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PER: Examining Content Understanding and Reasoning I

| **Type:** Con | **Organizer:** AAPT

Description:

Call for Papers:

Abstracts Submitted (# 9)

Abstract Title: An Observational Coding Scheme for Interactive Classroom Evaluations

Paper Type: Contributed

Author: Noel Klingler
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Speaker Order: AE05

Collaborative group-learning environments, including studio-based or SCALE-UP instruction, have grown in popularity and implementation at a wide variety of institutions. We are engaged in a multi-institutional project aimed at studying the factors that contribute to the success of student-centered pedagogical approaches in algebra-based physics courses. In this regard, the GW group is specifically focusing on documenting instructor actions and student activities taking place in the classroom; thus, we have been conducting systematic observations and analyses of various classroom environments. Our data, recorded as a chronological series of codes in the Teaching Dimensions Observational Protocol (TDOP), reflect the time sequence and pedagogical characteristics of classroom events. We have used a PER evidence-based approach to choose an efficient set of codes and have applied these codes during many observations at GW as well as at our partner institutions. We present here our final list of TDOP codes and inter-rater reliability results from our field-testing of this code set.

Conflicts: This talk should be scheduled adjacent to the one by Jarrad Pond (Univ. of Central Florida) and also adjacent to the one by Ozden Sengul (Georgia State Univ.). The order is not crucial, but these 3 talks should be put in sequence. Thank you.

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Abstract Title: Developing Students' Metacognitive Knowledge About Salient Problem Features*

Paper Type: Contributed

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Speaker Order: AE01

Student reasoning in physics is often context dependent. A possible explanation is that salient features in physics problems may cue automatic and subconscious (System 1) reasoning. Students often accept these first-available responses without question and do not reflect on their reasoning processes, even when such processes are unproductive and preclude the use of relevant conceptual understanding. Metacognition, the monitoring and regulation of one's thinking, around these salient features has the potential to address such difficulties. As part of a broader effort to identify methods for improving student learning in physics by explicitly supporting and enhancing student metacognition, we are currently investigating an instructional intervention focused on the development of students' metacognitive knowledge about salient features and cued System 1 reasoning. In this intervention, students are guided to synthesize contrasting cases involving sample student responses and descriptive vignettes highlighting the targeted metacognitive knowledge. Preliminary data and emerging findings will be presented.

Footnotes: *This work is supported in part by the National Science Foundation under Grant Nos. DUE-1245313, DUE-1245999, and DUE-0962805.

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Abstract Title: Development of Preservice Elementary Teachers' Science Self-efficacy Beliefs and its Relation to Science Conceptual Understanding

Paper Type: Contributed

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Speaker Order: AE09

Self-efficacy beliefs that play a major role in determining teachers' science teaching practices have been an important area of concern for pre-service science teacher education. This mixed-methods study investigated the changes in pre-service elementary teachers' science self-efficacy beliefs and its relationship with changes in science content understandings in a specialized physics content course. Participants included 51 pre-service elementary science teachers enrolled in two term of the course. Data collection included implementation of Science Teaching Efficacy Belief Instrument-B (STEBI-B) and Physical Science Concept Test as pre- and post-test as well as semi-structured interviews, observations and artifacts. A pre-post, repeated measures multivariate analysis of variance (MANOVA) design was used to test the significance of differences between the pre- and post-surveys across time. Results indicated statistically significant gains in participants' self-efficacy beliefs, personal science teaching beliefs, and outcome expectancy beliefs. Additionally, a positive moderate relationship between science conceptual understandings and personal science teaching efficacy beliefs was found. Findings from qualitative analysis suggest that despite of the nature of prior science experiences pre-service teachers previously had, exposure to a specialized content course that integrates relevant content along with modeled instructional strategies can positively impact self-efficacy beliefs. One implication from this study is that instructors teaching elementary physics content courses could shape science experiences within these courses to potentially support pre-service science teachers' self-efficacy beliefs and confidence to teach in future.

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Abstract Title: Expert and Novice Judgments of Problem Difficulty from Previously Administered Exams

Paper Type: Contributed

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Speaker Order: AE07

The ability to judge the difficulty of physics problems has implications for both exam preparation and performance. Previous research has shown that students spend more time studying problems they judge as more difficult, but this strategy is effective only when these judgments match the normative difficulty of the questions. Little is known about how accurate instructors and students are at judging problem difficulty. We present data from two experiments where physics experts and introductory physics students predict which question of a pair taken from real exams is more difficult for the "typical student." In the first experiment we analyze whether the

rationales given by physics experts are predictive of accurate judgments. In the second experiment we compare the accuracy of experts and novices in their judgments. We discuss the educational implications of our findings.

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Abstract Title: Exploring Student Learning Profiles in Algebra-based Studio Physics*

Paper Type: Contributed

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Speaker Order: AE06

As part of a project to explore successful strategies for using studio methods, such as SCALE-UP, we explore self-regulatory abilities and learning approaches of students in said courses at three universities with varying student populations and differing success in studio-mode courses. We survey students using compiled questions from several existing surveys designed to measure student characteristics such as attitudes toward and motivations for learning, organization of scientific knowledge, experiences outside the classroom, and demographics. Here, we utilize clustering methods to group students into learning profiles to better understand the study strategies and motives of algebra-based studio physics students. We present results from first-semester and second-semester studio-mode introductory physics courses across three universities, totaling 11 classrooms with 10 different instructors. We identify several distinct learning profiles and evaluate demographic and concept inventory performance differences between them.

Footnotes: *This work is supported in part by the U.S. National Science Foundation under grant DUE-1246024 and grant DUE-1347515.

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Abstract Title: How Physics Tutorials Facilitate Students’ use of Argumentation in Small-group Discussion

Paper Type: Contributed

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Speaker Order: AE04

Physics Education Research focuses on increasing student engagement and conceptual understanding, prompting different research groups to develop and use new teaching methods and materials in place of traditional ones. It is important for us to understand the basic features that present in course materials and their impacts on students’ learning. As part of a project to identify successful teaching strategies in studio physics, we are exploring how physics tutorials help students taking algebra-based introductory physics develop conceptual understanding using argumentation in small-group discussion. In order to identify basic features of tutorials, we conducted a literature review and did content analysis of physics tutorials; then, we videotaped groups of students working through physics tutorials. We analyzed the transcriptions of the students’ discussions and compared them to pre- and post-test results to understand how basic features facilitate students’ use of argumentation and development of conceptual understanding

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Abstract Title: Investigation of Student Reasoning in the Context of Scaffolded Instruction*

Paper Type: Contributed

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Speaker Order: AE02

Student-centered instruction can lead to strong gains in physics learning. However, even after targeted instruction, many students still struggle to analyze unfamiliar situations systematically. As a part of an ongoing investigation of student reasoning in the context of carefully designed, research-based scaffolded instruction, sequences of questions have been developed that allow for probing the relationships among conceptual understanding, reasoning, and intuition. Results from sequences of questions administered in the introductory calculus-based mechanics course will be presented. The dual process theory of reasoning will be applied to

interpret the results. Implications for research and instruction will be discussed.

Footnotes: *This work is supported in part by the National Science Foundation under Grant Nos. DUE-1245999, DUE-1245993, DUE-1245313 and DUE-1245699.

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Abstract Title: Physics Experts' Use of Contrasting Cases When Solving Novel Problems

Paper Type: Contributed

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Speaker Order: AE03

Instruction that makes use of contrasting cases has been extremely successful. Furthermore, contrasting cases appear to be at the center of expert problem-solving strategies. Previously we have shown that physics experts make use of contrasting cases more frequently than any other epistemological or reasoning process resource. Gaining a deeper understanding of the function of these contrasting cases can help physics educators better incorporate contrasting cases into instruction. In this talk, we analyze the function of contrasting cases as a part of the problem- solving process of a group of physics experts as they solve a novel, challenging physics problem. We show how the ideas of variation theory can help us better understand the function of these contrasting cases and discuss how the knowledge gained through this analysis can inform the development of effective instruction.

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Abstract Title: Physics Learning Facilitates Enhanced Resting-State Brain Connectivity in Problem-Solving Network

Paper Type: Contributed

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Speaker Order: AE08

Modeling how students think about physics is often measured via observation of students solving physics problems [1]. Functional magnetic resonance imaging (fMRI) may inform how these processes occur, but currently no neuroimaging studies have examined how students develop physics problem-solving skills. To provide insight into the neural nature of physics learning we examined resting-state functional connectivity (rsFC) in brain regions associated with problem-solving. Meta-analysis identified the left inferior frontal gyrus (IFG) as the region most consistently implicated across problem-solving tasks. Resting-state fMRI data were acquired pre/post instruction in eight undergraduate, first-time enrollees in introductory physics. Correspondence between post-instruction rsFC and meta-analytic results suggests a semester of university physics may facilitate enhanced recruitment of posterior brain regions involved in reasoning. Increased IFG-correlated activity from pre to post instruction indicates intrinsic brain connectivity may be modulated as a result of educational experience.

Footnotes: [1]Reif et al, Educ Psych 17 (1982).

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