Fall 10-23-2009

Validating the Instrument: Students' Perceptions on Learning Calculus

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Validating the Instrument - Students' Perceptions toward Learning Calculus

Abstract

The purpose of this study is to develop and validate the instrument, Students' Perceptions toward Learning Calculus (SPLC). The SPLC contains three scales and 31 items. The three scales include Usefulness of Calculus, Professor Efficacy, and Work Ethic. The surveys were given to14 sections of students who had registered for Calculus I, Calculus II, and Business Calculus at Uconn in spring, 2009. Each section had approximately 30 students. The instructors administered the survey to their students in class. In total, 340 students completed the surveys. An exploratory analysis was applied to validate the instrument. Map and Parallel Analysis were used as guidelines to help extracting factors. Using principal axis factoring with oblique rotation, the analysis suggested that 7 items should be dropped and that the remaining 24 items could be best represented by the three factors

A Statement of the Problem

People's perceptions on learning are related to their performance in learning. What factors have the best explanation to Students' perceptions on learning calculus? What instrument can adequately measure students' perceptions on learning calculus? It is hypothesized in this study that Usefulness of Calculus, Professor Efficacy, and Work Ethic would be able to do the job.

Literature Review

By reviewing the literature, the author found that the three hypothesized factors are supported by the studies in the literature. Students' perceptions on what they are learning affect their learning ability (McREL, 2009). Without exception, perceptions on learning calculus would affect students' performance in learning calculus. The question was raised: how can one measure Students' Perceptions on Learning Calculus?

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Studies have found that students' perceptions of the utility of what they are learning have effects on their motivation, interest, and achievement (Kauffman & Husman, 2004; Hulleman, 2007, Eccles & Wigfield, 2002; Malka & Covington, 2005; Miller, Debacker, & Greene, 1999). This study has assumed that perception on Usefulness of Calculus is one of the factors to measure students' perceptions on learning calculus.

Students are motivated by different reasons. Researchers have identified some aspects of the teaching situation that enhance students' self-motivation (Lowman, 1984; Lucas, 1990; Weinert & Kluwe, 1987; Bligh, 1971). Activities promoting learning will also enhance students' motivation (Davis, 1993). Based on the review of literature, the author includes Professor Efficacy as another factor of measuring students' perceptions on learning calculus.

Students' work ethic affects their academic achievement. According to Angela L. Duckworth and Martin E.P. Seligman, self-discipline predicts academic success even better than IQ (Duckworth & Seligman, 2005). The author made the assumption that students' work ethic is one of the factors to measure students' perceptions on learning calculus.

Description of Sample

The sample population of this study includes the 14 sections of the students who were enrolled for Calculus I, Calculus II, or business calculus at Uconn in spring, 2009. The instructors asked their students to complete the surveys in class. In total, 340 students completed the surveys. The completed surveys were collected by the instructors or the researcher in the case that she was on the classroom site.

The Measurement Methodology

An exploratory factor analysis (EFA) was conducted for the 340 completed surveys. Principal axis factoring with oblique rotation was chosen to run EFA. Parallel Analysis and Map were also undertaken for

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helping make decision on factor retention. The reliability analysis was done to check the internal consistency of the instrument. Principal Component Analysis (PCA) was also conducted to help extracting factors.

Factor Extraction

An exploratory factor analysis has been done on the collected data. The KMO is 0.865. This result indicates that EFA may be appropriate to use for the factor analysis. Principal axis factoring (PAF) was used to extract the factors. Correlation matrix and Measures of Sampling Adequacy (MSA) were checked to see if there were unreasonable results. Principal component analysis (PCA) was used as a reference to compare the results of factor extraction between PAF and PCA. The following criteria for factor retention were used:

1. Eigenvalues > 1
2. The Scree Plot
3. Percent of Extracted Variance (5%)
4. Result of a parallel analysis
5. Result of Map
6. Factor interpretability and Usefulness

Oblique Rotation Method was employed to do factor rotation. The pattern Matrix and Communality Table are attached with my annotations (see Appendix). The following table presents the results of factors extracted by different methods.

Method	Eigenvalue>1	Scree plot	Percent extracted variance (5%)	Parallel analysis	MAP
Factor extracted	7	4	5	4	4

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Based on the results, it is reasonable to extract four factors. However, the pattern matrix indicates that more than a 3-factor solution does not fit the data, because most items are highly loaded on three factors, the other factors "do not have sufficient items on them to contribute meaningfully to the solution" (Pett et al, 2003, p.125). The author can identify the three hypothesized factors that have high loadings with their hypothesized items. As a result, 3 factors were determined to keep: Usefulness of Calculus, Professor Efficacy, and Work Ethic.

Item Retention

Before running reliability analysis, the author deleted items 21, 24, 26, 27 and 31, because these items had low loading (<0.3) in pattern matrix. After reliability analysis, items 8 and 17 were dropped, because the Cronbach's Alphas of the subscales increased after these items had been deleted. And also item 17 and 31 have low communalities, 0.236 and 0.192 respectively (see Table of Communalities in Appendix).

The Internal Consistency

The Cronbach's Alphas are: 0.855 (0.858 after deleting item 8) for Usefulness of Calculus, 0.890 (0.939 after deleting item 17) for Professor Efficacy and 0.725 (no item deletion needed to improve Cronbach's Alphas) for Work Ethic.

Conclusions

Based on the results of exploratory factor analysis and reliability analysis, the three-factor instrument of 24 items was a good fit for the data collected. Even though 3 factors of 24 items work well accordingly to the data, a revised form of SPLC could be developed based on the results of this study. A revised version of items for the factor - Work Ethic, could improve this instrument.

Since this study surveyed students in calculus courses at Uconn, these results cannot be generalized to students at other universities. The Cronbach's Alpha of the subscale -Work Ethic is 0.725, still needed to be

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improved to reach the level of 0.80. At least 4 items needed to add to the factor of Work Ethic for further testing in the future. Future research should include calculus students from other universities so that the findings could be generalized more broadly. It would also be useful to test whether there is any difference between female and male calculus students. Finally, the use of confirmatory factor analysis would provide interesting insights to improve the model. This instrument has the potential to be revised to measure perceptions on general learning for future studies.

Acknowledgements

The author would like to thank Betsy McCoach, Associate Professor in Measurement, Evaluation, and Assessment Program at Educational Psychology Department, University of Connecticut for her valuable feedbacks and suggestions during the process of this study.

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Appendix: Tables

Pattern Matrix

	Usefulness of calculus	Professor efficacy	Work Ethic
1. Calculus is important.	0.733		
2. I see how Calculus is useful for many other fields of study.	0.751		
3. I will be able to use Calculus in other academic areas.	0.780		
4. Calculus is very useful for my intended career.	0.773		
5. Calculus is useful in our daily lives.	0.540		
6. Calculus is often used in other science disciplines.	0.460		
7. Calculus is not useful in any respect of my life.	-0.524		
8. Calculus helps me to be a better thinker.	0.314		
9. I will never use Calculus outside the class.	-0.670		
10. My Calculus professor is enthusiastic about teaching Calculus.		0.815	
11. My Calculus professor tries to stimulate our interest in learning Calculus.		0.901	
12. My calculus professor is very encouraging.		0.919	
13. My Calculus professor is approachable		0.794	
14. My Calculus professor uses visual tools to teach.		0.810	
15. My Calculus professor use humor to get us engaged in class.		0.691	
16. My Calculus professor makes complicated Calculus problems easy to understand.		0.866	
17. I look forward to going to my Calculus class.		0.338	
18. My Calculus professor makes Calculus relevant to our daily life.		0.584	
19. My Calculus professor helps us build self-confidence about learning Calculus.		0.785	
20. I preview Calculus materials before the class.			0.455

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21. I finish my calculus homework on time.			0.258
22. I do extra problems in addition to the required homework.			0.573
23. I summarize each chapter that we covered in Calculus class.			0.481
24. I often discuss Calculus problems with my classmates after class.			0.233
25. I spend at least 5 hours per week working on Calculus outside the class.			0.447
26. I attend the Calculus class.			0.239
27. I consistently miss my Calculus classes.			-0.239
28. I don't do homework unless the professor is going to grade it.			-0.536
29. I only study calculus the night before the exams.			-0.620
30. I start studying for Calculus exams at least a week before the exam date.			0.599
31. I often go to see my professor during his office hours.			0.256

Communalities

Items	Communalities
1. Calculus is important.	0.608
2. I see how Calculus is useful for many other fields of study.	0.640
3. I will be able to use Calculus in other academic areas.	0.595
4. Calculus is very useful for my intended career.	0.591
5. Calculus is useful in our daily lives.	0.364
6. Calculus is often used in other science	

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disciplines. 0.406

7. Calculus is not useful in any respect of my life. 0.376

0.308

8. Calculus helps me to be a better thinker.

0.506

9. I will never use Calculus outside the class.

0.736

10. My Calculus professor is enthusiastic about teaching Calculus.

0.818

11. My Calculus professor tries to stimulate our interest in learning Calculus.

0.834

12. My calculus professor is very encouraging.

0.674

13. My Calculus professor is approachable

0.646

14. My Calculus professor uses visual tools to teach.

0.579

15. My Calculus professor use humor to get us
engaged in class. 0.730

0.236

16. My Calculus professor makes complicated Calculus problems easy to understand.

0.603

17. I look forward to going to my Calculus class.

0.720

18. My Calculus professor makes Calculus relevant to our daily life.

0.325

0.282

19. My Calculus professor helps us build self-confidence about learning Calculus.

0.345

20. I preview Calculus materials before the class.

0.301

21. I finish my calculus homework on time.

0.194

22. I do extra problems in addition to the required homework.

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23. I summarize each chapter that we covered in Calculus class.	0.308
24. I often discuss Calculus problems with my classmates after class.	0.585
25. I spend at least 5 hours per week working on Calculus outside the class.	0.599
	0.320
26. I attend the Calculus class.	0.459
27. I consistently miss my Calculus classes.	
28. I don't do homework unless the professor is going to grade it.	0.384
29. I only study calculus the night before the exams.	0.192
30. I start studying for Calculus exams at least a week before the exam date.	
31. I often go to see my professor during his office hours	