The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)

Volume 1, Pages 83-89

ICONTES2017: International Conference on Technology, Engineering and Science

ANALYZING THE RELATIONSHIP BETWEEN CHEMISTRY MOTIVATION WITH CHEMISTRY LABORATORY ANXIETY THROUGH STRUCTURAL EQUATION MODELING

Fatma Alkan
Hacettepe University

Nursel Koyuncu
Hacettepe University

Abstract: Affective factors such as motivation, attitude and anxiety are very important in learning realization of people. Motivation is a situation which determines the willingness degree of attending an activity. Motivation contains belief, inner power and reactive behaviors to warning. Motivation is necessary for individuals to act as cognitively. Therefore it is very important for teachers knowing in advance of their students' motivation degree. If the teachers know the reason of their students' low motivation to lessons, they can improve the motivation of their students. Anxiety is also a variable which affects the learning negatively. Science anxiety can be defined as a fear oriented learning science. In this research it is aimed that the analysis of the relation between motivation and anxiety variables which are highly effective on learning. For numerical analysis we studied 652 high school students in Turkey. The data is collected with chemistry motivation scale and chemistry laboratory anxiety scale. The study has been designed in relational survey model. The correlation between the variables are examined using Structural Equation Modeling (SEM). Structural equation modeling provides a very general and convenient framework for statistical analysis that includes several traditional multivariate procedures, for example factor analysis, correlation analysis, discriminant analyses, as special cases. With this study we conclude that there is a negative and significant correlation between chemistry motivation and chemistry laboratory anxiety. This result can be interpreted that the person with low chemistry laboratory anxiety has high chemistry motivation.

Keywords: Structural equation modeling, multivariate analysis

Introduction

What students learn is closely related to how they learn. In this respect, it is very important to plan and manage the process of transferring the targeted knowledge, skills, attitudes and values to the students with the curriculum effectively and efficiently. Care should be taken that an effective learning-teaching process has attidudes such as value-focused, motivating, enable active use of information and communication technologies, contain different teaching and strategies approach together (MEB, 2017). Affective factors such as motivation, attitude and anxiety are very important in learning realization of people. Motivation, is an internal status, which brings out, guides and makes permanent, behaviour (Woolfolk, 2004). Besides, motivation is also defined as an internal force which actuates, guides and ensures the lastingness of behaviour (Thorkildsen, Nicholls, Bates, Brankis & DeBolt, 2002) and a process in which activity for an aim is initiated and sustained (Pintrich, & Schunk, 2002). Motivation has a structure which comprises; internal forces, permanent traits, reactionary behaviour against stimuli, faith and influences. Motivation contains belief, internal forces, and reactive behavior against stimuli. For this reason, it is an important factor in participating in learning activities in the environment where the individual is. In this process it was determined that students have self-determination, they improve new motivation strategies and as a result of this academic success is effected (Matuga, 2009). It is observed that positive emotions such as motivation provide high request and success whereas in negative emotions such as anxiety has an important concern (Laukenmann, Bleicher, Fu, Glaser-Zikuda, Mayring, & Von Rhöneck, 2003).

- Selection and peer-review under responsibility of the Organizing Committee of the conference

*Corresponding author: Fatma Alkan- E-mail: alkanf@hacettepe.edu.tr

Motivation is necessary for individuals to act as cognitively. Therefore it is very important for teachers knowing in advance of their students' motivation degree. If the teachers know the reason of their students' low motivation to lessons, they can improve the motivation of their students. Anxiety is defined as concern, worry or sadness. Math, test, science and laboratory anxiety are usually investigated types of anxiety among the researchers. There are many researches showing that the level of anxiety is effective in learning (Turner, & Linsay, 2003; Mallow, Kastrup, Bryant, Hislop, Shefner, & Udo, 2010; Kurbanoğlu, & Akın, 2010; Kaya, & Çetin, 2012; Alkan, 2012; Güven, Çam, & Sülün, 2015; Alkan, & Koçak, 2015; Aydoğdu, 2017). Anxiety is a variable that affects learning in the negative. Science anxiety is a debilitating interaction of emotion of fear, and tension during the interaction with science concepts (Mallow, 1994). Science anxiety indicated as a career filter; students avoids from entering certain fields as they have fear of participation in the prerequisite science courses (Udo, Ramsey, and Mallow, 2004). Science anxiety is defined as fear of learning science (Azizoğlu, & Uzuntiryaki, 2006). Laboratory activities present opportunities to students to understand scientific concepts by enhancing their mental development (Hofstein, & Lunetta, 2004). Laboratory is one of the unique environments in which scientific applications are carried out, which makes the learning more permanent, efficient and effective. Chemistry laboratory practices enhance students' on the one hand handicraft on the other hand improve high-level cognitive skills such as critical thinking, use of knowledge, and inquiry. When the laboratory is considered as a complement to science teaching, it is also necessary to determine the laboratory anxiety of the students. The researches in this area are mostly focused on the anxiety about the science, while the anxiety about the laboratory is handled in few studies. When a student who is not worried about science courses enters the laboratory environment, he/she may develop anxiety by the influence of different stimuli (Azizoğlu, & Uzuntiryaki, 2006). Knowing the size and the origin of the anxiety will be instrumental in directing the students to the laboratory. For this reason, the identification of chemistry laboratory anxiety of students is gaining importance. Chemistry, one of the important areas of science is perceived by the students as a course that must be passed and as a result of these, chemistry interest is at a lower level (Becker, 1978). The low motivation of individuals suggests that their anxiety for this area of science may also be high. It is necessary to determine how the science of chemistry which is important to society is perceived by the high school students students and suggestions should be made according to the outcome to be revealed. In this study, it was aimed to determine the chemistry motivation and chemistry laboratory anxiety levels of high school students and to examine the relationship between them.

Aim of the Study

The most important feature that distinguishes science from other sciences is firstly experimentation, observation, giving priority to discovery provide students to develop the ability questioning, research, hypothesize and interpret the results. The laboratory provides opportunities for students and teachers to facilitate the achievements that are difficult to achieve with other ways. It contributes to the development of students' abilities such as observing, thinking, generating ideas and making comments. It is necessary to determine the causal relationships between chemistry which is an important part of the sciences and motivation for chemistry with chemistry laboratory and chemistry laboratory anxiety. This study is important in terms of examining cause-effect relationship between chemistry motivation and chemistry laboratory anxiety. The aim of this study is that determine the relationship between chemistry motivation and chemistry laboratory anxiety with structural equation modelling. This research will contribute to the determination of the relationship between motivation and anxiety which are the affective variables in learning and in the view of this result it helps to the restructuring of learning environments that suply student's emotional needs.

Methods

In this study relational screening models is used. These models are studies in which relationships between two or more variables are described and analyzed in depth (Karakaya, 2011). For this purpose, structural equation model is used to determine the relationship between chemistry motivation and chemistry lab concerns. SEM includes specific multivariate procedures such as factor analysis, correlation analysis and discriminant analysis and is very usefull for statistical analysis. In the correlation analysis, only the interchanges of variables are examined. In this study latent variables are used with SEM. SEM allows for the simultaneous analysis of the direct and indirect effects between observable and non-observable variables and allows linear relationships between variables to be computed correctly (Bayram, 2011; Seçer, 2015).

Sampling

The sample group of the study consists of 1091 high school students in Turkey. 55.5% of the students were female, 44.5% were male.

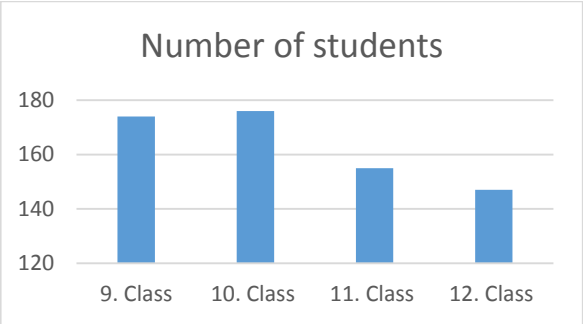

Figure 1. Distribution of sample groups by classes

Data Collection Tools

Chemistry Motivation Scale

Chemistry motivation scale were developed by Glynn, Brickman, Armstrong ve Taasoobshirazi (2011) and adapted to the Turkish by Tosun (2013). The motivation scale consisted of 19 statements in a 5-point Likert Type. Scale consists of career motivation, self-efficacy, grade motivation, self-determination, instrinsic motivation as named five sub-dimensions. The Cronbach Alpha reliability coefficicent of the whole scale 0.84. The Cronbach's alpha reliability coefficient obtained from sample datas is 0.89.

Chemistry Laboratory Anxiety Scale

The anxiety of high school students' towards chemistry laboratory were determined by the "Chemistry Laboratory Anxiety Scale" developed by Bowen (1999) and the Turkish adaptation studies made by Azizoğlu and Uzuntiryaki (2006). The anxiety scale consisted of 20 statements in a 5-point Likert Type. The scale had four sub dimensions. The Cronbach Alpha reliability coefficient of the use of laboratory instruments and chemicals sub dimension was 0.88, work with other students sub dimension was 0.87, data collection sub dimension was 0.86 and using laboratory time sub dimension was 0.87. The Cronbach's alpha reliability coefficient obtained from sample data's is 0.92.

Data Analysis

In the analysis SPSS 15 and LISREL 8.7 programmes are used. Descriptive statistics and correlations were calculated for the variables of chemistry motivation and chemistry laboratory anxiety. SEM is used to establish the model of relationships between these variables. Correlation analysis is used to determine the level of relationship between variables, whereas regression analysis is used for functional explanations. However, if the correlation coefficient calculated between two variables is influenced by another variable or variables, or if the causal relation between two variables depends on the effect of a third variable, the correlation coefficient is insufficient to explain this relationship. In this situation SEM should be used. It is also known as a statistical analysis that examines the relations between standardized variables. It contains creation of path diagrams which show relations between variables and detail comments on direct and indirect effects of correlation coefficient. The difference between path analysis and other analysis is that it can analyze direct and indirect effects among variables. The simple model of the path analysis is the model with only direct effects among the variables, and this is similar to the multiple regression analysis. The direct effect means that when the other independent variables are constant, correlation between the one independent variable and dependent variable.

Results and Findings

Descriptive statistics related to the average of the scales applied within the context of the relationship between chemistry motivation and chemistry laboratory anxiety of high school students are summarized in Table 1.

Table 1. Descriptive statistics of the scales

Scales	M	SD
Chemistry Motivation	**3.36**	**.62**
Career motivation (M1)	3.28	.78
Self-efficacy (M2)	3.42	.75
Grade motivation (M3)	3.53	.75
Self-determination (M4)	3.26	.77
Instrinsic motivation (M5)	3.14	.88
Chemistry Laboratory Anxiety	**2.94**	**.72**
The use of laboratory instruments and chemicals (E1)	2.89	.75
Work with other students (E2)	3.01	.88
Data collection (E3)	2.98	.79
Using laboratory time (E4)	2.95	.81

When we examine the Table1, we can say that the level of chemistry motivation of students is high and chemistry laboratory anxiety is medium level. When the sub-scales of the chemistry motivation scale are examined, it is noteworthy that the students have the highest average in the dimension of note motivation. In the sub-scales of the chemistry laboratory anxiety scale, while students are highly concerned about the work with other students in the laboratory, it is observed that the level of anxiety about the use of instruments and chemicals is the least.

Table 2. Correlations of the sub-scales

Correlations

		M1	M2	M3	M4	M5	E1	E2	E3	E4
M1	Pearson Correlation	1	,624**	,482**	,589**	,568**	-,540**	-,395**	-,488**	-,445**
	Sig. (2-tailed)		,000	,000	,000	,000	,000	,000	,000	,000
	N	652	652	652	652	652	652	652	652	652
M2	Pearson Correlation	,624**	1	,574**	,544**	,525**	-,439**	-,308**	-,382**	-,372**
	Sig. (2-tailed)	,000		,000	,000	,000	,000	,000	,000	,000
	N	652	652	652	652	652	652	652	652	652
M3	Pearson Correlation	,482**	,574**	1	,493**	,509**	-,209**	-,044	-,144**	-,134**
	Sig. (2-tailed)	,000	,000		,000	,000	,000	,266	,000	,001
	N	652	652	652	652	652	652	652	652	652
M4	Pearson Correlation	,589**	,544**	,493**	1	,489**	-,405**	-,342**	-,387**	-,362**
	Sig. (2-tailed)	,000	,000	,000		,000	,000	,000	,000	,000
	N	652	652	652	652	652	652	652	652	652
M5	Pearson Correlation	,568**	,525**	,509**	,489**	1	-,445**	-,317**	-,395**	-,394**
	Sig. (2-tailed)	,000	,000	,000	,000		,000	,000	,000	,000
	N	652	652	652	652	652	652	652	652	652
E1	Pearson Correlation	-,540**	-,439**	-,209**	-,405**	-,445**	1	,752**	,806**	,787**
	Sig. (2-tailed)	,000	,000	,000	,000	,000		,000	,000	,000
	N	652	652	652	652	652	652	652	652	652
E2	Pearson Correlation	-,395**	-,308**	-,044	-,342**	-,317**	,752**	1	,815**	,828**
	Sig. (2-tailed)	,000	,000	,266	,000	,000	,000		,000	,000
	N	652	652	652	652	652	652	652	652	652
E3	Pearson Correlation	-,488**	-,382**	-,144**	-,387**	-,395**	,806**	,815**	1	,825**
	Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	,000		,000
	N	652	652	652	652	652	652	652	652	652
E4	Pearson Correlation	-,445**	-,372**	-,134**	-,362**	-,394**	,787**	,828**	,825**	1
	Sig. (2-tailed)	,000	,000	,001	,000	,000	,000	,000	,000	
	N	652	652	652	652	652	652	652	652	652

**. Correlation is significant at the 0.01 level (2-tailed).

In Table2, we give the correlations between all sub-scales using correlation analysis. From this table we can say that all correlations are significant and there is a negative correction between chemistry motivation and chemistry laboratory anxiety.

Findings regarding the Structural Equation Modeling;

To examine the relationship between the latent variables chemistry motivation with chemistry laboratory anxiety we have used Structural Equation Modeling. In this analysis our null hypothesis is;

H_0 : There is no significant correlation between the chemistry motivation with chemistry laboratory anxiety.

H_s : There is significant correlation between the chemistry motivation with chemistry laboratory anxiety.

The model which obtained from SEM is given in Figure1.

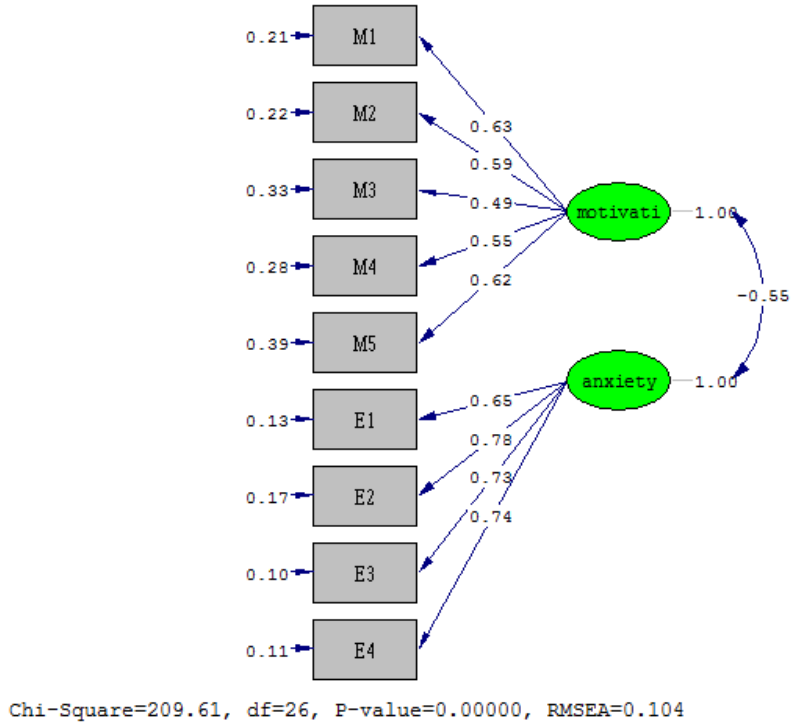

Figure 2. The SEM Model for Chemistry Motivation with Chemistry Laboratory Anxiety

As can be seen in Figure 2, there was a negative and significant correlation between the chemistry motivation and chemistry laboratory anxiety. The standardized path coefficient from chemistry motivation and chemistry laboratory anxiety was found to be -.55.

Table 3. Results of SEM for chemistry motivation with chemistry laboratory anxiety

Variables	**Path Coefficient**	**T Values**	R^2
M1	0.63	23.61	0.66
M2	0.59	22.30	0.60
M3	0.49	17.45	0.42
M4	0.55	20.05	0.52
M5	0.62	19.58	0.50
E1	0.65	27.75	0.76

E2	0.78	28.61	0.79
E3	0.73	30.20	0.80
E4	0.74	29.92	0.83

The path coefficients which are obtained with path diagram are given in Table3 and we can say that all are significant. The goodness of fit of the model shown in Figure1 is examied with the criterias given in Table 4. We can say that our model is significant based on all criterias. (For details see: Dursun and Kocagöz, 2010).

Table 4. Criteria of SEM

	Well Fitness	**Acceptable Fitness**	**Result**
RMSEA	0<RMSEA<0.05	0.05<RMSEA<0.10	0.104 Acceptable
NFI	$0.95 \le NFI \le 1$	$0.90 \le NFI \le 0.95$	0.97 Well
NNFI	$0.97 \le NNFI \le 1$	$0.95 \le NNFI \le 0.97$	0.96 Acceptable
CFI	$0.97 \le CFI \le 1$	$0.95 \le CFI \le 0.97$	0.97 Well
GFI	$0.95 \le GFI \le 1$	$0.90 \le GFI \le 0.95$	0.93 Acceptable
AGFI	$0.90 \le AGFI \le 1$	$0.85 \le AGFI \le 0.90$	0.88 Acceptable
χ^2	209.61 (sd=26 P=0.00)		

According to above Table there is significant correlation between the chemistry motivation with chemistry laboratory anxiety.

Conclusion

In this study we have examined the relationship between chemistry laboratory anxiety and chemistry motivation using different statistical tools. We try to take into account the direct and indirect correlations between sub-scales of chemistry laboratory anxiety and chemistry motivation. We try to model the sub-scales with SEM. We obtain a statistically significant model. We can conclude that there is a significant negative relationship between chemistry laboratory anxiety and chemistry motivation.

The present study has several inferences for high school students. It is important to improve students' motivation towards chemistry and to reduce anxiety towards laboratory in learning environments. These expectations can be realized when students' have a chance to observe their teachers who use the science and chemistry effectively (i.e., experimenting in class) or when students use chemistry experiments in their own instruction during the projects. Teachers should help students to see the benefits of chemistry through experiments which are basic and not dangerous. Through can be diminishable the anxieties of students towards laboratory and so augmentable the motivation towards chemistry. For example, chemistry teachers should use daily life applications and daily chemistry experiments in their lessons to make them more conceptual, which will allow students' to see how chemistry is helpful and useful in understanding science concepts. Furthermore, teachers should gain more experience in using chemistry laboratory; this could be succeed by presenting more laboratory applications include incorporating experiments use in teaching chemistry. Teachers' laboratory practices not only enhances students' motivations, but also reduces their laboratory anxieties. Grounded on our feedback of students' statements and wishes, laboratory applications can be impressive in enhancing chemistry motivations.

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