REASON Spring School 2018 Poster Session I

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I-1 **How does teacher dashboard support instructors' pedagogical decisions in online asynchronous problem-based learning environments?**

Lingyun Huang, Stephen Bodnar, Juan Zheng, Maedeh Assadat Kazemitabar, Susanne Lajoie, Yuxin Chen, Gurpreet Birk and Cindy Hmelo-Silver

Problem-based learning (PBL) is a student-centered instructional approach by which small groups solve an ill-structured problem. The instructor in PBL plays a role in facilitating group discussion, monitoring group progress and participation, intervening when necessary. Previous research has shown that PBL is effective in face-to-face and synchronous online PBL groups. However, it is little known how the approach could be used to manage low student-instructor ratio discussion. Accordingly, our research aims to investigate scaling up PBL by enhancing instructors' ability to facilitate multiple groups by means of a learning analytics dashboard. The assumption is that the teacher dashboard has potential to support instructors' pedagogical decision making by visualizing the synthesized real-time information. The study takes place in the context of HOWARD, a web-based collaborative learning environment designed to support online asynchronous PBL. Instructors were invited to facilitate five medical students PBL groups (simulated groups) discussing the communication of bad news to patients. This poster presents the results of a study that examined instructors' think-aloud protocols to understand their perspectives of the benefits and constraints of the teacher dashboard and visualization techniques. We conclude by discussing the pros and cons of the current designs and implications for the possible redesigns in future work.

I-2 **Explanations as Learning Mechanism in Learning to Apply Knowledge in Reasoning and Argumentation – A Process Analysis**

Sarah Bichler, Frank Fischer, Birgit Neuhaus and Marcia Linn

Students have difficulties in learning to reason with their knowledge and integrate it in an argument. A previous study in the domain of statistics (Schwaighofer, Bühner, & Fischer, 2016) found that worked examples help students learn to apply their knowledge. The benefit of worked examples was greatest for students with low shifting ability (the ability to flexibly shift between task demands). We aimed to capture the relevant learning mechanism to understand the process leading to these outcomes. To this end, we analyzed process data of Schwaighofer et al.'s study. In the intervention, students (N = 74) were asked to provide an explanation that justified their solution to an authentic statistical problem. Students had either access to textbook materials as support, or textbook materials and a worked example. We developed a rubric to capture the quality their explanations. The rubric assessed whether students reasoned with statistical concepts and integrated them as justifications in their explanation. Results indicated that worked examples improved the quality of explanations. Interestingly, the quality of explanations did not mediate the effect of worked examples on knowledge application at posttest (preliminary analysis). This surprising finding, we investigate further in a replication study with 231 university students. We learned from out data that it is not sufficient to only define quality on the content level. We also have to consider the strategy students use, their meta-cognitive statements, and specific misconceptions they hold. We plan to assess these aspects with a bottom-up rubric.

I-3 **The effects of argumentation based STEM practices on preservice teachers' reasoning and argumentation skills and STEM competencies**

Zeynep Oskay

A multidisciplinary STEM approach, is seen very important in Turkey as in the world, and is being studied by researchers in various aspects. However, this approach seems to lead learners more in engineering and technology dimensions widely. This suggests that the STEM approach needs to be investigated in terms of the results and causes of the problems encountered in the learning process. In this sense, argumentation and reasoning are fundamentals of STEM where they both allow learners organize their thoughts, learning and learning processes. For this reason, the aim of this project is to develop an argumentation based STEM model which will support the argumentation and reasoning. The project also aims to invegtigate the effects of the argumentation based STEM

model on reasoning skills, argumentation skills and STEM competencies of pre-service science teachers. The study will be carried out with three experiment or treatment groups (argumentation group, STEM group and argumentation based STEM group) and one control group according to the convergent parallel pattern of mixed research method. Argumentation Skills Test, Reasoning Skills test and STEM Competencies questionnaire which will prepared by the researcher will be used as data collection tools. At the same time, semi-structured interviews will be held with the pre-service science teachers, selected from the groups. The data collected by quantitative and qualitative instruments will be evaluated as a whole and the effects of the Argumentation Based STEM model on the determined variables will be revealed.

I-4 **Written Argumentation on Socio-Economic Issues: Analysis of Students' Written Skills in a Performance Test**

Nicole Ackermann

In a constitutional democracy with a liberal economic and social system, citizens are involved in private, business and political decision-making processes. They are, for instance, periodically invited to express their opinion on socio-economic issues via public debates and referenda. The process of individual opinion-building and decision-making requires content knowledge (i.e., technical terms and basic concepts in politics and economics) as well as transferable skills (i.e., analysing, evaluating, explaining, reasoning, deciding) (Eberle, 2015; Simonneaux, 2008; Sadler & Donnelly, 2006).

The research goal of this study is (1) to develop a rubric for students' argumentation quality in socio-economic contexts, and (2) to analyse students' argumentation quality in a written performance test on socio-economic issues. It answers the following research questions: (FF1) What is the argumentation quality on socio-economic issues? (FF2) What is the relation between content knowledge and argumentation quality?

The data were collected in 2017 from a sample of 375 high school students in a German-speaking canton of Switzerland using the revised test on economic-civic competence (ECC test) (Ackermann, in progress). The ECC test is a written performance test on socio-economic issues (e.g., retirement provision, energy policy) with items in closed-ended and open-ended format (e.g. reason ambiguous socio-economic mechanisms explain effects of socio-economic policy measures, evaluate opposing solutions for socio-economic issues). Regarding construct validation, probabilistic and classical item analysis showed satisfying values for item infits, item discriminations and test reliability (EAP/PV = .74, alpha = .76). For this study, the data of the open-ended items, which have already been coded according to technical accuracy, are re-coded using an argumentation quality rubric (Toulmin, 1958; McNeill, 2011).

As data coding has not finished yet, preliminary results will be presented at the poster session. However, the results of this study may have implications for teaching and evaluating in social sciences classes.

I-5 **Who Did It? Students' Reasoning about Teleological Agents in Evolution**

Friederike Trommler and Marcus Hammann

In biology education students' teleological intuitions are considered a major learning obstacle. Especially in the field of evolution, students seem to consider teleological agents responsible for evolutionary change. In particular, students provide 'god', 'nature', 'organisms' (their will power), and 'bodies' (their wisdom) as teleological agents. As students might either talk literally or metaphorically about teleological agents, assessment of students' teleological intuitions requires a clear focus on students' literal teleological reasoning. Thus, using the context of the evolution of the giraffes' neck, the present study confronted 23 students (11 lower secondary level, 12 upper secondary level) in personal interviews with five teleological agents whose literal meaning was communicated using concept cartoons with captions and additional oral explanations. For each teleological agent scenario, the students were asked whether they agreed or disagreed and to explain their choice. Five lower secondary level students and one upper secondary level student agreed with at least one teleological agent. Students' reasoning was coded in terms of the knowledge elements they employed and the interactions they constructed between these knowledge elements. Students who did not employ the knowledge elements 'gene' and 'population' hypothesized more frequently teleologically about the mechanism underlying the giraffes' evolution. The students filled their explanatory vacuum proceeding from the functional information that 'neck and tree length always match', which led them astray. Rather than reasoning backwards from functional information, biology instruction should guide students' reasoning forward from one mechanistic activity to the next, so that students come to understand function as an emergent phenomenon.

I-6 **Identifying Epistemic Growth in Dialogic Instruction: An Apt Epistemic Performance Approach**

Na'Ama Y. Av-Shalom

In modern life, people are exposed to various types of scientific information, and have opportunities to reason about it and discuss it with others. Often, the conclusions drawn from this information have practical implications: for example, deciding whether or not to vaccinate their children. Laypeople may have specific aims they wish to achieve as they engage with scientific information and therefore need reason well, and come to the best conclusion given their aims.

In their Apt-AIR framework, Chinn and Barzilai (accepted) define apt epistemic performance as epistemic performance, which is successful (comes to the best conclusion based on one's aims) through competence. We expect that dialogic instruction that addresses the five aspects proposed in Apt-AIR framework will promote students' epistemic competence. Hence, the objectives of our study are:

1. To identify indicators of growth in apt epistemic performance in student discourse during model-based inquiry in science.
2. To identify teacher moves that promote or hinder the development of students' apt epistemic performance.

We are analyzing discourse in seventh-grade classrooms of two teachers implementing a model-based inquiry curriculum over six months; one of whom was highly effective and the other was ineffective at engendering productive epistemic discourse. Our results will establish an empirically grounded approach for evaluating aptness epistemic performance of students' and the extent to which instruction promotes such apt performance. We envision that these analytic tools may have the potential to inform the design of learning environments that are discourse-rich and support productive epistemic engagement.

I-7 Cooperative reasoning in times of competition

Andreas Domberg, Bahar Köymen and Michael Tomasello

A fast growing literature explores the view that reasoning is best understood as a social phenomenon. The idea is that its function is not primarily to reach conclusions based on known premises, but to justify towards peers what conclusions and decisions a speaker prefers. Within this tradition, Mercier & Sperber (2011; 2017) emphasize a competitive-persuasive perspective on reasoning, under which speakers select evidence to further their individual goals by way of communicating with their peers. Tomasello (2014), in turn, emphasizes a cooperative perspective, under which speakers select evidence to critique each other's arguments, thus homing in on the best solution for the group. I present a soon to be completed developmental study that is part of my PhD project: It integrates cooperative and competitive motivations, asking whether group-level rivalry can stimulate cooperative reasoning in a joint problem-solving situation. Pairs of 5- and 7-year-old children complete a task together, making several joint decisions, while they either do or do not compete against another group. We code and analyze the justifications that they produce, looking at how many options children consider and discuss, depending on the presence of competitors, and on age. We want to show whether children's motivation, which is visibly heightened in an intergroup context, also translates into more productive argumentation, and thus, into a more effective search of the space of possible solutions.

I-8 ArguKos – Fostering students' scientific argumentation skills and situational interest by prompt-based instructions

Magdalena Lenker, Doris Lewalter and Burkhard Priemer

Students' scientific argumentation skills and their willingness and interest to engage with science and scientific argumentation are significant components of scientific literacy, which builds a basic aim of physics education. However to achieve these essential aims only a few evidence-based learning environments exist which take both components into account. Thus, we developed the learning unit "ArguKos" which combines the potential interesting topic of black holes with a scientific argumentation training. The main aim of our study is to identify the impact of individualized instructions on the development of students' argumentation skills and situational interest. Concerning scientific argumentation skills, we use a simplified model of Toulmin's "Argumentation Pattern" to teach students to examine and to create arguments about scientific phenomena. Regarding the willingness to engage we consider situational interest, which refers to a specific situation. We designed three kinds of prompt-based instructions (structured vs. unstructured prompts vs. no prompts) which are supposed to foster students' scientific argumentation skills. Currently we are analyzing the collected data from 134 secondary tenth-grade students. For assessing argumentation skills, we used Concept Cartoons with a pre-posttest design (developed and evaluated by Kraus & von Aufschnaiter, 2005; Osborne, Erduran, Sibel, & Simon, 2004; Wächter & Kauertz, 2012) and added argumentation tasks combined with the individualized prompt-based instructions several times during the learning unit. First results will be presented and discussed according to theoretical and practical issues.

I-9 Inducing Graph Rules for Argumentative Structure Analysis

Linting Xue and Collin Lynch

Argumentative structures are essential for evaluating the quality of argumentation, since they reveal how students justify testable hypotheses through reasoning. Argument diagrams are a visual representation of argumentative structures that reify the key features of arguments such as hypothesis statements, claims, and citations as nodes and the supporting, opposing, and clarification relationships between them as arcs. Prior research has shown that hand-authored graph rules can be used to automatically assess student-produced argument diagrams. However, hand-authored rules can be costly and time consuming, and they may not generalize well to novel contexts. To address this issue, we applied Evolutionary Computation (EC) algorithm with novelty selection to automatically induce empirically-valid graph rules for expert-graded argument diagrams. Our results showed that the rules induced by EC outperformed the expert rules and the rules induced by other state-of-the-art algorithms. The significance of this work is that we can train an assessment model from the dataset of expert-graded argument diagrams with the features of induced graph rules; the assessment model can be used to evaluate the structure of arguments and to provide feedback by identifying both good features and structure flaws in students' work. Our work has been published in the 9th and 10th International Conference on Educational Data Mining (EDM 2016 and EDM 2017) and the Genetic and Evolutionary Computation Conference (GECCO 2016). I will be presenting a poster on this work and our preliminary results on identifying the structure of arguments in essays automatically.

I-10 Development of a self-efficacy scale in argumentation for secondary science teachers

Michael Van Winkle and Michael Nussbaum

Self-efficacy, or feeling of competence, is an important factor in the implementation of educational reforms generally and scientific reasoning and argumentation (SRA) in classrooms specifically. In order to determine if an intervention is able to improve teachers' self-efficacy in this area, it is necessary to conduct pre- and post-test assessments of teachers' self-efficacy. A review of extant scales for science teaching revealed that there are few if any self-efficacy scales regarding the teaching of science through argumentation specifically. Authors therefore developed a scale based on a list of desired teacher competencies for teaching scientific argumentation. These outcomes were generated through a review of the research in SRA from Osborne, Reznitskaya, Clark, Bulgren, and others. Two Items were then written for each competency. The scale includes measures of confidence in conducting argumentative discussions in classrooms and in planning units and lessons. The scale will be piloted with in-service teachers, using think alouds and item and factor analysis. Results will be available by the time of publication of the poster. The aim is to assess teachers' self-efficacy prior to and after an SRA summer institute in 2018.

I-11 Scientific reasoning and norms of evidence production across different disciplines: An empirical investigation

Gina Scappucci, Christopher Osterhaus and Frank Fischer

Evidence-based practice demands that practitioners base their decisions on the best evidence currently available. What counts as sound evidence, however, is under debate and constantly negotiated within the scientific communities.

In this project, we investigate which processes of evidence production are commonly reported in scholarly publications across three disciplines (psychology, medicine and economics) and whether particular forms of evidence production have become more dominant than others in the past 20 years. Building on Crombie's (1994) and Hacking's (1984, 2012) work on scientific reasoning styles and evidence production; we developed an analytical instrument (coding scheme) to capture the most salient indicators of the different processes of evidence production. These indicators tap specific aspects of the assumptions, designs, methods and objectives of the studies under investigation. Using cluster analysis and latent class analysis, we will then empirically determine the different types of evidence production commonly adopted and presented within the scientific communities. An initial piloting sample of 100 articles will be analyzed; the preliminary results of the analysis will be presented at the REASON spring school. The development of this analytical instrument will constitute a powerful tool to investigate the dynamic and social process of evidence production. Additionally, our study will allow to draw important conclusions on the current best practice of evidence production.

I-12 Using scientific and subjective knowledge to analyze technology-supported teaching: a question of (technology-related) teaching expertise?

Christina Wekerle

Digital technologies are attributed many potentials to foster learning. Yet, when reflecting about how to use technology in the classroom, teachers often draw on their subjective theories and experiences rather than on scientific theories and evidence about teaching and learning. However, little is known about the role that teacher

expertise plays for the use of these different knowledge types. Therefore, N=110 pre-service teacher freshmen, N=94 advanced pre-service teachers, N=26 pre-service technology education teachers and N=40 technology-experienced teachers were asked to analyze a description of an authentic technology-supported classroom lesson. The open-ended answers were analyzed regarding the use of (1) scientific theories, (2) scientific evidence, (3) subjective theories and (4) experiential evidence (Cohen's κ=.89-1). Results show a significant effect of expertise group on the application of the different knowledge types ($F(2.48, 621)=2.48$, $p=.00$, $\eta^2=.05$), with scientific theories being used significantly more often than scientific and experiential evidence ($p=.00$), and subjective theories being used significantly more often than the other three knowledge types ($p=.00$). Further, pre-service technology education teachers employed significantly less subjective theories than pre-service teacher freshmen ($p=.04$). The results suggest supporting teachers in the acquisition and application of scientific knowledge is of great importance on all levels of expertise.

I-13 **Relations between cognitive learner characteristics and scientific reasoning proficiency**

Erika Schlatter, Ard Lazonder, Inge Molenaar and Noortje Janssen

Research has shown that scientific reasoning develops asynchronously in same-aged children. It therefore seems important to adapt early science instruction to children's individual learning needs. Successful adaptation requires insight in the cognitive factors that explain and predict children's natural growth in scientific reasoning proficiency. Studies using paper-and-pencil tests point to two moderating factors: reading comprehension and mathematical ability. However, initial evidence using a performance-based test indicates that the portion of variance explained by these cognitive factors is rather small.

The current study investigates how children's proficiency in scientific reasoning relates to cognitive learner characteristics above and beyond reading and math. Academic vocabulary will be included as a domain-general measure of prior knowledge, and students' tendency towards convergent or divergent thinking will be measured as it could explain why children are better at some scientific reasoning skills than others.

Data for this study will be collected early 2018 using a sample of 180 grade 5 and 6 children. First, information on the four cognitive factors that are expected to explain scientific reasoning is gathered. Then, five scientific reasoning skills (predicting, experimenting, inferencing, evaluating data and drawing conclusions) are assessed by means of a validated performance-based test. The administration of this test takes approximately 20 minutes, in which the experimenter guides children through four inquiry cycles of increasing complexity. The data gathered in this study will provide more insight into the relations between cognitive learner characteristics, which will be used for the development of adaptive science lessons.