A FRAMEWORK AND SURVEY FOR MEASURING INSTRUCTORS' MOTIVATIONAL ATTITUDES TOWARD STATISTICS

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Recently, teachers of statistics have become the subject of increased research in statistics education. However, few instruments have been developed specifically for use with this population, and those instruments focus only on individual constructs, e.g. self-efficacy (Harrell-Williams et al., 2015). As part of the Survey of Motivational Attitudes toward Statistics (SOMAS) project, surveys to measure instructors' attitudes and classroom characteristics are being developed in addition to surveys for students. The survey for measuring instructor attitudes will be based on Expectancy-Value Theory (EVT) (Eccles, et al., 1983), which parallels the framework used on the student survey. This paper describes the EVT model for instructors' motivational attitudes, the constructs to be assessed by the instructor SOMAS instrument, and future directions for the project.

INTRODUCTION AND BACKGROUND

Instructor attitudes toward teaching statistics and instructor practices in the statistics classroom are two important areas that affect student attitudes toward statistics. Previous research has typically focused on students' attitudes, preparedness, etc. Though there are a few attempts to measure instructor characteristics, the instruments used are often adapted from a student survey. Several studies have used the SATS instruments with pre-service teachers (e.g. Estrada et al., 2005; Hannigan et al., 2013) and in-service teachers (Whitaker, 2016). Others have developed separate instruments for instructors, such as the Statistics Teaching Inventory (STI) (Zieffler et al., 2012). The STI was developed to measure teachers' practices and their beliefs about teaching and students learning statistics. The STI measured teaching and assessment in four parts (*Teaching Practice, Assessment Practice, Teaching Beliefs,* and *Assessment Beliefs)* and collected information on course and teacher characteristics (*Course Characteristics* and *Additional Information)*. The STI has not been linked to students' attitudes or outcomes, nor has the structure of the STI been studied. Validity evidence supporting interpretations of results from teacher populations is limited. Further, how student attitudes relate to both instructor attitudes *and* the structure of an undergraduate statistics course has been studied even less. In this paper, we will briefly introduce our meta-model for the Survey of Motivational Attitudes toward Statistics (SOMAS) which describes the hypothesized relationships among the three groups – student, instructor and classroom – and explain the instructor model (I-SOMAS) in detail.

According to the Expectancy-Value Theory (EVT), developed by J. Eccles, the choice of task, performance on the task and persistence on the task are affected by two factors: expectancies for success and subjective task values. Expectancies refer to the confidence an individual has in his or her ability to succeed in a task, whereas subjective task values refer to how important, useful, or enjoyable the individual finds the task to be. In the EVT model, all other factors such as demographic characteristics, beliefs and stereotypes, prior experiences, and perceptions of others' beliefs and behaviors indirectly affect achievement through the factors of expectancies and values. The EVT model has been applied and used most widely in education research and focuses on what psychologists call motivation. However, in statistics education, researchers have used the term attitudes when studying student motivation. Due to the interdisciplinary nature of our research, we are using the term "motivational attitudes."

META-MODEL

Figure 1 shows our theoretical framework for the meta-model for the SOMAS project. The meta-model draws on a framework developed by the Organization for Economic Co-operation and Development (OECD) for their Teaching and Learning International Survey (TALIS) (OECD, 2009). The meta-model provides an overview of the mediators of student motivation and achievement in the statistics classroom. The meta-model identifies the relationships between

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instructor, course and institutional factors as well as student background and how these impact student motivation and achievement.

The students' backgrounds, goals, values and the like are key factors in determining students' attitudes and achievements. We explain these factors in the model for students and plan to measure this with the SOMAS student instrument (S-SOMAS) (Whitaker et al., 2018). This model is based on the EVT model and was developed by our research team after a close reading of the literature.

Institutional characteristics are posited to influence specific aspects of the course and classroom as well as to affect instructors' motivations and pedagogies. The learning environment, specific course characteristics and those of the institution are also believed to directly affect students' attitudes and achievements. This part of the meta-model is still being developed and will be measured with the SOMAS classroom instrument (C-SOMAS).

We also hypothesize that instructor motivation and behavior affect student motivation and achievement. Instructors' motivations and backgrounds affect their professional activities and related pedagogical decisions. These pedagogical decisions and the specifics of the course and classroom are hypothesized to have a direct effect on student motivation and, in turn, on student achievement. The instructor model is the focus of this paper and will be measured with the SOMAS instructor instrument (I-SOMAS).

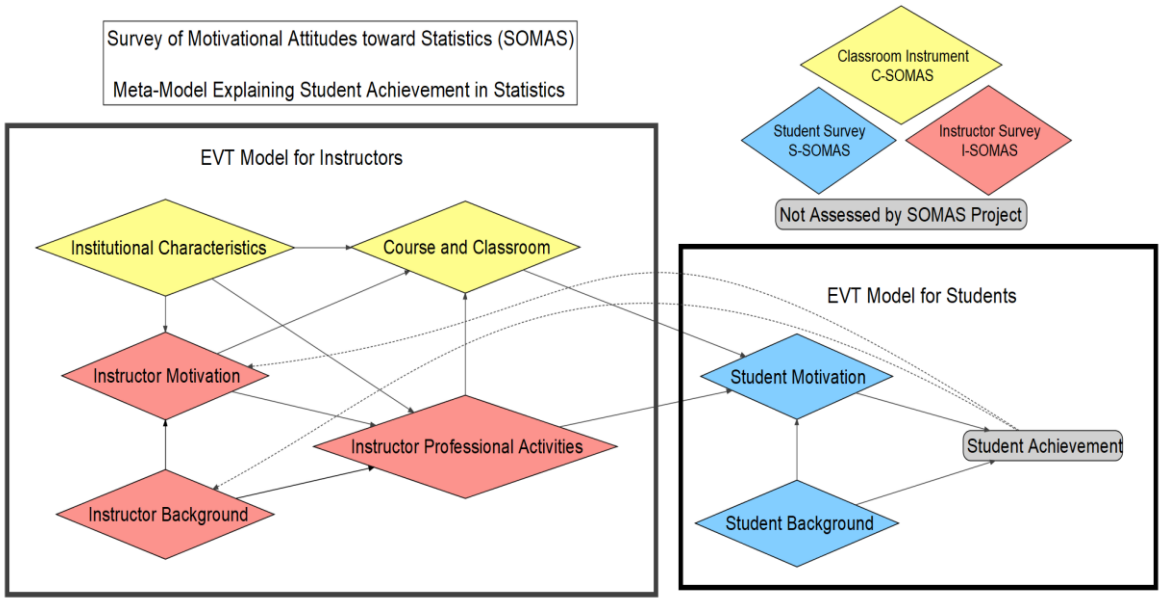

Figure 1. Meta-Model for SOMAS

INSTRUCTOR MODEL

Like the student model, the model for instructors (Figure 2) is based on the EVT model. The constructs measured by the instructor instrument were determined by a process similar to selecting the student instrument (S-SOMAS) constructs. Some instructor model constructs were determined to be too difficult to measure (e.g. Perception of Others' Attitudes and Expectations) while others were determined to be outside the scope of an attitude survey (e.g. Interpretation of Past Events). The I-SOMAS instrument will not measure the Expectancies or Aptitude for Teaching Statistics because other instruments already address these mediators, namely the Self-Efficacy for Teaching Statistics (SETS) instruments (Harrell-Williams et al., 2015) and the Statistics Teaching Inventory (STI) (Zieffler et al., 2012), respectively. We anticipate using SETS and STI instruments to complement the I-SOMAS instrument.

Selected constructs measured by the I-SOMAS instrument are defined below (from left to right on the diagram).

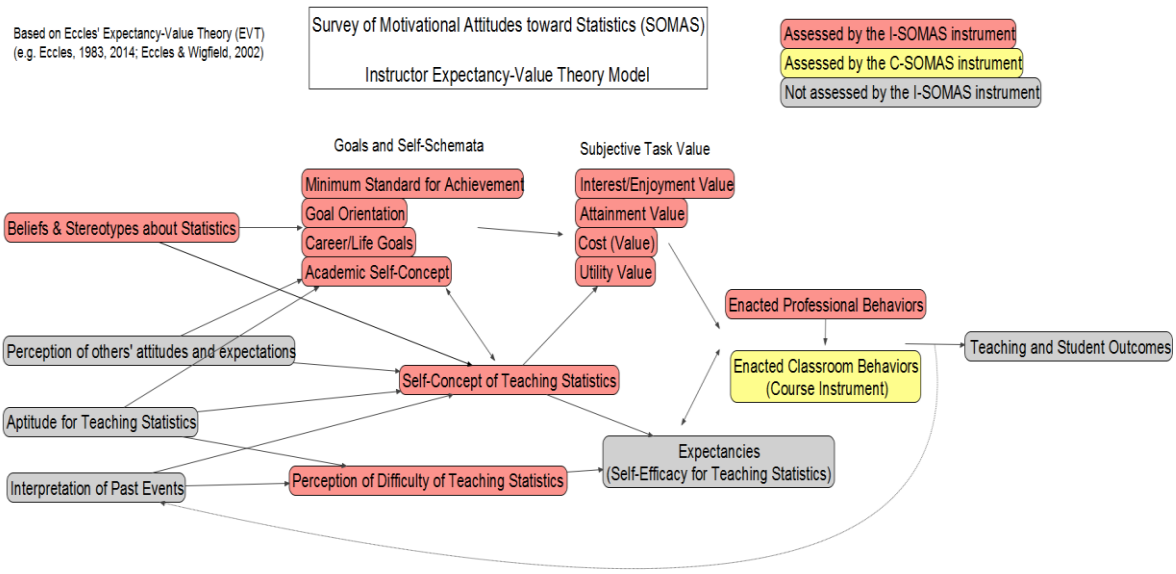

Figure 2. The Expectancy-Value Theory model as enacted in the I-SOMAS

Beliefs & Stereotypes about Statistics and Teaching Statistics

This construct is similar to constructs assessed by many extant surveys for attitudes about statistics and the teaching thereof. Beliefs & Stereotypes refer to the instructor's relationship with the discipline of statistics and his/her beliefs and stereotypes about teaching statistics. We conceptualize beliefs and stereotypes broadly for the purposes of this construct and implicitly include other closely related constructs, such as emotions and attitudes, while recognizing that these are not synonymous with beliefs (Philipp, 2007). Notably, how an instructor values statistics is not included as part of this construct, despite value being conceptualized as a type of belief (Philipp, 2007). Rather, there are separate constructs related to value included in an over-arching Subjective Task Value construct described below.

Subjective Task Value

Subjective Task Value consists of four individual components: Interest/Enjoyment Value, Utility Value, Attainment Value and Cost (Eccles, 1983). The subjective value of a given task for an individual is based on their perceptions of the characteristics of the task and how that task will help them meet their needs, goals and ideals. These benefits are then compared to the costs associated with the task to determine if the task should be attempted. If the perceived benefits outweigh the perceived costs, the individual should attempt the task.

An individual's interest in and enjoyment derived from performing a task are combined into a single Interest/Enjoyment Value construct in EVT (Eccles, 1983). For instructors, we will be attempting to ascertain their pleasure related to the teaching of statistics. This construct measures a type of intrinsic value that is considered immediate and related specifically to the act of performing the task.

Utility Value is determined by how well a task relates to current and future aspirations, such as social or career goals. Unlike interest/enjoyment value, utility value is extrinsically-focused and forward-thinking, focusing on the outcomes that can be achieved because one completes the task. A task can have a high utility value for an individual because it facilitates important future goals, even if he or she is not interested in the task for its own sake (Eccles & Wigfield, 2002). Utility Value captures the importance of teaching statistics for the instructor to reach their personal and professional goals. The I-SOMAS instrument will ask instructors to identify their goals and how important they perceive the teaching of statistics to be in reaching those goals.

Attainment Value is the individual significance placed on succeeding at the task (Eccles, 1983; Eccles & Wigfield, 2002). The importance of success on the task includes the effect that engaging in the task has on defining or confirming elements of the individual's identity (Wigfield & Cambria, 2010). Doing well on a task that an individual perceives as being central to his/her identity necessarily has a higher attainment value. We will attempt to measure the individual

importance of being a successful statistics teacher and how closely tied to one's identity this is. It is also important to understand how the instructor defines success in the classroom.

Finally, Cost refers to the negative aspects of engaging in the task. Cost includes performance anxiety, the fear of both failure and success, the amount of effort needed to succeed and the value of lost opportunities that result from making one choice rather than another (Eccles & Wigfield, 2002). To capture this information, we will attempt to gauge instructor anxiety for the teaching of statistics and how instructors perceive the costs of the success and failure of their teaching. We will also make an effort to measure the perceived effort instructors put into teaching and the value of the lost opportunities for these instructors to get a better understanding of their individual cost-benefit analyses.

Self-Concept of Teaching Statistics

Self-concept of ability is defined as the assessment of one's own competency to perform specific tasks or to carry out role-appropriate behaviors (Eccles, 1983). In the context of the I-SOMAS, the self-concept of ability is seen as the Self-Concept of Teaching Statistics. This refers to instructors' perceptions of who they are as teachers of statistics, their views on their competence with the subject matter and their perceived ability to communicate this information. We believe that the perception of others' attitudes and expectancies, their own aptitude for teaching statistics and interpretation of past events directly affect this construct.

Perception of Difficulty

The perceived level of difficulty influences attitudes (Estrada, 2005). The perception of the difficulty of teaching statistics may directly affect expectancies (self-efficacy) for teaching statistics. If teachers view statistics as difficult to teach, their negative perceptions might influence their inclination to use or teach statistics in the future, or indeed might transfer this perception to their students (Fitzmaurice et al., 2014). This could, in turn, affect the students' attitudes and achievements.

Enacted Professional Behaviors

Enacted Professional Behaviors include instructor behaviors that span across all of their courses and will be measured by the I-SOMAS instrument. These behaviors include teaching pedagogy, the psychology of learning, relationship building and the like. There is a significant body of literature in the scholarship of teaching and learning that provides strong evidence that these enacted behaviors impact student attitude and achievement.

CONCLUSION

The Survey of Motivational Attitudes toward Statistics (SOMAS) is a family of instruments (S-SOMAS, I-SOMAS and C-SOMAS) designed to assess attitudes toward statistics. The SOMAS project has developed the Meta-Model in Figure 1 based on EVT to investigate the connections between students' backgrounds, motivation and achievement as well as instructors' backgrounds, motivation and professional activities. Characteristics of the specific course, classroom and the institution are also measured. Instruments to test the hypotheses in this model are being developed and validity tested by the SOMAS team. The model may be revised based on empirical results from the instruments we create. As of the spring 2018, SOMAS Focus Groups have been formed at Monmouth College under the supervision of Wendine Bolon and Marjorie E. Bond. The input from the Focus Groups may also be used to revise our models. The team hopes to develop a first draft of I-SOMAS instrument by the spring of 2019 and initial data collection will begin the following year. Analysis of the pilot data will be used to revise the instrument.

REFERENCES

Eccles, J. S., and Wigfield, A. (2002). Motivational Beliefs, Values, and Goals. *Annual Review of Psychology, 53*, 109-132.

Eccles, J., Addler, T., Futterman, R., Groff, S., Kaczala, C., Meece, J., & Mindgley, C. (1983). Expectancies, Values, and Academic Behaviors. In J. Spence (Ed.), *Achievement and*

Achievement Motives: Psychological and Sociological Approaches (pp. 76-146). San Fransisco: W.H. Freeman and Company.

Estrada, A., Batanero, C., Fortuny, J. M., & Diaz, C. (2005). A Structural Study of Future Teachers' Attitudes. *Proceedings of the 4th Conference of the European Society for Research.*

Fitzmaurice, O., Leavy, A., & Hannigan, A. (2014, December). Why Is Statistics Perceived as Difficult and Can Practice during Training Change Perceptions? Insights from a Prospective Mathematics Teacher. *Teaching Mathematics and Its Applications, 33*, pp. 230-248.

Hannigan, A., Gill, O., & Leavy, A. (2013, Dec). An Investigation of Prospective Secondary Mathematics Teachers' Conceptual Knowledge of and Attitudes Towards Statistics. *Journal of Mathematics Teacher Education, 16*(6), 427-449.

Harrell-Williams, L., Sorto, M., Pierce, R., Lesser, L., & Murphy, T. (2015). Identifying statistical concepts associated with high and low levels of self-efficacy to teach statistics to middle grades. *Journal of Statistics Education, 23*(1), 1 – 20.

Organisation for Economic Co-operation and Development. (2009). *Creating Effective Teaching and Learning Environments: First Results from Talis.* France: OECD Publications.

Philipp, R. (2007). Mathematics Teachers' Beliefs and Affect. In F. Lester, Jr. (Ed.), *Second Handbook of Research on Mathematics Teaching and Learning* (pp. 257-315). Charlotte, N.C.: Infomation Age.

Schau, C. (2003). *Survey of Attitudes Toward Statistics (SATS-36).* Retrieved from http://evaluationandstatistics.com/

Whitaker, D. (2016). The Developoment of a Professional Statistics Teaching Identity. In M. Wood, E. Turner, M. Civil, & J. Eli (Ed.), *Proceedings of the 38th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 992-999). Tuscon: The University of Arizona.

Whitaker, D., Unfried, A., & Batakci, L. (2018). A Framework and Survey for Measuring Students' Motivational Attitudes toward Statistics. *ICOTS 10th International Conference on Teaching Statistics.*

Wigfield, A., & Cambria, J. (2010). Expectancy-Value Theory: Retrospective and Prospective. In S. Karabenick, & T. Urdan (Eds.), *The Decade Ahead: Theoretical Perspectives on Motivation and Achievement (Advances in Motivation and Achievement)* (Vol. 16A, pp. 35-70). Emerald Group Publishing Limited.

Zieffler, A., Park, J., Garfield, J., & Bjornsdottir, A. (2012). The Statistics Teaching Inventory: A Survey on Statistics Teachers' Classroom Practices and Beliefs. *Journal of Statistics Education, 20*(1), 1–29.