New Trends and Issues Proceedings on Humanities and Social Sciences
Volume 6, Issue 2 (2019) 001-008
DOI: https://doi.org/10.18844/prosoc.v6i2.4276
www.prosoc.eu

An analysis of achievement goal orientations and chemistry motivations of students within the structural equation modelling and an evaluation of the influencing factors

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Suggested Citation:
Fatma, A. & Yucel, A. S. (2019). An analysis of achievement goal orientations and chemistry motivations of students within the structural equation modelling and an evaluation of the influencing factors. *New Trends and Issues Proceedings on Humanities and Social Sciences.* [Online]. *6*(2), pp 001–008. DOI https://doi.org/10.18844/prosoc.v6i2.4276

Recived, 19 January 2019; Revised, 23 March 2019; Accepted, 15 May 2019.
Selection and peer review under responsibility of Prof. Dr. Hafize Keser, Ankara University, Turkey

Abstract

The aim of this study based on this view is to investigate the relationship between the achievement-goal orientations of students during learning and their motivation levels towards learning chemistry. The study was designed in the relational survey model. The sample of the research consists of 688 high school students. In the research, the scale of achievement goal orientations and chemistry motivation questionnaire have been used as data collection tools. According to the structural equation modelling results, the fit indexes of the model are at the levels of good fit and acceptable fit. There is a positive and substantive link between achievement goal orientation and chemistry motivation. According to Manova results of the research, it has been determined that sex has a substantive impact on the performance-approach and performance-avoidance sub-dimensions of the achievement goal orientations scale and the internal motivation-personal convenience, external motivation, self-determination-self-sufficiency and anxiety of evaluation sub-dimensions of the chemistry motivation questionnaire.

Keywords: Achievement goal orientation, chemistry motivation, structural equation modelling, multivariate analysis of variance.

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1. Introduction

Among one of the main objectives of chemistry education involved in our education system, to make students understand and make sense of chemistry, and to establish relations between chemistry and the events that occur in daily life is ranked. This objective will be possible with the use of scientific methods in chemistry teaching and by making students' learning more effective. In order for students to realise permanent and meaningful learning, they should be made aware of the ways they learn and what the learning process means. So far in teaching activities, the answers to the questions such as what students do in the learning process, what they care about or why they learn, have not been elaborated much. In the learning process, students may have different personal perspectives that affect their cognitive, affective and behavioural responses. The approach that takes the topic of studying these different perspectives in learning processes is defined as the achievement-goal orientations (Dweck, 1986). In the achievement-goal approach, the mental processes and activities stemming from the desire of students to reach their goals in their learning processes are examined. When the literature is examined, achievement-goal orientations are examined in two dimensions as learning orientation and performance orientation (DeShon & Gillespie, 2005; Dweck & Leggett, 1988). There may be many variables that affect the learning orientations of students in their learning processes. While examining students' achievement-goal orientation approach in their learning processes, evaluating the concept of motivation for learning together with this approach will also give important feedback in terms of learning selectivity and quality. The motivation the student gains with the learning motive in the learning process has a fundamental function in his or her adaptation to the subject he or she will learn. The importance levels of the objectives that students have play an important role in determining their motivation levels (Tuna & Turk, 2006). Determining the chemistry motivation levels and achievement-goal orientations of high school students towards learning chemistry courses and examining the relationship between the two, the findings that will be obtained as a result will be an important guide for teachers, field experts and even students as to points of attention in terms of learning–teaching processes in chemistry lesson. The aim of this study based on this view is to investigate the relationship between the achievement-goal orientations of students during learning and their motivation levels towards learning chemistry.

2. Method

The study was designed in the relational survey model. Relational survey is a model that enables to examine the relationship of two or more variables with one another (Fraenkel, Wallen & Hyun, 2012). The aim of this study was to determine the achievement goal orientations and chemistry motivations of high school students', examine the relationship between these variables and according to gender and class variables were compared and evaluated.

2.1. Sampling

The sample of the research consists of 688 high school students in Turkey. 55.1% of the students were female and 44.9% were male. The students who participated in the research were attending either in Anatolian high schools, high school or vocational high schools. Also, their classes were classified as '9. Class, 10. Class, 11. Class and 12. Class'.

Table 1. Characteristics of sampling

		F	%
Gender	Female	379	55.1
	Male	309	44.9
School type	Anatolian high school	183	26.6
	High school	434	63.1
	Vocational high school	71	10.3
Class	9. class	191	27.8
	10. class	197	28.6
	11. class	190	27.6
	12. class	110	16.0

2.2. Data collection tools

In the research, achievement orientation scale and chemistry motivation questionnaire were used as data collection tools.

2.2.1. Achievement goal orientations scale

Achievement goal orientations scale were developed by Midgley et al. (1998) and adapted to the Turkish by Akin and Cetin (2007). The scale consisted of 17 statements in a five-point Likert Type. Scale and have three dimensions. These dimensions are mastery goals, performance-approach goals and performance-avoidance goals. The Cronbach Alpha reliability coefficient of learning orientation 0.77, performance-approach orientation 0.79 and performance-avoidance orientation 0.78.

2.2.2. Chemistry motivation questionnaire

Chemistry motivation questionnaire was developed by Glynn, Taasoobshirazi and Brickman (2009) and adapted to the Turkish by Ilhan, Yildirim and Sadi Yilmaz (2012). The questionnaire consisted of 22 statements in a five-point Likert Type. The scale consists of internal motivation-personal convenience, external motivation, self-determination-self-sufficiency and anxiety of evaluation as named four sub-dimensions. The Cronbach Alpha reliability coefficient of the whole scale 0.82 and of the sub-dimensions are as follows: 0.81, 0.74 and 0.62.

2.3. Data analysis

In the analysis of the data obtained from the study was performed with SPSS 17 and LISREL 8.7 programmes are used. Descriptive statistics and correlations were calculated for the variables of achievement goal orientations, chemistry motivation and all sub-dimensions. Thus, achievement goal orientation and chemistry motivation levels of the sample group were determined. Structural equation modelling (SEM) is used to establish the model of relationships between these variables. The difference between the achievement goal orientations and chemistry motivation sub-dimensions according to the gender and class was examined by 'Multivariate Variance Analysis (MANOVA)'.

3. Results

3.1. Assumptions of SEM and MANOVA

All assumptions required for SEM and MANOVA were justified before analysing data. The analysis results are given in Table 2.

Table 2. Descriptive statistics for the observed variables

Observed variables	*N*	Mean	5% Trimmed mean	SD	Min	Max	Skew.	Kurt.	*α*
Achievement goal orientations	688	3.20	3.22	0.72	17	85	−0.429	1.634	0.916
Mastery goals	688	3.22	3.24	0.84	6	30	−0.356	0.520	0.877
Performance-approach goals	688	3.54	3.59	0.89	5	55	−0.449	−0.032	0.867
Performance-avoidance goals	688	2.76	2.74	0.89	6	30	−0.233	−0.136	0.792
Chemistry motivation	688	3.40	3.43	0.75	22	110	−0.533	0.749	0.785
Internal motivation-personal convenience	688	3.23	3.25	0.78	9	45	−0.333	0.494	0.815
External motivation	688	3.54	3.57	0.87	3	15	−0.432	0.281	0.544
Self-determination-self-sufficiency	688	3.33	3.35	0.84	6	30	−0.378	0.136	0.777
Anxiety of evaluation	688	2.76	2.75	0.84	4	20	0.094	−0.082	0.603

Skew. = Skewness; Kurt. = Kurtosis; α = Cronbach's alpha.

When the kurtosis skewness values are examined, it is seen that the data are distributed normally (Tabachnick & Fidell, 2013). To observe whether there are multivariate normality and extreme values, the mean and the trimmed mean were compared, and if these two mean values were very different from each other, the Q–Q plot was first checked to specify the outliers. In these data set when means compared to 5% trimmed means a few outliers were observed and Mahalanobis distance value was examined. In the data file, outliers whose Mahalanobis distance is above the critical value are excluded from the data set. In order to meet the multivariate normality assumption, these data were excluded from the analysis and the remaining 680 data met the multivariate normality assumption. Homogeneity of variance-covariance matrices was evaluated by Box's M test and Levene tests. The significance of the Box's M test is as follows (Box's M = 274.236, $F_{(7.662)}$:1.347, $p > 0.05$). The homogeneity of covariance matrices was met. Levene test results are ($p > 0.05$). Equality of variance in terms of dependent variables was accepted. The data meet the assumptions and were analysed in accordance with the purpose of the study.

3.2. Findings descriptive statistics

Descriptive statistics related to the average of the scales applied within the context of the relationship between achievement goal orientations, chemistry motivation and all sub-dimensions of high school students are summarised in Table 3.

Table 3. Descriptive statistics

Observed variables	*N*	Mean	SD
Mastery goals	680	3.22	0.84
Performance-approach goals	680	3.54	0.97
Performance-avoidance goals	680	2.76	0.99
Internal motivation-personal convenience	680	3.24	0.77
External motivation	680	3.54	0.85
Self-determination-self-sufficiency	680	3.33	0.83
Anxiety of evaluation	680	2.77	0.83

3.3. Findings regarding the structural equation modelling

To examine the relationship between the latent variables achievement goal orientations with chemistry motivation, we have used Structural Equation Modelling. 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 standardised variables. It contains the creation of path diagrams which show relations between variables and detail comments on direct and indirect effects of the correlation coefficient. The difference between path analysis and other analysis is that it can analyse 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, a correlation exists between the one independent variable and dependent variable. Obtained findings are presented in Table 4.

Table 4. Correlation between sub-dimensions

		Ach Go1	Ach Go2	Ach Go3	Chem Mo1	Chem Mo2	Chem Mo3	Chem Mo4
Ach Go1	Pearson correlation	1	0.460 (**)	0.356 (**)	0.397 (**)	0.515 (**)	0.429 (**)	−0.331 (**)
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000
Ach Go2	Pearson correlation	0.460 (**)	1	0.315 (**)	0.254 (**)	0.430 (**)	0.535 (**)	−0.432 (**)
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000
Ach Go3	Pearson correlation	0.356 (**)	0.315 (**)	1	0.209 (**)	0.335 (**)	0.222 (**)	−0.289 (**)
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000
Chem Mo1	Pearson correlation	0.397 (**)	0.254 (**)	0.209 (**)	1	0.796 (**)	0.447 (**)	−0.377 (**)
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000	0.000
Chem Mo2	Pearson correlation	0.515 (**)	0.430 (**)	0.335 (**)	0.796 (**)	1	0.589 (**)	−0.473 (**)
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000
Chem Mo3	Pearson correlation	0.429 (**)	0.535 (**)	0.222 (**)	0.447 (**)	0.589 (**)	1	−0.608 (**)
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000
Chem Mo4	Pearson correlation	−0.331 (**)	−0.43 2 (**)	−0.28 9 (**)	−0.377 (**)	−0.47 3 (**)	−0.608 (**)	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	

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

In Table 4, we give the correlations between all sub-dimensions using correlation analysis. From Table 4, we can say that all correlations are significant and there is a negative correlation between the anxiety of evaluation and other sub-dimensions. The model obtained from SEM is given in Figure1.

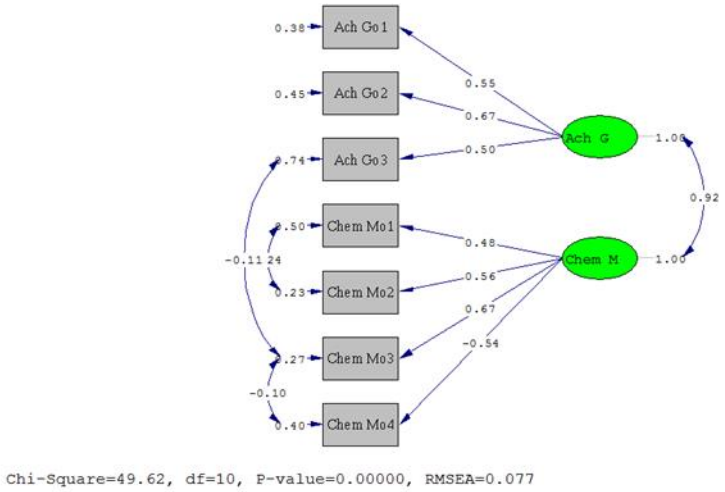

Figure 1. The SEM model for achievement goal orientations with chemistry motivation

As can be seen in Figure 1, there was a positive and significant correlation between achievement goal orientations and chemistry motivation. The standardised path coefficient from achievement goal orientations and chemistry motivation was found to be 0.92. According to the structural equation modelling results, the fit indexes of the model are at the levels of a good fit. There is a positive and weak link between achievement goal orientation and chemistry motivation.

Table 5. Criteria of SEM

	Well fitness	Acceptable Fitness	Result
χ^2/df	$0 \le \chi^2/df \le 2$	$3 \le \chi^2/df \le 5$	4.962 Acceptable
RMSEA	0 < RMSEA < 0.05	0.05 < RMSEA < 0.08	0.077 Acceptable
NFI	0.95 ≤ NFI ≤ 1	0.90 ≤ NFI ≤ 0.95	0.98 Well
NNFI	0.97 ≤ NNFI ≤ 1	0.95 ≤ NNFI ≤ 0.97	0.97 Well
CFI	0.97 ≤ CFI ≤ 1	0.95 ≤ CFI ≤ 0.97	0.99 Well
GFI	0.95 ≤ GFI ≤ 1	0.90 ≤ GFI ≤ 0.95	0.98 Well
AGFI	0.90 ≤ AGFI ≤ 1	0.85 ≤ AGFI ≤ 0.90	0.94 Well

Adapted from Schermelleh-Engel, Moosbrugger and Muller (2003).

As demonstrated in Table 5, fit indexes of the created model fit within the range of the well and acceptable fit indexes.

3.4. Findings regarding the MANOVA

The comparison of mastery goals, performance-approach goals, performance-avoidance goals sub-dimensions of achievement goal orientations and internal motivation-personal convenience, external motivation, self-determination-self-sufficiency and anxiety of evaluation sub-dimensions of chemistry motivation of high school students' according to gender and class was conducted with MANOVA. MANOVA findings are given in Table 6.

Table 6. MANOVA findings

Source of the variance		Value	*F*	Hypothesis df	Error df	*p*	η^2
Gender	Wilks' Lambda	0.971	2.802	7	666	*0.007*	0.029
Class	Wilks' Lambda	0.933	2.240	21	1,912.943	*0.001*	0.023
Gender*Class	Wilks' Lambda	0.972	0.892	21	1,912.43	0.603	0.009

When the table is examined, it is seen that there was significant difference on sub-dimension of scales according to gender and class ($F_{(Gender)}$ = 2.802; η^2 =.029; p < 0.05; $F_{(Class)}$ = 2.240; η^2 = 0.023; p <

0.05). It was observed that the effect sizes were medium (Cohen, 1988). There was no significant difference when gender and class independent variables were considered simultaneously ($F_{(Gender*Class)}$ = 0.892; p > 0.05). The ANOVA test was applied to determine which sub-dimensions of significant difference were determined according to MANOVA. According to Tukey multiple comparison test, gender has a significant impact on the performance-avoidance goals of the achievement goal orientation scale and external motivation and anxiety of evaluation sub-dimensions of the chemistry motivation questionnaire. It has been identified that the class variable was also influential on the achievement goal orientations and chemistry motivations of high school students'. Class variable has a significant impact on mastery goals and self-determination-self-sufficiency and anxiety of evaluation dimensions. According to the results, the substantive difference resides at 9th and 12th-grade students in the extent of learning orientation, at 10th- and 12th-grade students and 11th- and 12th-grade students in the extent of self-determination-self-sufficiency, and at 10th- and 12th-grade students in the extent of the anxiety of evaluation. The research findings point out that achievement goal orientations are positive predictors of chemistry motivation.

4. Discussion and conclusion

According to the results of the structural equation model, the fit indices of the model are in good fit and acceptable fit levels. There is a positive and significant relationship between the achievement-goal orientation and chemistry motivation. According to the Manova results of the study, it has been determined that gender has a significant effect on the performance-avoidance sub-dimension of the achievement-goal orientation scale and the external motivation and the anxiety of evaluation sub-dimensions of the chemistry motivation questionnaire. When the achievement-goal orientations of the female students are examined, it has been detected that the performance-approach orientation has a higher tendency compared to the male students. This result is in accord with the findings of other studies (Church, Elliot & Gable, 2001; Elliot, Cury, Fryer & Huguet, 2006; Kucukoglu, Kaya & Turan, 2010). It is seen that the gender factor has an effect on the anxiety of evaluation and external motivation sub-dimensions of the chemistry motivation questionnaire. Accordingly, it has been observed that female students have higher scores for all the levels of the chemistry motivation questionnaire and have higher motivation for learning chemistry compared to male students. This finding is supported by other research studies (Altundag & Alkan, 2016). When the motivation levels of the questionnaire are analysed, it has been reached that although the external motivations of female students in terms of being interested in chemistry, receiving high grades being successful are high, the anxiety of evaluation levels are also high due to the anxiety of failure towards this course. Motivation of individuals can be improved with activity-based training in the chemistry and laboratory (Onen Yucel, Altundag, Koçak & Mustafaoglu, 2017). It has been determined that the classroom variable in which students learn has also a significant effect on the achievement-goal orientations and chemistry motivations of students. According to the results of the analysis carried out in order to determine the dimensions of the significant difference, it is in the learning orientation dimension of the achievement-goal scale and in the self-determination, self-sufficiency and anxiety of evaluation dimensions of the chemistry motivation questionnaire. According to the results, the significant difference is in the learning orientation dimension between the 9th and 12th grades, in the self-determination and self-sufficiency dimensions between the 10th and 12th grades and between the 11th and 12th grades, and in the anxiety of evaluation dimension between the 10th and 12th grades. According to the results, it is remarkable that the 12th-grade students have a higher average when it is compared to the other grades. As senior high school students feel like they have higher learning orientation and self-sufficiency on the one hand because of the exams they have prepared for such as TYT, AYT and so on, it is also an expected situation that their anxiety of evaluation is higher as well. In addition, although their self-sufficiency is high, they are worried about failing in the evaluation processes. The findings of the research point out that achievement-goal orientations are a positive predictor of chemistry motivation.

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