Work in Progress: Assessing Engineering Students' Motivation and Learning Strategies - A Psychometric Analysis of the Motivated Strategies for Learning Questionnaire

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Prof. Prashanta Dutta has received his PhD degree in Mechanical Engineering from the Texas A&M University in 2001. Since then he has been working as an Assistant Professor at the School of Mechanical and Materials Engineering at Washington State University. He was promoted to the rank of Associate and Full Professor in 2007 and 2013, respectively. Prof. Dutta is an elected Fellow of the American Society of Mechanical Engineers (ASME). He current serves as Editor for Electrophoresis.

WIP: A Psychometric Analysis of Engineering Students' Motivation and Learning Strategies

Abstract

This work in progress seeks to examine the psychometric analysis of the motivated strategies for learning questionnaire (MSLQ) for assessing engineering students' motivation and learning strategies. Although there are many standardized questionnaires used to assess student motivation to learn, the MSLQ is one of the more widely used in general education research and has been reported to be reliable and valid. However, it has rarely been used in engineering education. The entire instrument comprises 81 items assessing motivation and learning strategies related constructs, with the motivation and learning strategies comprising six and nines sub-scales respectively. Constructs on the instrument are assessed on a 7-point Likert scale and scores are determined by obtaining participants mean score for items on each sub-scales. Confirmatory factor models were used to examine the performance of the MSLQ scales with the engineering student data. Preliminary findings show that the model fit was good to excellent for each sub-scale

Keywords: motivation; learning strategies; engineering; psychometric; active learning

Introduction

Although there are many standardized questionnaires used to assess students' self-regulatory behavior and motivation to learn, the MSLQ is one of the more widely used in general education research [1, 2, 3]. The MSLQ is a self-report instrument specifically designed to assess students' motivational orientations and their use of different learning strategies. . By focusing on the roles of both motivation and cognition during learning, the MSLQ reflects the research on self-regulated learning, which emphasizes the interface between motivation and cognition [4, 5]. Prior research using the MSLQ has found relationships between constructs on its motivational subscales such as: intrinsic goals, extrinsic goals, task value, control of learning beliefs, self-efficacy, and test anxiety, and constructs on its use of learning strategies subscales such as: rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, and effort regulation [6, 7] . As widespread as the use of MSLQ is in educational research, its use is very limited in engineering education research even though it has been recognized as a viable instrument to explicate student motivation and learning strategies [8].

The MSLQ instrument comprises 81 items assessing motivation and learning strategies related constructs, with the motivation and learning strategies comprising six and nines sub-scales respectively. The MSLQ is completely modular, thus allowing the subscales to be used together or individually. Constructs on the instrument are assessed on a 7-point Likert scale and scores are determined by obtaining participants mean score for items on each sub-scales. We used items on four motivational sub-scales of the instruments to assess intrinsic and extrinsic goal orientations, task value and self-efficacy for learning and performance. Items were adapted from four of the learning strategies sub-scales to assess students' use of cognitive and regulatory learning strategies (critical thinking, peer learning, metacognitive self-regulation and elaboration).

Objectives of the Study

This work in progress describes a proposal for examining the psychometric analysis of MSLQ for assessing engineering students' motivation and learning strategies. Although there are many standardized questionnaires used to assess student motivation to learn, the MSLQ is one of the more widely used in general education research and has been reported to be reliable and valid. However, it has rarely been used in engineering education. Indeed, very few instruments exist in engineering education to more robustly measure both motivation and learning strategies that students adopt while studying engineering concepts. Hence, the present work-in-progress study seeks to fill this important gap.

Method

Participants

The participants for this study were 102 undergraduate students of chemical engineering at a large public university in the Pacific Northwest of the United States. Students were enrolled in Fluid Mechanics and Heat Transfer, a thermodynamics foundational course. This is the first fluid mechanics course that mechanical engineering students in the university are required to take. The sample included 86 male and 16 female.

Materials

As part of a large program of research, we developed desktop learning modules (DLMs) to facilitate active learning in the engineering classrooms (see Figure 1). They are miniaturized versions of industry-type equipment that can be used to illustrate engineering concepts in the classroom. The module consists of a base unit with rechargeable batteries, fluid reservoirs, pumps and tubing, and receptacle ports to which different detachable equipment cartridges can be installed (e.g. venturi, orifice and packed/fluidized bed cartridges) depending on the instructional need. Also connected to the base units are digital displays to monitor readings (e.g. differential pressure and stream temperatures) and a rotameter to control readings.

Figure 1. A miniaturized Desktop Learning Module (DLM)

Procedure

Data for this study was obtained from participants in three classes across two semesters. The same professor taught across the two semesters. All the participants were lectured on the same topics in thermodynamics over the course of the semesters. However, specific fluid mechanics and heat transfer concepts were facilitated using DLMs. Different DLM cartridges were installed on the DLM units depending what concepts were being taught. In each session, the professor guided the class through worksheets that were designed to allow students work cooperatively in interactive learning groups. Participants were then asked to complete an online version of the MSLQ survey administered over Qualtrics©. Participation on the survey was voluntary.

Data Analysis & Results

Confirmatory factor models were used to examine the performance of the MSLQ scales with the engineering student data. First, each sub-scale was examined individually for model fit using the Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). Thresholds of .95, .05, and .08 were used for CFI, RMSEA, and SRMR respectively [9, 10]. A *p*-value threshold of .05 was used to determine item loading significance. Then, second-order factor models, based on motivation behaviors and learning strategies, were tested for fit and significance. Given the exploratory nature of the application of the MSLQ instrument to engineering students, an exploratory approach was taken to the fitting of the confirmatory models. For example, decisions were made based on model fit and levels of significance to determine which sub-scales, items, and second-order models provided the most accurate information within the engineering context. If sub-scales or items fit poorly or lacked significant relationships where expected for the MSLQ instrument, then model modifications were made and tested.

Table 1 provides model fit information for all MSLQ scales that were tested. As expected, model fit was good to excellent for each sub-scale with only *CT* producing a CFI below .95. RMSEA for *SLP*, *IGO*, and especially *CT* exceeded the preferred threshold of .05 indicating that further item analysis be conducted to determine what wording improvements might be made. Nevertheless, all items for all sub-scales were significant ($p < .05$) with the exception of *MSR* where item 1 was not significant ($p = .251$). The wording for *MSR* item 1 was opposite that of the other items in the sub-scale. Further examination of the wording of item 1 should be undertaken.

Table 1

Model Fit for all Sub-Scales Examined

	Sub-Scale	**CFI**	**RMSEA**	**SRMR**
Motivation	SLP	0.958	0.079	0.039
	TV	1.000	0.000	0.006
	EGO	1.000	0.000	0.015
	IGO	0.986	0.059	0.027
Learning Strategies	ELA	0.979	0.050	0.029
	CT	0.930	0.162	0.035
	MSR	1.000	0.005	0.024
	PL	1.000	0.000	0.000

SLP = self-efficacy for learning and performance; TV = task value; EGO = extrinsic goal orientation; IGO = intrinsic goal orientation; ELA = elaboration; CT = critical thinking; MSR = metacognitive self-regulation; PL = peer learning.

Table 2 shows the completely standardized loading results of the second-order motivation and learning strategies models. The second-order motivation model exhibited moderately good fit (CFI = .897, RMSEA = .068, SRMR = .064). Three of the four subscales produced significant loadings ($p < .05$) onto their respective second-order factors of *motivation orientation* and *motivation belief*. Only the EGO loading failed to test significant ($p = .309$). Furthermore the correlation between *motivation orientation* and *motivation belief* was not significant ($r = .165$, $p = .307$).

The second-order learning strategies model also produced moderately good fit (CFI = .891, RMSEA = .062, SRMR = .065). All four sub-scales produced significant loadings ($p < .05$) onto their respective second-order factors of *learning strategies cognition* and *regulatory strategies*. Furthermore the correlation between *cognition* and *regulatory strategies* was not significant ($r = .097$, $p < .136$). These results were especially problematic for the *MSR* sub-scale as it produced a standardized loading larger than 1 and a negative residual variance.

Table 2

Second-order Models

2nd Order Model	**Sub-Scale**	**Standardized Loading**	**SE**	***p*-value**
Motivation Orientation	SLP	0.962	0.080	<.001
	TV	0.947	0.072	<.001
Motivation Belief	EGO	0.244	0.240	0.309
	IGO	0.598	0.283	0.035
Learning Strategies Cognition	ELA	0.605	0.098	<.001
	CT	0.888	0.090	<.001
Regulatory Strategies	MSR	1.028	0.086	<.001
	PL	0.701	0.083	<.001

Discussion

This study is part of a large federally-funded program of research that is examining motivation, and learning in engineering education. This work in progress specifically seeks to examine the psychometric analysis of the motivated strategies for learning questionnaire (MSLQ) for assessing engineering students' motivation and learning strategies. Preliminary findings show that the model fit was good to excellent for each sub-scale with only critical thinking producing a CFI below .95. The majority of items for all sub-scales were significant ($p<.05$). We are rewording items so that did not produce good model fit so as to improve validity and reliability of MSLQ in engineering education.

In sum, this work in progress is an important step in validating the motivated strategies for learning questionnaire for use in engineering education. Our research team is collection more data so as to provide more robust analyses with a large sample size.

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