

REASON Spring School 2018 Poster Session II

REASON Spring School 2018 Poster - Session II, Tuesday 6.03.2018

II-1 **Improving statistical inferences: Rates of p-value, confidence interval (CI), & Bayes factor (BF) misconceptions among online learners**

Arianne Herrera-Bennett, Daniël Lakens, Moritz Heene and Stefan Ufer

Background: In the wake of the recent replicability crisis, doubts have been raised about the methodological & statistical rigour of psychology and the social sciences. It follows that some camps of research (e.g., Badenes-Ribera et al., 2015) have sought to build upon Oakes' (1986) work, which found that 97% of psychologists fell prey to at least 1 erroneous interpretation when evaluating the meaning of p-values. In light of observing similar misconception rates, authors invoked a call for improved statistical education when it comes to drawing valid inferences from data. The current research answers this need, instilling a more positive outlook on the matter of improving statistical inference making, namely via the use of online learning tools, such as Daniël Lakens' 8-week MOOC "Improving your statistical inferences".

Methods & Results: Pre-/posttest design with 3 measurements (each with 14 True/False questions about p-values, CIs, & BFs), serving respectively as a proxy of prior knowledge (pretest), as well as indices of immediate improvement (posttest1, weeks 1 to 4), and retained learning (posttest 2, week 8). Demographics and confidence ratings were also measured. Based on previous findings, we expect accuracy rates to positively correlate with confidence levels and self-ratings of statistical expertise. Repeated measures ANCOVA and regression analyses are used to evaluate the effects of course participation on learning, with additional separate analyses for each statistical concept (i.e., p-values, CIs, BFs). Results are discussed in relation to conceptual knowledge gain vs. applied learning, and how each form of inferential reasoning might inform the other.

II-2 **Historians' epistemic cognition: Interviewing experts**

Mikko Kainulainen, Marjaana Puurtinen and Clark Chinn

During the past few decades there have been some pursuits in spotlighting historians' views on their work and discipline. Although they provide crucial insights about how eminent historians reflect on their general practices, these reports have been unable to systematically access the daily epistemic processes of "doing history" by a significant sample of working historians. It is crucial to approach historians' work not only through their published output and the general level beliefs they hold about the nature of history, but also through more detailed reflections on their everyday practices: How are methods chosen for research projects? What happens when one comes upon an unexpected research finding? To approach this issue, we conducted a series of semi-structured interviews with 26 Finnish academic historians about their situated work practices, conceptual understanding of historical research, motivations for specific projects, and the criteria they use to evaluate quality in outputs of historical research. Applying the AIR model of epistemic cognition, we analyze the historians' narrations through a qualitative content analysis focusing on three components: epistemic Aims and value, epistemic Ideals, and Reliable processes for producing epistemic products. Preliminary results mostly support and extend previous empirical findings about the cognitive aspects of historiography, but also challenge them in some parts.

II-3 **Assessing scientific reasoning skills in STEM education**

Pakon Ko

STEM (science, technology, engineering and mathematics) has become an important education agenda in recent years. Many STEM activities in K-12 are underpinned by situated constructionism which emphasizes learning by making. The making process not only helps students integrate and apply their knowledge and skills across different disciplines but also let them explore new knowledge. To achieve, students need thinking skills to build new knowledge otherwise students might keep doing unsystematic trial and error and find no grounds for their decisions. While computational thinking has been asserted in STEM education, little attention has been paid to scientific reasoning skills. This study aims at finding ways to assess student scientific reasoning skills in STEM education and investigating its correlation with computational thinking.

This study will examine student scientific reasoning process by looking at how students plan and make their

decisions in their STEM activities which are designed under frameworks of constructionism and self-directed learning. Student scientific reasoning skills are externalized when they plan and collect relevant data, search for supportive evidence and connect with what they have known. This study will be in the context of a STEM project serving 32 schools in Hong Kong. The data will be collected through classroom observation, learning artifacts and student interview. A table for scientific reasoning is built for coding the qualitative data and to assess students' scientific reasoning skills and computational thinking skills. The correlation between two set of skills will inform us that whether one set of skills can be supplemented by another.

II-4 Motivated Reasoning could be Reasonable: Vigilance in the Face of Untrustworthy Sources

Lukas Gierth and Rainer Bromme

Scientific information has become a relevant part of everyday life for laypeople. It is not surprising, that in their pursuit of scientific information they bring along their own motivations, which drive this pursuit, but also moderate their reception, understanding and acceptance of scientific information. This type of motivated reasoning is generally seen as a hindrance to science communication, but not all types of motivated reasoning have to be.

There is evidence that self-serving reasoning about health information can lead people to a more effortful and precise evaluation of this information. Even logical reasoning can improve when people are motivated to find a cheater. Taken together, when personal motivations shape reasoning processes, they don't always hinder reception of scientific information, but they can sometimes improve understanding.

One motivation that guides reception of scientific information is the wish to receive reliable and true knowledge. What if a source is perceived to not be trustworthy, potentially due to conflicting interests? In this case, people can become vigilant towards the claims the source makes and thus evaluate them with more scrutiny.

We conducted an experiment to investigate whether the detection of a conflict of interest of an expert source leads people to evaluate claims made by this source with more scrutiny and whether this leads to better processing of numerical information presented alongside the expert source's claim. Results show, that people are less likely to correctly interpret the numerical information when the expert sources' claim runs counter to the interests of that source.

II-5 The Revelation of Social Work Fallacies: Using Script Theory in Critical Thinking Education

Florian Spensberger, Sabine Pankofer and Ingo Kollar

Identifying fallacies is an important aspect in social work decision making. However, social work students often have difficulties in revealing social work fallacies. This may be related to inappropriate internal fallacy revelation scripts (IFRS; Kollar, Fischer & Slotta, 2007) that guide them in the identification of fallacies. Students may be supported in building up more appropriate IFRS by case-based reasoning. However, building up an 'ideal' IFRS just by interacting with cases alone is unlikely. Based on the Script Theory of Guidance (Fischer, Kollar, Stegmann & Wecker, 2013), students may be scaffolded in their development of 'ideal' IFRS by presenting them worked examples (WE) and external scripts (ES) (Vogel et al. 2016) that guide them through the analysis of cases in which social workers produce fallacious diagnoses. Based on Damer (2009), we developed an 'ideal' IFRS as well as corresponding WE and ES. Their effectiveness is likely to depend on the students' current IFRS. Thus, we try to answer two research questions: (1) What internal scripts regarding the decision making process in social work do students have? (2) What are the effects of worked examples and reasoning scripts as well as their combination on students' development of IFRS? Participants will be 3rd semester social work students. We will analyze their internal scripts before and after an intervention in which students of the experimental groups will receive step-by-step guidance based on our 'ideal' fallacy revelation script and/or worked examples for their analysis, thereby establishing a 2x2 factorial quasi-experimental pre-post design.

II-6 Differences between Peer-Explanations and Device-Explanations during scientific reasoning on the concept of sun protection in Biology

Katja Löppenber, Christine Florian and Angela Sandmann

By combining example-based laboratory work and the strategy of explaining it could be possible to influence the quality of scientific reasoning skills and content knowledge acquisition during experimentation. Explaining showed great effects related to worked-out examples, just as these showed positive effects on learning outcomes while experimentation. Yet, it is unclear to what extent and in which type explanation-activities will influence the quality of learning outcomes when added to this kind of learning environment. Against this background, we developed an example-based learning environment that guides students through the process of scientific reasoning during experimentation. The environment systematically varied according to the types of explanations students were asked to perform after they had passed the example-based learning procedure. One group was asked to explain their

experiment to a partner. Another other group was asked to produce a YouTube tutorial about their experiment. Students cognitive activities were recorded and two types of explanation activities were compared based on qualitative content analysis. First analysis shows that the device-explanations contain longer phases of inquiry and they use more technical language and inferences. In addition, students who perform the device-based tutorial reproduced more information from the material and showed more prior knowledge. The results show that using a technical device could promote students in learning scientific reasoning skills. Initially it was supposed, that peer-explanation would animate students to make a bigger effort to explain their topic to a partner. Therefore, the qualitative results are going to be triangulated with quantitative results in the next step.

II-7 What cognitive narrative can teach science: using narrative structure to improve scientific reading skills

Monica Gonzalez-Marquez

Why is reading scientific articles so difficult? Most learners experience a deep-rooted anxiety when asked to read scientific texts. Reading classical literature produces no such feeling, likely because readers know to expect a progression of interconnected events. This is in stark contrast to science reading, an area where most students receive no training, other than being told that what they are reading is not a story. We argue that this assessment is incorrect. There is growing evidence that narrative underlies general information structuring, as such, it should also underlie scientific literature. We propose that once students learn to read science as narrative, by discovering the narrative structure that underlies scientific writing, their comprehension will increase significantly.

We tested this prediction with a pedagogical method that uses narrative structure to guide readers in constructing the story told in an article. We tested our predictions in a three-condition study using three separate university classes. The conditions were 1) no training, the norm for most students; 2) an explanation of the parts of a research article; 3) narrative training. All groups read actual scientific articles. The collective responses to general comprehension questions were treated as a small corpus, and coded for type of language used, type of response, etc. Our results showed that general comprehension was significantly greater in the narrative condition. We found no differences between the two control conditions, suggesting that doing something, is not necessarily better than doing nothing. We will describe these findings, and their implications for science literacy.

II-8 Assessment of arguments: criteria used by university students in academic and daily situations

Diana Carolina Latorre Velasquez and Selma Leitão Santos

The purpose of this work is to analyze how university students who have faced a learning experience that seeks the development of critical-reflexive thinking (Model of Critical Debate, adapted by Leitão, 2012) assess the argumentation of other persons in different situations and moments (during and after the learning experience).

Exactly, we concentrate on understanding the transformation of criteria for the evaluation in the argumentation of others, during and after 4, 8, 12 weeks of the learning experience. The results that will be presented correspond to the analysis of 20 cases of a Psychology students course.

During the learning experience, students evaluated between 2-4 sessions of critical debates and during the subsequent weeks (4,8,12) they evaluated 9 argumentative fragments of everyday situations presented through videos. In this argumentative situations, the pragmatics (evaluation of the discursive situation and the context of critical communication, Van Eemeren, et.al., 2008) and the dialectic (acceptability, relevance, sufficiency, Govier, 1998) criteria were analyzed. In the same way, the transformation of criteria and its use and permanence in different contexts.

During the learning experience was evidenced a higher use of pragmatic criteria. While during the subsequent evaluation of everyday situations (4,8,12 weeks after the learning experience) students used indicators such as citation of studies or experiments, assessment of sources to evaluate the acceptability of the justifications offered in support of the point of view. No evidence of incorporation of relevance and sufficiency criteria was found.

II-9 Analysing school-specific epistemological beliefs concerning science

Frauke Voitle, Nele Kampa, Julia Schwanewedel, Irene Neumann and Kerstin Kremer

Epistemological beliefs (EBs) are about students conceptions about knowledge and knowing. With reference to science they can be considered a very basic part of scientific literacy that affects students' scientific reasoning and argumentation skills (Mason & Scirica, 2006) and also their science learning in general (Edmondson & Novak, 1993; Hofer, 2001). But what does it mean for students' science learning, if they hold differing EBs about classroom science and science conducted in a professional context? This discrepancy is a frequently observed phenomenon but still lacks empirically investigation. Our work faces this deficit. In a first step we adapted an established

questionnaire of Conley et al. (2004) for the assessment of students' EBs concerning classroom science. We applied an iteratively developed scheme of analogous phrases for classroom and professional science. In three interdependent studies, we plan to validate the adapted questionnaire and to administer it to students in different grades. Currently we conduct the first quantitative study that will control for the questionnaire's verbal intelligibility. Furthermore, the study will enable an interpersonal comparison of students' EBs concerning classroom and professional science. The second qualitative study will use the concurrent think-aloud method to investigate how students make sense of the questionnaire's items. In the third study, we plan to administer the adapted and the original questionnaire simultaneously to enable the intrapersonal comparison of students' EBs and their factor structure about classroom and professional science. In the future, we plan to investigate how the students' understanding differs and develops depending on their grade.

II-10 Argument qualities of pre-service science teachers as indicator of their epistemological understandings

Ayşe Büber and Gül Ünal Çoban

The purpose of this study was to determine argument qualities and epistemological views of pre-service science teachers in General Physics Laboratory Course. Participants were 52 pre-service science teachers in Dokuz Eylül University, in Izmir, Turkey. The study is a case study having mixed methods approach in convergent parallel design. Data were collected by using worksheets, observations, argumentation test, interviews and audio records of participants. Pre-service science teachers engaged in argumentation activities about fluids in small groups during physics laboratory course. Each group's discussions were recorded during the argumentation process and their works were gathered through argumentation worksheets. The researcher observed the groups and took field notes during the argumentation process. Then, every pre-service science teachers were given argumentation test and they prepared reports about their research results. Afterwards, the researcher interviewed with 12 pre-service science teachers about coordination of claim and evidence in order to figure out their epistemological understandings. The data collected via worksheets and hot reports were analyzed by using rubrics which were developed by the researchers for determine argument quality. Besides, argument quality was also revealed through the data collected via audio records which were transcribed and categorized. The data collected via argumentation test was analyzed to descriptive statistics in order to determine quality of a scientific claim and rebuttal. And the interviews were analyzed and categorized in order to determine epistemological views of pre-service science teachers. The data analysis has been going on and the whole results will be presented in the session.

II-11 The research-practice gap: Evidence-based teaching in university

Despoina Georgiou, Sog Yee Mok, Frank Fischer and Tina Seidel

Teacher educators play a crucial role in the classroom ecology of teacher education. The present study aims to shed light on their thinking processes and address a topic that to date has received little attention within the literature: namely, the use of evidence in university teaching and specifically in teacher education. In detail, the present study aspires to investigate teacher educators' knowledge, beliefs, and attitudes toward the use of Evidence-Based Teaching (EBT). EBT refers to teaching practices based on robust evidence retrieved from quality research studies. Initially, and based on the lack of literature on EBT, descriptive data will be collected on teacher educators' actual knowledge, beliefs, and attitudes toward EBT. The interrelations between the aforementioned variables will be also under investigation. Furthermore, differences between novice and expert teacher educators' will be explored. Data will be collected via an online questionnaire, development of which was based on existing instruments and was adapted for the teacher education context. A pilot study (N = 30) was conducted in order to determine the validity and reliability of the developed instrument. The final version of the questionnaire will be distributed to teacher educators in Germany and other European countries.

II-12 Argumentation skills on controversial scientific topics: What is it and how can we measure it?

Olga Ioannidou, Andreas Hetmanek, Frank Fischer and Tina Seidel

Scientific literacy skills are considered core objectives for science education. As a part of scientific literacy, the ability to argue about scientific topics is thoroughly examined by previous research revealing gains in knowledge and argumentation skills. However, the ability to argue for or against controversial scientific topics, such as climate change and the use of vaccines, has been recently become a topic of research interest. While institutions, researchers and teachers highlight the importance of teaching socio-scientific argumentation (SSA), there is no consensus on what the construct means and whether we are able to measure it in a reliable way. To address this

issue, this study aims to shed some light in the way that researchers define and measure socio-scientific argumentation. For this purpose, a systematic literature review was conducted, gathering data from two electronic databases (Web of Science and EBSCO). After applying screening and inclusion criteria, from 489 articles retrieved, 78 articles were included in the full-text analysis phase. The included articles were qualitatively analyzed with MAXQDA software using the principles of grounded theory and content analysis. From 62 open codes, 10 axial coding categories emerged reflecting the two core categories: conceptualization and measurement of SSA. As a next step, interrater reliability will be calculated as well as frequencies of the codes. A citation network analysis will be conducted in order to illustrate cluster of ideas and the corresponding authors. As a desired outcome, the study will introduce a clearer definition and a respective way of analyzing SSA.