TECHNISCHE UNIVERSITÄT MÜNCHEN

February 18th – 20th 2019
Technical University of Munich (TUM), TUM School of Education

Bridging the research-practice gap: Advancing evidence-based argumentation

3rd Interdisciplinary REASON Winter School 2019

REASON
International Doctoral School Reason

Technische Universität München

REASON Winter School 2019

February 18th – 20th 2019 TUM Munich

Prof. Dr. Tina Seidel

Technical University of Munich (TUM), TUM School of Education
Friedl Schoeller Endowed Professor of Educational Psychology

Dear Colleagues,

It is a great pleasure and an honor to extend to you a warm welcome to the 3rd Interdisciplinary REASON Winter School, organized by the REASON doctoral school at the TUM School of Education in the beautiful city of Munich.
'Bridging the research-practice gap: Advancing evidence-based argumentation' is the theme of our meeting. We chose this theme because we firmly believe that research can make a considerable contribution to the work of practitioners, and that it is scientific evidence that should influence how far-reaching decisions in many domains, including medicine, education, or social work, are taken. We also believe that argumentation is the relevant skill that people need in order to incorporate evidence into their daily decisions in practice.
Scientific reasoning and argumentation are the primary research foci of the international doctoral school REASON, which is funded by the Elite Network of Bavaria and is the organizer of this event. REASON is an interdisciplinary and collaborative research project that links psychology, education, and empirical research on learning in various domains. Not only do we study experts' scientific-reasoning processes, but also, we focus on students' and professionals' competences to use scientific concepts and methods.
At the TUM School of Education, a university partner in the REASON doctoral school and the host of this event, we are bridging the research-practice gap by introducing the 'Clearinghouse Unterricht.' For us, the university should be the place where research evidence is communicated to practitioners, and this is precisely what the 'Clearinghouse Unterricht' does: We communicate the often-complex research evidence to teacher educators and practicing teachers in a comprehensive and clear way, in order to narrow the gap between research and practice.
In the REASON winter school, we will address important questions related to the research-practice gap and to evidence-based argumentation, such as: Are teacher educators and teachers trained well enough to incorporate research evidence? Are students, professionals and citizens able to take far-reaching decisions and defend them on the basis of sound argument and evidence? And how can we foster evidence-evaluation and scientific-reasoning skills in different domains?

We are happy that leading researchers from all around the world followed our invitation to discuss these and related questions in the course of the next three days. Our program includes keynote lectures from internationally renowned experts on science learning and science motivation, on fostering argumentation, as well as philosophical perspectives on argumentation, including methods for argument evaluation and invention. Workshops will address teachers' use of scientific evidence, evidence-based argumentation and practice, and evidence-generation and evaluation methods.

Please use these next three days to deepen your knowledge in your area of research. Engage in fruitful discussions about present and future challenges in the field of scientific reasoning, argumentation, and evidence. Make many new contacts. And please return to your host institutions with many happy memories from Munich!

Tina Seidel

Prof. Dr. Kristina Reiss

Dean of the TUM School of Education
Technical University of Munich

A warm welcome to all participants in the 3rd Interdisciplinary Winter School of the International Doctoral School REASON. We are happy to host this meeting at TUM School of Education, one of the university partners in REASON. I am very pleased to see that outstanding international scholars as well as committed PhD students accepted our invitation and will discuss their work and their ideas at this conference.
The program aims to explore scientific reasoning and argumentation and thus addresses a topic which is important for all scientific disciplines. Accordingly, it is addressed in the program with respect to an interdisciplinary perspective. The topic of this meeting adds to this broad view: "Bridging the research-practice gap: advancing evidence-based argumentation" takes into regard that there are important contributions of practice and practitioners to research in the field of education. Moreover, this topic emphasizes the responsibility of science in addressing research questions which take their relevance for practice into account. This is an important part of research that accepts and understands its responsibility in the societal context. I am convinced that the topic will result in fruitful discussions on reasoning and argumentation and that these discussions will contribute to a better understanding of the relation between theory and practice.

Kristina Reiss

Scientific Committee Members

- **Prof. Dr. Frank Fischer**, Ludwig-Maximilians-Universität München
- **Prof. Dr. Birgit Dorner**, Katholische Stiftungshochschule München
- **Prof. Dr. Martin Fischer**, Ludwig-Maximilians-Universität München
- **Prof. Dr. Moritz Heene**, Ludwig-Maximilians-Universität München
- **Prof. Dr. Heinrich Hußmann**, Ludwig-Maximilians-Universität München
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- **Prof. Dr. Sabine Pankofer**, Katholische Stiftungshochschule München
- **Prof. Dr. Reinhard Pekrun**, Ludwig-Maximilians-Universität München
- **Prof. Dr. Beate Sodian**, Ludwig-Maximilians-Universität München
- **Prof. Dr. Stefan Ufer**, Ludwig-Maximilians-Universität München
- **Prof. Dr. Tina Seidel**, Technische Universität München
- **Prof. Dr. Kristina Reiss**, Technische Universität München
- **Prof. Dr. Dr. h.c. Manfred Prenzel**, Technische Universität München
- **Prof. Dr. Johannes Bauer**, Universität Erfurt

Scientific Coordination Committee Members

- **Prof. Dr. Tina Seidel**, Technische Universität München
- **Prof. Dr. Frank Fischer**, Speaker of the REASON Doctoral School
- **Dr. Christopher Osterhaus**, REASON Postdoctoral Research Associate
- **Irina Ciobanu**, Coordinator of the REASON Doctoral School
- **Anastasia Datsogianni**, REASON PhD Candidate
- **Despoina Georgiou**, REASON PhD Candidate
- **Olga Ioannidou**, REASON PhD Candidate
- **Mary Opio**, REASON PhD Candidate

Guest Speakers

- **Judith Harackiewicz** (University of Wisconsin-Madison)
- **Sibel Erduran** (University of Oxford)
- **Douglas Walton** (University of Windsor)
- **Stephan Hartmann** (Ludwig-Maximilians-Universität München)
- **Andreas Hetmanek** (Technische Universität München)
- **Riikka Hofmann** (University of Cambridge)
- **Maximilian Knogler** (Technische Universität München)
- **Konrad Krainer** (Alpen-Adria Universität Klagenfurt)
- **Andras Csanadi** (Universität der Bundeswehr München)
- **Karsten Stegmann** (Ludwig-Maximilians-Universität München)

Program

Monday 18.02.2019

Coffee & Tea Buffet starting from 8:30

9:00 – 9:45 — **Registration** — *Open area (6th floor)*

9:45 – 10:30 — **Welcome Session**
- **Kristina Reiss** (REASON, Dean of the TUM School of Education)
- **Frank Fischer** (REASON, LMU)
- **REASON Team**

(Short musical moment) — *Lecture Hall 605*

10:30 – 12:00 — **Keynote**
Your thesis as an argument: How are you justifying your claims?
- **Sibel Erduran** (University of Oxford)

Chair: Kristina Reiss (TUM) — *Lecture Hall 605*

12:00 – 13:00 — *Lunch* — *Room 607 & Open area (6th floor)*

13:00 – 15:30 — **Workshop**
Teachers' use of scientific evidence based on a nation-wide project
- **Konrad Krainer** (AAU)
- **Stefan Ufer** (LMU)
- **Andras Csanadi** (UniBW)

Seminar Room 134

Workshop
Arguing with and about evidence – exploring two sides of evidence-based argumentation
- **Andreas Hetmanek** (TUM)
- **Maximilian Knogler** (TUM)

Seminar Room 140

15:30 – 16:00 — *Coffee break* — *Room 607 & Open area (6th floor)*

16:00 – 17:30 — **Paper Session I (5 Papers)**
Evidence integration and decision making in teacher education
Chair: Kristina Reiss (TUM) — *Seminar room 140*

18:00 — REASON Winter School Dinner at **Wirtshaus Maxvorstadt**
(https://www.wirtshaus-maxvorstadt.de/)

Tuesday 19.02.2019

Coffee & Tea Buffet starting from 8:30

9:00 – 10:30 — **Paper Session II (5 Papers)**
Arguing about socio-scientific issues
Chair: Birgit Dorner (KSH) — *Seminar room 140*

10:30 – 12:00 — **Keynote**
A Survey of Leading Argumentation Methods for Argument Evaluation and Argument Invention
- **Douglas Walton** (University of Windsor)

Chair: Beate Sodian (LMU) — *Lecture Hall 605*

12:00 – 13:00 — *Lunch (Open Science)* — *Room 607 & Open area (6th floor)*

13:00 – 14:30 — **Paper Session III (5 Papers)**
Exploring, assessing and enhancing students' reasoning skills
Chair: Heinrich Hußmann (LMU) — *Seminar room 140*

14:30 – 15:00 — *Coffee Break* — *Room 607 & Open area (6th floor)*

15:00 – 16:30 — **Keynote**
Reasoning and Argumentation in Science – A perspective from mathematical philosophy
- **Stephan Hartmann** (MCMP LMU)

Chair: Frank Fischer (LMU) — *Lecture Hall 605*

17:00 — Guided tour at the **"Alte Pinakothek"**
(https://www.pinakothek.de/en/visit/alte-pinakothek)

Wednesday 20.02.2019

Coffee & Tea Buffet *starting from 8:30*

9:00 c.t. – 12:00

Workshop
Analysing and theorising mechanisms of change towards evidence-based dialogue and practice
- **Riikka Hofmann** (University of Cambridge)

Chair: Martin Fischer (LMU)
Seminar Room 140

Workshop
Meta-analyses as evidence generation and evaluation methods
- **Karsten Stegmann** (LMU)

Seminar Room 134

12:00 – 13:00

Lunch

Roundtable discussions **on various academic topics**
- **Sibel Erduran**, Women in Academia
- **Frank Fischer**, Engaging in Interdisciplinary Research
- **Judith Harackiewicz**, Career Opportunities at US Universities
- **Beate Sodian**, Building a Research Program
- **Karsten Stegmann**, Financial Opportunities in Research

Room 607 & Open area (6th floor)

13:00 – 14:30

Poster Session (14 Posters)
Chair: Christopher Osterhaus (LMU) *Seminar Room 140*

14:30 – 16:00

Keynote
Connecting research and practice in social psychology – From the laboratory to motivation interventions in education
- **Judith Harackiewicz** (University of Wisconsin-Madison)

Chair: Reinhard Pekrun (LMU) *Lecture Hall 605*

16:00 – 16:15

Closing Session *Lecture Hall 605*

Keynotes

Connecting research and practice in social psychology – From the laboratory to motivation interventions in education

Judith Harackiewicz
University of Wisconsin-Madison

It is essential that students perceive value in their academic work. I will discuss longitudinal studies that document the importance of perceived value for interest and performance in high school and college courses, as well as experimental laboratory studies that show the potential for promoting utility value and interest in students. This basic research provides the basis for three recent lines of intervention research, in which we took these laboratory findings to practice.
In one, we tested the potential of utility value interventions to promote interest and performance for high school students in science classes and for college students in an introductory psychology class. In a second line of research, we examined the role of parents in communicating utility value to their teens, and tested an intervention intended to encourage parental communication with teens about utility value. In a third, we tested the potential of utility-value interventions to close achievement gaps in a gateway college science class. Theoretically, this research contributes to our understanding of value transmission and interest development, and practically, this research suggests that teachers and parents can make important contributions to students' academic performance by focusing on utility value.

Keynotes

Reasoning and Argumentation in Science: A Perspective from (Mathematical) Philosophy

Stephan Hartmann
Ludwig-Maximilians-Universität München

Reasoning and argumentation play an important role in the practice of science. In this talk, I will identify a number of new types of reasoning and argumentation (such as the No Alternatives Argument) that are used in science and show how they can be assessed in a normative framework. This will help us to better understand which types or reasoning and argumentation are successful, and which need to be improved or discarded. As scientific reasoning and argumentation crucially involve uncertainties, a Bayesian (or probabilistic) approach suggests itself. This approach is currently very popular in the field of mathematical philosophy. I will present the Bayesian framework and focus on its normative foundations and applications to the psychology of reasoning.

Your thesis as an argument: How are you justifying your claims?

Sibel Erduran
University of Oxford

A doctoral thesis is based on a long journey of learning about the research process. Like Charles Darwin who famously referred to his book The Origin of Species as "one long argument", your dissertation will be based on an argument. From the formulation of the research problem to the development of research questions, analytical tools and evaluation of results, effective use of arguments is critical in thesis development. How do you justify the study of the problem? What claims are you making about what is lacking in the literature so that you are justified in studying the particular aspect? What data do you select to use and why? What reasons do you have for preferring one analytical approach instead of another? Such questions demand that you engage in evidence-based reasoning or argumentation, and that you present your work in a way that convinces the readers of your thesis that you are relying on evidence and reason. In this talk, I will review some ideas about argument drawing on research findings that illustrate effective engagement. I will draw on some strategies that might facilitate the use of argument in your own work.

A Survey of Leading Argumentation Methods for Argument Evaluation and Argument Invention

Douglas Walton
University of Windsor

Argumentation is a set of context-sensitive practical methods used to help a user identify, analyze and evaluate arguments, especially common ones of the kind often found in everyday discourse. In the past it was the prevalent assumption that the deductive model of valid inference was the cornerstone of rational thinking. There has now been a paradigm shift to highly knowledge-dependent models of reasoning under conditions of uncertainty where a conclusion is drawn on a basis of tentative acceptance on a balance of considerations. Argumentation can be described as (1) a means of arriving a reasoned decision to accept or reject a claim that is open to doubt or disputation by weighing the pro arguments against the con arguments, (2) a means to build evidence-based knowledge that is provisional and fallible, (3) a means for inventing new arguments to support or attack a designated claim, and (4) an interdisciplinary subject that so far most notably includes subjects such as informal logic, speech communication, artificial intelligence, multi-agent systems, legal argumentation, computational linguistics, education, formal logic and argumentation in medical communication.
This presentation surveys argumentation tools that can be applied to common kinds of tasks encountered in solving argumentation problems. The following tools are included: argumentation schemes, including the scheme for inference to the best explanation, argument diagrams, a profile of dialogue tool for repairing informal fallacies, and use of formal and computational argumentation models for automated argument invention and for explanation. A brief survey on how these tools can be applied to some specific fields is included. It is shown how scientific argumentation can be modeled as evidence-based using the Carneades Argumentation System.

Workshops

Arguing with and about evidence – exploring two sides of evidence-based argumentation

Andreas Hetmanek and Maximilian Knogler
Technical University of Munich (TUM)

Before we start talking about evidence-based argumentation a crucial question needs to be addressed: Is there reliable and relevant evidence concerning a specific issue at hand? Only with a substantial research base can we start thinking about arguing with evidence in a specific context or debate.
To answer this fundamental question, throughout the workshop we use the example of effective teaching in STEM education with secondary populations. We then explore ways of communicating this evidence base into practice along the case of the Clearing House Unterricht project. Thereby we will also touch upon the so-called "prescriptive statements debate" and discuss the contribution that empirical research can make to the discourse about the design of education.
During the workshop participants are introduced to the exploration of an evidence database in a particular area of interest, gain insights about ways to transfer evidence into practice and reflect theoretical / methodological concerns about argumentation at the edge between research and practice.

Analysing and theorising mechanisms of change towards evidence-based dialogue and practice

Riikka Hofmann
University of Cambridge

Research has demonstrated that guidelines and professional development programmes aimed at improving evidence-based reasoning and practice in educational and healthcare settings often fail to translate to change in professional practice. Moreover, research has shown that interventions are often implemented in a superficial way with apparently visible modifications to practice post-intervention failing to lead to genuine transformation. Quasi-experimental designs tell us about interventions' capacity to impact change, but say little about how change happens or what may hinder it.
This workshop focuses on the conceptual and methodological tools from recent research to understand and investigate the mechanisms of, and barriers to, changing professional reasoning and practice, focusing primarily on observational data but drawing on other sources. In the workshop you will discuss recent research findings and have the opportunity to engage hands-on with real data examples. The presentation, discussion and data work will consider the subtle but effective discursive ways of resisting change, and the role norms, accountability and risk play in moving towards evidence-based practice and reasoning, and how we can analytically examine and establish these in our qualitative data sets.

Teachers' use of scientific evidence based on a nation-wide project

Konrad Krainer, Alpen-Adria-Universität Klagenfurt
Stefan Ufer, Ludwig-Maximilians-Universität München
Andras Csanadi, Universität der Bundeswehr München

The workshop focuses on the use of evidence by teachers in practice based on our experiences from the IMST project. IMST is a nation-wide MINDT (German abbreviation for Mathematics, Informatics, Natural Science, German, and Technology) learning and teaching initiative in Austria. It represents a flexible support system primarily financed by the Federal Ministry of Education and consists of scientists accompanying teachers in their endeavours to improve instruction.
Based on examples from the report database of the IMST project, we will discuss the forms of evidence used by teachers and some of the major challenges in using and interpreting evidence. We will also extend on an analysis tool from the REASON program to shed light on the ways teachers apply the knowledge they acquired in a university context as well as different types of evidence when solving educational problems.

Workshop

Meta analyses as evidence generation and evidence evaluation methods

Karsten Stegmann
Ludwig-Maximilians-Universität München

Meta analyses have been frequently regarded as appropriate method to derive strong evidence on specific factors and their interaction with moderators. Not each meta analysis, however, provides strong evidence. One the one hand, many older meta analyses applied statistical analyses that – from today's perspective – are problematic (e.g. overestimating effects). One the other hand, even current meta analyses often are hard to interpret: too heterogeneous studies are used to compute integrated effect sizes, control conditions are not adequately specified, correlated effect sizes are ignored, the quasi-experimental nature of meta analyses is ignored.
The workshop will introduce a set of serious pitfalls and demonstrate ways to avoid them. R and RStudio are used to demonstrate and practice specific procedures. RMarkdown is used to document data handling and data analyses. Participants are invited to bring their own data to the workshop.

Paper Session I

Evidence integration and decision making in teacher education

Monday 18.02.2019
16:00 – 17:30

M-1. Developing a video-based learning environment for preservice teachers' diagnostic competences concerning mathematical argumentation

Elias Codreanu and Tina Seidel
Technical University of Munich, Germany

Diagnostic skills are a central element and basic requisite for teaching and learning in the 21st century (Darling-Hammond & Bransford, 2007). The advanced level of noticing and reasoning involved in diagnostic decision-making often drowns in the high-density interaction of everyday teaching (Grossman et al., 2009). High-quality professional development must provide learning opportunities to hone these skills and connect the conceptual knowledge to examples of the professional practice (Borko, 2012). The learning environment developed in this study aims to meet these requirements with the use of video sequences as an authentic representation of practice (Kang & van Es, 2018). The formative assessment task that needs to be worked on in the learning environment was designed on the base of the model of professional vision (Seidel & Stürmer, 2014). This offers an insight into the epistemic-diagnostic activities as part of the reasoning process (Fischer et al., 2014). In the paper presented, case analyses demonstrate differences between expert and preservice teachers regarding their reasoning processes for diagnostic decisions.

The presented paper focusses on two expert and two preservice teacher from a sample of N = 10 expert and N = 15 preservice teachers. The cases illustrate differences between the two subsamples. The learning environment's short scripted video clips showed seventh graders of four different skill levels working on a mathematical proof in geometry – two students with similar abilities and two with clearly discernible abilities, as established in research around mathematical argumentation (Usiskin, 1982). The participants adopt the role of an assistant teacher whose task is to assess the students' argumentation skills for the purpose of subsequent individualized support. The learning environment leads participants through the individual video sequences. After a video sequence, participants provide written responses regarding their assessment of observed student argumentations. Open responses were coded with verified agreement by independent coders. The coding scheme is based on the professional vision's framework, which was independently developed and field-tested prior to the study.

The case analyses illustrate experts' more efficient noticing process, in consecution with elaborated explanations and appropriate predictions as part of their reasoning, being shown both for the two clearly discernible as well as the two more subtle student argumentation types. In their explanations, they argue more often by connecting the observed situation to concepts from the field of education of mathematics. Regarding the two subtle student profiles, particularly preservice teachers exhibited an expanded noticing process that was connected with an inconsistent reasoning also lacking connections to pedagogical content knowledge.

The findings show, that the designed structure can present valuable insights into the process of decision-making. The identified critical points for further training offer an evidence base for the development of precise intervention. After all, high-quality instruction requires providing teachers with the best possible learning opportunities research can find.

M-2. Fostering the use of evidence from models in science learning: interactive and example-based scaffolding

Sarah Bichler[1], Sonya Richards[1], Lisa Hasenbein[1], Marcia Linn[2] and Frank Fischer[1]
[1] Ludwig-Maximilians-Universität München, Germany; [2] University of California, Berkeley, USA

Dynamic visualizations are powerful in science learning because they make salient features of natural phenomena observable (McElhaney, Chang, Chiu, & Linn, 2015). Learners can be effectively supported to use evidence from dynamic visualizations in their argumentation and to gain integrated understanding of the phenomenon under study (Ryoo & Linn, 2012). Scaffolded dynamic visualizations are a characteristic feature of inquiry learning environments, which typically also involve collaboration (Linn, 2000). Collaborative learning is understood as constructing shared understanding (Roschelle & Teasley, 1995) and needs guidance (Fischer, Kollar, Stegmann, & Wecker, 2013) because its effectiveness depends on "the extent to which groups actually engage in productive interactions" (Dillenbourg, Järvelä, & Fischer, 2009, p.6). Scaffolding collaboration has positive effects on collaboration skills and domain knowledge; it is especially effective on the latter when prompting learners to build on each other's ideas (Vogel, Wecker, Kollar, & Fischer, 2017). We investigated whether the design of content scaffolds affect naturally occurring that is, unscripted collaboration. We compared a constructive (Wylie & Chi, 2014) and an example-based (Renkl, 2014) scaffolding activity in an inquiry unit on global climate change with dynamic visualizations. In the constructive scaffold condition learners generated a visual model to show energy flow. They received automated knowledge integration feedback to revise their representation (Vitale, McBride, & Linn, 2016). In the example-based scaffold condition, learners observed a modeling video of the energy flow diagram activity. The constructive scaffold was assumed to be more effective for collaborative and the example-based scaffold was assumed to be more effective for individual learning. Preliminary data consists of N = 71 (target N = 199) university students with a mean age of 25.39 years (SD = 5.85). Participants were randomly allocated to one of four experimental conditions in the 2x2 between-subjects design: scaffold (constructive vs. example-based) and study mode (collaborative vs. individual). Learning materials evolved around types of energy, energy flow and transformation, and the role of greenhouse gases and the ozone layer for global temperature. Integrated understanding was measured with 10 single-choice items that had a low reliability rtt = .60. Preliminary results of a 2-factorial ANOVA indicated that while neither one scaffold or study mode was more effective, collaborative learners benefitted more from the constructive and individual learners benefitted more from the example-based scaffold. These findings indicate that a constructive scaffold might be challenging, but opens the way for transactive collaboration processes (Vogel et. al., 2017). In such, the constructive scaffold presented an opportunity for interactive behavior, which is linked to deep learning (Wylie & Chi, 2014). Without a peer to overcome the challenge, to engage in effective collaborative processes, or to interact with, the example-based scaffold better fosters learning. The present study showed that the design of content scaffolds can (indirectly) guide collaboration and might resolve the danger of "over scripting" (Dillenbourg, 2002). Currently we are analyzing learners' explanations. We also want to address a limitation of this preliminary analysis: Namely, that we used individual scores of learners in the collaboration condition as outcome measure (Cress, 2008).

M-3. Does a utility-value intervention foster preservice teachers' instructional reasoning for technology-enhanced teaching?

Iris Backfisch, Andreas Lachner, Christoff Hische and Katharina Scheiter
Leibniz-Institut für Wissensmedien, Tübingen, Germany

In the course of digitalization, using information and communication technology (ICT) for teaching becomes increasingly important. However, teachers often do not fully exploit the potential of ICT in an effective manner. Therefore, it is generally argued that teachers need to possess flexible knowledge to successfully reason about potential benefits of ICT-technologies for teaching and for the implementation of powerful technology-enhanced learning arrangements in the classroom. This general type of teacher knowledge is broadly referred to technological pedagogical content knowledge (TPACK, Mishra & Koehler, 2007). Besides teachers' professional knowledge, it is argued that particular motivational factors, such as the perceived utility of technology affect teachers' reasoning during instructional situations (Ermter et al., 2012; Backfisch et al., 2018).

Recent studies documented that the perceived utility of distinct actions (e.g., preparing for a test, text comprehension) can be enhanced, when students additionally receive relevance instruction (i.e., utility-interventions), in which students directly receive information about the potential utility of subsequent actions (e.g., Gaspard et al., 2018; Harackiewicz & Priniski, 2018; McCrudden & Schraw, 2006). Against this background, we will investigate whether the benefits of utility-value interventions can also be generalized to applied settings such as in teacher education, and enhance preservice teachers' acquisition of integrated technological pedagogical knowledge. At the beginning of the study, pre-service teachers (N = 90) will randomly receive either a societal utility-value intervention (utility of technology for society), a pedagogical utility-value intervention (utility of technology for teaching) or no utility-value intervention (control condition). Afterwards all pre-service teachers receive a complex hypertext environment with information on how to teach the Pythagorean Theorem from a technological, pedagogical and content knowledge perspective. After the learning phase the students will answer a knowledge test. To examine whether the higher knowledge gains also resulted in a better reasoning performance, the participants will additionally plan a technology-enhanced lesson.

We will examine the level of cognitive processing of the hypermedia environment with the help of log file analysis (i.e., processing time and navigation behavior). To analyze reasoning performance, we will rate the cognitive activation and level of instructional support of the teaching concepts (Hugener et al., 2009).

We hypothesize that students in the utility-value conditions will process the hypermedia environment more deeply than students in the control condition. Furthermore, students in the two utility-value conditions should outperform students of the control condition in the knowledge test and in reasoning performance (i.e., quality of the lesson plans). Additionally, we explore potential differences between the two utility-interventions.

M-4. Evidence-based practice in teacher education: The role of personal domain variables and expertise among teacher educators

Despoina Georgiou[1], Anne Wiesbeck[2], Sog Yee Mok[3], Frank Fischer[1] and Tina Seidel[2]
[1] Ludwig-Maximilians-Universität München, Germany; [2] Technical University of Munich, Germany; [3] University of Zurich, Switzerland

Evidence-based teaching (EBT) refers to teaching practices based on robust evidence retrieved from quality research studies (Davies, 1999). Research on evidence-based practices in medicine has shown the significance of several personal domain variables (Clarke & Hollingsworth, 2002) such as practitioners' knowledge, their beliefs, and their attitudes toward the implementation of Evidence-based practices. Research in teacher education also emphasized that beliefs, knowledge and attitudes play a pivotal role in the professional growth of teacher educators (Richardson, 1996; Korthagen, 2005). Because teacher educators play a crucial role in the classroom ecology of teacher education, a consistent use of EBT in this field is especially important and may accelerate a more rapid shift toward EBT. The present study, therefore, investigates European teacher educators' personal domain variables toward the use of EBT. Additionally, we investigate the potential differences between novice and expert teacher educators.
Based on existing instruments from the fields of medicine and social work, we developed three scales that assess teacher educators' knowledge, beliefs, and attitudes toward EBT. Teacher educators (N = 243) from all over Germany, Austria, Switzerland and the United Kingdom completed the Evidence-based teaching scale, developed by the authors of the study. Exploratory factor analysis yielded a three factor model with good internal consistency for all three scales (ranging between Cronbach's $\alpha = .78$ and .83). Multiple regression analysis revealed statistically significant differences between expert and novice teacher educators based on their academic rank. The present study provides first insights into teacher educators' personal domain variables and the role of expertise when it comes to the implementation of Evidence-based teaching practices.

Paper Session I Monday 18.02.2019

M-5. Challenges for teacher educators to integrate evidence from educational research in higher education teaching

Annika Diery and Tina Seidel
Technical University of Munich, Germany

Higher education (HE) teacher educators serve as facilitators for evidence-oriented practice, who bridge the gap between research and practice (European Commission, 2013). It is therefore necessary to find out what teacher educators do to integrate empirical evidence in HE teaching and what might be obstacles and supportive means for them. To be able to teach evidence-oriented practice, teacher educators should be familiar with the current state of educational research and continually expand their own knowledge (Cochran-Smith, 2005). They should systematically integrate knowledge about the current state of educational research into the education of teachers (Bromme, Prenzel, & Jäger, 2014).
In existing works it becomes clear that teacher educators are a very heterogeneous group (Vanassche & Kelchtermans, 2014). They come from different backgrounds and may differ in their working or teaching experience and qualification (Ping, Schellings & Beijaard, 2017). However, research about the role of teacher educators and their practice can hardly be found. Consequently, the study aims to address the lack of research on the role of HE teacher educators with different backgrounds and the use of evidence in HE teaching.

Research Questions
- For which purposes do teacher educators use evidence?
- Which specific challenges do teacher educators perceive regarding evidence-oriented practice in HE?
- How do novice and expert teacher educators differ in their answers to RQ I and II?

Method
A convenience sample of n=55 teacher educators answered the online survey (54% female, M=44.33 years). 47.3% of the participants have their habilitation; the remaining participants have a university degree/doctorate.

The developed online survey consists of 30 items and is based on previous works in the field of evidence-oriented practice. The questionnaire assessed two dependent variables: (I) Use of evidence in HE teaching was measured with purposes of use (7 items, α=.90) and intensity of use (5 items, α=.89). (II) Challenges regarding the use of evidence were measured with difficulty of use (5 items, α=.80), methodological challenges (6 items, α= .93) and practical challenges (4 items, α=.86). For all items, six-point Likert scales were used as item response format (1: “I totally disagree”, 6: “I fully agree”).

Results and Discussion

Participants stated high purposes (M=5.19, SD=0.85) and high intensity (M=4.55, SD=1.03) regarding the use of evidence in HE teaching (RQ I). They emphasized the use of evidence for HE teaching overall as unproblematic (M=2.34, SD=0.95). On average, they rated methodological challenges less difficult (M=2.17, SD=1.07) than practical challenges (M=3.52, SD=1.25) (RQ II). Novice teacher educators had statistically significant higher values in the methodical challenges-scale ($t(53)= -3.20$, $p \leq .05$) and practical challenges-scale ($t(53)= -3.37$, $p \leq .05$) than expert teacher educators (RQ III).

Novice teacher educators tend to have greater and different difficulties. Upcoming work has to clarify, if different presentation formats of evidence and explanatory material can further support teacher educators to integrate evidence into HE teaching (Cochran-Smith, 2005). Additionally, for clearer insights, surveys of the teacher students themselves or observations of teacher education courses are suggested.

Paper Session II

Arguing about socio-scientific issues

Tuesday 19.02.2019
9:00 – 10:30

T1-1. Real-world problems in classroom: A systematic literature review on socio-scientific argumentation

Olga Ioannidou[1], Andreas Hetmanek[2], Frank Fischer[1] and Tina Seidel[2]
[1] Ludwig-Maximilians-Universität München, Germany; [2] Technical University of Munich, Germany

As the world is faced with critical issues such as climate change, or the use of vaccines, the call for teaching scientific literacy to pre-service and in-service teachers and students is more prominent than ever. Socio-scientific argumentation (SSA) has been introduced to science education as an attempt to promote civic and scientific literacy (Sadler, 2007). Although teachers embraced the concept as beneficial for students' learning, they report difficulties in teaching in SSA contexts, because they often do not feel confident and well-prepared to address the complexity of these issues (Juntunen & Aksela, 2014). This problem is amplified by the fact that teachers are expected to teach SSA without having a clear definition and a way to reliably measure it. In order to address this issue, this study investigates the way that researchers define and measure socio-scientific argumentation. A systematic literature review was conducted and a mixed-methods approach was followed. Data was gathered from two electronic databases (Web of Science and EBSCO); from 572 articles retrieved, 75 articles were included in the full-text analysis phase. In the qualitative analysis, a coding scheme was constructed based on content analysis and the articles were analyzed with MAXQDA software. Among other findings, our quantitative analysis revealed that 77% of the articles conceptually connected SSA with scientific literacy, while 59% linked it with civic competencies. Furthermore, most of the studies between 2014 and 2017 presented SSA as issue-specific, while Toulmin's TAP the measurement mostly used. The present findings will be backed up by a citation network analysis to highlight whether researchers are consistent with the choice of concepts and methods used. As a next step, a pilot study will be conducted in which pre-service teachers will validate the emerged definition and measurement.

Paper Session II Tuesday 19.02.2019

T1-2. Argumentation on socio-economic issues: An exploratory analysis of students' written argumentation structure

Nicole Ackermann and Bengü Kavadarli
University of Zurich, Switzerland

In modern democratic societies, citizens are involved in private, business and political decision-making processes. On the political level, for instance, they are periodically invited to express their opinion on socio-economic issues (e.g., retirement provision, health care, energy supply, agricultural trade) via public debates and referenda (Dubs, 2011; Eberle, 2015). Socio-economic issues, seen as a subdomain of socio-scientific issues (SSI), typically are complex (ill-structured, open-ended) and controversial (subject to multiple perspectives and solutions) (King & Kitchener, 2004; Sadler & Donnelly, 2006; Simonneaux, 2008).
Argumentation on socio-economic issues belongs to informal reasoning (Kolsto & Retcliffe, 2008) with either a rhetorical (e.g., political speech, position paper) or dialogic (e.g., political debate) meaning. It is connected to social sciences and demands for socio-scientific evidence-based reasoning. According to Toulmin's (1958) argumentation model, an argument consists of a claim (statement/position) supported by reasoning (data/backing/rebuttal). Thus, taking informed and reasoned decisions on socio-economic issues require domain-specific content knowledge (i.e., technical terms, basic concepts in politics and economics) and domain-specific skills (e.g., analysing, evaluating, reasoning, deciding) (Eberle, 2015; Ackermann, in progress).
The goal of this research study is to explore students' written argumentation structure when dealing with socio-economic issues. (RQ1) What argumentation structure regarding complexity of reasoning (simple, elaborated), source of reasoning (scientific, everyday) and type of reasoning (backing, counter, rebuttal) do students' answers reveal? (RQ2) What exploratory clusters of argumentation structure and domain-specific content knowledge can be identified?
The data were collected from a sample of 159 12th grade high school students in German-speaking Switzerland using the revised test on economic-civic competence (WBK-T2) (Ackermann, 2018). Out of the WBK-T2, four open-ended tasks from the issues "retirement provision" and "energy supply" had been chosen for a qualitative

content analysis of students' written argumentation structure (Mayring, 2015). The coding scheme consists of various adapted (McNeill, 2011; Morris, 2017) and newly developed categories for claim and reasoning and was deductively applied to the material. Two independent raters coded 20 % of the students' answers separately and discussed their disagreements in order to probe and refine the general coding scheme and to enrich the task-specific rubrics. The inter-rater reliability was calculated for each code by relative agreement and showed satisfying values (> 80 %).
Preliminary results show that two thirds of all students' answers (67 %) are elaborated reasoning; the most frequently used connectives between reasoning elements are additive, causal and inferential. In about three quarters of all students' answers (78 %), backing is found as type of reasoning, in less than 10 % it is counter or rebuttal each. Moreover, 57 % of all students' answers include scientific evidence-based explanations as source of reasoning, 36 % everyday experienced-based explanations.
Expected results of this study may give meaningful new insights into 12th grade students' written argumentation on socio-economic issues and may have manifold implications for teaching and learning in social sciences classes. For example, written argumentation can be trained by essay writing, oral argumentation by role-plays and panel debates.

T1-3. Student-to-student interactions and their effect on the development of economic competence

Christin Siegfried
Goethe-Universität Frankfurt, Germany

Daily life situation gets more and more an economic perspective. Thus, economic competence has been implemented as part of general education in school curricula. Despite that, studies report that young adults show a severe lack of economic competence (e.g. Schumann, Eberle & Oepke, 2013). Several surveys indicate a direct connection between the competences of students and their teachers (e.g. Goldhaber & Anthony, 2007). However, since teaching processes can be modeled as interaction dynamics, nowadays the focus is no longer just on teachers´ competence, but rather on teachings-learning interactions. According to these interactions, communication processes are often assumed to be the fundamental source of the development of students' knowledge (Steinbring, 2000).

This is in line with the constructivist's understanding of learning (Piaget, 1989), which suppose that the communication of individuals with its environment (other learners) is crucial for the co-construction of knowledge (Chi & Menekse, 2015) and cannot be replicated by a single learner (Hinsz et al., 1997). To what extend students are interacting depends on the knowledge base they have. Especially undivided knowledge base (group members have different information available) promotes the need for interaction (Kopp & Mandl, 2006). Moreover, Barron (2003) shows in their study that neither the number of correct solutions nor the previous knowledge of group members can predict the learning outcome of a group. The amount of connecting solutions was the most powerful predictor. Hence student-to-student interaction is not about convincing the other learning partners uncompromisingly (Nussbaum, 2008).The focus of this mixed-method approach is to answer the research question: To what extend the quality of group discussion and the quality of individual arguments in student-to-student interaction effects the individual leaning outcome.

To analyse the effect of communication quality, a problem-based teaching unit (energy supply) was developed and the entire teaching and learning process (90 minutes) was

videotaped and accompanied with questionnaires (demographic data, actual motivation, goal orientation) and a knowledge tests before and after classes. In total seven classes of upper school in Hesse with 90 students were conducted from March 2017 until June 2017.

In order to analyze the videotapes and its transcription intensive coder trainings have been carried out. Results show, that the overall knowledge increased after the lesson ($F(1,89)=4.288$, $p=.04$, $\eta 2=0.05$). The students demonstrate a positive interest ($M= 3.19$, $SD=0.52$). Regarding the problem-based teaching and the presented problem in classes, students indicate a relatively high probability of success ($M=4.14$, $SD=0.36$). After the problem-based teaching students state that they were mostly motivated internally ($M=3.22$, $SD=0.86$) and intrinsic ($M=3.17$, $SD=0.75$). First results of the video coding show the high connection between high quality communication and an increase in economic knowledge.

This study offers preliminary empirical evidence of the positive impact of the quality in discussions on economic knowledge and can provide first indications to support the learning process of students to overcome the actual debate about their insufficient economic knowledge. Moreover, the findings could be used as a basis for further research and initial recommendations in the context of teacher training.

T1-4. Characteristics of argumentative thinking among Haredi students

Ehud Tsemach and Anat Zohar
The Hebrew University of Jerusalem, Israel

The Haredi (Ultra–Orthodox) yeshiva is an unusual educational institution in the state of Israel. From the age of 13, young ultraorthodox men study in a yeshiva, devoting all their time to the Talmud (the holy book of Jewish law), with no general studies like mathematics or sciences (Brown 2017). However, in recent years more and more Haredi men have left the yeshiva, pursuing academic education.
Argumentation is a fundamental thinking skill in the yeshiva (Schwartz 2015), as well as in the academia (Kuhn 1991). Talmudic studies include understanding of argumentation processes, proposing hypotheses, supporting them, and refuting arguments. This study wishes to examine the argumentation of Haredi men in academic context.
Our theoretical framework integrates a cognitive perspective which focuses on the argument components and its quality; and a sociocultural one which emphasizes the cultural context, values and traditions (Newell 2011). Using both perspectives can enrich our understanding on the matter. Therefore, we focus on two main questions: What are the argumentative thinking features of Haredi men which stem from their unique cultural background? And how they affect the quality of their arguments?
To characterize the features of argumentative thinking we requested 80 Haredi students and 80 public school "regular" graduates studying in pre-academic preparatory programs to write an argumentative assignment (Uccelli, Scott & Dobbs, 2013). In the cognitive analysis we examine the argument components (claims, reasons, rebuttals etc.) and grade the writing assignments. We use top-down criteria to assess argumentation quality according to supporting reasons, organization and integration of counterarguments (Nussbaum & Schraw 2007).
In the socio-cultural analysis we compare between Haredi and public education graduates, trying to discover argumentative features that are unique to the Haredi group (Kuhn et al. 2010; Dong et al. 2008). This comparison enables us to better understand the cultural context of a unique culture which tries to integrate in the mainstream (Perelman 1999).

Preliminary analysis presents a complex picture. The cognitive analysis shows that Haredi arguments are less organized and reflect an oral tradition that is different from the academic standard. The socio-cultural analysis reveals distinctive argumentative features that are unique to the Haredi students, such as different argument structure, thinking patterns and goals. These thinking features derive from the structure of the Talmud and dispute traditions in the Yeshiva. Furthermore, while there is a similarity in the argumentative characteristics among the public education graduates', among the Haredi group there is a great diversity. These will be elaborated in the full paper.
Our findings indicate that Haredi students constitute an argumentative subculture with unique thinking characteristics, which differ significantly from the mainstream public education graduates. When the Haredi students move from the yeshiva to the new context of academia, they bring their own cultural and intellectual interpretations which are rooted in the oral study of Talmud.

T1-5. The role of moral reasoning in socio-scientific issues: A case study in high school biology education

Tore Van der Leij
University of Groningen, The Netherlands

Aim
The aim of this case study is to explore a group of high school students' moral reasoning and its development within the context of a socio-scientific issue in a classroom-based intervention in the Netherlands.

Theoretical Framework
Socio-scientific issues are typically value-laden (Zeidler, 2014) and hence, they are subject to individuals' moral considerations. Despite the importance of moral reasoning in socio-scientific issues, it is often left out during instruction and hasn't received much research attention (e.g., Van der Zande et al., 2009). Especially in the Netherlands, the number of empirical studies with a focus on moral reasoning in high school biology education is scarce. Another existing gap in the literature is that the limited number of studies with a focus on moral reasoning is situated in the context of genomics, leaving the context of human-nature relation largely unexplored. With a focus on moral reasoning in the context human-nature relation, in high-school biology, this study aims to address these gaps in the literature. This study is theoretically framed within the Four Component Model of Morality (Rest et al., 2000), which includes the following: (a) Exploration of values, which leads to being more sensitive to the moral nature of the issue; (b) Making an informed choice for a specific moral value; (c) Applying the chosen moral value in a concrete situation; (d) Attune behaviour to the chosen norm.

Research Question
- In what ways (if any) does a specially-designed intervention support students' development of moral reasoning in the context of a socio-scientific issue?

Methods
This study lies at the intersection of qualitative case study research and grounded theory as it aims to develop a theory about moral reasoning development (Merriam & Tisdell,

2015). Data were collected from 5 modules taught 3 high school classrooms where students worked in small groups.

Data source	Purpose	Number of students
Written essays	Investigate the level of students' moral reasoning prior to the intervention	95
Worksheets: individual and group assignments	Investigate moral reasoning regarding a contemporary socio-scientific issue	95 23 groups
Audio recordings of group dialogues	Investigate small-group discussions regarding a contemporary socio-scientific issue	7 groups
Individual interviews	Investigate individual development with regard to moral reasoning	12

Results/Relevance

The analysis of the data will provide insights into students' individual development of moral reasoning by examining the impact of the intervention on the following:

- Students' awareness of the moral-ethical nature of dilemmas.
- Students' ability to map the (moral) values of the interest groups.
- Students' ability to consider the (relative) part of their intuition and other values in order to form an opinion regarding a dilemma.

These findings will contribute to theory regarding moral reasoning and how it develops by identifying different developmental levels as well as types of moral reasoning in the context of socio-scientific issues.

Paper Session III

Exploring, assessing and enhancing students' reasoning skills

Tuesday 19.02.2019
13:00 – 14:30

T2-1. Assessing primary school students' reasoning in interpreting experiments

Sonja Peteranderl and Anne Deiglmayr
ETH Zurich, Switzerland

This project investigates the training and development of experimentation skills in primary school students. It is embedded in the longitudinal large-scale "Swiss MINT Study" (PIs: Prof. Dr. Elsbeth Stern and Dr. Ralph Schumacher). Experimentation skills encompass the ability to plan, conduct and evaluate conclusive experiments. This project focusses on the assessment and training of one of the core skills of scientific reasoning, the Control of Variable Strategy (CVS). An experimental study with n = 669 elementary school students in 38 5th- and 6th-grade classrooms from the German-speaking part of Switzerland (Agemean = 11.14) evaluated the effects of an experimentation skills training on children's understanding and application of CVS. Within classrooms, students were randomly assigned to either the Experimentation Skills Training (EST) or the Active Control Training (ACT). The EST focused on scientific experimentation and CVS, whereas the ACT focused on conceptual knowledge without applying CVS. To assess children's competence with regards to CVS, a paper-and-pencil test was developed. This test covers all four subskills of CVS that have previously been described in the literature: understanding the rationale behind CVS, planning non-confounded experiments, identifying non-confounded comparisons, and interpreting evidence gained from non-confounded comparisons. In addition, the test assesses typical misconceptions in designing conclusive experiments, such as testing multiple hypotheses or varying the wrong variable (not the variable of interest). Open-answer items allow us to assess the argumentation and reasoning of primary school students. We use an iteratively developed coding system to classify and analyze students' open answers. Data from pre- and posttest in the training (EST) and control condition (ACT) show significantly higher learning gains for the trained children with regards to all four CVS subskills. Furthermore, we could demonstrate a decrease in misconceptions for the trained, but not for the control students. The analysis of the open answers is still in progress and we are confident that these results will shed light on students' reasoning in planning and interpreting confounded and non-confounded experiments.

Paper Session III Tuesday 19.02.2019

T2-2. Investigating and scaffolding elementary students' conditional reasoning skills in mathematical and everyday contexts

Anastasia Datsogianni, Stefan Ufer and Beate Sodian
Ludwig-Maximilians-Universität München, Germany

Reasoning about conditional "if..then" statements is a central component of logical reasoning (Inglis & Simpson, 2009), referring to a semantic process based on the construction and manipulation of mental models (Johnson-Laird & Byrne, 2002). However, are elementary school children able to engage in conditional reasoning in mathematics? Research in developmental psychology has shown that even very young children possess basic abilities in (at least some forms of) conditional reasoning when tasks are presented in an everyday context (e.g. Markovits & Thomson, 2008), while there is a great deal of variation in performance due to external factors. Nevertheless, a link between conditional reasoning and mathematics has been found only in the case of late adolescence and adults (Attridge & Inglis, 2013; Inglis & Simpson, 2009). Our knowledge about elementary students' conditional reasoning within mathematics is still weak, despite claims in the literature about the importance of deductive reasoning for mathematics learning and success (Morsanyi & Szücs, 2014; Nunes et al., 2007). Given also that current theories describe conditional reasoning as a process that involves domain-specific knowledge, it is an open question to which extent students can transfer their existing logical reasoning skills to contexts that involve mathematical concepts. In this study, 100 Cypriot elementary students took part in an individual interview. Eight conditional reasoning tasks in two contexts (mathematical, everyday) were constructed to measure students' understanding of conditional statements in different contexts and their ability to logically draw valid conclusions based on given information. There were also corresponding tasks (mathematical and everyday), measuring the generation of alternative mental models for each situation described in the tasks, as well as a mathematical skills test and a working memory test (backwards digit span). The tasks were piloted through a previous feasibility study (Datsogianni, Ufer, & Sodian, 2018). This study is focused on the following research questions:

- How does conditional reasoning in every-day context and in context involving

mathematical concepts develop over the primary school age?
• To which extent is conditional reasoning performance, as surveyed in every-day contexts, related to conditional reasoning performance in tasks that address mathematical concepts.
• To which extent is conditional reasoning in tasks that address mathematical concepts related to alternative generation skills in the given mathematical context, domain-specific knowledge, and the individual predictor of working memory.
This study is of great importance to understand and support children's learning in mathematics and beyond. The detailed results will be presented in the REASON Winter School 2019. The next step of this project would be to investigate how elementary students' conditional reasoning skills in mathematics can be supported regardless of their level of prior knowledge and how different scaffolds such as a training of mathematics multiple solution tasks or creativity tasks, affect students' conditional reasoning skills in mathematics. The outlook of this study will be presented in the REASON Winter School 2019.

T2-3. Exploring primary students' data-based argumentation – an empirical analysis of students' strengths and difficulties

Jens Krummenauer and Sebastian Kuntze
Ludwigsburg University of Education, Germany

In modern societies, statistical data are often used as evidence for argumentation and decision-making in various domains. Thus, it can be seen as an important goal to encourage already primary students to critically evaluate whether a statement is supported by a set of statistical data. Therefore, data-based argumentation is often required.
When students develop data-based arguments they have to deal with several requirements, like interpreting representations of data, using statistical models or drawing logical conclusions. As described in Krummenauer & Kuntze (2018), those requirements can be described under a scientific reasoning perspective. For example, when students have to generate data-based arguments for evaluating a given claim, they have to separate the claim from the statistical evidence and treat the statement as a hypothesis which is potentially to reject.
Studies have shown that already primary students can be able to apply strategies of scientific reasoning and that fostering such skills is possible in primary school (cf. Bullock & Ziegler, 1999; Kuhn, 1989; Kuhn, 2010; Sodian et al., 2006; Zimmermann, 2007). However, these and further studies also show that children often use deficient strategies, like seeking for confirming evidence only or accepting hypotheses too hastily (e.g. Kuhn et al., 1988; Bullock & Ziegler, 1999; Klahr & Dunbar, 1989). An important strategy for dealing with data-based claims is, therefore, to challenge them actively by searching for counter-evidence in the data (Kuntze et al., 2013).
In a prior study with fourth-graders (Krummenauer & Kuntze, 2018) we found that about one-third of our sample was able to coordinate a given claim with a set of statistical data by generating at least one data-based argument. We also found indications that some of the students' difficulties in data-based argumentation can be explained with deficits concerning scientific reasoning strategies. Beyond this, there is a need to expand research addressing primary students' strengths and difficulties in generating data-based

arguments and the role of scientific reasoning strategies in the underlying process. In particular, it should be investigated what obstacles primary students encounter to provide an empirical basis for a future intervention study.
This leads to the following research questions:
(1) To what extent are primary students able to generate data-based arguments?
(2) Is it possible to detect specific difficulties of primary students when they develop data-based arguments?
In our current study, we analysed answers from a test with N=209 primary students (grade 3 and 4). The test contains 13 tasks which require the students to develop data-based arguments for evaluating a claim that refers to a given set of data. The analysis of the data combines a theory-based top-down coding, which was already successfully applied in a former study (cf. Krummenauer & Kuntze, 2018), with a bottom-up analysis for exploring possible difficulties of the participants. The results of the study give insights both into students' abilities and their difficulties, thus providing an empirical basis to inform interventions for fostering primary students' data-based argumentation.

T2-4. Digital information retrieval in secondary school geography education – The development of reasoned judgements on complex geographic issues by researching digital evidence

Eva Engelen
Universität Köln, Germany

In geography education pupils face the challenge of forming reasoned judgements on complex, societal issues. In their analysis and evaluation they need to consider human and natural circumstances, compare different perspectives and justify their argumentation with appropriate evidence. In traditional geography lessons, all sources are provided by the teacher. However, this way of teaching does not fully prepare students for higher educational studies and independent learning, as information retrieval and the evaluation of sources constitute a prerequisite in the elaboration of an argument.
Current geography school books do not comply with the educational standards, as they lack a variety of argumentative tasks and multi-perspective material. The most popular and easily accessible way to obtain the required information has become the internet. Even though it is also the pupils' primary private source of information, teachers hesitate to embed digital research into the classroom. This is based on the perception that pupils often search for information in a mostly inconsiderate manner. In fact, extensive studies have been shown, that young people are facing major difficulties when researching and evaluating online information.
Previous publications provide valuable insights into the digital research behaviour of pupils and students and their difficulties in providing coherent argumentations on complex geographic issues. This study fills the gap of explaining the actual abilities of 15-18 year old pupils to identify digital multi-perspective evidence suitable for forming reasoned judgements on societal issues. Furthermore it points out the impact of different research approaches on the learners' success in finding the appropriate evidence.
The 20 pupils this study is based on are requested to form a reasoned judgement on a complex geographic issue by researching all necessary information on the internet. While completing the task the students comment loudly on their thoughts and actions. In-depth

qualitative data is gathered by capturing all of the participants' digital actions and accompanying speech with a screen and audio recorder. The transcribed protocol is analysed firstly with regard to the pupils' success in researching multi-dimensional evidence to justify their argumentation. Secondly, their actual approaches, such as search strategy and modifications of search terms, are evaluated.
First attempts show that pupils face major problems in identifying relevant evidence which, subsequently, has negative effects on forming solid arguments. There seem to be specific correlations between the pupils' success in finding multi-perspective evidence and their research approaches: a comparably high number of modifications of search terms and switching between websites are shown to have negative influence on finding appropriate evidence.
The findings of this study give valuable insights into the pupils' skills in identifying digital evidence on geographic issues and possible explanations for the outcomes. It thereby has an influence on the implementation of digital research into geography classes.
Furthermore, this research serves as a starting point for further studies in this domain. Apparent correlations between the chosen approach and evidence-retrieval have to be verified and teaching methods have to be created to improve the students' skills.

T2-5. Enhancing acquisition of scientific reasoning skills through memory tests?

Johanna Kranz[1], Katrin Kaufmann[2], Tobias Tempel[3] and Andrea Möller[1]
[1] University of Vienna, Austria; [2] Universität Trier, Germany; [3] Ludwigsburg University of Education, Germany

Theoretical background:
The control-of-variables strategy (CVS, Chen & Klahr, 1999) describes a method for creating valid experiments in which the dependent variable is held constant and the independent variable is varied, whilst all alternative causal effects can be excluded. Although reasoning on the basis of unconfounded evidence is crucial, students often perform poorly when it comes to tasks that require a scientific understanding of CVS (e. g. Schauble et al., 1995). A variety of studies in cognitive psychology have shown that the integration of retrieval, the active cue-driven process of reconstructing knowledge, into learning processes, can enhance sustainable learning (e. g. Karpicke & Blunt, 2011). In this study, we compare the effects of retrieval practice to other more conventional learning methods on the acquisition of CVS skills.

Methodology:
In two experimental studies (post/follow-up design), high school students (grade 5/6, study I: n= 179, age M= 10.8, SD= .07, = 60.5%; study II: n= 217, age M= 11.3, SD= .70, = 45.8%) took part in a half-day out-of-school laboratory intervention. After receiving an instruction about the nature of CVS, all students were randomly assigned to the following learning treatments: [study I] (1) retrieval (open recall, n= 88) and (2) repeated study of the instruction content (n= 91); [study II] (1) retrieval (cued recall, n= 72) and (2) repeated study of the instruction content (n= 72) and (3) practical performing of the experiment formerly presented in the instruction (n= 73). The CVS-test (nine items, based on Chen & Klahr, 1999; Edelsbrunner et al., 2015) showed a good test quality (Item-Reliability: .98, Person Reliability: .86, Item MNSQ-INFIT: 1.0 (MEAN), Cronbachs Alpha: .89).

Findings:
The first study shows that students, who trained CVS trough repeated studying, performed significantly better in CVS than students who practiced retrieval (open recall)

as a learning activity (F(1, 169)= 3.93, p= <.05, η2= .02). Although the retrieval method was easier in the second study (cued recall, cloze test), students, who trained CVS trough repeated studying, still performed significantly better in CVS than students, who practiced the less difficult retrieval method or practically conducted the experiment that was formerly presented in the instruction (F(2, 214)= 4.17, p= <.01, η2= .04, LSD-Post-hoc: p= <.05).

Conclusions:

Even though retrieval practice proved to be a powerful tool for shaping memory (Karpicke, 2017), our results of both studies show that in grade 5/6 repeated study was the most effective learning method to train CVS. This raises the question, why learning complex concepts like CVS, might not benefit from retrieval practice as much as learning content knowledge (Karpicke, 2017). Interestingly, a most recent study with university students on the acquisition of CVS skills shows that at an older age retrieval practice is the best learning tool compared to repeated study (Author et al., 2018). Therefore, we would like to discuss if age might play a key role in learning complex concepts like CVS trough memory tests.

REASON Spring School 2019

Poster Sessions

Wednesday 20.02.2019
13:00 – 14:00

W-1. Scientific reasoning in preschool: Understanding contrastive and controlled tests

April Moeller
Ludwig-Maximilians-Universität München, Germany

The ability to use evidence to support one's claims is just one of many important components of scientific reasoning. Also of importance is the ability to first generate unconfounded evidence. The Control of Variables Strategy (CVS) is a strategy for designing unconfounded experiments, which manipulate the variable in question while keeping all others constant, and can be used to determine cause–effect relations between variables (Chen & Klahr, 1999). Although CVS has traditionally been shown to develop late (Kuhn, Garcia-Mila, Zohar, & Andersen, 1995; Schauble, 1996), recent research has shown beginning competence in elementary school and even preschool when children are asked to select rather than produce a controlled experiment or when they are provided with support for producing one (Bullock & Ziegler, 1999; van der Graaf, Segers, & Verhoeven, 2015). In the present study, we systematically investigated preschoolers' abilities in CVS with novel, knowledge-lean choice tasks using the blicket detector paradigm (Gopnik & Sobel, 2000). Children must select a "good" test for a hypothesis about the cause of a light effect. The 2-choice task represented a contrastive test and the 3-choice task represented a controlled test. Each child performed each task twice. The experimenter placed a stick of two or three differently colored bricks on a "light box" and the box lit up. Children were instructed to find out if the X brick (e.g. green brick) was a lighter. To do so, they could pick one stick from two or three options, to place on the box. In each task, there is one correct stick that varies the X brick and keeps the other bricks the same. The other options vary either two or three bricks. Results showed that preschoolers (N = 108, $M_{ageyoung}$= 4;8, M_{ageold} = 6;1, range: 3;5 - 6;9) selected the correct option in at least one of two trials more often than to be expected by chance (2-choice: 62%; 3-choice: 46%). Across two trials, 40% of children were consistently correct in the 2-choice task, but only 20% were in the 3-choice task, suggesting that the 3-choice task is more difficult. This is further supported by the difference in performance between younger and older children: older children selected the correct choice twice in the 3-choice task (26% vs 15%). Of those children who selected the correct choice, 45% provided valid justifications (referencing controlling variables), with older children providing more valid justifications than younger children (54% vs 29%). Van der Graaf et al. (2015) found that, after repeated feedback on experimental design, 47% of preschoolers could produce a controlled experiment with three variables. Our results show that about the same proportion of preschoolers could spontaneously select a controlled test without support or training. Further, our results indicate that preschoolers also find contrastive testing easier to understand than CVS. These findings indicate genuine scientific reasoning abilities in preschoolers. Age-related developmental change and individual differences remain to be explored in depth in future research.

W-2. Influences of motivational constructs on scientific thinking in children

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Evidence-based argumentation is an important part of scientific thinking. The development of scientific thinking is considered following a long path from early basic understanding in elementary and even preschool years (e.g. Piekny & Mähler, 2013) to still maturing abilities in adolescence (Bullock, Sodian & Koerber 2009, Kuhn, 2013; Sodian & Bullock, 2008;). Factors influencing the development of scientific thinking are subject of ongoing research. Most research in this area addresses the impact of general cognitive factors like language, intelligence, problem solving, executive functioning and specific variables (e.g. advanced theory of mind) on the development of scientific thinking (Koerber, Mayer, Osterhaus & Sodian, 2015; Mayer, Sodian, Koerber & Schwippert, 2013; Osterhaus, Koerber, & Sodian, 2017; for an overview see Zimmerman & Klahr, 2018). A study conducted by Koerber et al. (2015) for instance showed an influence of intelligence, parental education and schooling on scientific thinking in elementary school years. Furthermore Osterhaus et al. (2017) reported on relations between social cognition (advanced theory of mind) and understanding the nature of science (NOS) and its importance for the development of scientific thinking in children. While cognitive factors are widely considered when researching the development of scientific thinking, the influence of motivational aspects such as self-efficacy and interest are not well investigated. Especially self-efficacy seems to be an important factor in academic achievement. Jansen, Scherer and Schroeders (2015) found in regression models a significant positive effect of self-efficacy on science achievement. But so far, little to no research has been done concentrating on the specific influences of domain general and domain specific self-efficacy, self-concept, interest and motivation on performance in scientific thinking beside the general cognitive factors. The current ongoing study answers this need, investigating the influence of these constructs on performance in scientific thinking in fourth and eighth graders. The performance is assessed by focusing on two central aspects of scientific thinking: NOS and experimentation. The NOS items were derived from the project Science P (e.g. Koerber et al., 2015; Mayer et al. 2014) and the experimentation items were used from Osterhaus et al. (2017). Items measuring domain specific self-efficacy, self-concept, interest and motivation were developed based on the literature (e.g. Scherer, 2013). Additionally, general factors like intelligence and inhibition were included. Data for this study are collected in autumn of 2018 with a sample of a minimum of 100 fourth graders and 100 eight graders. The children complete paper-pencil tests, which takes about 45 -60 minutes in a whole-class procedure. Based on findings of prior research, we expect a positive influence of motivational constructs on the performance in scientific thinking in addition to influences of cognitive factors. Due to the eighth-graders' more frequent opportunities of scientific thinking in school we expect a higher relation of motivational factors and scientific thinking in eighth than in fourth grade. Apart from regression analyses and ANOVAS scientific thinking abilities will be modeled in structural equation models in fourth and eighth grade including motivational, cognitive, and basic information processing variables.

W-3. Teachers' knowledge as prerequisite for the diagnosis of biology instruction

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Teachers' knowledge is structured into three dimensions: content knowledge (CK), pedagogical content knowledge (PCK) and pedagogical knowledge (PK) (Tepner et al., 2012). The quality of performance in class depends on teachers' knowledge (Dreher & Kuntze, 2015) and situation-specific skills (perception, interpretation, decision making; Blömeke et al., 2015). Fischer et al. (2014) identified eight situation-specific skills across different domains during diagnostic processes: the epistemic diagnostic activities (EDAs). By now effects of professional knowledge dimensions on reasoning aspects are not systematically examined. Research is also lacking when measuring teachers' knowledge in the nature of real-world demands (Blömeke et al., 2015).
To provide a tool for representing real-world teacher practice, a simulation based learning environment (SBLE) was developed. The research questions of this DFG-funded study are:
(1) Is the SBLE a valid test instrument for measuring EDAs?
(2) How does professional knowledge (CK, PCK, PK) influence the diagnosis of biology instruction (use of EDAs)?
The SBLE is an online learning platform, which shows six different classroom situations using staged-videos. Each classroom situation includes another biology-specific instructional quality feature based on empirical studies (cf. Dorfner et al., 2018; Förtsch et al., 2017; 2018a; 2018b). After watching the situation shown in the video, participants describe problematic aspects (EDA evidence generation), reason about the described aspects (EDA evidence evaluation) and propose an alternative teaching action (EDA drawing conclusions).
(1) For validation of the SBLE a pre-study with experts (N = 5; average teaching experience: 9.4 years (SD = 6.88)) was carried out. Content (A) and construct validity (B) was scrutinized by think-aloud interviews. First, experts watched the six classroom situations. When they identified problematic aspects, they stopped the video and talked about their thoughts (A). Second, they did one case of the SBLE by answering the items in the SBLE while simultaneously thinking aloud (B). The interviews were transcribed and analysed by qualitative text analysis (Mayring, 2015).
(2) In the intervention study (scheduled for November 2018) pre-service teachers with the subject biology (N = 125 planned) are divided into five treatment groups differing in knowledge impartation (no knowledge, only CK, only PCK, only PK, combination of CK/PCK/PK). Pre and post the intervention, professional knowledge using a paper-pencil-test and diagnosis of biology instruction (use of EDAs) using the SBLE is measured.
Results to part (1) show that (A) almost all of our scripted problems could be identified, but with different frequency. Solely one scripted problem (teacher did not react to a special student error) could not be identified at all. (B) The created tasks measure the theoretically underlying EDAs. Solely one task (describing problematic teaching situations) triggered not only evidence generation, but also drawing conclusions. Content and construct validity has been achieved for almost all parts of the SBLE. As the integrated theoretical and experiential knowledge of experts (de Jong et al., 2012) allows them to reason about critical events by using effective teaching and learning principles (Palmer et al., 2005), the strategy to reason by explaining an alternative performance might be part of this expertise.

W-4. Examining students' perspective on a training for achievement emotion regulation

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Objectives and Theoretical Framework. Throughout their educational careers, students are confronted with various emotional and achievement-related challenges. Negative emotions have been shown to negatively impact students' achievement and mental wellbeing. Students report to frequently experience negative emotions in achievement contexts (Pekrun, Goetz, Titz, & Perry, 2002). Pekrun's (2006) control-value theory (CVT) forms the theoretical framework for this study. According to CVT the arousal of achievement emotions is mainly due to cognitive appraisals of perceived control and the perceived value of achievement activities and their outcomes. Research has shown that negative achievement emotions increase and positive emotions decrease during K-12 education (e.g., Pekrun, Lichtenfeld, Marsh, Murayama, & Goetz, 2017). Therefore, from a scientific perspective, there is an urgent need to develop interventions that help students better regulate these emotions. In moving towards practical applications of these findings, this study examined whether this need is also perceived by students and whether individual differences exist.
Methods. The sample comprised 381 5th and 6th grade students (Mage =10.82 years, SD =.73; 47.5% female) from academic-track secondary schools (Gymnasium). GPA (average of math, German, foreign language, and science grades) was 2.46 (SD =.71) (1 =very good to 6 =insufficient). Participants filled out a questionnaire covering demographic data, achievement emotions (AEQ-M; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; s =.64 to .89), perceived academic control (Perry, Hladkyj, Pekrun, & Pelletier, 2001; =.66), and perceived academic value (Wigfield, 1994; s = .92, .65, and .82 for intrinsic, utility and attainment, respectively). Items were answered using a 5-point scale (1 = not at all true to 5 = completely true) and averaged to form the respective scales. Furthermore, students responded on a 1 (strongly disagree) to 5 (strongly agree) scale to different statements to assess their perceived need for an achievement-related emotion regulation (ER) training.
Results. Overall, 40% of the students (strongly) agreed that they would like to participate in such training whereas 28.7% (strongly) disagreed.

As expected, students experiencing negative achievement emotions reported a higher need for an ER training (rs =.14 to .28) Perceived control correlated significantly negatively with perceived need. Positive achievement emotions, perceived control, perceived intrinsic value, and GPA correlated significantly positively with the statement "I am already learning how to deal with such emotions from my teachers." GPA was negatively correlated with perceived need (r = -.15).
Significance. Altogether, these results suggest that there is a need for an achievement ER training from students' perspective. The findings document that particularly students who experience negative achievement emotions, low control, and who have low academic achievement perceive a higher need for such training. Additional findings of this study provide insight into students' reported preferences for different training formats (e.g., face-to-face vs. computer-based; individual vs. group training; topics to be covered; didactic methods). We are currently evaluating these findings and examining whether these preferences are connected to students' emotions and individual differences as well. The results of this needs assessment can deliver important scientific information for designing an effective intervention.

W-5. Analyzing preservice teachers' diagnostic argumentations to design and implement an adaptive feedback component

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Every fifth German school child is at risk to develop or has a mental health problem (Hölling et al., 2014). Consequently, teachers face students' mental health problems and related issues in their daily work. However, affected students are not always diagnosed yet making diagnostic reasoning about students' mental health problems a relevant aspect of teachers' everyday practice. Nevertheless, it is not necessarily a part of teachers' education. Therefore, we explore how to foster preservice teachers' diagnostic reasoning using simulation-based learning as well as different measures to support their learning. One such measure is feedback which is known to have a large positive effect on learning outcomes (Hattie, 2008) particularly when targeting the process level (Hattie & Timperley, 2007). However, giving such detailed feedback is very time-consuming for university instructors. This problem can be approached by using automatic text analyses and methods of artificial intelligence (AI): Preservice teachers' diagnostic reasoning processes can be automatically analyzed using free format questions that ask learners to argue for and against their diagnose; These can be automatically classified with AI text analysis methods, activating a predefined set of feedback components and generating an adaptive feedback response. The classification included the categories hypothesis generation, evidence generation, evidence evaluation and drawing conclusions which were stated to be four out of eight cross-domain epistemic activities occurring in scientific reasoning and argumentation (Fischer et al., 2014). These were already applied in previous studies to code think aloud protocols of preservice teachers reasoning on everyday classroom problems ($\kappa = 0.68$; Csanadi, Kollar, & Fischer, 2016) and social workers reasoning on client problems ($\kappa = 0.69$; Ghanem, Kollar, Fischer, Lawson, & Pankofer, 2018). The resulting text data was explored regarding the use of automatic text analysis methods as well (Csanadi, Daxenberger, et al., 2016) resulting in a prediction accuracy that can be considered as insufficient for generating adaptive feedback answers.
In our current attempt, 550 diagnostic argumentations formulated by 120 teachers which received training on diagnosing eight cases in the spectrum of behavioral and developmental disorders were manually coded by four coders. The intercoder reliability was calculated on 150 fourfold coded texts using Krippendorffs αU (Krippendorff, 1995) and resulted in an overall reliability of αU = .65 (ranging from hypothesis generation αU = .43 to evidence evaluation αU = .75).
Based on the data set of 550 argumentative texts first attempts of applying neural network architectures were made: An F1 harmonic mean of Precision and Recall interpretable as percent (Van Rijsbergen, 1979) was calculated over 10 iterations with the scikit-learn library (Pedregosa et al., 2011). The F1 values for the four categories were ranging from F1 = 57.97 (hypothesis generation) to F1 = 78.58 (evidence generation) indicating a high improvement of prediction accuracy compared to previous attempts of predicting epistemic activities attaining values of F1 = 34 to F1=39 (Csanadi, Daxenberger, et al., 2016). These analyses will be extended to a data set of 960 argumentative texts which will also serve as a basis for the development of the feedback components.

W-6. What misconceptions do preservice teachers hold about core educational topics? – Development and psychometric analysis of the Questionable Beliefs in Education Scales (QUEBEC)

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Having misconceptions or questionable beliefs about educational topics may hamper the reception and use of evidence-based content in teacher education (König, 2012; Reusser & Pauli, 2014). Therefore, it is crucial to identify potential misconceptions. Though there is abundant research on (preservice) teachers' beliefs, there is a lack of measures for diagnosing to which degree questionable beliefs about school-related educational topics prevail in beginning teachers. This study targeted a first psychometric evaluation of the Questionable Beliefs in Education Scales (QUEBEC).
The QUEBEC includes four subscales on exemplary educational topics on which students frequently have beliefs that conflict with research (i.e., class size effects, grade retention effects, effectiveness of direct instruction, and effects of the proportion of female staff in elementary and primary education). Each subscale consists of six to nine items referring to typical misconceptions (e.g., "The size of a class significantly influences the quality of teaching"; "Grade retention of low performing students contributes strongly to remedying their knowledge deficits"; "Direct instruction (i.e. a strongly teacher centered instructional method with high proportion of lecture and instructed exercise) mainly build up tacit knowledge that cannot be applied in everyday life"; "The above-average proportion of women among elementary and primary school teachers is a key reason for boys' worse average school performance"). The participants rated to which degree they believed the statements to be correct on a six-point Likert scale.
The sample comprised N = 217 students recruited from different disciplines for comparison (n = 90 teacher education, n = 41 psychology/pedagogy, n = 86 others). We conducted (a) traditional item analyses, (b) exploratory factor analysis (parallel analysis, principle axis factoring, oblimin rotation), and (c) reliability analysis (McDonalds Omega). (a) The item difficulties ranged from M = 1.86 (SD = 1.00) to M = 5.22 (SD = 1.03) and no items were excluded because of extreme values. Except for the proportion of females, all means fell into the upper half of the answer scale indicating that the participants on average endorsed the questionable beliefs. The items showed moderate to strong inter-item-correlations per subscale. (b) The EFA yielded a four-factor-solution conforming completely to the theoretical QUEBEC-subscales. All primary factor loadings were between .38 and .90 and no cross-loadings > .3 occurred. The extracted subscales showed significant medium correlations among the subscales class size, retention and direct instruction (other correlations close to zero). (c) Finally, we found good reliabilities for the subscales class size (Omega = .69), grade retention (Omega = .70) and proportion of women (Omega = .88), whereas the reliability of direct instruction (Omega = .63) requires improvement.
Overall, these preliminary results indicate that the QUEBEC provides a suitable instrument for measuring questionable beliefs about educational topics. Beyond research, the QUEBEC may be a useful tool in teacher education, educational, and psychological studies to screen and discuss the prevalence of typical misconceptions. This may break the ground for introducing research-based knowledge and for initiating conceptual change. Next steps in research include validation and investigating change in questionable beliefs across the course of studies.

W-7. Teaching assessment competence in social work with flexible computer supported scripts and metacognitive reflection prompts

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Computer supported scripts (CSS) are scaffolds (instructional interventions) which provide learners with external guidance regarding when, how and in what sequence to perform certain activities (Kollar, Fischer, & Hesse 2006). Researches from the Learning Sciences shows that instructional interventions (scaffolds) can be used to support learners acquire domain specific skills (Fischer, Kollar, Stegmann & Wecker, 2013). The aim of our study is to examine how computer support scripts can be used to enhance the use of evidence during assessment and we raise the following research questions:

- What is the effect of computer-supported scripts (strict/flexible strict) on student´s assessment competence?
- What is the effect of metacognitive reflection prompts (specific/generic) on student´s assessment competence?

We created a 2x2 quasi experiment, with the independent variables (1) computer-based script (strict vs. flexible) and (2) reflection prompts (specific vs. generic). In our pre-post-test design, students received four case vignettes to stimulate their engagement in child welfare assessment. We expect flexible scripts to increase assessment competence more than stable scripts. Specific prompts should increase assessment competence more than generic prompts. Combining flexible scripts with specific prompts is expected to yield the highest increases in assessment competence.

W-8. Effects of worked examples and external scripts on social work students' internal fallacy revelation scripts

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Fallacies are mistakes in reasoning (e.g. 'Manualized treatments are best because they provide detailed instructions which improve effectiveness' – the conclusion resembles the same as the premise). Identifying fallacies is an important aspect in social work decision making. However, social work students often have difficulties in revealing fallacies in reasoning about social work problems. This may be due to inappropriate internal fallacy revelation scripts (IFRS) that guide them in the identification of such fallacies. With an inappropriate IFRS, students might for example solely check if an argument has a logical internal consistency, whereas an appropriate IFRS would guide them in recognizing the individual components of an argument and verify these components against certain criteria for good argumentation (e.g. a premise´s sufficiency in terms of offering evidence to warrant a specific conclusion). 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 to happen. Based on the Script Theory of Guidance, students may be scaffolded in their development of 'ideal' IFRS by presenting them worked examples (WE) and external fallacy revelation scripts (EFRS) that guide them through the analysis of cases in which social workers produce fallacious diagnoses. Based on Damer (2009), an 'ideal' IFRS would guide students through the following sequence of ideal cognitive operations: identify conclusion, identify premise(s), check structure, check relevance, check acceptability, check sufficiency and check rebuttal. With reference to Damer, we developed an 'ideal' IFRS as well as corresponding WE and EFRS. Their effectiveness is likely to depend on the students' current IFRS. Thus, we try to answer two research questions: (1) What are the effects of WE and EFRS as well as their combination on students' development of IFRS? (2) To what extent are the effects of WE and EFRS on students' development of IFRS influenced by students' initial IFRS? We hypothesize that (1) learners in the WE condition will reveal more fallacies correctly than

learners in the control condition, (2) that learners in the EFRS condition will reveal more fallacies correctly than learners in the control condition and (3) that learners in the combined WE and EFRS condition will reveal more fallacies correctly than learners in the WE, ES and control condition. With regards to our second research question, we hypothesize that (4) that the effects of WE and EFRS on the development of students' IFRS are moderated by students' initial IFRS. Participants are 6th semester social work students (N = 130). We established a 2x2 factorial experimental pre-post design with the factors 'worked examples' (with vs. without) and 'external fallacy revelation scripts' (with vs. without). We will analyze students´ internal scripts before and after an intervention in which students of the experimental groups will receive step-by-step guidance based on our 'ideal' EFRS and/or worked examples for their analysis. The design will be supported by an additional baseline condition. Data collection was finished in June 2018, so we will be able to present our results at the REASON Winter School 2019.

W-9. Using argument mapping to model requirements of argumentative synthesizing tasks with unreliable information

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In educational assessment in higher education, the next generation of criterion-sampled Performance Assessments of Learning (PAL) aims to assess various 21st century skills, including critical thinking (e.g., Davey et al., 2015; Pellegrino, 2017). PAL tasks pose a realistic case-based scenario including a document library to be evaluated in terms of trustworthiness and relevance, information and arguments to be evaluated and synthesized, and a written recommendation for action to be made (with consequences), supported by arguments and information. While information is provided, arguments need to be constructed. Task characteristics are varied and controlled, including the number of sources to be evaluated, their distribution along the information quality parameters, and affordances for judgment heuristics. Student responses are scored by trained scorers along a tested rubric, with information-related, cognitive, and linguistic sub-dimensions, derived from the construct definition. The scenario is based on a newly developed PAL task, focusing on an energy investment decision within a rural community (on the construct, see Shavelson et al. 2018). PAL tasks are intended to be replicated and adapted internationally. However, their strengths of employing realistic specific scenario contexts easily turn into challenges when transferred to another cultural context or to other domains within the same cultural context. Parallel tasks with different comparable scenarios claiming to measure the same construct are a stated goal, but not easily attainable without error (e.g. Solano-Flores, Backhoff, & Contreras-Nino, 2009).
To minimize error due to imprecise modelling, facilitate construction of comparable tasks, and support claims of task validity (cf. Kane 2013), I employed argument mapping in assessment as a way of formalizing and making comparable the task requirements of the argumentative writing task. The use of argument maps in education, especially for formative purposes such as argumentation training has received growing attention in recent years (e.g., Davies 2012, van Gelder 2015), with studies almost uniformly highlighting its benefits. Argument maps have been applied for fostering student

reasoning also in business education (Kunsch, Schnarr & van Tyle 2014), the field in which the current PAL task originates. Moreover, early applications have recently also been tried for assessment in higher education (Rapanta & Walton 2016).
I present the current state of modeling the requirements of the specific critical thinking PAL task, using an argumentation framework inspired by Villata et al. (2011) and Mailly (2015), to describe required student reasoning on the argumentative synthesizing task using given sources with varying trustworthiness and relevance. Following a modeling recommendation by Wiese (2018) on the approximation of ideal reasoning, an expert mapping of the task by test developers was taken as ideal reasoning, while student responses from a small-sample pretest were matched to the predefined argument map.

W-10. Styles of scientific reasoning: An empirical study of how psychologists produce evidence

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Scientists investigate natural phenomena using multiple forms of reasoning (styles of scientific reasoning). These styles of scientific reasoning do not only differ in their objects of study but also in their procedural norms and epistemic values (Osborne, 2016).
Analysing the history of scientific thought, Crombie (1994) identified six different styles of scientific reasoning: Mathematical Deduction (representation of the world in mathematical forms to build deductive arguments); Experimental Evaluation (production of empirical evidence to test hypotheses); Hypothetical Modelling (construction of models to make predictions about natural phenomena); Categorization and Classification (identification of criteria to classify and organize the variety); Probabilistic Reasoning (use of statistics to investigate patterns in the population); and Historical-Based Evolutionary Reasoning (construction of abductive explanations of the origin of the world).
The present study investigates if Crombie's six styles of scientific reasoning are used in psychology, and it asks which style is the most dominant one.
To identify the different styles, we developed a coding scheme that contains 26 features. These features are derived from Crombie's work, and several features point to each of the different styles (e.g., the manipulation of independent variables is a feature that points to the style of Experimental Evaluation). Until now, we coded 170 articles that were published in the peer-reviewed, high-impact factor journal Psychological Science in the years 1998 and 2017.
The most common style of scientific reasoning reported in Psychological Science is Experimental Evaluation (40%), followed by Probabilistic Reasoning (20%) and Hypothetical Modelling (12%). We did not find Mathematical Deduction in Psychological Science, and the frequencies for Categorization and Classification (4%) and Historical-Based Evolutionary Reasoning (2 %) were low. In many publications (27%), more than one style was used to answer the same research question. A third of the articles (33%) could not be classified as pertaining to one of the six styles described by Crombie, either

because there were quality issues in the articles (e.g., an experiment did not control for extraneous variables, which was one of our mandatory features for the style Experimental Evaluation), or because several styles were combined in an incomplete way, or an exploratory approach was used.
In conclusion, the styles of scientific reasoning introduced by Crombie are a useful framework to describe reasoning in current academic psychology. Our results show that five of Crombie's six SSRs are reported in Psychological Science. While we did not find any publication that used the style Mathematical Deduction, this finding is not surprising considering the specific nature of this style (building deductive arguments on mathematical representations) and the generally more experimental nature of academic psychology (40% Experimental Evaluations). Although we identified Experimental Evaluation to be the dominant style of scientific reasoning in psychology, our findings show that diverse styles are used in psychology, which is a fact that should be considered in current methodological discussions (e.g., the use of pre-registration). A better understanding of different SSRs and their use may help to improve the communication of research findings to practitioners, as well as teaching research methods to future researchers.

W-11. Repeated k-fold cross-validation as a predictor of replicability: A meta-scientific approach to evaluating scientific evidence

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Background: In the wake of the recent *replicability* crisis, the extent to which scientific findings can be trusted is at the forefront of scientific debate. Specifically, given the findings of the *Reproducibility Project* (OSC, 2015) in which low rates of replication were observed among 100 replication studies (approx. 39% - 68%), authors not only invoked a call for higher-powered research designs, but also concluded that no single indicator was sufficient to describe replication success and that there is not only one way to evaluate 'reproducibility'. The *Reproducibility Project* findings not only speak importantly to the concepts of evidence-generation and evidence-evaluation at the meta-scientific level, but also to how we conceptualize, as a field, credibility and uncertainty of scientific evidence. Because reproducibility is considered *"a hallmark of credible scientific evidence"* (OSC, 2015, p. aac4716-7), gaining a deeper insight in how to conceptualize and quantify 'replication' and 'reproducibility' is central to advancing our understanding of individual effects and overarching psychological phenomena.
One interesting outcome of the *Reproducibility Project* was that strength of original evidence positively correlated with replication success. The current project aims to build indirectly upon this finding, appealing to cross-validation and resampling techniques as an attempt to empirically test the link between the concepts of model stability and effect replicability.

Methods: The current project will borrow from the *Social Sciences Replication Project* (SSRP; Camerer et al., 2018) database; a sample of high-powered replication studies comprising N=21 experimental studies within the social sciences, published in *Nature and Science*, between 2010 and 2015. While the initial *Reproducibility Project* (2015) failed to account for effect size inflation of the original studies when determining replication sample sizes, the 2018 replication studies were on average 5 times larger than the original N, reaching 90% a *priori* power. Borrowing from these large high-powered studies, we

will apply a repeated 10-fold cross-validation approach to reanalyze each of the given effects. Specifically, this will allow us to quantify an index of model stability (e.g., mean r-squared across the 10 test folds) that we will then correlate with replication success indicators (e.g., statistical significance criterion and/or relative effect size).

Results & implications: As the current project is still in its design phase, we cannot speak yet to the results, but only to its important implications. While the project may appear to reside in the realm of statistical theory, it also has strong practical merit. Namely, by capitalizing on potentially under-utilized statistical approaches, we hope to shed light on means of attaining more accurate inferences when it comes to the strength, stability, and/or replicability of an observed finding. Moreover, our work hopes to empirically test how resampling and cross-validation techniques can – *or cannot* – be reliably put into practice as a means of applied reasoning when it comes to the evaluation of evidence of effects within psychological research. In this way, it bridges theory and practice when it comes to statistical reasoning and evidence-evaluation.

W-12. Can science literacy help individuals identify misinformation in everyday life?

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Introduction
Individuals are exposed to misinformation on science-related issues in everyday life, including false claims about vaccine safety and about global warming. These are often transmitted through media. Since „science literacy“ (hereafter SL) was coined, science education scholars have been discussing what knowledge is needed to cope with everyday science-related issues (DeBoer, 2000).
This leads us to the following question: Can science literacy help individuals identify misinformation on science-related issues in everyday life? We use recent findings from public engagement with science to offer an answer. We rely on this field because it helps explain the intractability of such misinformation.

Major Conceptualizations of Science Literacy
Definitions of SL typically refer to science content knowledge and to scientific inquiry, from a scientist‘s perspective. This is true also for three major documents about SL published in recent years: The U.S. Framework for K-12 Science Education (National Research Council, 2012; hereafter the “NRC framework”), the PISA 2015 Science Framework (OECD, 2016), and the National Academies of Sciences, Engineering and Medicine‘s consensus report (2016). Of the three, only the last mentions „identifying and judging appropriate scientific expertise“ from a citizen‘s perspective, and dispositions such as open-mindedness, as aspects of SL.
Additionally, all three documents refer to identifying misinformation in the media, and the first two put an emphasis on vigilance towards misinformation, based on individual scientific knowledge. According to the NRC Framework, scientists and citizens must „make evaluative judgments about the validity of science-related media reports“ (National Research Council, 2012, pp. 71). According to the PISA 2015 Science Framework „students need to understand the importance of developing a skeptical attitude towards all media reports in science“ (OECD, 2016, p. 25).

Critique

We claim that motivated reasoning partly explains citizens' tendency to believe misinformation, and that the focus on individual competencies in SL Frameworks fails to account for this. Studies have repeatedly shown that individuals tend to reject valid scientific findings that threaten their own existing positions, identities or world-views, and accept misinformation that coheres with them (Lewandowsky & Oberauer, 2016). Moreover, education polarizes public opinion on certain controversial science-related issues. As education or science knowledge increase (on the horizontal axis), the opinion gap between opposing groups towards a science-related issue widens (on the vertical axis), creating a funnel shape. These findings recur across several controversies: Climate change, stem cell research, the Big Bang, and human evolution (Drummond & Fischhoff, 2017). Different explanations exist for this effect, including over-confidence increasing with education.

Hence, we propose that as a goal of science education, students should learn open-mindedness, including intellectual humility, intellectual courage and intellectual diligence (Taylor, 2016). In this sense, SL can help them identify misinformation in everyday life. After Porter (2016), we propose teaching open-mindedness by practicing intellectually virtuous behaviors and habituating virtuous dispositions in class. For example, students could compile evidence and advice on authentic issues of interest for the local community, e.g., on health and environmental issues. This would entail searching for information and assessing its credibility, while reflecting on intellectual virtues.

W-13. Please mind the knowledge gap: source evaluation and content evaluation of science-based arguments online

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Already Dewey (1916) has argued that education should prepare citizens to be reflective and capable of critical discourse rather than passive receptors of facts. Nonetheless, knowledge nowadays is highly distributed and specialised, and in light of our limited resources it is difficult for an individual to efficiently tackle complex problems across various domains (Bromme & Goldman, 2014). Moreover, high availability of information in open-ended environments such as the Internet does not automatically imply high comprehensibility of information (Bråten, Britt, Strømsø, & Rouet, 2017). In practice, people are therefore faced with two levels of judgments, firstly What is true? and secondly Who to trust? (Bromme, Kienhues, & Porsch, 2010). Very often more than basic domain specific content knowledge is needed for making advanced judgments of what is true, therefore people are usually more equipped to answer the second question. For makings sound judgments of epistemic trust, one has to take into account the body of evidence behind a certain claim (Nussbaum, Sinatra, & Poliquin, 2008), have an understanding of how knowledge is distributed in the society (Bromme & Goldman, 2014), and be able to critically reflect on the limits of own skills and knowledge (Barzilai & Chinn, 2017). With the present project, we aim to better understand the role of content evaluation and the role of source evaluation, when reading science based arguments online. We are also interested in how written reflections about the correctness of scientific arguments and credibility of the source influence the perception of own and experts' knowledge, trustworthiness of the source and argument evaluation. To answer these questions, an experimental study was designed, in which university students will read a science based argument presented in an online environment. Afterwards, participants will either write a reflection on the correctness of the argument or trustworthiness of the source, while one third will skip the reflection part. Furthermore, all participants will give ratings of the metacognitive perception of their own knowledge about the scientific issue as well as the perception of knowledge of experts in the field, evaluate the credibility of the scientific

argument, report on how much they trust the source´s abilities, integrity and benevolence (Hendriks, Kienhues, & Bromme, 2015), and report on their strategies for coping with the way knowledge is distributed in our society (Kienhues, Hendriks, & Bromme, in preparation). We predict that the type of the reflection will be linked to the perceived discrepancy between own knowledge and experts´ knowledge, as well as with the participants judgments of the trustworthiness of the source. Moreover, smaller discrepancy between perception of own knowledge and experts´ knowledge will be linked to higher reliance on own knowledge. In addition to quantitative analyses, participants´ written reflections will be analysed qualitatively to gain a deeper understanding of their evaluation processes. Our study will contribute to understanding of how reflective writing about the source or the content of science-based arguments is related to critical metacognitive evaluation of own and experts´ knowledge, a skill which is deemed necessary in our information-rich society.

W-14. Sequencing learning activities to promote active learning and comprehension in science education

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There is a lot of research and debate (e.g., Kirschner, Sweller, & Clark, 2006) regarding whether problem solving or direct instruction is better for teaching scientific concepts and reasoning. Instead of comparing the two approaches in a horse-race approach, my PhD project argues that research should rather focus on how to best combine them. The first study hence aims to investigate which sequence of learning activities fosters better scientific reasoning when learning with simulation experiments. It aims to contribute to the literature on scientific reasoning by grounding its research against the backdrop of three theoretically contradictory approaches, namely, productive failure (Kapur, 2008), example-based learning (Renkl, 2014), and discovery learning (Bruner, 1961).
The different ways to structure learning activities originate from two theoretical frameworks about learning. Cognitive load theory postulates that direct instruction (e.g., example-based learning) before a problem-solving task allows students to allocate their cognitive resources on creating a problem-solving schema, thus leading to better learning (Kant, Scheiter, & Oschatz, 2017; Mulder, Lazonder, & de Jong, 2014; Sweller, 2010). Contrarily, productive failure posits that starting with a problem-solving activity allows students to generate and explore multiple solutions and the consecutive instruction consolidates the correct solution, which will especially maximize long-term learning (Kapur, 2008, 2012). Lastly, discovery learning assumes that providing students with problem-solving tasks without direct instruction results in more intuitive knowledge (Swaak & de Jong, 1996); however, there is little evidence to support its benefit for teaching scientific reasoning unless guidance is provided (de Jong & van Joolingen, 1998; Lazonder & Harmsen, 2016). To conclude, the sequence of different learning activities can influence learning and depending on the theoretical framework, contradicting hypotheses about sequencing can be derived.
To compare the different sequences of learning activities, the present study will employ a between-subjects design with 3 conditions (sequence). In each sequence three learning activities (two problem-solving tasks and one direct instruction) will be presented in

different order. The problem-solving tasks comprise two virtual simulation experiments and the direct instruction consists of a video modeling example illustrating a model's learning and reasoning processes while using a simulation. Sequence 1 (productive failure) will start with a simulation, followed by multimedia instruction, and another simulation. Sequence 2 (example-based learning) will start with multimedia instruction, followed by two simulations. Lastly, Sequence 3 (discovery learning) will start with two simulations followed by multimedia instruction and will serve as a control condition. Process and outcome measures will be combined for a comprehensive assessment of the influence of sequencing on scientific reasoning.
Given the little evidence of the effects of discovery learning, we expect that participants with Sequence 3 will perform worse than participants in Sequences 1 and 2. If we adopt the theoretical framework of productive failure, we expect participants in Sequence 1 to perform better than participants in Sequence 2. Conversely, if we adhere to the theoretical framework of example-based learning, we expect participants in Sequence 2 to outperform participants in Sequence 1. Data will be available at the time of the REASON Winter School.

Social Events

Monday 18.02.2019

- **Dinner at „Wirtshaus Maxvorstadt“** starting at 18:00
  Augustenstraße 53, 80333 München

Tuesday 19.02.2019

- **Open Science Lunchtime Talk** 12:00 – 13:00
  Room 607 & Open area (6th floor)

Guided Tour at the “Alte Pinakothek” starting at 17:00
Barer Straße 27 (Entrance Theresienstraße), 80333 München

Wednesday 20.02.2019

- **Roundtable discussions for young researchers** 12:00 – 13:00
  Room 607 & Open area (6th floor)

  - Sibel Erduran, Women in Academia
  - Frank Fischer, Engaging in Interdisciplinary Research
  - Judith Harackiewicz, Career Opportunities at US Universities
  - Beate Sodian, Building a Research Program
  - Karsten Stegmann, Financial Opportunities in Research

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Additional information and helpful links:
https://osf.io/x3s5c/wiki/Open_Science_Infos/

© August 2017:
Mitja Back, Friederike Hendriks, Felix Schönbrodt and the Network for Open Science Initiatives (NOSI).
Send your questions, suggestions, comments to
felix@nicebread.de

Notes

Mon

Tue

Wed

Notes

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