Validation of Science Motivation Questionnaires with Korean college students

Abstract

This study examined how Korean college students, who enrolled in a general education science course, conceptualized their motivation to learn science. The 509 Korean college students completed the Science Motivation Questionnaires (SMQ, Glynn & Koballa, 2006). We also conducted deeply interview with 7 students. In order to exam construct validity, exploratory factor analysis (EFA) was performed. The result of EFA revealed that the students' conceptualization of their motivation to learn science in five dimensions: intrinsic motivation, personal relevance and career motivation, self-efficacy and self-determination, assessment anxiety, and interest grade motivation. There are gender differences within the two sub dimensions. The interview data presented examples of construct and relations between each dimensions of SMQ. Based on the findings, we discussed follow-up research and collage general science course development.

Introduction

In the 21st century, the remarkable and rapid advances of science and technology have brought about unprecedented changes in the quality of human life. It is essential that the latter become scientifically literate citizens who are able to understand the scientific issues (e.g., cloning, genetic engineering, stem-cell research, and global warming) that confront them.

College should play an important role in public understanding of science. The ratio of students who go on to college and university is more than eighty percentages in Korea. Therefore, it is not too much to say that college has a responsibility for training scientific literate citizen. At many colleges, the required science courses for nonscience majors have hundreds of students enrolled in each section, making it difficult to address the specific needs of individuals. As instructors of college science courses respond to the need for fostering students' scientific literacy. Many researchers suggests that majority of these students are poorly motivated, do not see the relevance of science to their careers, and find science frustratingly difficult (Arwood, 2004; Duchovic, Maloney, Majumdar, 1998). Therefore, the important role of students' motivation has been focused (Dalgety, Coll, & Jones, 2003; Siebert, 2001; Zusho, Pintrich, & Coppola, 2003).

Glynn and Koballa (2006) developed Science Motivation Questionnaire (SMQ) for understanding college students' motivation toward science learning. It consisted of 30 Likert scale items over the five sub construct. They also have found reliability and criterion-validity measures such as students' grades in their science courses and their belief in the relevance of science to their careers (Glynn *et al.*, 2007). The SMQ is not intended to substitute for advisement sessions with struggling students, but to provide instructors with a reliable, valid, and convenient tool for gathering information that could increase the effectiveness of those sessions. It can also be used as a tool to evaluate the effectiveness of instructional strategies and materials designed to increase students' motivation.

In fact the cross-cultural adaptation of an instrument involves two primary steps: (1) assessment of conceptual and linguistic equivalence and (2) evaluation of measurement properties. In order to adapt cross-cultural use of instruments, the translated versions must display the same scale structure and should be tested in terms of reliability and validity to enable data pooling with the various countries participating in a trial (Gandek et al., 1998).

The purposes of this study are to further examine the psychometric properties of the SMQ and provide evidence of its construct validity with Korean nonscience majors learning science in a course that satisfies a required course and to explore Korean college students' motivation for learning science. Construct validation of translated tool is an important step in the process of conducting instrument to cross-cultural adaptation. A construct, such as motivation to learn science, is not a directly observable variable. For this reason, a measured by means of items that serve as empirical indicators of how the construct is conceptualized by Korean students.

This study shows how we validate the Korean version of SMQ with Korean college students. We conducted exploratory factor analysis for examining construct validity of Korean version SMQ. Exploratory factor analysis is designed for the situation where links between the observed and latent variables are unknown or uncertain. The analysis thus proceeds in an exploratory mode to determine how and to what extent the observed variables are linked to their underlying factors (Byrne, 2001, p.5). Another of our goals was to gain additional insight into students' motivation to learn science by asking them to explain their motivation in interviews.

Method

Participants

Five hundred nine Korean college students (women 65.6%, man 34.4%), who were enrolled a general science course at the three different Universities in Seoul Korea, voluntarily participated in this study. We also did follow-up interview with 7 students in order to understand their motivation deeply.

Instrument

We translated Science Motivation Questionnaire (Glynn & Koballa, 2006) into Korean and pilot tested with 113 Korean college students. Based on pilot test result, we fixed some words and translation errors. We also continued to have internal discussions until all the researchers agreed on the Korean translation of each item. It consisted 30 Likert scale items based on the literature on six motivational components that influence self-regulatory learning theory (intrinsic motivation, extrinsic motivation, examination anxiety, personal relevant, self-determination, self-efficacy). Glynn *et al.*(2007; 2009) tested with science and nonscience majors and found to be reliable and valid. Students respond to each of the 30 randomly ordered items on a five-point Likert-type scale of temporal frequency ranging 1=naver, 2=rarely, 3=sometimes, 4=usually, 5=always.

Procedure

To validate the Korean SMQ, we conducted statistical analysis such as internal reliability and construct validity of scales by exploratory factor analysis.

Semi-structured follow-up interviews were also conducted (Corbetta, 2003; Patton, 2002; Silverman, 2000). Seven students who had completed the SMQ voluntarily participate in the interview. The interview conducted by two authors using interview questions that were developed based on the five dimensions of SMQ and the each interviews have took during 40-50 minute. The interviews were recorded, transcribed, and categorized into five dimensions of SMQ. And we compared each dimensions and overall SMQ mean scores between gender and future job preferences for exploring Korean college students' motivation to learn science.

Result

Exploratory factor analysis and internal Reliability

Construct validity of SMQ was investigated using exploratory factor analysis. Exploratory factor analysis was used to identify subcomponents and the result of factor analysis can be used to reduce the number of items on an inventory by eliminating items that fail to load on any factor or that load at approximately equal levels on two or more factors (Floyd & Widaman, 1995). Exploratory factor analysis was conducted using principal components analysis with varimax rotation and Kaiser Normalization. We considered being meaningful when factor loadings exceed .40. Two items failed to have any substantially high loadings on any factor and so was deleted. The result yielded a five-factor structure The initial Eigenvalues of eight factors ranged 8.60 to 1.00.The 28 items of SMQ cluster into eight factors explaining 59.58 % of the total variance. Table 1 shows items and factor loadings for five dimensions.

Table.1. Factor loadings on the Science Motivation Questionnaire

# of Item	Factor loading	Items
Factor 1 : self-determination & self-efficacy		
5	.549	If I am having trouble learning the science, I try to figure out why.
8	.623	I put enough effort into learning the science.
9	.647	I use strategies that ensure I learn the science well.
21	.660	I am confident I will do well on the science labs and projects.
26	.653	I prepare well for the science tests and labs.
28	.641	I am confident I will do well on the science tests.
29	.559	I believe I can earn a grade of ''A'' in the science course.
Factor 2: personal relevance & career motivation		
2	.682	The science I learn relates to my personal goals.
10	.815	I think about how learning the science can help me get a good job.
11	.682	I think about how the science I learn will be helpful to me.
17	.785	I think about how learning the science can help my career.
19	.452	I think about how I will use the science I learn.
23	.562	The science I learn is relevant to my life.
Factor 3: assessment anxiety		
4	.746	I am nervous about how I will do on the science tests.
6	.769	I become anxious when it is time to take a science test.
13	.819	I worry about failing the science tests.
14	.757	I am concerned that the other students are better in science.

18	.575	I hate taking the science tests.
Factor 4: intrinsic motivation		
16	.526	The science I learn is more important to me than the grade I receive.
27	.476	I like science that challenges me.
24	.711	I believe I can master the knowledge and skills in the science course.
25	.712	The science I learn has practical value for me.
30	.574	Understanding the science gives me a sense of accomplishment.
Factor 5: extrinsic motivation		
1	.590	I enjoy learning the science.
3	.683	I like to do better than the other students on the science tests.
7	.471	Earning a good science grade is important to me.
12	.541	I expect to do as well as or better than other students in the science course.
22	.533	I find learning the science interesting.

These results are different from Glynn and *et al.* (2009)'s study. They suggested five-factor structure based on exploratory factor analysis with USA students. Table 2 shows comparison between Glynn *et al*. (2009) and current result.

Table 2. Factors of SMQ from Glynn et al. and current study.

<table>
<tr><th colspan="2">Glynn et al. (2009)</th><th colspan="2">Current study</th></tr>
<tr><th>Factor</th><th>Items numbers</th><th>Factor</th><th>Item numbers</th></tr>
<tr><td rowspan="2">Intrinsic motivation and personal relevance</td><td rowspan="2">1, 2, 11, 16, 19, 22, 23, 25, 27, 30</td><td>Intrinsic motivation</td><td>16, 24, 25, 27, 30</td></tr>
<tr><td rowspan="2">Personal relevance and career motivation</td><td rowspan="2">2, 10, 11, 17, 19, 23</td></tr>
<tr><td>Career motivation</td><td>10, 17</td></tr>
<tr><td>Self-determination</td><td>5, 8, 9, 26</td><td rowspan="2">Self-determination and self-efficacy</td><td rowspan="2">5, 8, 9, 21, 26, 28, 29</td></tr>
<tr><td rowspan="2">Self-efficacy and assessment anxiety</td><td rowspan="2">4, 6, 13, 14, 18, 21, 24, 28, 29</td></tr>
<tr><td>Assessment anxiety</td><td>4, 6, 13, 14, 18</td></tr>
<tr><td>Grade motivation</td><td>3, 7, 12, 15, 20</td><td>Interest and grade motivation</td><td>1, 3, 7, 12, 22</td></tr>
</table>

The reliability of SMQ was assessed by internal consistency for all items using Cronbach's α coefficient. The Cronbach's α of SMQ is 0.902 (28 items). The reliability of each SMQ dimensions was also calculated. Intrinsic motivation is .746(5 items). Personal relevance and career motivation is .854(6 items). Self-determination and self-efficacy is .831(7 items). Assessment anxiety is .819(5 items). Interest and grade motivation is .762(5 items).

Five dimensions of motivation to learn science

We also found example quotes from students' interview data for each five factor. The students' *intrinsic motivation* dimension included four items about students' interest to science. One student express one's thought as following.

> Science is all around. I want to know about system of nature. I was curiosity for everything in my daily life. Therefore, I really enjoyed science class when I was high school student.

The students' *personal relevance and career motivation* dimension included six items about how student valued to learn science and how related students' future job or career. USA students' personal relevance correlated with intrinsic motivation, however, Korean students' personal relevance highly correlated with career motivation. This result shows that cultural differences between USA and Korea. The example is next:

> Learning science is helping me to extend my knowledge amount, and it will be very helpful for finding good job. This society very related with science and technology, therefore, for getting good job, I should have scientific knowledge.

Self-determination and self-efficacy dimensions included three self-efficacy items (21, 28, 29) and four self-determination items. This factor revealed self-determination and self-efficacy highly correlated. Students' self-determination ability influenced students' self-efficacy and motivation. Assessment anxiety consisted five items. Glynn and *et al.* (2009) suggested that students' had high self-efficacy, were not worry about assessment. Therefore, they combined self-efficacy and assessment anxiety into one dimension. Otherwise, in this study, we defined assessment anxiety as an independent factor. *Assessment anxiety* dimension shows row correlation to other five dimensions.

Interest and grade motivation dimension included some of extrinsic motivation components (I like to do better than the other students. Earning a good science grade is important…) and items about students' interest for learning science. College students were very motivated to earn good grade from the public science lecture.

Korean college students' motivation to learn science

The total mean of SMQ was 3.29 (SD=.530). The dimension of interest and grade motivation was highest (M=3.88, SD=.655) and assessment anxiety was lowest (M=2.97, SD=.834). Table 3 provides the mean scores and standard deviation for each dimension of motivation to learn science. There are significant differences between man and woman in self-determination and self-efficacy (t= 2.242, p<0.05) and assessment anxiety (t= 2.456, p<0.05) dimensions. Woman has lower self-determination and self-efficacy than man.

Table 3. Mean and Standard deviation of SMQ

Dimensions	Man (N=175)		Women (N=334)		Total (N=509)	
	M	SD	M	SD	M	SD
Intrinsic motivation	3.41	.648	3.36	.677	3.37	.667
Personal relevance and career motivation	3.06	.814	3.05	.826	3.05	.821
Self-determination and self-efficacy	3.34	.707	3.20	.667	3.25	.684
Assessment anxiety	3.09	.878	2.90	.804	2.97	.834
Interest and Grade motivation	3.94	.614	3.85	.674	3.88	.655

Total	3.35	.506	3.26	.540	3.29	.530

Discussions

We conducted this study to validate Korean translation Science Motivation Questionnaire and to explore Korean college students' motivation for learning science. First of all, we found five dimensions of motivation to learn science. This result was not matched on Glynn et al.(2009)'s study with USA college student. From this result, we suggested that validation of translated instrument is very important process for using instrument that developed by other countries. There are different construct from Korea and USA students. And we also discussed that the SMQ is not intended to substitute for advisement sessions with struggling students, but to provide instructors with a reliable, valid, and convenient tool for gathering information that could increase the effectiveness of those sessions. It can also be used as a tool to evaluate the effectiveness of instructional strategies and materials designed to increase students' motivation. The potential value of the SMQ is that it can provide information about how motivated a student is and why a student is motivated or not motivated to learn science. This information can be useful to science instructors and science education researchers in fostering motivation, and thereby, achievement.

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