSLY?

Author(s): Hiroto Fukuda, Naoya Miwa, Yoshiki Hashimoto
Institution : Okayama University of Science, Okayama City, JP

3. ID No.751
MODEL PROPOSAL TO PROMOTE THE CONSTRUCTION OF THE STRONG
MEANING OF VOLATILITY
Author : Miguel Andres Diaz Osorio
Institution : Universidad Antonio Narino, Bogota, CO

4. ID No.1166
IMPROVING STATISTICAL PEDAGOGY AMONG K TO 12 MATHEMATICS
TEACHERS IN THE PHILIPPINES
Author : Enriqueta Deguit Reston
Institution : University of San Carlos, Cebu, PH

5. ID No.1539
DEVELOPING MATHEMATICAL KNOWLEDGE FOR TEACHING MEAN AND
MEDIAN OF PROSPECTIVE MATHEMATICS TEACHERS THROUGH THE LESSON
STUDY
Author : Thi Ha Phuong Nguyen
Institution : University of Education, Da Nang University, Da Nang, VN

6. ID NO. 1707

CO-DESIGNING A STATISTICS UNIT FOR JAPANESE ELEMENTARY STUDENTS:
WHAT DOES THIS MEAN IN PRACTICE?
Author(s): Pauline Anne Therese Mangulabnan, Hiroyuki Igarashi
Institution : University of Fukui, JP

7. ID NO.1986

ANALYSIS OF THE MOST FREQUENT ERRORS IN PRACTICAL WORKS ON
TABLES AND GRAPHS IN BIOSTATISTICS
Author(s): Teresita Evelina Teran, Augusto Nascimbene
Institution : National University of Rosario, Rosario, AR

8. ID NO.2069
COMPARING THE STATISTICAL CONTENT OF ELEMENTARY SCHOOL
MATHEMATICS TEXTBOOKS FROM JAPAN, INDIA AND CHINA
Author(s): Yuqi Li, Xue Li, Zhemin Zhu
Institution : Beihua University, Jilin City, Jilin Province, CN

9. ID NO.2076
COMPARING THE STATISTICAL CONTENT OF ELEMENTARY SCHOOL
MATHEMATICS TEXTBOOKS FROM JAPAN, INDIA, THE UNITED STATES,
SINGAPORE AND CHINA
Author(s): Zhemin Zhu, Yuqi Li, Yilin Li, Lulu Li, Xue Li
Institution : Beihua University, CN

10. ID NO.2181
ASPECTS OF CRITICAL THINKING IN STATISTICAL EDUCATION-RESEARCH
SURVEY ON SIXTH-GRADE ELEMENTARY SCHOOL-
Author(s): Naoki Ohta, Ken Teraguchi
Institution : Fukuyama City University, JP