

Self-regulation and Self-efficacy as learning motivation factors of Natural Sciences

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Abstract

In today's highly scientifically-based society, scientific knowledge is essential for every individual. However, its proper development requires a response to the individuals' requirements and prior experiences, which are represented in their effort to acquire Natural Science-related knowledge and skills. Consequently, it is of the utmost importance to examine students' learning motivation factors, and specifically those concerning learning Natural Sciences, which is the focus of this study. The research approach for measuring this motivation was based on the adaptation of a research tool (questionnaire) in the Greek language, administered to a research sample of 187 Junior high school students, aged 13 to 15 years. The results of the research showed the existence of a high correlation between the individual motivational factors for the learning of Natural Sciences.

Keywords: Natural Sciences, Learning Goal Orientation, Task value, Self-efficacy, Self-Regulation

Introduction

Reviews of modern scientific education in many parts of the world highlight the current dilemma of low student achievement and enrollment in science courses and argue for fundamental reforms aimed at enticing all young people to study science (Osborne & Dillon, 2008; Sjøberg & Schreiner, 2010; Tytler, 2007). Specifically, in the Greek educational system, Science classes make up only a minimal portion of the primary education curriculum, while their practical value predominates in secondary education. This means that Science classes in secondary school level are viewed as primarily relevant to students because of the evaluation of their performance in these classes, prior to their advancement to higher education (Tsihouridis et al. 2020).

Students' perspectives on learning, coursework and their own academic potential are crucially important (Guido, R. M. D. ,2018). People's attitude is the way they tend to organize their feelings, thoughts, and actions in relation to some sort of mental object. Attitudes are something that people acquire through life experience, rather than being innate. People's perspectives are formed in a variety of ways, some from introspection and reflection on their own experiences, knowledge, and abilities, and others from exposure to new information and ideas.

There are two main tracks of inquiry regarding how the psychological term 'interest' should be conceptualized (Djudin, 2018). As a first step, interest is defined as a personal characteristic or a strong and abiding fondness for a specific area of study or activity (known as individual or personal interest). Secondly, interest is understood as a state associated with the unique appeal of a certain scenario (termed situational interest or interestingness) (Hausler, et.al., 1998). Personal interest, which is always unique to the individual and which endures over time and can be differentiated into latent and actualized interest (Schiefele, 1999), evolves slowly and typically and has long-lasting effects on the learner's knowledge and values (Schraw, Flowerday, & Lehman, 2001). According to the literature (Schiefele, 1999), situational interest

is an "emotional state" that is evoked suddenly by something in the immediate environment and that may only have a short-term effect on an individual's knowledge and values and is aroused as a function of the interestingness of the content and context and partially under the regulation of a teacher (Schraw, Flowerday, & Lehman, 2001).

The importance a trainee places on completing a task is a driving force behind the level of dedication and commitment to seeing it through to completion. It was found that students who thought their learning work was interesting and important were more motivated to understand and learn more about it, and this was also confirmed by Tuan et al. (2005) in the context of science learning, based on research conducted by Pintrich and De Groot (1990) and Wolters, Yu, and Pintrich (1996) (as reported by Velayutham et al., 2011). Attainment value, intrinsic value, utility value, and cost are the four subsets into which Eccles et al. (1983) classified the subjective task value of a desired outcome (Wigfield et al, 2009). To emphasize the uniqueness of each aspect, i.e. the fact that they vary amongst learners, it is important to note that the aforementioned categories are not completely independent of one another, but rather are connected and complete the personal adding value to a goal or project.

Student's motivation is directly proportional to the degree to which they are goal oriented. This goal may pertain to learning, i.e., in-depth comprehension of the course material, or it may pertain to performance, i.e., the assessment and the overall picture formed in others. The first scenario, known as goal orientation, is a potent motivator, but the second, known as performance orientation, can inhibit a student's motivation. The role of science teachers, who must guide their students toward the proper learning objective, is also important by contributing to the development of adaptive behaviors, the growth of their interest in science, and their performance. The availability of a clearly articulated goal that also takes into account the individual's interests and experiences, together with a disciplined approach to the work required to accomplish this goal, is a significant determinant for improved commitment to this aim.

Motivating pupils to engage in learning is one of the most difficult tasks for educators at all levels. Typically, reference to learning motivation is made by defining two forms of motivation: endogenous and extrinsic. However, learning motivation is a continuous spectrum, not a binary state. According to Deci et al. (1991), the distinction between autonomous and regulated behavior is based on the locus of causality. Endogenous motivation results in autonomous behavior, whereas external motivation results in controlled behavior. The classification of motivation is similar, as endogenous motivation leads to autonomous behaviors, while exogenous to controlled ones. There is a spectrum of conditions ranging from the total association of a person's values and desires with the behavior or act in question, to the complete absence of such identification and the presentation of conduct or action as a result of external factors and other individuals. In this spectrum, distinct degrees of a person's own adoption of the ideals underlying particular behaviors or acts are delineated. One can fully identify with them, identify with the result of them, adapt said behavior or act according to one's own values, agree with a behavior due to the environment without embracing its values, or act based on specific conditions of remuneration or punishment, whether external, such as reward, or internal, such as guilt (Deci et al, 1991). In conclusion, in addition to evident endogenous reasons, one's motivation may be derived from balancing a peoples' values and aspirations with the demands coming from their environment, a state that typically develops after adulthood. After reviewing the current research, Velayutham et al. (2011) identified four characteristics that influence a person's motivation for science learning: orientation to the learning objective, value of the target object, self-efficacy, and self-regulation.

In the context of education, self-regulation refers to a students' predisposition to engage in the learning process autonomously, based on their emotions and desires. In self-regulated or self-controlled learning, the students select not only their objectives, but also the

techniques and procedures that will lead to their success. According to Pintrich and De Groot (1990, cited in Velayutham et al, 2011), the three fundamental parts of self-regulated learning are the metacognitive management of knowledge, the use of cognitive strategies, and the control and management of effort for the learning task. Individuals who orchestrate their own learning in physical education discovers ways to learn more efficiently and retain the abilities they gain while displaying prolonged determination and dedication to the goals they establish. Simultaneously, this perseverance leads to the maintenance of interest and systematic efforts, as well as the efficient management of disruptive elements (Kryona, 2020).

Self-efficacy was first defined by Bandura as "a person's belief in his skills to arrange and execute a predetermined course of action in order to solve a problem or successfully accomplish a task." In addition, is considered as self-efficacy as "a multidimensional construct that varies in terms of strength, generalizability, and level (or difficulty)". In simpler terms, self-efficacy is a facet of a person's self-belief, which refers to the belief that one can generate the desired results through the appropriate application of one's abilities and skills. The enhancement of self-efficacy is a result of the individual's positive experiences, i.e., success in physical education courses. This will result in future higher levels of self-confidence in their physical education learning abilities. There is a correlation between students' self-efficacy and their performance and displayed the tenacity to succeed, while this element influences their career choices, according to research findings (Schunk & Pajares, 2009).

Tuan, Chin, and Shieh (2005), who designed a six-factor questionnaire for high school students, conducted a significant study on student learning motivation in the context of the scientific course (SMTSL questionnaire). According to the findings of this study, there is, in general, a steady and dynamic relationship between students' achievement, their enthusiasm to learn in Science, and their scientific attitude. In 2009, Glynn, Taasoobshirazi, and Brickman did a noteworthy study on the motivation to learn science; they examined the motivation of college students who had not chosen science as their major but were attending the required university Science course. This study's questionnaire focused on five motivation "dimensions" and three external factors that were demonstrated to be related to the motivation dimensions. In this study, gender variations in the degrees of some dimensions of mobilization were observed. Later, Bryan, Glynn, and Kittleson (2011) investigated the perspectives of high school students on Science classes. The research was based on socio-cognitive theory, and student motivation was defined by three individual criteria that were examined in relation to students' performance and inclination to enroll in higher-level elective Science courses. The results of the study demonstrated the existence of a relationship between the three motivational elements and the students' performance, as well as their intention to enroll in more Natural Science courses, whereas there were no significant gender differences.

Methodology

The research approach of this study was quantitative, and the research strategy aimed mainly at finding relationships between the variables examined (Cohen, Manion & Morrison, 2008). It was also a sampling based research, using a basic data collection tool, an appropriately structured questionnaire and the research strategy followed the stages as reported by Cohen, Manion & Morrison (2008).

Purpose of the Research

The purpose of this research was to investigate whether there is a correlation between the four pillar factors of Learning Goal Orientation, Task value, Self-efficacy, and Self-Regulation as that were analyzed above.

Research Sample

The research sample consists of 187 junior high school students who participated voluntarily in the survey. The distribution of participants was 96 male and female participants

while regarding the class of attendance they are divided into three groups. The first group consists of 42 students in the 1st grade, the second group consists of 75 students in the 2nd grade, and the third group consists of 70 students in the 3rd grade.

Research Tool

The collection and processing of research data is a very basic element of a research. A common and effective data collection tool is the use of a properly structured questionnaire with specific axes, reliability and validity. Due to the many parameters taken under consideration, the creation of a reliable research-diagnostic tool is laborious and time-consuming so a good way to conduct a research is to look for an already tested tool, that will, of course, be tested again for its validity and reliability in the specific research sample. For data collection in this specific research, a questionnaire that covers the research objectives of this study was sought. The questionnaire developed and implemented by Sunitadevi Velayutham, Jill Aldridge & Barry Fraser (2011) was found to be the most appropriate for this purpose. According to Sunitadevi Velayutham, Jill Aldridge & Barry Fraser (2011), this tool was created in order to collect data on students' motivation on learning science. It consists of 32 questions, each of which has been created in such a way as to be associated with a motivational factor.

The 32 questions were divided into 4 broad categories based on the 4 pillars of motivation: Learning Goal Orientation, Task value, Self-efficacy, and Self-Regulation (Tsihouridis, Kryona & Vavougiou, 2020).

Translation of the questionnaire into the Greek language

The translation of the questionnaire from the English language to the Greek language was performed by following a predetermined specific three-step process that has been extensively studied by previous research. Briefly, the translation steps were as follows: a) forward translation b) back translation and c) application of the translated questionnaire to a small sample (Ioannou et al. 2020, Salehpoor, Latifi & Tohidast 2020, Andayani, Kristina & Endarti 2019). In order to avoid misunderstandings and difficulties when completing the answers by the respondents, attention was paid to the form and language of the questionnaire (Makrakis, 2005). Therefore, initially, a simple translation (forward translation) of the original questionnaire was carried out. After the simple translation, the Greek version of the questionnaire was back-translated. The final step for the final formatting of the questionnaire was the collection of answers from a small sample (8 students) in the context of a pilot study, in order to evaluate the clarity of the questions and to establish whether the language level used is the appropriate one. Taking into account the observations of the sample and making the corresponding necessary language modifications, the final form of the questionnaire, that was used in the research, was created.

The questionnaire consisted of 32 five-point Likert scale questions. The 32 questions were divided into 4 categories, of which the first measured the orientation towards the learning goal (Learning Goal Orientation) (questions 1-8), the second one measured the Task Value (questions 9-16), the third category measured Self-efficacy (questions 17-24) and the fourth one measured Self-regulation (questions 25-32).

Validity and Reliability of the Research

The internal reliability of the questionnaire was tested with Cronbach's Alpha Coefficient of Internal Consistency (Howitt & Cramer, 2003). In the present research, the reliability check after administering the translated questionnaire was $\alpha = 0.927$, an indicator that is considered high for the humanities sector (Roussos & Tsaousis, 2011) therefore deleting a question does not contribute substantially to the reliability of the tool. The Likert scale used is a Norm-referenced psychometric scale. This is commonly used in questionnaires and is widespread in research in which participants are asked to select the degree to which they agree or disagree

with a topic (Roussos & Tsaousis, 2011). In the present survey, respondents had to answer the questions based on a five-point Likert scale (1: Strongly disagree, 2: Disagree, 3: Not sure, 4: Agree and 5: Strongly agree). The validity and reliability of the research lie primarily in the voluntary participation and random selection of research subjects. As mentioned above, the voluntary and random participants of the research consist of a total of 187 students divided into three groups. The first group consists of 42 students in the 1st grade, the second group consists of 75 students in the 2nd grade, and the third group consists of 70 students in the 3rd grade.

Table 1. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,927	0,928	32

Research Ethics

The goal and objectives of the research were explained in detail to the participants, and they were informed that their participation was voluntary. It was clarified that their name and personal information would not be mentioned anywhere in order to avoid creating uncomfortable circumstances or negative feelings due to their identity being revealed. Finally, the participants were provided with the necessary explanations and clarifications regarding the questionnaire questions, so that none remained unanswered.

Analysis of Research Data

The statistical analysis of the questionnaire was performed using the SPSS statistical package and Excel application.

The analysis and demographic characteristics of the research sample data, the average values, and the standard deviations of the levels of the Learning Goal Orientation, the Task Value, Self-Efficacy and Self-Regulation are presented below along with the correlation between these variables.

The first statistical analysis refers to the basic statistical indicators concerning the independent variables of the present research: gender (male, female) and students' high school grade (1st, 2nd and 3rd grade of High School). The results of these analysis are presented below:

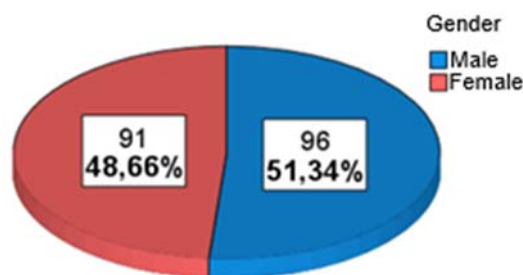


Figure 1. Students' gender

According to the above data, 48.66% of the research participants are female and 51.34% are male. We notice that the percentage of male participants in the research is similar to that of the female ones.

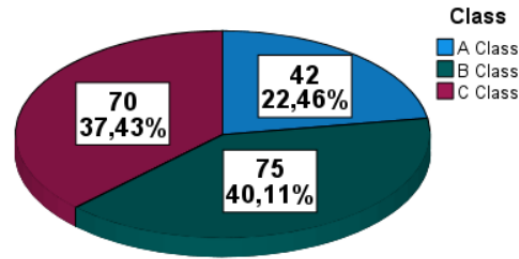


Figure 2. students' class attendance

Based on the above data, 22.46% of the research participants attend the 1st grade (A Class), 40,11% attend the 2nd grade (B Class) and 37,43% attend the 3rd grade (C Class).

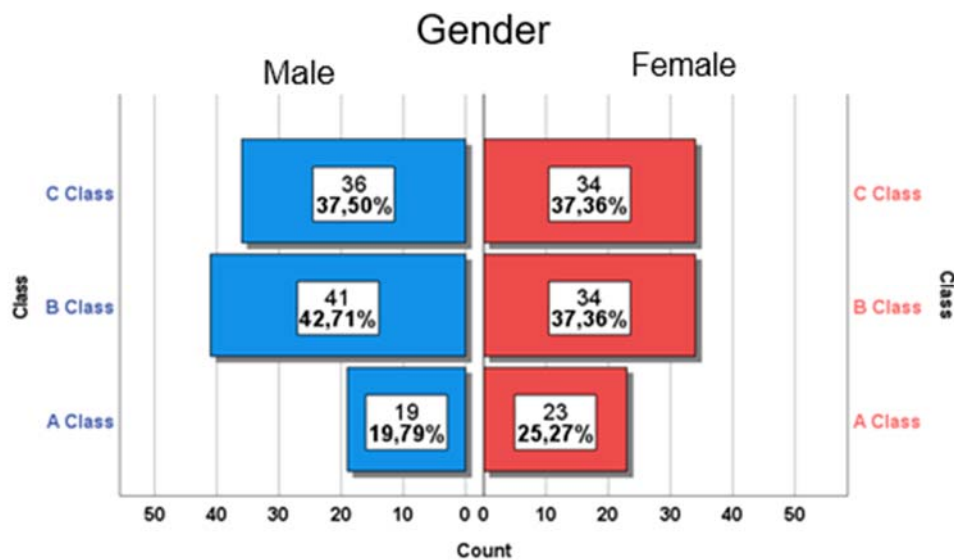


Figure 3. Students' gender-class diagram

Characteristics of dependent variables: Learning goal orientation, Task value, Self-efficacy, Self-regulation

The results of the analysis concerning Learning Goal Orientation, Task-value, Self-efficacy and Self-regulation are presented below. Table 2 presents the Means and Standard Deviations of the levels of the dependent variables. We can observe that the mean value of levels of Learning goal Orientation for all participants is $M=3.67$ ($S.D.=.61$), of Task-value for all participants is $M=3.32$ ($S.D.=.75$), of Self-Efficacy for all participants is $M=3.28$ ($S.D.=.72$), and of Self-Regulation for all participants is $M=3.51$ ($S.D.=.78$). The above values are reported on a scale from 1 to 5. This means that the students who participated in the research consider the levels of the dependent variables fairly good.

Table 2. Means and Standard Deviations of the levels of Learning Goal Orientation, Task-value, Self-efficacy and Self-regulation

	N	Mean	Std. Deviation
Learning Goal Orientation	187	3,67	0,61
Task Value	187	3,32	0,75
Self-efficacy	187	3,28	0,72
Self-regulation	187	3,51	0,78

The chart below (Figure 4) summarizes the mean values of the dependent variables for direct comparison

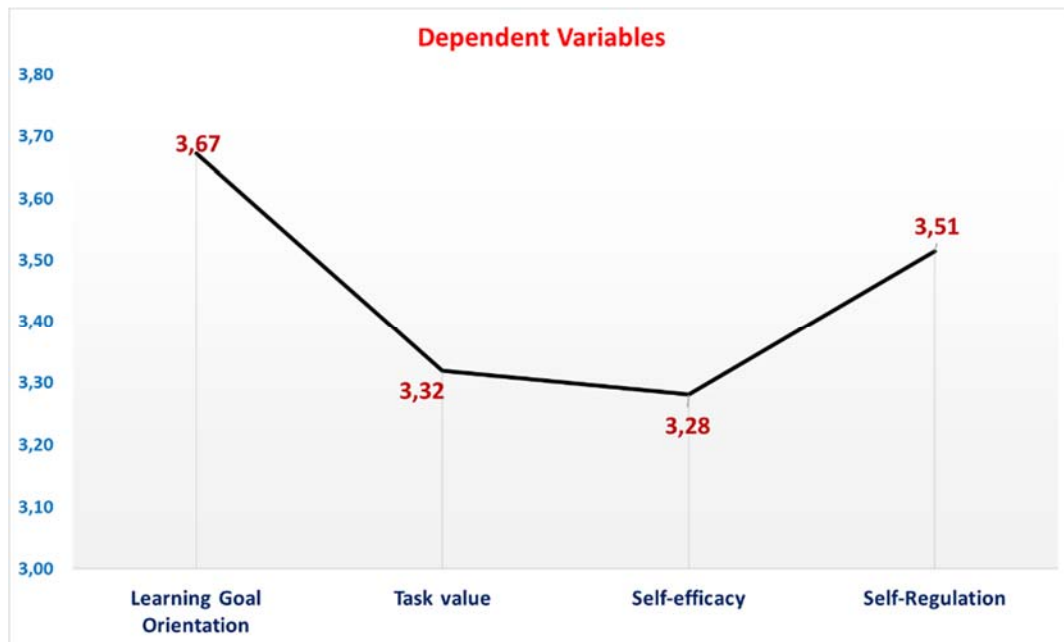


Figure 4. Dependent variables diagram

We observe that students effectively focus on the orientation of learning goals more than on self-regulation, on task value and even less on self-efficacy.

Correlation study between the dependent variables (Learning goal orientation, Task value, Self-efficacy and Self-regulation).

The dependent variables of Learning Goal Orientation, Task Value, Self-Efficacy and Self-Regulation, are measured on a five-point Likert scale (1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree) which is mainly considered as a hierarchical scale (but also in several cases as a scale of equal intervals). In this case, Spearman's rho correlation coefficient is considered the most appropriate one for studying the correlation between the variables. These scales are also usually considered as "interval scales" and therefore can have numerical values (Krowinski & Steiber, 1996).

It should also be noted that in order to measure these variables eight questions were used and for this reason the final value of each dependent variable was considered as the average of these questions. Consequently, the Pearson r correlation coefficient, which is used when the measurement scale is either proportional or of equal intervals, can also be utilized in this case, as can Spearman's rho correlation coefficient.

Before calculating the correlation coefficient using the statistical package SPSS, the following assumptions are formulated:

H0: There is no correlation between the variables: Learning goal orientation, Self-regulation, Task Value and Self-efficacy.

H1: There is a correlation between the variables: Learning goal orientation, Self-regulation, Task Value and Self-efficacy.

As mentioned above, we can study the correlation between dependent variables using the Pearson r coefficient. Results are given in the table below (Table 3).

Table 3. Table of Pearson r correlation coefficients between dependent variables

		<i>Learning Goal Orientation</i>	<i>Task value</i>	<i>Self-efficacy</i>	<i>Self-Regulation</i>
<i>Learning Goal Orientation</i>	Pearson Correlation	1	,638**	,540**	,515**
	Sig. (2-tailed)		<,001	<,001	<,001
<i>Task value</i>	Pearson Correlation	,638**	1	,567**	,459**
	Sig. (2-tailed)	<,001		<,001	<,001
<i>Self-efficacy</i>	Pearson Correlation	,540**	,567**	1	,528**
	Sig. (2-tailed)	<,001	<,001		<,001
<i>Self-Regulation</i>	Pearson Correlation	,515**	,459**	,528**	1
	Sig. (2-tailed)	<,001	<,001	<,001	

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

Based on the data of the table above:

a) learning goal orientation shows a strong correlation with task value, self-efficacy and self-regulation

$r(187) = 0.638, p < 0.001 (0.50 \leq |r| \leq 0.75 \text{ strong correlation})$

$r(187) = 0.540, p < 0.001 (0.50 \leq |r| \leq 0.75 \text{ strong correlation})$

$r(187) = 0.515, p < 0.001 (0.50 \leq |r| \leq 0.75 \text{ strong correlation})$

b) the task value variable shows a strong correlation with self-efficacy [$r(187) = 0.567, p < 0.001, (0.50 \leq |r| \leq 0.75 \text{ strong correlation})$], while with self-regulation a moderate correlation [$r(187) = 0.459, p < 0.001, (0.30 \leq |r| \leq 0.5 \text{ moderate correlation})$]

c) self-efficacy shows a strong correlation with self-regulation [$r(187) = 0.528, p < 0.001, (0.50 \leq |r| \leq 0.75 \text{ strong correlation})$]

Conclusions

In the present research, it was attempted to study motivation and its individual factors of learning natural sciences. The sample group of the research was male and female high school students in Greece, who answered questionnaires based on the tool of Velayutham et al (2011) that was translated into the Greek language and checked for its validity and reliability for the particular sample. The corresponding Greek version of the questionnaire in the present research gave a high Cronbach's alpha internal consistency coefficient ($\alpha=0.927$). The weighting of the specific tool in Greek data is considered particularly important and necessary, as a study by Dermitzaki et al (2013) points out the weaknesses of the SMTSL tool, an older questionnaire for measuring students' motivation in learning science.

The research questions were related to the correlation of the four motivational factors: Learning goal Orientation, Self-regulation, Task Value and Self-efficacy.

After the appropriate processing of the research data, the results in terms of student motivation showed an above-average motivation for learning natural sciences, and particularly high levels in the "Learning goal orientation" factor. This means that the male and female students of the specific sample have a high understanding and identification with the objectives set in the natural science courses they have attended. On the other hand, the students' self-efficacy factor was above average, but was also the lowest of the four factors. This means that, despite the fact that students demonstrate strong motivation for their education in the natural sciences, a stronger enforcement of their self-belief regarding their abilities is needed, and of course appropriate teaching for their substantial improvement.

Apart from the association between the Task Value and Self-Regulation, strong correlations were found between all of the motivational pillars that comprised the subgroups of questions

on the instrument in regard to the primary research question. These correlations demonstrate the validity of the tool's theoretical foundation, as the constituent elements are actually interconnected and produce a highly organized final result, the mobilization of the student.

Research limitations

The results of the present research should be evaluated based on some important limitations, which are mainly related to its sample. A major limitation appeared to be the number of participants, as it is relatively small to be able to draw unequivocal conclusions. Another limitation regarding the sample of the research is that the participants were purely students of lower secondary education, therefore the conclusions refer to a very specific set of people and it is not possible to be generalized.

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