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Uncovering Turkish Science High School Students' Learning Strategy, Inquiry-Oriented Self-efficacy, Task Value, Achievement Goals: A Structural Equation Modelling Analysis

Burak Feyzioğlu, Assoc. Prof. Dr., Aydın Adnan Menderes University, Türkiye, bfeyzioglu@adu.edu.tr
0000-0002-0128-3343

Barış Demirdağ, Dr.**,** Gaziemir Nevvar Salih İşgören High School, Türkiye, barisdemirdag@gmail.com
0000-0003-1474-4951

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Abstract

In the literature, the characteristics of students with high skills in the subjects of science and mathematics are generally examined independently of the social learning environment. The aim of this study was to investigate the relationship between achievement goal orientation, inquiry oriented self-efficacy, learning strategies and task value and to present that relationship with various models. This study was carried out with 292 students from Science High School (SHS) in Turkey in the 2018-2019 academic year. In this research, two models were tested with relational screening designs as theoretical models for the relationship between the learning strategies used by SHS students and their inquiry-oriented self-efficacy (IOS) and achievement goal orientations (AG). The IOS scale, the AG scale, semi-structured interview forms, and the learning strategies scale were used as data collection tools. Collected data was analysed using the Multiple Regression Analysis. The first model is developed according to a task in which scientific inquiry is valuable, considering the goals of the SHS chemistry curriculum, while the second model is designed according to a task in which competition and test scores are valued rather than scientific inquiry. Contrary to expectations, it is surprising that performance goal orientation (PE) is mediated through the learning strategy and IOS that SHS students use, as much as they explain their chemistry learning conceptions with the test score.

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INTRODUCTION

In different kinds of schools such as Gymnasium in Germany, Lukokoulutus-Gymnasieutbildning in Finland and Bachillerato in Spain (European Commission/EACEA/Eurydice, 2018) students with high academic achievement in the fields of science and mathematics are given advanced science and mathematics lessons like Science High School (SHS) in Turkey. It is expected that students who graduate from these schools will be able to closely follow scientific studies, use new technologies, and create new knowledge and plan projects. When the science curriculum for these schools is studied, the nature of science and scientific inquiry are taken into consideration. Therefore, it is advised that teachers prioritise laboratory practises alongside concept teaching in scientific lessons as part of the Science High School Chemistry Course curriculum. In this case, it is expected that teachers will give more space to active learning methods in chemistry lessons in such schools (Kovarik, Robinson & Wenzel, 2022), and that students' self-efficacy (Howell, Yang, Holesovsky & Scheufele,2021; Liu, 2022), achievement goal orientation (Feyzioğlu, 2019) and learning understanding (Baur & Emden, 2021) will also change positively. Although attention is expected to be paid to the nature of scientific inquiry, schools such as science high schools, where advanced science and mathematics courses are taught, have a highly competitive, perfectionist learning environment in which assessment is focused on results and success, and mistakes are not well received. Therefore, when examining SHS students, whose high academic achievement in the fields of science and mathematics differ from those of other students, the characteristics of the learning environment should be considered. This is because there is a dynamic relationship between these variables that make up the learning environment (Bardach, Yanagida, Klassen & Lüftenegger, 2022; Urdan & Kaplan, 2020).

CONCEPTUAL FRAMEWORK

THE DYNAMIC STRUCTURE OF LEARNING ENVIRONMENT: SELF EFFICACY, GOAL ORIENTATION, AND LEARNING STRATEGIES

Bandura (2001) defined self-efficacy as a person’s belief in his/her own capacity to attain the desired levels of learning and behaviour. On the other hand, Zimmerman (2008) stated that self-efficacy is as an individual’s belief that he can carry out a task in the most effective way. Self-efficacy determines the effort shown by students during a task, and the stability and flexibility that they show when faced with a challenge. The more self-sufficient students feel, the greater their effort, determination and flexibility is (Pajares, 1996). According to Pajares (1996) and Smith and Fouad (1999), it was highly challenging to generalise self-efficacy across all domains because it was domain-specific with regard to goals and result expectations. In this study, students’ IOS is examined. The characteristics of individuals who have high self-efficacy feel competent with regard to inquiry skills, strive to develop and use these skills, and demonstrate flexibility and stability when faced with a difficulty during a scientific task (Feyzioğlu, 2019; Howell et.al, 2021: Liu, 2022). It is expected that these students, who have high academic achievements in science and mathematics in schools that aim to train scientists and give weight to scientific applications, have high self-efficacy towards inquiry. For students to be able to show good performance regarding inquiry skills, it is not sufficient for them to have self-efficacy only in this regard. In the learning environment, goals for these skills should be included and these goals should be valuable enough. Raising individuals who have high-level IOS must be among the aims of SHS type schools. However, when setting these goals, the characteristics of SHS, where competition is high and, non-constructive feedback from peers is received in case of mistakes need to be taken into consideration. According to the relevant literature, there aren't enough studies at these schools that determined or developed IOS, in particular.

Another variable that constitutes the dynamic structure of learning environment, such as self-efficacy, is achievement goal orientation. AG can be characterised as orientation towards learning, mastery or a task in any subject (Zimmerman, 2008). According to this theory, understanding students' motivation and behaviours related to their academic success can be accomplished by connecting them to the elements that contribute to it or to the objectives they have for themselves as they pursue academic courses (Ames, 1992). While previous studies in this field focused only on two goals of students, namely, performance (PE) and mastery goal (MA) orientations, in the studies conducted in recent years, there are developments in these models. Elliot et al. (Elliot & Church, 1997; Elliot & Harackiewicz, 1996) developed the "two model" as performance-approach (positive valence; approaching success) and performance-avoidance (negative valence; failure avoidance). Thus, they introduced a triple model (performance-approach, performance-avoidance, mastery-oriented goals). Although studies conducted according to the tripartite model yield consistent results, Elliot and McGregor (2001) stated that MA in the tripartite model is expressed only in positive valence. They developed a new four-dimensional scale by adding items describing learning objectives negatively. According to this new model, called the “2 x 2 Achievement Goal Model”, students' AG are divided into four groups: mastery-approach, mastery-avoidance, performance-approach and performance-avoidance. However, in studies with students, mastery-avoidance goals received little empirical support (Lee & Bong, 2016). At the same time, although PE is classified as avoidance and approach, it has been determined that it cannot distinguish between normative and appearance features (Hulleman, Schrager, Bodmann & Harackiewicz, 2010). Finally a new model with sub-dimensions of mastery-approach, normative and appearance performance-approach, normative and appearance performance-avoidance goals has been proposed (Lüftenegger, Bardach, Bergsmann, Schober & Spiel, 2019).

When individuals with high IOS are faced with a task in which they will use their inquiry skills, it is expected that their goal will be to carry out the task by using these skills (Pintrich, 2000). Those students who are MA will define their deficiencies in the process and try to eliminate these by focusing on their own skills. In cases of failure, instead of seeking errors and deficiencies outside, they scrutinise their own skills. In some studies, however, it has been determined that students with high self-efficacy do not always demonstrate MA. These students may display PE (Jagacinski & Duda, 2001). It is revealed that these students, instead of self-regulating towards completing a task, will self-regulate towards being the best when compared to other students. It is seen that such students, rather than making an effort to understand the characteristics and goals of the learning environment, will adapt these characteristics to suit themselves (Henderson & Dancy, 2007). With this adaptation, students may sometimes become diverge from their actual goal. It can be asserted that these individuals, who spend their energies more on trying to be the best, have higher levels of anxiety and experience more burnout at the end of the process than those with mastery goal orientations (Linnenbrink & Pintrich,2000). Individuals with performance avoidance tend to be as anxious as individuals with performance approach tendencies. These individuals have low self-efficacy levels. The source of their anxieties differs from that of individuals with performance approach orientations. These students do not wish their errors and deficiencies to be seen by other students, or even by their teachers. Their focus is on not revealing their deficiencies rather than completing the task. They cognitively self-regulate accordingly. Students with this tendency choose the easy tasks or the most difficult ones to do. If they fail, they make the excuse that the task is too difficult to do anyway (Linnenbrink & Pintrich, 2000). Both individuals who display a performance approach and those who display an avoidance approach will seek the source of their failure outside. They will claim that the task was so difficult that it was impossible to complete, that they did not receive adequate support, or that they are treated unfairly. However, another source of their failure is their lack of skills in that subject. It can be noticed that they do not mention making an effort or showing resistance in the face of difficulty.

It is expected that individuals who are focused on learning and on completing tasks and making cognitive adjustments to the task would prefer to use deep learning strategies (Elliot & McGregor, 2001). Individuals who use these strategies search for sources of knowledge by comparing more than one source with each other. That is, they do not immediately accept the first information they obtain as accurate. They learn new information by associating it with previous information. They take a holistic view of concepts and skills (Marton & Säaljö, 1976). On the other hand, individuals who wish to be the best or who do not wish their errors to be seen will focus on the concepts and skills that are important and necessary for them. They are far from associating new information with previous one. They generally use surface learning strategies by accepting the first piece of information that they obtain as correct without questioning it (Marton & Säaljö, 1976).

AN INDICATOR FOR UNDERSTANDING THE TASK VALUE IN THE CHEMISTRY CLASSES: CONCEPTIONS OF LEARNING CHEMISTRY AMONG SHS'S STUDENTS

As stated in the literature there are models that self-efficacy predicts AG and learning strategies (Ames, 1992). However, when these models that include cognitive and affective variables are being developed, it is also necessary to consider the value placed on tasks in the learning environment (Feather, 2021). Is being the best more valuable in a learning environment where scientific studies are valued, or is it better to comprehend the traits of scientists and work toward acquiring these traits? How should students be assessed in this environment, and what are the criteria for evaluating these students? No matter how high a student's IOS is, if enough importance is not given to inquiry skills in the learning environment, then it cannot be expected that the student will set a goal for himself/herself in this subject or that he/she will use deep learning strategies for this subject. The characteristics of a learning environment and the tasks that are valued in that environment can be identified by means of observations related to the learning environment and students' explanations related to chemistry learning. The characteristics of the learning environment will be determinative on the students' self-efficacy towards questioning, their AG and the learning strategies they use within the framework of self-regulation.

Tsai (2004) determined and classified high school students' conceptions of learning science with a phenomenographic analysis. These conceptions will provide information related to which tasks are valued in these lessons. While this classification was being made, the questions "Why do we learn science?", "How do you best learn science?", "How do you know when you have learnt something?" and "Using which method of study do you learn?" were addressed to the students, and their learning conceptions were classified according to their answers. He classified these conceptions as memorising, test solving, calculating, increasing knowledge, practice, understanding information and interpreting with a different perspective.

The founding goals of SHS are explained as to prepare students with high academic achievement in the subjects of science and mathematics for higher education in these fields, and to be a source for educating the highly qualified scientists needed in science and mathematics. Students in science high schools are selected at the end of a central exam, which all secondary school students take. The exam consists of multiple-choice questions that covers secondary school subjects such as science, mathematics, language and reading, and social studies. In contrast to other high schools, science high schools have a different chemistry curriculum. Compared to the other chemistry curriculum, more experimental practices have been added to the Science High School Chemistry Curriculum. Moreover, emphasis has been placed on the use of information and communication technologies in chemistry teaching, on structuring outcomes that will also reflect high-level cognitive skills, and on associating these with everyday life.

Despite all these expectations, the teaching programmes are not sufficiently implemented in accordance with their goals in SHS. One of these reasons is that students who graduate from science high schools move on to higher education by taking the same central exam as students from other types of high school. The central exam is designed to measure students' academic success, rather than their high-level thinking skills. Moreover, this exam includes not only mathematics and science, but also other subjects as well. The reasons such as the intense content of the curriculum (Backus, 2005) the low readiness of the students in terms of high-level thinking skills (Hofstein & Lunetta, 2004), physical inadequacies (insufficient laboratory equipment, inadequate safety measures, crowded classrooms) (Hofstein & Lunetta, 2004), the teachers' epistemological beliefs are not compatible with the objectives of curriculum (Brown et al. 2006), indicate that lessons are not carried out in accordance with the objectives specified in the curriculum.

In the SHS in which this study was conducted, the learning conceptions of students in chemistry classes were investigated according to Tsai's (2004) model, with the aim of determining which goals had been specified for chemistry lessons and the extent to which these goals were implemented. Tsai (2004) discussed the Concepts, Memorising, Testing, Calculating and Increasing knowledge dimensions of chemistry learning approaches as superficial, and the applying, understanding, knowledge and Interpreting knowledge from a different perspective within the framework of a deep learning strategy. This classification has also been used in different studies (Wong, Liang & Tsai, 2021; Tan, Liang & Tsai, 2021). In an environment where test scores are important, students take part in superficial strategies such as repetition, memorization, and reinforcement by solving multiple-choice test questions instead of applications involving deep learning strategies such as research, questioning, and problem solving (Ardura & Galán, 2019; Lindblom-Ylänne, Parpala & Postareff, 2019). Science High School students' chemistry learning was associated with test solving, which is one of the surface learning approaches, rather than with deep learning approaches (Table 1).

Table 1. *Learning Conceptions of Students in Chemistry Classes in the Science High School*.

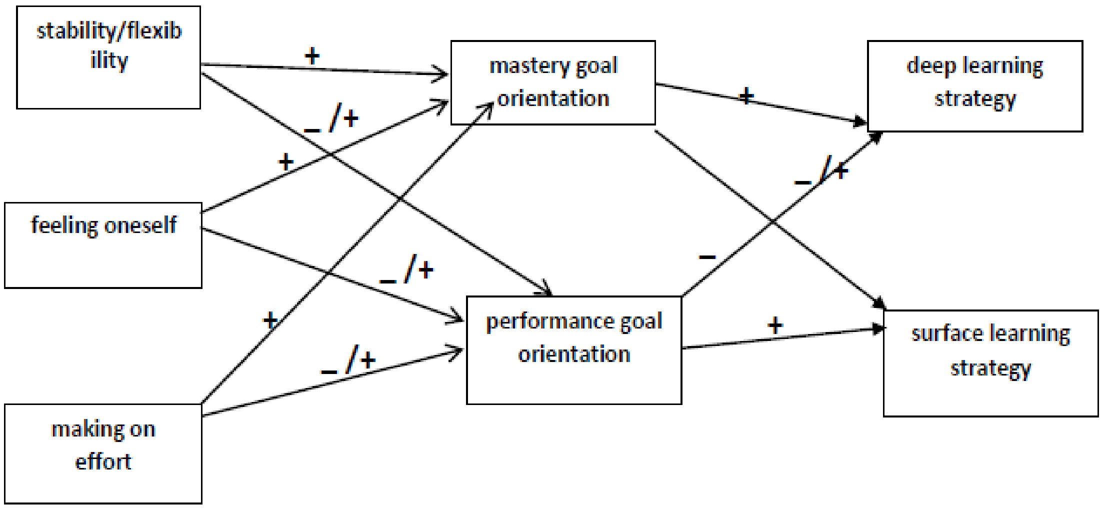
	Concept	*Grade 9*		*Grade 10*		*Grade 11*		*Grade 12*		*Total*	
		N	%	N	%	N	%	N	%	N	%
Surface learning approaches (External)	Memorising	2	3,17	2	5,13	-	-	-	-	4	2,7
	Testing	36	**57,13**	25	**64,1**	13	**44,85**	9	**52,94**	83	56,1
	Calculating	-	-	-	-	-	-	-	-	-	-
	Increasing knowledge	1	1,6	-	-	-	-	-	-	1	0,67
Deep learning approaches (Internal)	Applying	4	6,35	6	15,39	8	27,58	1	5,88	19	12,83
	Understanding	16	25,4	4	10,25	7	24,13	6	35,3	33	22,3
	Interpreting knowledge	4	6,35	2	5,13	1	3,44	1	5,88	8	5,40
Total		63	42,56	39	26,35	29	19,60	17	11,49	148	

As can be seen in Table 1, students at each grade level preferred the test score, which is described as a surface learning approach, over other concepts when describing chemistry. In other words, if the test scores related to chemistry are high, they have accepted that they have learned the concepts in this course. Defining SHS students to learn chemistry concepts with surface learning rather than a deep learning strategy also shows that the test score is a more important task in this environment than the nature of scientific inquiry.

In this study, two theoretical models have been created by considering the variable of value given to tasks in the learning environment. Learning strategies are dependent variable, while value placed on tasks in the learning environment (learning conceptions), IOS and AG are independent variables.

Since this study was conducted in a science high school, the first model was created by considering that inquiry (deep learning approaches of learning conception) in the chemistry learning is an important task (Figure 1). In this model, it is estimated that effort, stability/flexibility and feeling oneself efficient, which are sub-dimension of inquiry oriented self-efficacy, will be positive predictors of MA and either negative or positive predictors of PE. In this model, it is estimated that the sub-dimensions of IOS, namely effort, determination/flexibility, and feeling competent, will positively predict MA and negatively or positively predict PE. Although the development of high-level thinking skills in the learning environment is a valuable goal, however, some students, instead of focusing on developing these skills, will focus on avoiding making errors or on not revealing their deficiencies. Others, on the other hand, will select other students' learning as a criterion and create an atmosphere of competition by continually comparing themselves with those students. These students with PE are expected to use the same surface learning strategies as those showing avoidance. Students showing avoidance are expected to have low IOS, whereas students with PE, who try to be the best by taking their peers' learning as a reference, will have high levels of IOS. Just as these students, who aim to show good performance only in comparison to others, can use surface learning strategies, they can also use deep learning strategies.

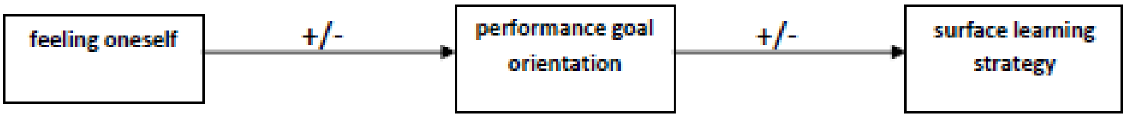
Figure 1. *First Model for in a Learning Environment where Scientific Inquiry is an Important Task*



In classrooms where the development of higher-order thinking skills is not an important goal, the nature of scientific inquiry will not be considered and applications will not be made. For example, laboratory practices will not be carried out, or even if they are carried, they will be types of practices in which inquiry level is low. Even though there are students with high IOS, since these skills are not considered important in the learning environment, these students will not see the need to display or develop these skills. For this unimportant goal, they will find it sufficient to use surface learning strategies instead of using deep learning strategies.

An alternative model to the first model was established by considering that test scores and competition (surface learning approaches of learning conception) were given priority. In this model, it is predicted that students will tend more towards a PE. *SHS's students'* identification of chemistry with test scores has been a crucial factor in testing this model. In the learning environment where test scores are important, SHS students are expected to use surface learning strategies. In an environment where scientific inquiry is not valuable, their efforts and determination towards this will not be very meaningful. This may also be a key factor in students' goal setting. It is expected that the IOS dimension of science high school students will positively predict PE and this will be a predictor of surface learning strategy (Figure 2).

Figure 2. *Second Model for in a Learning Environment where Test Score is a Much More Important Task than Scientific Inquiry*



IMPORTANCE OF THE STUDY

The relationship between AG, IOS, learning strategies and task value is presented with various models. However, it is seen that these models are not considered sufficiently in chemistry lessons and especially in learning environments with scientific inquiry. In literature, AG, learning strategies and self-efficacy are examined separately (Ardura & Galán, 2019; Lindblom-Ylänne et.al, 2019; Tan et.al, 2021). In this study, the relationship between these variables is discussed by considering tripartite structure of social cognitive learning theory. Another important aspect of this study is the characteristics of the study group. The study group is SHS students who are selected in order of success order with a multiple-choice exam that measures academic success throughout the country according to the courses they took in secondary school. In the schools these students attend, the subjects of science and mathematics are given priority over other subjects. Some of these students enter competitions at national and international level, such as physics, chemistry and biology Olympics, while some others also prepare scientific projects for national and international competitions. Academic studies conducted with these students are mostly studies that reveal their cognitive characteristics. However, studies that determine which tasks are of what value in the learning environment and that consider the interaction between students are not included. The findings obtained in this study will provide curriculum developers and implementers with an important resource regarding the characteristics of this environment and these students.

The aim of this study is to examine the cognitive characteristics of SHS students, where advanced science and mathematics lessons are taught, with goal orientation, task value, self-efficacy and, learning strategy. It is important to examine the relationship between these variables for chemistry classes, and especially for students with high academic success who take advanced science and mathematics courses and are placed by exam. It is thought that defining this relationship for SHS students will contribute to the literature.

METHOD

The data for this study, in which correlational survey models are used, were gathered from students who were in the 9th, 10th, 11th and 12th grades of a science high school located in the west of Turkey during the autumn semester of the 2018-2019 academic year. While the dependent variable of the study is learning strategies, the independent variable is achievement goal orientation, task value and inquiry oriented self-efficacy. IOS Scale, AG Scale, learning strategies scale and written form were used as the data tools.

PARTICIPANTS

The universe of the research is the students in the 9th, 10th, 11th and 12th grades of science high schools in Turkey, and the sample is the students at a state science high school located in the city of Izmir. The age range of the students in the sample of the study is between 14 and 17. A total of 292 students, including 102 male and 190 female students, took part in the study. The school where the research was conducted was chosen randomly as the sample. In the school which the data were collected, there are 3 classes in each of the 9th, 10th, 11th and 12th grades. The study was conducted with a total of 292 students, of whom 85 were in 9th grade, 68 were in 10th grade, 53 were in 11th grade and 86 were in 12th grade. 60 of these students had taken part in Olympic competitions at national and international level (13 in biology, 10 in physics, 8 in chemistry, 14 in mathematics and 15 in computers). Moreover, 79 students were engaged in national and international projects carried out at the school.

Three chemistry teachers are employed at the high school. Two of these teachers hold the title of PhD in the field. Moreover, all teachers are authors who have written chemistry course books. During the interviews with teachers, it was determined that there were physics, chemistry and biology laboratories at the school where students could do experiments. The education year consists of two semesters, and two exams are given during each term. At least one of the exams consists of open-ended questions, while one of the exams is applied in a multiple-choice format. These exams consist mostly of questions measuring the students' knowledge of chemistry. Development of the students' inquiry skills is not accounted for in the exams. In the interview with the teachers, although the teachers stated that they included laboratory practice and projects in chemistry lessons, these views do not conform to the student conceptions of chemistry lessons shown in Table 1.

DATA-COLLECTION TOOLS

INQUARY-ORIENTED SELF-EFFICACY SCALE

The scale was used to determine the students' self-efficacy levels regarding their inquiry skills. The five-point Likert type scale (55 items) prepared by the researcher (Feyzioğlu, 2019) consists of three sub-dimensions "Showing Stability- Being Flexible" (26 items), "Feeling Oneself Efficient" (22 items), and "Making an Effort" (7 items).

Since the scale would be applied to different age levels, Confirmatory Factor Analysis was performed using the Mplus software to determine its suitability for the study group. According to the fit indices of the three-factor DFA model, following values were calculated for $\chi^2(1423) = 2931,58$, $x^2/df= 2,06$, also for RMSEA= 0.060 (90%CI: 0.057, 0.063), CFI = 0.780, TLI = 0.770 and SRMR = 0.070. According to above values, it was decided that the three-factor structure was at an acceptable level for this study group. For this study, internal consistency coefficients were found as, 0,91; 0,93 and 0,79 respectively.

ACHIVEMENT GOAL ORIENTATIONS SCALE

The AG scale was used to determine the students' achievement goal orientation. It was developed by Ames and Archer (1988) was adapted by Demir (2011). The five-point Likert scale consists of 33 items and two sub-dimensions. The MA sub-dimension contains 17 items, and the PA sub-dimension contains 16 items. Since the scale would be applied to different age levels, Confirmatory Factor Analysis was performed using the Mplus software to determine its suitability for the study group. According to the fit indices of the two-factor DFA model, following values were calculated for $\chi2$ (43) = 200,133, $x2/df$= 4,65, also for RMSEA= 0.081 (90%CI: 0.070, 0.093), CFI = 0.992, TLI = 0.990 and SRMR = 0.059. According to above values, it was decided that the two-factor structure was at an acceptable level for this study group. The reliability coefficients are α=0.96 and α=0.92, respectively. For this study coefficients were as, 0,88 and 0,88 respectively.

LEARNING STRATEGIES SCALE

It is Five Point Likert Scale developed by Ellez and Sezgin (2002) and started to be used after it was finalized by Yıldız (2008). It consists of "Deep" (21 items) and "Surface" (10 items) learning strategies sub-dimensions. Since the scale would be applied to different age levels, Confirmatory Factor Analysis was performed using the Mplus software to determine its suitability for the study group. According to the fit indices of the two-factor DFA model, following values were calculated for $\chi2$ (433) = 1270,36, $x2/df$= 2,93, also for RMSEA= 0.082 (90%CI: 0.076, 0.087), CFI = 0.928, TLI = 0.922 and SRMR = 0.088. According to above values, it was decided that the two-factor structure was at an acceptable level for this study group. The reliability coefficients were measured for the deep learning sub-dimension as $\alpha = 0.82$, and for the surface learning sub-dimension as $\alpha = 0.76$. For this study, it was found as, α =0,85 and α = 0,76 respectively.

WRITTEN FORM FOR DETERMINING LEARNING CONCEPTIONS AND ANALYSIS

The form developed by Tsai (2004) was utilized to determine the learning goals of the students. According to the data obtained from this form, the degree of value placed on different tasks was identified in chemistry classes. The following open-ended questions aimed at determining learning goals were included in the form:

(1) In your opinion, how is the subject of chemistry best learnt?

(2) How do you understand that you have learnt the subject of chemistry?

(3) By which method of study do you learn the subject of chemistry?

(4) In your opinion, what is it intended that you should learn via the subject of chemistry?

148 of the 292 students who made up the sample of the study wanted to answer open-ended questions. The Written Form for Determining Learning Goals was administered to 148 students (63 9th grade, 39 10th grade, 29 11th grade and 17 12th grade) at the same time as the other forms. The responses given by the students were analysed by the researchers with the descriptive analysis method by taking the categories defined by Tsai (2004) into consideration. The analysis was performed separately for each class by the researchers, and an average goodness of fit index of 0.95 was calculated according to Cohen Kappa. After the students' opinions were placed in the sub-dimensions, the validity of the results was ensured by taking expert opinion by an expert separate from the researchers.

DATA COLLECTION PROCESS AND ANALYSIS

The data collection tools were applied to 9th, 10th, 11th and 12th grade students at a science high school located in the west of Turkey during the autumn semester of the 2018-2019 academic year. Participation in the research was carried out on a voluntary basis and ethical principles were fully complied with. Ethical permission for the study was obtained from Aydın Adnan Menderes University Educational Research Ethics Committee. Before collecting data, students were informed about the study and data were not collected from students who did not want to complete the scales.

At the first stage of the study, an analysis of the normal distribution of the data was made. At the next phase, before the model was tested, the measurement model of the factors was evaluated. At the final stage, structural equation modelling was done using Mplus 7 software to test the theoretical models.

The suitability of the established models is discussed by examining the fit indices. For this purpose, the ratio between chi square and degree of freedom (x^2/df), the comparative fit index (CFI), the root mean square error of approximation (RMSEA) and the standardized root-mean-square (SRMR) values are taken into account. Values of x^2/df that fall below 5.00 (Marsh & Hocevar, 1985), CFI values above .90 (Hu & Bentler, 1999), RMSEA values below .08 (Browne & Cudeck, 1993), SRMR values at .05 or below (Hu & Bentler, 1999) and TLI values close to .95 (Tucker & Lewis, 1973) are indicative of good fit.

RESULTS

The means and standard deviations of the scores of each sub-dimension of each scale collected from the participants and the skewness and kurtosis values tested for the normal distribution are presented in the table 2. In this study, it was determined that the data had a normal distribution (George & Mallery, 2016).

Table 2. *Means, Standard Deviations, Skewness and Kurtosis for the Sub-Dimensions of the Measures.*

Measures	*Sub-dimensions*	*M*	*SD*	*Skewness*	*Kurtosis*
IOS	Showing Stability- Being Flexible	88,04	14,66	-0,326	-0,031
	Feeling Oneself Efficient	78,62	12,79	-0,062	-0,236
	Making an Effort	23,17	3,89	-0,531	0,402
AG	MA	67,56	9,58	-0,723	0,822
	PE	58,97	10,41	-0,565	0,306
Learning strategies	Deep	79,83	10,66	-0,677	0,828
	Surface	21,16	5,87	0,363	-0,320

At the second stage of the study, with the aim of determining the relationships between the variables, correlation analysis was carried out and the correlation coefficients between the sub-dimensions were identified (Table 3).

Table 3. *Mean Values, Standard Deviation, and Correlation Levels of Variables.*

Observed variables	*1*	*2*	*3*	*4*	*5*	*6*
IOS						
1. Feeling oneself efficient	-	-	-	-	-	-
2. Stability/flexibility	.81**	-	-	-	-	-
3. Making an effort	.76**	.75**	-	-	-	-
AG						
4. MA	.45**	.41**	.51**	-	-	-
5.PE	.15*	-	.17**	.33**	-	-
Learning strategy						
6. Deep	.48**	.45**	.50**	.77**	.24**	-
7. Superficial	-.35**	-.39**	-.35**	-.49**	-	-.55**

Notes: Level of significance between the variables was taken as *p < .05 (N = 292), **p < .01 (N = 292).

When Table 3 is examined, it is seen that no significant relationship was found between the PE sub-dimension of AG and stability/flexibility or surface learning strategy. Apart from this, however, significant mutual relationships were determined among all the variables. While surface learning strategy had a negative relationship with all variables, the relationships between the other variables were positive.

Before the model was tested, the measurement model of the factors was evaluated. In the measurement model, it was determined that the fit values were within the desired limits. The indices of the model are found as$x^2(12) = 22.786 \ (p < 0.05)$, x^2/df= 1,90, RMSEA = 0.055 (%90GA: 0.017, 0.090), CFI = 0.988, TLI = 0.980, SRMR = 0.030. When the residual values are examined, all of the correlation residuals are below standardized factor loads vary significantly between 0.309 and 1.068. The factor load of the surface learning sub-dimension was determined as -0.601. That indicates that this dimension has an inverse relationship with the learning strategy dimension. The R^2 values of the model vary between 0.095 and 0.826. The R^2 value for the mastery sub-dimension was not calculated because while the standardized factor load of this dimension changed significantly, the non-standard factor load did not change significantly. These findings indicate that the measurement model has sufficient fit.

TESTING THE MODELS

Testing first hypothesis: In a learning environment where scientific inquiry is an important task the IOS would be associated with the learning strategies mediated through the AG

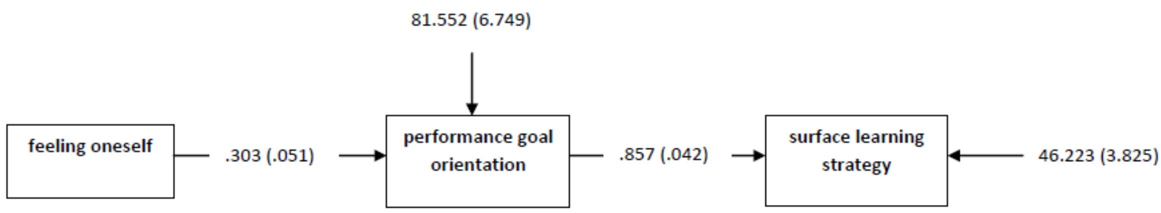
In the theoretical model for chemistry classrooms in which scientific inquiry was an important task, although the relationships between the variables was significant, the data fits were determined to be below the standards specified above (($\chi2(7) = 67.64$ $(p<0.05)$, $x^2/df = 9.66$, CFI = .876, SRMR =

.075, RMSEA = .171 (%90GA: 0.136, 0.211), TLI = .681). This model was abandoned, and fit values for the alternative model were examined.

Testing the second hypothesis: In a learning environment where test score is a much more important task than scientific inquiry, the IOS would be associated with the surface learning strategies mediated through the PE.

When the relationship between the variables for the alternative model, in which success in tests was an important task, was examined, it was determined that both effort and stability variables were not significant predictors of PE. Except for this, it was determined that the fit indices of the model that predicted surface learning strategy via PE were at an acceptable level for feeling oneself efficient sub-dimension (($\chi 2(2) = 6.00 (p < 0.05), x^2/df$= 3.00, CFI = 0.987, SRMR = .005, RMSEA = .083(%90GA: 0.002, 0.163), and TLI = 0.960).

Figure 3. *Relationships and Their Values in the Model with Acceptable Fit Values.*



DIRECT, INDIRECT AND TOTAL EFFECTS IN THE ACCEPTED MODEL

In this model, it was emerged that feeling oneself efficient sub-dimension of IOS was significant positive predictors of PE (β=.30; p<.001). It was also determined PE predicted surface learning strategy positively (β=.85, p<.001). In the established model, PE was explained at a rate of 18%, while surface learning strategy was explained at a rate of 54%. When examined in terms of standardized values, these values were determined as β=.33, p<.001, and β=.77, p<.001, respectively.

DISCUSSION AND CONCLUSIONS

In this study, the relationship of learning strategies used in chemistry lessons with inquiry oriented self-efficacy and achievement goal orientations of SHS students taking advanced-level science and mathematics was tested with theoretical models. The first model was set up according to chemistry classes in which scientific inquiry was valued by taking the goals of the SHS chemistry curriculum into account, while the second model was established according to chemistry classes in which competition and test scores were valued. Although chemistry teachers at the school claimed that they included laboratory practices and project work in their chemistry lessons, the first model, which was created according to an environment in which scientific inquiry was a valued goal, did not work. On the other hand, the second model, which was developed according to a learning environment in which test scores were more valued than scientific inquiry, did work.

When the students' conceptions towards the subject of chemistry were examined, it was determined that test scores were more valuable for them in these classes. This conception may be due to the beliefs that the students had brought with them from secondary school (from their previous experiences), rather than to the learning environment. However, the fact that test scores were an important goal, not only in 9th grade but in all grades, shows that the reason for this situation is not entirely independent of the learning environment. Although the chemistry teachers stated that laboratory practices and project work were important in the learning environment, the students declared that contrary to this, test scores were an important goal. This difference between teachers and students is important when defining the learning environment with task value. The reason for this may be the difference in the goals, future expectations and outcome expectations of the two groups.

The findings obtained in the study conform with theories and models existing in the literature. For example, the reason why the first model did not work and that the second one did can be explained with the expectancy value theory (Feather, 2021). According to this theory, students' beliefs about how confident they are in accomplishing an academic task and how remarkable the task are two important components in understanding students' achievement behaviours and academic outcomes. In the literature, the characteristics of students with high levels of skills in the subjects of science and mathematics are generally examined independently of the social learning environment. The findings obtained in this study reveal that learning outcomes are also affected by the learning environment. Vishnumolakala, Southam, Treagust, Mocerino and Qureshi (2017) determined that the positive relationship of inquiry-oriented learning with students' attitudes, self-efficacy and experiences. Learning outcomes are not a product of cognitive characteristics alone. The learning environment is as effective as cognitive characteristics for the behaviours displayed in this environment (Schunk, 2012). SHS students have high academic performance. Cognitively, they are at a high level. However, in this study, it was determined that the learning strategies used by them were affected by the characteristics of the learning environment as much as by cognitive characteristics. The fact that the students in this study were directed towards PE may be due to the environment of competition with their peers that they experienced. Another reason is the value placed on the task in the learning environment. If test scores rather than inquiry are important in SHS, this may have a negative effect on the development of students' IOS in the process. In this respect, even if a student feels oneself efficient, the fact that this characteristic is not valued in the learning environment will in time cause this behaviour to fade. In this case, when the student is faced with this task in the future, they will prefer to use surface learning strategies. The SHS students mostly associated learning chemistry with solving tests. As can be understood from the students' statements, most of which consisted of a surface learning approach, the most valuable goal of the SHS students was to be able to obtain a high average grade from tests in their chemistry lessons. Tsai (2004) placed the goal of "testing" in the "surface learning" category. He stated that this goal was related to extrinsic motivation. He also stated that a student in this category looks at knowledge quantitatively and that knowledge is learnt by repetition. The conception that knowledge is learnt by repetition and the fact that test scores were an important goal may have directed the science high school students towards PE even though their IOS was high. In this study, the SHS students' PE predicted surface learning strategy positively. That is, as disposition towards level of PE point increased, the SHS students used more surface learning strategies.

The findings obtained in the study conform with the self-regulation model proposed by Pintrich (2000). In this model, the value placed on tasks, and the perception of this, in a specified learning environment, are determiners in the relationship of IOS with AG and of AG with learning strategies. The way students perceive a task, or the learning goals will be effective in determining their learning goals and AG (Pintrich, 2000).

The extent to which SHS students associate the subject of chemistry with the future is important. The choice of a career related to chemistry will direct students towards MA when working on a chemistry-related project. This situation is explained with Miller and Brickman's (2004) model of future-oriented motivation and self-regulation. They stated that future-related goal orientations are driving forces such as concerns and needs. If students think that an academic task is useful and considerable for their futures, then they will display high effort. It cannot be expected that they will display the same effort in academic tasks that they perceive to be less related to the achievement of their future goals (Muenks, Yang & Wigfield, 2018). One of the founding aims of science high schools, and especially, one of the characteristics that distinguish them from other schools, was to be a resource for educating highly qualified scientists that are needed in the fields of mathematics and science. However, the findings obtained in this study reveal that the teaching-learning processes in chemistry lessons do not conform with the aims of science high schools in this respect.

The SHS students placed to this school according to academic achievement score from the multiple-choice central exam. When they graduate from high school, they will again move on to higher education by means of a multiple-choice exam. Students who entered high school as a result of a race will again enter higher education as part of a race. This race may lead to competition in the learning environment.

In this study, in the model that worked (the second established model), feeling oneself efficient sub-dimension of IOS positively predicted a PE, and this, in turn, predicted surface learning strategy positively too. However, making an effort and stability sub-dimensions were determined not to be a significant predictor of PE. The fact that IOS directly predicts AG can be explained with achievement motivation model (Elliot, 1999; Lüftenegger et.al, 2019). According to this model, individuals with high self-efficacy are oriented towards a MA and PE, while those showing low self-efficacy are oriented towards performance avoidance (Elliot, 1999). In this case, self-efficacy positively predicts a MA and PE (Uzuntiryaki-Kondakci & Senay, 2015), while it negatively predicts performance avoidance. In this study, the reason why the making an effort sub-dimension did not work like the feeling oneself efficient sub-dimension in the model may be because the SHS students, who had high levels of academic achievement, did not feel the need to strive with regard to scientific inquiry. The fact that they considered themselves competent in this respect may have prevented them from making an effort. Another reason may be that in a learning environment that focuses on test scores and in which inquiry skills are not assessed (Kolil, Muthupalani and Achuthan, 2020), making an effort towards the latter may not be necessary (Lüftenegger et.al, 2019).

SUGGESTIONS

The situations of science high school students (highly skilled or especially talented individuals with high academic achievement) in high school were determined in this study. However, studies can be conducted towards monitoring their situations prior to going to high school and after graduating from high school. Moreover, the models created in this study and in similar studies can be used for evaluating the effectiveness of education. The use of these models for evaluation can guide researchers and administrators.

LIMITATIONS

In this study, the characteristics of the learning environment were determined only with the views of teachers and students. The fact that when the characteristics of the learning environment were being determined, observations were not made independently of the participants can also be regarded as a limitation. Another limitation found in this study is that the achievement goal model is handled only with mastery and performance approaches.

AUTHOR CONTRIBUTION

The first author contributed to determining the theoretical framework of the study, analyzing the data, and preparing the discussion and conclusion sections. The second author contributed to data collection, literature review, and preparation of the methodology. Both authors critically reviewed the article and approved the final version.

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