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Motivational Factors Contributing to Turkish High School Students' Achievement in Gases and Chemical Reactions

Cansel KADIOGLU[1] and Esen UZUNTIRYAKI[2]

[1] Gaziosmanpasa University

[2]Middle East Technical University

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Correspondence to: kcansel@metu.edu.tr

Abstract

This study aimed to investigate the contribution of motivational factors to 10th grade students' achievement in gases and chemical reactions in chemistry. Three hundred fifty nine 10th grade students participated in the study. The Gases and Chemical Reactions Achievement Test and the Motivated Strategies for Learning Questionnaire were administered to measure students' achievement level and motivational orientations, respectively. The motivational constructs studied were intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. Multiple Regression Correlation analysis indicated that the constructs of intrinsic goal orientation, self-efficacy for learning and performance, and test anxiety each made a statistically significant contribution to the students' achievement. Suggestions for further research are provided.

Introduction

For nearly three decades in education literature, increased attention has been given to self-regulated learning (SRL) in an attempt to understand how students learn (i.e., how students motivate and guide their own learning). SRL is defined as "self-generated thoughts, feelings, and actions that are planned and cyclically adopted to the attainment of personal goals" (Zimmerman, 2000, p.14). Accordingly, self-regulated learners are metacognitively, motivationally, and behaviorally active participants in their own learning (Zimmerman, 2002). Although different theories have been proposed to explain features of SRL, most of the definitions include some common features: Students are aware of the processes that improve their academic achievement and they monitor these processes by getting feedback from their previous learning processes. In addition, SRL follows a cyclic path and include motivational processes. Zimmerman (1994) proposes four psychological dimensions in which students can self-regulate their activities. These dimensions are motivation, learning methods, performance outcomes, and physical and social environment. In literature, students' motivational beliefs (such as goal orientation, personal interest, and self-efficacy beliefs) and cognitive learning strategies (rehearsal, elaboration, organization, goal setting, planning, monitoring etc.) are most commonly studied constructs. In this study, the contribution of students' motivational orientations to their chemistry achievement was investigated.

The question *why* addresses the motivational dimension. Pintrich and Schunk (2002) define motivation as "the process whereby goal-directed activity is instigated and sustained" (p.5) and underline that motivation is a process rather than a product, and not directly observed but inferred from students' behaviors. They propose a reciprocal relationship between academic motivation and performance; in other words, students' motivation influences their learning and/or performance, and what they do and learn, in turn, influences their motivation. Motivated students engage in difficult tasks, expend effort and persist even

when they encounter difficulties; as a result, they increase their academic achievement. Recently developed motivational theories explain the structure of student motivation in conjunction with cognitive theories emphasizing learners' constructive interpretations of events.

Among these theories, the achievement goal orientation theory is the most common one in the achievement motivation literature (Elliot, 1999). This theory explains achievement by proposing a dichotomous achievement goal framework: Goal orientation construct has been characterized as intrinsic (mastery/learning) goals versus extrinsic (performance) goals. Intrinsic goal orientation focuses on task mastery, development of competence, challenge or curiosity; while extrinsic goal orientation focuses on grades, rewards and/or approval from others (Ames, 1992). Intrinsic goals are associated with positive processes or outcomes such as persistence in the face of failure, choosing challenging tasks, using deep-processing strategies and intrinsic motivation (Dweck & Leggett, 1988; Harackiewicz, Barron, & Elliot, 2000; Meece, Blumenfeld, & Hoyle, 1988; Pintrich & De Groot, 1990). In contrast, extrinsic goals are linked with grades and other extrinsic rewards rather than an interest in learning (Ames, 1992; Dweck & Leggett, 1988; Jagacinski & Nicholls, 1987; Harackiewicz, Barron, & Elliot, 2000). Presently, Elliot and his colleagues defined goal constructs in a trichotomous framework: *mastery* goals, *performance-approach* goals, and performance-*avoidance* goals (Elliot, 1999; Elliot & Church, 1997; Elliot & Harackiewicz, 1996). They hypothesized that students possessing performance-approach goals made positive competency judgments, and those possessing performance-avoidance goals focused on avoiding negative judgments. They hypothesized that students possessing performance-approach goals dealt with attainment of favorable judgments of competence, and those with performance-avoidance goals focused on avoiding unfavorable ones. In the study conducted by Elliot and Church (1997), factor analysis results supported this trichotomous framework, and path analyses revealed that these

constructs had different antecedents and consequences. When antecedents of these goals were investigated, mastery goals were associated with high competence expectancy and achievement motivation. Moreover, performance-approach goals were linked to achievement motivation, high competence expectancy and fear of failure; while performance avoidance goals were linked to low competence expectancy and fear of failure. The present study was guided by dichotomous framework to provide comparability with earlier studies.

Another construct explaining student motivation is self-efficacy which is defined as students' judgments of their capabilities to perform a specific task successfully (Bandura 1997). Self-efficacy is distinguished from outcome expectancy by Bandura (1997). Outcome expectancies refers to children's beliefs about how well they will do on upcoming tasks, either in the short or long term (Wigfield & Eccles, 1999). Bandura (1997) states that expectancy–value theorists have focused on outcome expectations in their models, and claims that efficacy expectations are more predictive of performance and choice than outcome expectations. Research studies have revealed that students' self-efficacy beliefs significantly predict achievement motivation (Pajares, 2002; Pintrich & De Groot,1990; Wolters & Pintrich, 1998). In addition, highly self-regulated learners were found to be intrinsically motivated and possessing high self-efficacy beliefs (Schunk & Swartz, 1993; Zimmerman & Bandura, 1994).

A third construct commonly studied in achievement motivation literature is students' task value beliefs which consist of four components: interest value (enjoyment of the activity), attainment value (importance of doing the task well), utility value (applicability of the task for future goals), and cost value (negative aspects of engaging in the task) (Wigfield & Eccles, 1999). Interest value can be thought of as similar to the construct of intrinsic motivation and utility value can be linked to the construct of extrinsic motivation (Eccles & Wigfield, 2002). Research studies have revealed that students' task value beliefs predicted

their course performance significantly (Yumusak, Sungur, & Cakiroglu; 2007; Zusho, Pintrich, & Coppalo, 2003).

Control of learning beliefs is another construct which refers to students' beliefs that they will get positive outcomes as a result of their own effort (Pintrich, Smith, Garcia, & McKeachie, 1991). Students attribute academic success or failure to different causes taking into account the environmental and personal factors. In educational settings success and failure are usually attributed to ability, effort, task difficulty, and luck **(**Weiner, 2000). Students behave differently when they perceive that the cause of any academic outcome is under their control versus under the control of the situation **(**Weiner, 2000). If the outcome of failure, for example, is perceived to be under the student's control, then the student feels responsible and believes that s/he can change failure to success by increasing effort. However, if individuals think the outcome is not under their control, such as task difficulty, they do not feel responsible for the outcomes and therefore will not increase effort (Weiner, 2000). In short, attributing failure to lack of effort makes students responsible for the negative outcome and subsequently will increase effort.

The last construct studied in this study is *test anxiety* which is described as the phenomenological, physical, and behavioral responses about possible negative consequences or failure (Zeidner, 1998). Although a large body of research has supported the negative effects of test anxiety on students' performance (i.e., debilitating anxiety), in some cases it has been claimed to enhance learning; this is known as *facilitating anxiety* (Zeidner, 1998). Based on Yerkes and Dodson's work (1908; as cited in Zeidner, 1998) a curvilinear relationship between test anxiety and performance was proposed rather than a negative linear one. There are many moderator variables that influence this relationship in different ways such as task difficulty, item arrangement, and test format. For example, because highly anxious students' believe that they will fail on the task, their performance (score) on difficult tasks decreases.

On the other hand, low anxious students possess optimal level of motivation in difficult tasks; consequently their performance increases (Zeidner, 1998). Contrary to other motivational constructs, research revealed negative relationship between test anxiety and academic achievement (Chapell et al., 2005; Everson, Millsap, & Rodriguez, 1991).

Students have difficulties in understanding some concepts in chemistry due to the abstract nature of the topic (Andersson, 1986; Barker & Millar, 1999; Nurrenbem & Pickering, 1987). For example, they may not comprehend the concept of gases and reactions occurring in the gas phase (Azizoglu, Aklan, & Geban, 2006; Stavy, 1990). Gases and chemical reactions concepts constitute a fundamental part of chemistry. Partial or no understanding of these topics may block learning more advanced topics such as chemical equilibrium and rate of reaction. Students who develop motivational and cognitive strategies can overcome their difficulties. In the present study, students' motivational orientations and the contribution of these orientations on their achievement in gases and chemical reactions concepts were studied.

Based upon aforementioned literature, the purpose of this study was to examine the contribution of the motivational factors to 10^{th} grade students' achievement in gases and chemical reactions units. The motivational factors included intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety.

Methodology

Subjects of the Study

A total of 359 tenth grade students enrolled in chemistry courses at three public high schools in the capital city of Turkey, Ankara, participated in the study. In Turkey, all of the students get general courses (literature, geography, mathematics, science etc.) at their ninth grade level. At the beginning of tenth grade, in consideration of their future professions, they

select their primary focus such as “science & mathematics”, “social sciences”, or “literature and mathematics”. The students who participated in this study were “Science and Mathematics” majors.

Instruments

In this study, the Gases and Chemical Reactions Achievement Test (GCRAT) and the Motivated Strategies for Learning Questionnaire (MSLQ) were used as instruments.

Gases and chemical reactions achievement test.

The GCRAT was developed by the authors considering chemistry textbooks and instructional objectives of National Chemistry Curriculum. It was administered to the students to assess their understanding of gases and chemical reactions topics. The test consisted of 25 multiple choice items with one correct answer and four distracters. Each item in the test was examined by four experts in chemistry and chemistry education regarding content and face validity. Each correct answer was scored as 1 and wrong and missing answers as 0. The total achievement score was calculated by adding up each item score. Consequently, the possible maximum score was 25. The length of time given to complete the test was 45 minutes. The KR 21 reliability coefficient for the test was found to be .78.

Motivated strategies for learning questionnaire.

The motivation section of the Turkish version of the MSLQ was administered to measure students’ motivational orientations. Thirty one items assessed students’ goal and value beliefs for chemistry, their beliefs about their skills to succeed in chemistry, and their anxiety about test taking in chemistry. The test was originally developed by Pintrich et al. (1991), and translated and adapted into Turkish by Sungur (2004). The MSLQ, a self-report questionnaire, allows students to rate themselves on a seven point Likert scale from 1 (not at all true for me) to 7 (very true for me).

Considering the factor structures proposed by Pintrich et al. (1991), Confirmatory Factor Analysis using LISREL 8.30 for Windows (Jöreskog & Sörbom, 1993) was conducted to test the factor validity of the scale. The maximum likelihood estimation method was used in LISREL analyses. The 31 motivation items were tested to see how well they fit six latent variables: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. Each item was assigned to one specific factor. When the fit statistics for a six factor solution were examined, it was found that the chi-squared to degrees of freedom ratio (χ^2/df) was 3.49; the goodness of fit index (GFI) was .77; and the root mean residual (RMR) was .07. Pintrich et al. (1991) claimed that although the goodness of fit indices were not within acceptable limits, they were quite reasonable values, because motivational attitudes may differ depending upon different factors such as course characteristics, teacher demands, and individual student characteristics. Therefore, these values appeared to be reasonable although it did not indicate a good fit.

The reliability analyses were conducted separately for each independent variable. The Cronbach's Alpha coefficients of the subscales ranged from .54 for control of learning beliefs to .86 for self-efficacy for learning and performance. Table 1 shows the Cronbach's alphas for the questionnaire.

Table 1.

Reliability Coefficients of Factors

Subscale	Reliability Coefficients
Intrinsic goal orientation	.66
Extrinsic goal orientation	.63
Task value	.82
Control of learning beliefs	.54
Self-efficacy for learning and performance	.86
Test anxiety	.60

Analysis of Data

Multiple Regression Correlation (MRC) analysis was conducted with the six motivational measures as predictors of chemistry achievement in gases and chemical reactions units.

Results

Results of the present study are reported in two sections: initially descriptive statistics are presented; and then results of inferential statistics are given. Seven variables were involved in the present study; a dependent variable (chemistry achievement in gases and chemical reactions units) and six independent variables (intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety).

Descriptive Statistics

The mean, standard deviation, minimum, maximum, skewness, and kurtosis values for the dependent variable and independent variables are presented in Table 2. The mean of students' achievement test scores was found to be at a moderate level with a value of 13.85. The higher values for the motivational constructs indicated higher achievement motivation and the means above 5.00 were accepted as high academic motivation in the chemistry course. However, the reverse was true for test anxiety, lower scores indicated higher motivation. The mean of 4.42 for test anxiety pointed out that students possessed high test anxiety.

Table 2.

Descriptive Statistics for the GCRAT and the MSLQ

Variables	Mean	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis
Chemistry achievement	13.85	4.94	2.00	25.00	.127	-.899
Intrinsic goal orientation	5.35	1.09	2.25	7.00	-.325	-.660
Extrinsic goal orientation	5.35	1.20	1.50	7.00	-.789	.331
Task value	5.48	1.04	2.00	7.00	-.744	.190
Control for learning beliefs	5.82	.86	3.50	7.00	-.469	-.375
Self-efficacy for learning and performance	5.28	1.01	1.88	7.00	-.466	-.103
Test anxiety	4.42	1.25	1.00	7.00	-.238	-.354

Inferential Statistics

To investigate the contribution of students' motivational orientations to their achievement in gases and chemical reactions in chemistry, MRC analysis was conducted. Students achievement scores on GCRAT was the criterion (dependent) variable and six motivational constructs (intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety) were the predictor (independent) variables in the analysis. Before conducting the analysis, assumptions of MRC (multicollinearity, outliers, sample size, normality, linearity, homoscedasticity, and independence of residuals assumptions) were checked and no violation was found.

The results of MRC indicated that 11% of the variance in chemistry achievement in gases and chemical reactions units was accounted for by three variables. Intrinsic goal orientation, self-efficacy for learning and performance, and test anxiety were found to be significant predictors of the students' chemistry achievement in gases and chemical reactions ($R= 0.32$, F (6, 352) = 7,255, $p<0.05$). Of these three predictors, intrinsic goal orientation and test anxiety had negative influence, while self-efficacy for learning and performance had positive influence. That is, while students' scores in intrinsic goal orientation and test anxiety

constructs increased, their achievement scores decreased. On the other hand, when they got high scores from self-efficacy subscale, their achievement scores increased. Intrinsic goal orientation, with a standardized beta coefficient of -.22, was the best predictor, followed by self-efficacy for learning and performance with a beta coefficient of .19, and test anxiety with a beta coefficient of -.13. Beta coefficients and related significance values are presented in Table 3.

Table 3.

Beta coefficients and related significance values of independent variables

Independent Variable	Beta Coefficient	Significance (p)
Intrinsic Goal Orientation	-.22	.001
Extrinsic goal orientation	-.02	.647
Task Value	-.09	.209
Control of Learning Beliefs	-.05	.425
Self-Efficacy for Learning and Performance	.19	.003
Test Anxiety	-.13	.023

Discussion and Implications

In this study, the contribution of motivational constructs to 10th grade students' achievement in gases and chemical reaction units was examined. Results showed that intrinsic goal orientation, self-efficacy for learning and performance, and test anxiety were significant predictors of achievement explaining 11% of the variance in chemistry achievement. As opposed to previous research (Ames & Archer, 1988; Wolters, Yu, & Pintrich, 1996, McWhaw & Abrami, 2001) the direction of the influence of intrinsic goal orientation was found to be negative. This unanticipated result can be explained with the grade-focused nature of Turkish educational system. In Turkey, students are accepted to universities based on their high school grade point average scores and their scores on the University Entrance Examination (OSS). Although many students apply for university, a minority of them get accepted. Therefore, students might highly value their grades, which are important criteria to

enter university. This might also promote competition among students, and in turn might affect students' learning goals and study strategies.

Another finding that self-efficacy makes a positive contribution to achievement supports the previous research (Pintrich & De Groot, 1990; Wolters & Pintrich, 1998; Zusho, Pintrich & Coppalo, 2003). Students who believe that they are capable of satisfactorily completing a task and confident in their ability engage in academic behaviors that promote learning and increase their achievement. The present study, also supporting prior work, reveals that test anxiety makes a negative contribution to students' achievement (Wolters & Pintrich, 1998; Zeidner, 1998).

In sum, this study provides a general picture to explain the contribution of motivational factors on students' chemistry achievement in Turkish high schools. Some of the findings supported previous studies in the literature like negative influence of test anxiety on achievement; while, others contradicted with earlier findings such as negative contribution of intrinsic goal orientation. Moreover, some of the predicted relations did not reveal any significant result. For example, students' task value beliefs did not make any significant contribution to their achievement. This study was conducted in Turkish high school chemistry context and guided by different motivational theories. In order to understand which theory can explain students' motivational beliefs better, deeper understanding of the context is required. In further studies, investigating classroom context such as teaching strategies, peer interactions or classroom assessment can provide better understanding in terms of the interaction between personal and contextual variables. In addition, data from quantitative research could be triangulated with qualitative data. Students' goal orientations can be investigated using the trichotomous framework suggested by Elliot and Church (1997) to test whether the differentiation of the performance (i.e., extrinsic) goal construct into performance-approach versus performance-avoidance is related to student' learning outcomes

in different ways. The sub-concepts under each theory can be helpful for further understanding. For example, students' task value beliefs were divided under four categories (namely; interest value, attainment value, the utility value, and the cost value) and each type can influence different ways. This study focused on the relations between the motivational components and chemistry achievement in 10^{th} grade level. Future studies should also examine how personal characteristics such as age and gender, or classroom context influence students' motivational and cognitive process as well.

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