



Validation of an Instrument to Measure Science, Engineering, and Mathematics Graduate Students' Mental Health (Work in Progress)

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Abstract

The mental health of students in higher education has been an increased focus in recent research. Current literature points to aspects of the student's social environment, such as feelings of connectedness, a sense of belonging, social self-efficacy, and social support, influencing students' reported mental health measures in addition to lasting academic impacts. It is still unclear, however, to the extent which of these concepts are present in current surveys used to assess graduate student mental health. The research question guiding this study is, What underlying factors are important when looking at the mental health of science, engineering, and mathematics graduate students?

This study will look specifically at the Healthy Minds Study (HMS), conducted by the Healthy Minds Network (HMN): Research on Adolescent and Young Adult Mental Health group, to try and determine the underlying structure of the HMS questionnaire as it relates to the social context. Data collected from the 2013 survey by the HMN will be analyzed. Responses will be included for United States graduate students in the natural sciences, mathematics, and/or engineering field of study. These responses will then be randomly split to conduct a cross-validation study to determine which underlying factor structures are present in the existing HMN survey instrument relating to science, engineering, and mathematics graduate student mental health.

The anticipated results will reveal the underlying factor structures of these items through the exploratory factor analysis and attempt to explain these groupings by evaluating a proposed factor structure through the confirmatory factor analysis. The ultimate purpose of this work is to shed light on factors that influence science, engineering, and mathematics graduate student mental health so that graduate students, faculty, and staff can use these results for both individual and programmatic change. This study will help do so by providing some direction and guidance to those who wish to use the larger HMN survey in future analysis.

Introduction

There has been a rise in mental health problems reported among college-aged individuals and these mental health concerns have been shown to have a lasting impact on students [1-3]. Studies have shown that there are unique stressors to the graduate student experience and that these mental health concerns (e.g. stress, anxiety, exhaustion, lack of interest) have contributed directly in reducing graduate students' intention to persist in their degree programs [4-5]. Recent research has shown aspects of the students' social environments, such as feelings of connectedness, a sense of belonging, social self-efficacy, and social support, influence students' reported mental health measures (i.e. depression, suicidal ideation) [6]. It is still unclear, however, the extent to which these concepts are present in current surveys used to assess graduate student mental health.

One of the major current concerns is that most existing national surveys (e.g., the American College Health Association National College Health Assessment and the Healthy Minds Network Healthy Minds Study) are targeted towards the general higher education population [2-

3,7-10]. This presents problems for those wishing to study graduate student mental health as graduate degree programs present different social, academic, and personal demands compared to undergraduate programs, resulting in different mental health problems and concerns [10-11]. Some smaller scale studies have tried to circumvent this with a combination of using parts of existing survey instruments and creating survey questions specific to their study aims [12-13]. However, these survey instruments tend to be limited and are not definitively validated for use past the researcher's current study. Furthermore, when looking across studies, many different survey items are used and vary in their respective data analysis methods. This shows a lack of consistency in the work done and a need to provide a consolidated, validated survey instrument that focuses solely on graduate student mental health. This paper then begins to ask the question,

What underlying factors are important when looking at the mental health of science, engineering, and mathematics graduate students?

Methodology

The goal of this work is to create a survey instrument that can be used to assess science, engineering, and mathematics graduate student mental health using data collected by the Healthy Minds Network [14]. Guiding this study is the instrument development process illustrated in Figure 1, taken from the authors' prior work [15-16]. This process is broken into six stages: (1) item generation and construct development, (2) validity testing, (3) implementation, (4) exploratory factor analysis, (5) confirmatory factor analysis, and (6) instrument modification and replication. This is an iterative, six-step process. This study assumes that the survey instrument being analyzed has already undergone stages one, two, and three by the Healthy Minds Network. That is, the items have been generated and listed under constructs in the codebook, the survey has publicly available documentation since 2007, and it has undergone many revisions [14], leading us to assume that items were altered in order to better capture desired constructs (and these desired constructs may have altered from one year to the next, although the general form of the survey has remained the same). The goal of this work is to complete stages 4 and 5 by

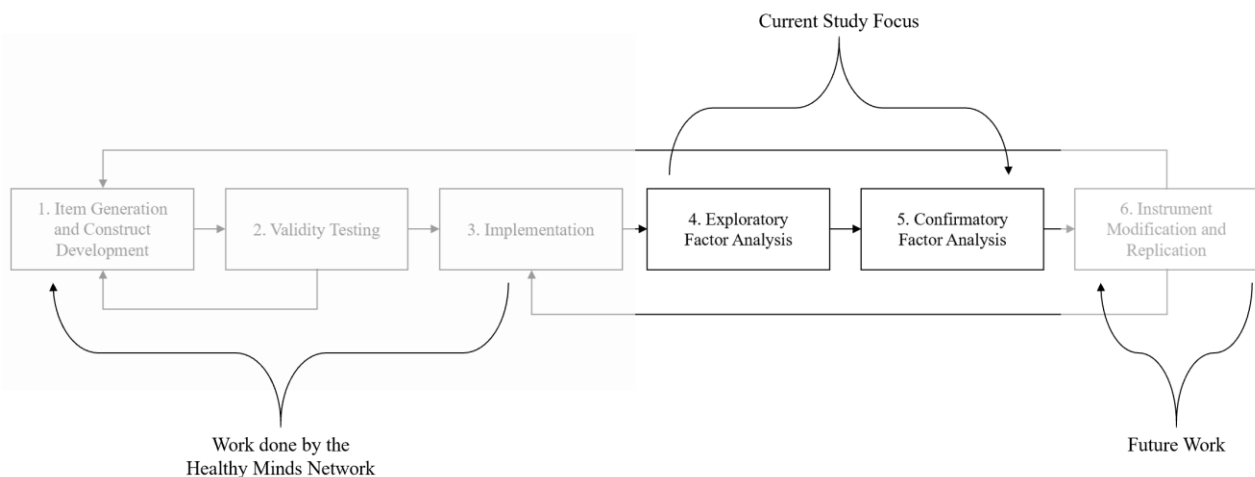


Figure 1. Instrument Development Process modified for this study [15-16]

conducting an exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The following sections present the data used to conduct this study and the current progress regarding the factor analysis.

Data

Data collected from the Healthy Minds Network's 2013 Healthy Minds Study (HMS) was used. In 2013, The Healthy Minds Study consisted of seventeen modules [17]. The first three modules are (1) Basic survey variables, (2) Demographics, and (3) Academics, which provide information about the participants, their backgrounds, and academics. The remaining fourteen modules cover a variety of mental health topics: (4) Positive mental health, (5) Depression and anxiety screen, (6) Eating and body, (7) Self-injurious behavior and suicide, (8) Diagnosed mental illness, (9) Knowledge and beliefs about mental health services, (10) Stigma, (11) Mental health service utilization, (12) Informal help-seeking/support, (13) Reasons for seeking or not seeking help, (14) Insurance, (15) Substance use, (16) Other behaviors/lifestyle, and (17) Witnessing/experiencing negative things.

Table 1. Demographic Descriptive Statistics for the Sample (n=1,021)

Age	
18-22	112
23-25	346
26-30	358
31-35	103
36(+)	59
NA	43
Gender	
Male	575
Female	403
Other/NA	43
Race	
African American/Black	12
American Indian/Alaskan Native	0
Arab/Middle Eastern or Arab American	35
Asian American/Asian	297
Hispanic/Latino	22
Pacific Islander	3
White or Caucasian	525
MultiRace	43
Other/NA	84
Degree Program	
Master's	311
PhD (can include embedded Master's)	576
Other/NA	134

The sample for the study was restricted to master's and doctoral science, engineering, and mathematics students (technology not an available subset of the survey), resulting in 1,021 available responses. Table 1 shows the basic descriptive statistics for this sample.

Factor Analysis

The EFA was a semi-guided analysis. The codebook provided by the Healthy Minds Network organizes modules based on topics in addition to providing citations from instruments that come from other sources or existing instruments [17]. This information provides insight as to what these items were intended to measure and gives us some idea of the underlying factor structure that may be present in these modules. When cleaning the data, only questions provided from the fourteen modules related to mental health measures were looked at. Any items that had skip logic resulting in few responses or were redundant (i.e., a categorical variable being broken into multiple dichotomous variables) were removed from the data set. Then the data was split into two random, comparable groups using a 50%/50% split for the EFA and CFA, respectively.

Current Results

This paper will focus on the preliminary EFA conducted on modules (4) Positive mental health and (5) Depression and anxiety screen. A total of 28 items were included in the EFA, eight from Module 4 and twenty from Module 5. These items can be seen in Table 2 on the following page. When doing the preliminary analysis, any respondent missing a response for any of the items included in Table 2 were dropped from the study. This resulted in 71 responses being dropped, leaving 950 responses to work with in the analysis, or 475 after the split between EFA and CFA, meeting the recommendation of at least 300 participants per data set [18]. The data analysis began with running factor models for one to nine factors, given the recommendation of a minimum of 3 variables per factor [18]. Pearson correlations were used for the EFA (the items are approximated to be continuous) and an oblique rotation were used as these items are believed to be correlated to one another. The factor loadings and goodness of fit statistics were then observed. As this was just the preliminary run for the EFA, and the sample size was over 350 individuals, a cutoff value of $|0.3|$ was elected [19]. Using this cutoff value in conjunction with a minimum of three items per factor, any model over five factors was found to not work. Based on the scree plot below, showing a leveling off at four factors, there should be at least a three-factor model [18].

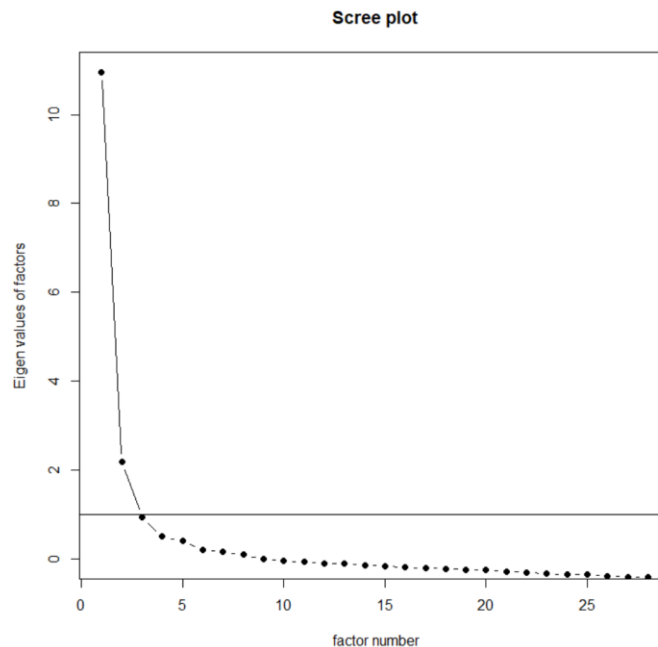


Figure 2. Scree plot for preliminary EFA.

Table 2. Items included in preliminary EFA

Question	Wording	Scale
Module 4: Positive Mental Health		
diener1	I lead a purposeful and meaningful life.	1=Strongly disagree 2=Disagree 3=Slightly disagree 4=Mixed or neither agree nor disagree 5=Slightly agree 6=Agree 7=Strongly agree
diener2	My social relationships are supportive and rewarding.	
diener3	I am engaged and interested in my daily activities.	
diener4	I actively contribute to the happiness and well-being of others.	
diener5	I am competent and capable in the activities that are important to me.	
diener6	I am a good person and live a good life.	
diener7	I am optimistic about my future.	
diener8	People respect me.	
Module 5: Depression and Anxiety Screen		
<i>Depression</i>		
	Over the last 2 weeks, how often have you been bothered by any of the following problems?	
phq9_1	Little interest or pleasure in doing things	1=Not at all 2=Several days 3=More than half the days 4=Nearly every day
phq9_2	Feeling down, depressed or hopeless	
phq9_3	Trouble falling or staying asleep, or sleeping too much	
phq9_4	Feeling tired or having little energy	
phq9_5	Poor appetite or overeating	
phq9_6	Feeling bad about yourself—or that you are a failure or have let yourself or your family down	
phq9_7	Trouble concentrating on things, such as reading the newspaper or watching television	
phq9_8	Moving or speaking so slowly that other people could have noticed; or the opposite—being so fidgety or restless that you have been moving around a lot more than usual	
phq9_9	Thoughts that you would be better off dead or of hurting yourself in some way	
	Think about a two-week period in the past year when you experienced the two problems below the most frequently. During that period, how often were you bothered by these problems?	
phq2_1	Little interest or pleasure in doing things	(+) Screen for any depression (0=No, 1=Yes)
phq2_2	Feeling down, depressed or hopeless	
dep_any	PHQ-9 score cut-off for any depression, major or moderate	
<i>Anxiety</i>		
	In the past four weeks, how often have you been bothered by any of the following problems?	
gad7_1	Feeling nervous, anxious or on edge	1=Not at all 2=Several days 3=Over half the days 4=Nearly every day
gad7_2	Not being able to stop or control worrying	
gad7_3	Worrying too much about different things	
gad7_4	Trouble relaxing	
gad7_5	Being so restless that it's hard to sit still	
gad7_6	Becoming easily annoyed or irritable	
gad7_7	Feeling afraid as if something awful might happen	
anx_any_gad	PHQ algorithm for generalized anxiety disorder screen	(+) Screen for generalized anxiety (0=No, 1=Yes)

Item	Model with Three Factors			Model with 4 Factors				Model with 5 Factors				
	F1	F2	F3	F1	F2	F3	F4	F1	F2	F3	F4	F5
diener1	0.04	-0.1	0.75	0.03	0.75	-0.1	0	0.74	0.01	-0.13	0.04	-0.01
diener2	0.04	-0.12	0.62	0.04	0.63	0.02	-0.21	0.61	0.02	0	0.02	-0.22
diener3	0.08	-0.27	0.64	0.07	0.65	-0.22	-0.07	0.65	0.04	-0.21	-0.01	-0.09
diener4	0.04	0.03	0.76	0.04	0.76	0.03	0.02	0.76	0.06	0.05	-0.05	0.01
diener5	-0.12	0.06	0.66	-0.12	0.66	0	0.1	0.65	-0.13	-0.03	0.03	0.1
diener6	-0.14	0.12	0.79	-0.14	0.79	0.08	0.08	0.8	-0.08	0.14	-0.12	0.08
diener7	-0.02	-0.11	0.74	-0.02	0.74	-0.07	-0.05	0.72	-0.08	-0.16	0.14	-0.06
diener8	-0.05	0.03	0.67	-0.04	0.67	0.06	-0.06	0.67	-0.01	0.1	-0.08	-0.06
dep_any	0.1	0.68	-0.03	0.13	-0.06	0.51	0.26	-0.07	0.12	0.41	0.15	0.28
phq9_1	-0.03	0.67	-0.18	0	-0.21	0.57	0.12	-0.23	-0.02	0.44	0.19	0.14
phq9_2	0.13	0.68	-0.14	0.16	-0.17	0.55	0.18	-0.17	0.18	0.49	0.09	0.2
phq9_3	0.26	0.48	0.08	0.28	0.06	0.45	0.01	0	0.07	0.13	0.63	0
phq9_4	0.28	0.43	0.04	0.3	0.02	0.44	-0.03	-0.04	0.12	0.15	0.54	-0.05
phq9_5	0.22	0.44	0.05	0.24	0.03	0.35	0.13	-0.02	0.03	0.03	0.59	0.14
phq9_6	0.22	0.47	-0.16	0.24	-0.18	0.42	0.07	-0.19	0.25	0.37	0.08	0.08
phq9_7	0.21	0.43	-0.04	0.22	-0.06	0.35	0.13	-0.08	0.18	0.23	0.2	0.14
phq9_8	0.06	0.33	-0.04	0.04	-0.03	-0.01	0.67	-0.02	0.02	-0.07	0.09	0.67
phq9_9	0	0.46	-0.18	-0.01	-0.19	0.18	0.52	-0.17	0.02	0.17	0	0.54
phq2_1	-0.09	0.81	-0.02	-0.07	-0.03	0.86	-0.06	-0.05	-0.06	0.79	0.13	-0.04
phq2_2	0.05	0.72	0.03	0.07	0.02	0.74	-0.02	0.03	0.13	0.78	-0.01	-0.02
anx_any_gad	0.83	-0.03	-0.04	0.82	-0.05	-0.05	0.05	-0.03	0.85	0	-0.05	0.04
gad7_1	0.74	-0.02	-0.1	0.73	-0.1	-0.04	0.05	-0.11	0.69	-0.08	0.1	0.04
gad7_2	0.86	-0.03	-0.05	0.86	-0.05	0.02	-0.08	-0.05	0.84	0.02	0.04	-0.09
gad7_3	0.78	0.03	-0.01	0.79	-0.02	0.1	-0.12	-0.02	0.77	0.08	0.07	-0.12
gad7_4	0.67	0.21	0.02	0.67	0	0.19	0.03	-0.02	0.6	0.07	0.23	0.03
gad7_5	0.56	0.18	0.16	0.56	0.16	-0.01	0.32	0.17	0.53	-0.04	0.09	0.31
gad7_6	0.36	0.27	-0.06	0.37	-0.07	0.2	0.11	-0.1	0.27	0.04	0.29	0.11
gad7_7	0.68	0.05	0.02	0.68	0.01	-0.02	0.13	0.04	0.74	0.06	-0.12	0.13

Figure 3. Initial EFA Factor Loadings for Three, Four, and Five Factor EFA Models, with F1 indicating factor one, F2 indicating factor 2, and so on.

Following this, the factor loadings for the models with three, four, and five factors were observed to see which items, if any, should be removed. These factor loadings can be seen in Figure 3. As one can see, the three-factor model replicates the breakdown of items as seen in the HMN survey (positive mental health, depression, and anxiety). Looking at the four-factor model, there begins to be breakdown in the depression scale items, which can be seen further in the five-factor model. Looking at the items, one can see that gad7_6 has relatively low factor loadings across the three models and should be considered for removal in future analysis. Also, gad7_5 should be monitored going forward as it is shown to be crossloading in the four and five-factor models. This crossloading also indicates that the five-factor model has a relatively weak fifth factor.

Future Work

Future anticipated results will reveal the underlying factor structures for items across all fourteen modules through the exploratory factor analysis. A confirmatory factor analysis will then evaluate the proposed emerging factor structure. The analysis will conclude with a finalized factor structure, completing steps four and five in the instrument development process. Future work past this project will extend to step 6, in which we will work to interview current science, engineering, and mathematics graduate students to ask them to comment on the final survey instrument and reflect on what areas regarding to their current mental health experiences are missing.

The ultimate purpose of this work is to create an instrument that measures science, engineering and mathematics graduate students' mental health. This work can lower the barrier for those wishing to study this population through the instrument by providing an existing standardized instrument as well as foster collaborations among stakeholders invested in improving graduate student mental health. Further, researchers from differing backgrounds will be able to communicate their results as the questions and means to analyze these metrics will be consistent.

Limitations

There are two major limitations for this study. First, the HMS is an opt in survey, meaning that the schools that participate must elect to take the survey. This means that the sample has a response bias as it may appeal to certain institution types over others. Second, analysis is restricted currently by the items that have large response rates (i.e. not skip logic based). This restricts the number of responses used for analysis as well as the ability to test the survey instrument's factor structure in its entirety. This means that there may be larger underlying themes that we cannot pull out or important themes present in these opt in items that will be overlooked.

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