

Appendix

CEHD Grant Application Form

Submit this application form by one of the following due dates along with your proposal. Applications must be received, at tate-center@wmich.edu, by 5:00 p.m. on August 15, November 15, March 15, and June 15.

Application					
Applicant Name:	Ya Zhang				
Title:	Assistant Professor				
Department:	Educational Leadership, Research and Technology				
Title of Proposal:	Understanding the subtypes of student learning motivation in STEM subjects				
Amount Requested:	\$2000				
Dates of Project:	April 15 - September 15, 2018				
Evaluation Guidelines					
Strongly Agree 5	Agree 4	Undecided 3	Disagree 2	Strongly Disagree 1	
The proposed research/creative activity is well conceived and organized.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5	4	3	2	1
The proposed work will increase the likelihood that the applicant will secure external funding in the future.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5	4	3	2	1
The methods and/or procedures are clearly stated and appropriate for the proposed activity.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5	4	3	2	1
The plans for data analysis or evaluation critique are clearly stated and appropriate for the proposed activity.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5	4	3	2	1
The costs for the proposed budget are clearly itemized and justified.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5	4	3	2	1
This project has the potential to advance the scholarly/creative reputation of WMU.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	5	4	3	2	1

Title:

Understanding the Subtypes of Student Learning Motivation in STEM Subjects

Objectives:

Previous studies showed that student learning motivation and career aspiration in science, technology, engineering, and mathematics (STEM) depend on a variety of factors, including students' own beliefs and expectations in their academic achievement, student engagement in STEM learning activities, the academic and social support from families and educators, as well as student peer relationship (Blumenfeld & Meece, 1998; Wang & Degol; Wang, 2013). The focus of the proposed project is to reveal the structure of student motivation in STEM learning. Specifically, the proposed project aims to:

1. Identify the key factors that predict student aspiration in a STEM career.
2. Differentiate student motivation in STEM learning in terms of the identified key factors.
3. Investigate individual differences in student motivation in STEM learning.

Background:

Despite the United States' significant investment in STEM education, the size and the composition of the STEM workforce continues to fail to meet the demand. For example, there were approximately 7.4 million STEM positions in the U.S., and this number is expected to grow to 8.65 million by 2018 (My College Options & STEM connector, 2012). The STEM employers throughout the U.S. report shortages of skilled workers, raising concerns about the quality of the U.S. educational system and its ability to produce a large enough workforce to fill these positions.

Theoretical models have been used to explain adolescents' educational and career choices in STEM fields (Eccles, 2009; Wang, 2012). These models link student motivational beliefs to their experiences in school, peer, and family contexts, student perceptions on their abilities, and values attached to STEM subjects. Given the great impact of these factors on student decision of pursuing a STEM career or not, it becomes an important task to differentiate students in terms of these key influential factors in order to develop a thorough understanding of their learning motivation in STEM subjects.

Research that focused on identifying the subtypes of STEM learning motivation is limited, and there has been debate regarding the selection of reliable classifying methods. Many statistical models have been proposed as a way of classifying students into groups, however, there is a lack of clear evidence regarding what classifying method is superior in generating groups that are informative and easily interpretable. Identifying the subtypes of student learning motivation in STEM subjects remains to be an unresolved problem.

Method and Plan of Work:

Three statistical procedures are employed to tackle the three main tasks identified in the "Objectives" section of this work, including regression analysis, clustering data mining, and multiple group analysis.

1. Regression Analysis

The purpose of regression analysis is to select a subset of variables that predict student STEM learning motivation the best. Specifically, student aspiration for STEM learning is used as the outcome variable and motivation relevant factors are used as predictors, such as math/science grade, school engagement, teacher support, beliefs in STEM learning, etc. Among these predictors, a subset of predictors that contribute to the prediction of student STEM learning motivation the most are retained as the “core factors”.

2. Clustering Data Mining

Clustering data mining is a family of statistical procedures that are frequently used to identify group membership based on factors specified by the researcher. Specifically, three different clustering data mining procedures are compared to identify the superior method in disclosing the subtypes of student STEM learning motivation based the “core factors” identified above.

3. Multiple Group Analysis

Given the knowledge of student learning motivation type from last step, the next question is “to what extent students of one motivation type is different from students of another motivation type?” Multiple group analysis provides a way of quantifying individuals’ differences. It compares student STEM achievement (i.e., math and science scores) between groups such that the characteristics of different subtypes of STEM learning motivation can be delineated.

A four-step plan is proposed to carry out the current study. In the first step data is retrieved from for a survey study on student engagement in STEM learning that was conducted by the author previously. The second step is to identify all the variables that are related to student engagement in STEM learning, and run regression analysis to select a subset of predictors that predict student college aspiration in STEM the best. Based on the “core factors” selected, the third step is to run three different clustering data mining procedures to identify the subtypes of STEM learning motivation. In the meantime, a statistical technique, known as bootstrapping, is used to evaluate the quality of group classification. The last step is to run several multiple group analyses to examine to what extent students of different STEM learning motivation types perform differently in STEM subjects (i.e., math and science).

Anticipated Outcomes:

The findings of the proposed project contribute to the understanding of student motivation in STEM learning in several aspects:

Theoretically, extracting the key predictors of STEM learning enables the reconsideration of the complex motivation system in STEM learning. For instance, the conventional motivation system where many factors are equally weighted could be simplified using the “core factors” of STEM learning motivation identified in the proposed study.

Methodologically, the proposed work fills in the gap in literature by identifying the optimal method of classifying student STEM learning motivation. Comparing of different statistical models advances the understanding of the critical role of clustering algorithms in grouping student learning motivation. The innovative use of a statistical validation procedure provides a way of evaluating the stability of the generated motivation subtypes (i.e., how well students of different STEM learning motivation are separated).

Practically, the differentiation of subtypes of STEM learning motivation can be applied to help students and teachers set appropriate academic goals in STEM learning. There has been a call for conducting interventions to improve adolescent students' motivation for STEM subjects and their choices to pursue educational trajectories that can lead them to careers in STEM field (Rosenzweig & Wigfield, 2016). The understanding of STEM learning motivation subtype helps identify students who may need motivation interventions to succeed in STEM fields and thus is beneficial to career choice in the long run.

Plans for Continuing Research:

Upon the completion of the proposed study, two grant proposals are planned to be submitted for external funding.

First, the comparison of statistical models in differentiating STEM learning motivation will be expanded by adding more classifying algorithms and using a large-scale dataset from the Longitudinal Study of American Youth by the National Science Foundation (NSF). This proposal will be submitted to the research grant program in American Educational Research Association (AERA), which supports quantitative research on U.S. educational issues using large-scale dataset supported by NSF or other federal agencies. This grant program especially welcomes proposals related to STEM learning.

Second, driven by the empirical evidence from the current work, a simulation study will be proposed to assess the performance of classifying methods in isolating the subtypes of student motivation in STEM learning. This proposal will be submitted to the Division of Research on Learning (DRL) in NSF, which supports research that advances the development of theory, method, measurement, and application in STEM education. Proposals on STEM learning by comparing different statistical methods have been found to be funded by this division.

Budget and Justification:

(Redacted)

References:

Blumenfeld, P. C., & Meece, J. L. (1988). Task factors, teacher behavior, and students' involvement and use of learning strategies in science. *The Elementary School Journal*, 88(3), 235-250.

Eccles, J. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist*, 44(2), 78-89.

MyCollegeOptions & STEMconnector (2012). Where are the STEM students? What are their career interests? Where are the STEM jobs? 2012–2013 Executive summary. <https://store.stemconnector.org/Where-are-the-STEM-Students_p_15.html>.

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescents: a promising start, but further to go. *Educational Psychologist*, 51(2), 146-163.

Wang, M. T. (2012). Educational and career interests in math: A longitudinal examination of the links between classroom environment, motivational beliefs, and interests. *Developmental psychology*, 48(6), 1643.

Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy–value perspective to understand individual and gender differences in STEM fields. *Developmental Review*, 33(4), 304-340.