A Family of Instruments to Measure Data Science Attitudes

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ABSTRACT

Attitudes play an important role in students' academic achievement and retention, yet quality tools to measure them are not readily available in the new field of data science. Through funding from the National Science Foundation, we are developing a family of instruments that measure attitudes toward data science in the context of an introductory, college-level course. This poster will showcase preliminary results discussing pilot instruments to assess instructors' attitudes toward teaching data science and an inventory which captures classroom characteristics. These instruments, based on Expectancy-Value Theory, will enable data science education researchers to evaluate pedagogical innovations and measure instructional effectiveness relating to student attitudes. We invite instructors of data science courses to join in this discussion and to use these instruments for their own data science education research projects.

CCS CONCEPTS

• Human-centered computing - Visualization • Information systems - Data structures • Information systems - Information integration • Mathematics of computing - Statistical paradigms • Computing methodologies - Modeling and simulation • Computing methodologies - Machine learning

KEYWORDS

Data Science, Attitudes, Instrument Design

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1 ATTITUDES MATTER

As a new field, there is a clear lack of research about student attitudes in data science. Educators are therefore constrained to assuming the relevance of disciplinary based education research from fields which are closely related to data science, namely computer science and statistics, or from the literature on attitudes toward STEM in general. Across STEM programs, student attitudes are linked with student achievement and future career choices (e.g., [9]). In computer science, Gurer, Cetin, and Top [5] found that attitudes toward computer programming are associated with achievement in and perceived learning of computer science. Robinson, Pérez-Quiñones, and Scales [8] found that African American school-aged girls tend to have low attitudes toward computer science, but that appropriate interventions can improve these attitudes. In statistics, Evans [4] and Budé et al. [1], found a significant correlation between negative attitudes and poor achievement in undergraduate introductory statistics courses. The report Connecting Research to Practice in a Culture of Assessment for Introductory College-level Statistics [7], which was approved by the American Statistical Association, states the importance of understanding attitudes and identifies outcomes that can be realized when students' attitudes are adequately measured. Specifically, 1) how attitudes contribute to success in learning, in either the short or long term; (2) how attitudes contribute to long term engagement; and (3) what are the important attitude constructs to measure about instructors, and how do these influence teaching practices and ultimately student outcomes.

2 EXPECTANCY-VALUE THEORY

The theoretical framework guiding the development of the student and instructor instruments Expectancy-Value Theory (EVT) [2, 3], a psychological theory of motivation that has been thoroughly researched and widely adopted by researchers in many disciplines since it was first proposed nearly 40 years ago [3, 10, 11]. In EVT, one's achievement-related choices and performance are affected by how much one values the task (Subjective Task Values [STVs]) and what one expects to happen (Expectancy) - all other psychological components of the model are mediated by one's STVs and/or Expectancy [10]. EVT was chosen as the framework for these instruments because STVs and Expectancy have been shown to predict choices and performance on tasks and have been used extensively with undergraduate students [11].

3 FAMILY OF DATA SCIENCE INSTRUMENTS

In response to the need for validated, reliable instruments assessing student attitudes toward data science, the authors were awarded a grant under the National Science Foundation's Improving Undergraduate STEM Education program (DUE-2103392). The goal of the grant is to develop six instruments assessing student and instructor attitudes toward data science and statistics, as well as inventories of the learning environment. We refer to this research as Motivational Attitudes towards Statistics and Data science Education Research (MASDER).

Two workshops were hosted that brought together faculty from fields including computer science, statistics, education, and political science who taught introductory data science as well as data scientists from industry who work with undergraduate students. We met for a total of four days to discuss what data science is (and is not), identify content in an introductory data science class, and write specific items for the student data science survey (Student Survey of Motivational Attitudes toward Data Science (S-SOMADS)); the first pilot had 87 items measuring eight constructs.

Instructor attitudes affect teaching and the propensity to pursue and engage in professional development, as well having a direct effect on the attitudes of their students [6]. Our instructor survey instrument (Instructor Survey of Motivational Attitudes toward Data Science (I-SOMADS)), with 80 items and 10 constructs, is designed to be used with the student instrument to answer broader questions about the relationship between instructor attitudes and student attitudes and achievement.

To complement the measurement of student and instructor attitudes toward data science, we are also developing a learning environment inventory. The Environment Survey of Motivational Attitudes toward Data Science (E-SOMADS) inventory will measure course characteristics, the learning environment, and enacted classroom behaviors. For example, in what type of institution was this course taught? Did the instructor use peer evaluation for in-class coding activities? This will serve as a valuable tool to be used by itself. When used in conjunction with the other instruments, it will identify differences in student attitudes related to these characteristics as well as enable comparisons and research across contexts.

4 PRELIMINARY RESULTS

Preliminary results from the first pilot (n=402 students) of the S-SOMADS instrument will be discussed and items from the first I- and E-SOMADS pilot instruments will be presented.

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REFERENCES

[1] Budé, L. et al. 2007. Students' achievements in a statistics course in relation to motivational aspects and study behaviour. *Statistics Education Research Journal*. 6, 1 (2007), 5–21.

[2] Eccles[Parsons], J.S. et al. 1983. Expectations, values, and academic behaviours. *Achievement and achievement motives: Psychological and sociological approaches*. 76–146.

[3] Eccles, J.S. and Wigfield, A. 2020. From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology*. 61, (2020). DOI: https://doi.org/10.1016/j.cedpsych.2020.101859.

[4] Evans, B.R. 2005. *STUDENT ATTITUDES, CONCEPTIONS, AND ACHIEVEMENT IN INTRODUCTORY UNDERGRADUATE COLLEGE STATISTICS*. Temple University.

[5] Gurer, M.D. et al. 2019. Factors affecting students' attitudes toward computer programming. *Informatics in Education*. 18, 2 (2019), 281–296. DOI: https://doi.org/10.15388/infedu.2019.13.

[6] Martins, J.A. et al. 2012. Looking back over their shoulders: a qualitative analysis of portuguese teachers' attitudes towards statistics. *Statistics Education Research Journal*. 11, 2 (2012), 26–44.

[7] Pearl, D.K. et al. 2012. Connecting research to practice in a culture of assessment for introductory college-level statistics.

[8] Robinson, A. et al. 2016. African-American Middle School Girls: Influences on Attitudes toward Computer Science. *Computing in Science & Engineering*. 18, 3 (2016), 14–23. DOI: https://doi.org/10.1109/MCSE.2016.43.

[9] Schunk, D.H. 1991. Self-efficacy and academic motivation. *Educational Psychologist*. 26, 3–4 (1991), 207–231. DOI: https://doi.org/10.1080/00461520.1991.9653133.

[10] Wigfield, A. and Eccles, J. 2000. Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*. 25, 1 (2000), 68–81. DOI: https://doi.org/10.1006/ceps.1999.1015.

[11] Wigfield, A. and Eccles, J.S. 2019. 35 years of research on students' subjective task values and motivation: A look back and a look forward.