EFFECTS OF SOCIOECONOMIC STATUS, LOCUS OF CONTROL, PRIOR ACHIEVEMENT, CUMULATIVE GPA, FUTURE OCCUPATION AND ACHIEVEMENT IN MATHEMATICS ON STUDENTS' ATTITUDES TOWARD PHYSICS

Hakan UZ*   Ali ERYILMAZ**

ABSTRACT: In this research, the factors affecting the students' attitudes toward physics were investigated. In order to find the effects of six independent variables namely socioeconomic status, prior achievement, cumulative GPA, future occupation, locus of control and achievement in math on students' attitudes toward physics were examined. Three scales; Physics Attitude Scale, Socioeconomic Status Scale and Locus of Control Scale were developed and administered to 317 high school students. Multiple Regression and Correlation Analysis (MRC) was used to analyze the data obtained from the scales. This research showed that the combined effect of these six independent variables on students' attitudes toward physics is significant. The unique effects of future occupation, locus of control, achievement in math and prior achievement were significant factors while the unique effects of socioeconomic status and cumulative GPA were not.

KEY WORDS: *Attitudes toward physics, socioeconomic status, prior achievement, cumulative GPA, locus of control, and future occupation.*

ÖZET: Bu araştırmada öğrencilerin fiziğe karşı tutumlarını etkileyen faktörler araştırıldı. İsimleri sosyoekonomik durum, önceki başarılar, genel not ortalaması, gelecekteki meslek, denetim odağı ve matematikteki başarılar olan altı bağımsız değişkenin öğrencilerin fiziğe karşı tutumuna olan etkileri incelendi. Fizik Tutum Ölçeği, Sosyoekonomik Durum Ölçeği ve Denetim Odağı Ölçeği adında 3 ölçek geliştirildi ve 317 lise öğrencisine uygulandı. Bu ölçeklerden elde edilen sonuçları analiz etmek için çok boyutlu regrasyon ve ilişki analizi (MRC) metodu kullanıldı. Bu araştırma 6 bağımsız değişkenin öğrencinin fiziğe karşı tutumuna olan birleşik etkisinin önemli olduğunu gösterdi. Gelecekteki meslek, denetim odağı, matematikteki başarılar ve önceki başarılar önemli faktörler iken sosyoekonomik durum ve genel not ortalamasının önemli faktörler olmadığı ortaya çıktı.

ANAHTAR SÖZCÜKLER: *Fiziğe karşı tutum, sosyoekonomik durum, önceki başarılar, genel not ortalaması, denetim odağı ve gelecekteki meslek.*

1. INTRODUCTION

Teachers and the students are the two important factors in education. Between the two, the importance of the teacher is obvious. Teachers serve as models for children and adults as they teach and as they live their lives both inside and outside schools. He or she is a director, a source of knowledge and the only applicator of the curriculum. Beside this we must not undervalue the importance of the situations of the students. There will not be adequate education when the teachers are not qualified. Similarly this fact is also valid for the students when they are not ready to learn.

There had been many research studies, which were intended to improve the achievements of the students in many subject areas. Since many research studies showed that the attitudes of the students towards the intended goals are very important for the quality of education, we are intending to improve the achievements of the students in physics by means of identifying the factors effecting students' attitudes toward physics in this research. One of the researchers, Butcher [1], indicates that attitude variables had very much higher loading on a science/arts orientation factor than did school marks in science. This shows that attitude variables can be of considerable value as predictors of subject choice.

Many researchers tried to identify the factors effecting the students' achievement. For instances, Frances and Cheryl [2] performed a study to measure the effects of the family on the achievements of the students. They showed that

* Hakan Uz, Graduate Student, Middle East Technical University, Faculty of Education, Secondary School Science and Mathematics Education.
** Dr. Ali Eryılmaz, Middle East Technical University, Faculty of Education, Secondary School Science and Mathematics Education Department

parents have potential importance on the students' academic lives for promoting students' academic achievement. In this study it is clearly evident that family encouragement as well as the family interest in schools and classrooms affect children's achievement, attitudes and aspirations even after student ability and family socioeconomic status are taken into account. In the research of Talton and Simpson [3], it is found that self-perception, family and classroom were significant predictors of attitudes towards science. They claim that high parent involvement was related to high science attitudes and interests among adolescents. Schibeci and Riley [4] found that home environment and parent education exerted a strong influence within a casual chain linking instruction with attitude and achievement (cf. Talton and Simpson [3]). When we look at the research of Gogolin and Swartz [5] we get some considerable information about the importance of the family environment. In this research it is written "By strengthening family commitment to science and enhancing the opportunities for science interest to develop in children, the school may have greater success in nurturing that interest through involvement in science-related activities in the classroom." So, many research studies showed that family environment and the socioeconomic status of the family play a significant role in the development of the students in many areas.

Hudson and Rottmann [6] mainly concentrated on the importance of prior Mathematics knowledge in the Physics performance of the students. In their research, they applied some pretests about the mathematics knowledge in order to correlate with the physics performance of the students. They found high correlation between the two and concluded that mathematical skills may serve as a reasonable predictor of performance in physics.

According to the research of Talton and Simpson [3], a huge amount of investigators have reported positive relationships between student self-perception and cognitive and non-cognitive learning outcomes. Beside this, they points out that "It appears that students with a strong positive regard for their own abilities to learn have a

positive attitude toward science." Gardner [7] performed several studies and found that self-concept and achievement motivation was related to a positive attitude toward science. Haladyna [8] found that students who have confidence in their own abilities, a sense of control of their own fate, and a feeling of science as being important, also have positive attitudes towards science.

Elmer [9] explained the fact that there was a strong correlation between the achievement in physics and the attitudes towards physics. According to Doruk [10], the attitudes towards physics play an important role in the physics achievement. Beside all these when we look at Eryılmaz's study [11] we can clearly see that Cumulative GPA and the prior achievements have strong influences on students' achievement in physics. In the research of Peterson and Charlson [12] we found a statement as "a much stronger argument can now be made for saying that achievement creates positive attitudes and probably not the reverse, as many of us have thought." (cf. Schibeci and Riley[13]).

Oliver and Anderson [14] performed a research about the career choices of junior high school students. In their research they found that the attitudes of the students toward teaching as a career in grades six through twelve became less favorable as the students increased in age. They also reported that twelve grade students considering teaching as financially unrewarding, uninteresting, underpaid in relation to the training required, having no chance for advancement and monotonous. In addition to this, they points out that the twelfth graders felt that career choices should be based on security, good salary, good chance for advancement, no monotony, pleasant surroundings and chances to meet people. According to this research, it can be said that eight grade students generally do not see science teaching as being well paid or enjoyable as a profession and generally do not view science teaching as a highly desirable career. Furthermore, Çağlar [15] and Borg [16] studied qualities of teachers. They emphasized the importance of qualities of teachers for students' attitudes and achievement.

We performed a pilot study with 100 students from different grade levels to identify the factors, which may affect students' attitudes and achievement toward physics by asking a single question; "Why do you like or dislike physics?". They listed the factors mainly under the following headings:

* Teacher characteristics

* Difficulty of physics

* Content of physics

* Achievement in mathematics

* Their own ability to physics

* School conditions

* Their future occupations etc.

Under the light of the reasons above, main objective of this study is to examine the combined and unique effects of the factors such as socioeconomic status (SES), locus of control (LoC), prior achievement (PrAch), cumulative GPA (cGPA), achievement in Math (AchMath) and future occupation (FutOcc) on students' attitudes towards physics (StAtt).

2. METHODOLOGY

2.1. SUBJECTS

Population of the study was the 10th and 11th grade students who take the physics course in some inner city and suburban high schools in Ankara during the 1998-1999 school year. Sample of the study was 317 students from 5 schools; one of them was Anatolian high school, three of them were inner city high schools and one of them was a suburban high school. Therefore sample was a sample of convenience.

2.2. MEASURING TOOLS

In this study, we developed 3 instruments to assess the students' attitudes towards physics, socioeconomic status and locus of control. All items were written in Turkish.

INSTRUMENT1: PHYSICS ATTITUDES SCALE (PAS)

PAS was developed to measure the students' attitudes towards physics. In the preparation of this scale, some of the items were taken directly and some of them were adapted from the previous attitude scales [17, 18]. The possible minimum and maximum scores of this scale were 24 and 120, respectively. A high score on this scale means a positive attitude toward physics. It consisted of 24 likert-type items with 5 point likert scale; (5- strongly agree, 4- agree, 3- neutral, 2- disagree, and 1- strongly disagree). Split Half and Alpha Reliability coefficients of this scale were 0.85 and 0.87, respectively. A sample item from the scale was given below.

* I like physics.

(5)   Strongly Agree

(4)   Agree

(3)   Neutral

(2)   Disagree

(1)   Strongly Disagree

INSTRUMENT 2: SOCIOECONOMIC STATUS SCALE (SES)

SES was developed to measure students' socioeconomic status. Socioeconomic status is composed of three main parts. One of them is occupation, the other one is educational level and the last one is monthly income of a family. It contained 16 multiple choice type items. The possible minimum and the maximum score of this scale were 16 and 71, respectively. A high score on this scale means a high socioeconomic status. Split Half and Alpha Reliability coefficients of this scale were 0.82 and 0.74 respectively. A sample item from the scale was given below.

* What is or was your father's occupation?

( ) Officer   ( ) Unemployed

( ) Worker   ( ) Retired

( ) Tradesman   ( ) Other ....

( ) Farmer

INSTRUMENT 3: LOCUS OF CONTROL SCALE (LCS)

LCS was developed to measure how the students interpret their achievement. That is, whether they show inner agent (hard working, ability) or outside agent (chance,...) responsible for their achievement. The scale contained 8 likert-type items. The possible maximum score of this scale was 40 and the possible minimum score was 8. A high score on this scale means that the student is responsible for his achievement, not the chance factors. Alpha Reliability coefficient of this scale was 0.51. A sample item from the scale was given below.

* At times I feel that I have little influence over the things that happen to me.

(5)   Strongly Agree

(4)   Agree

(3)   Neutral

(2)   Disagree

(1)   Strongly Disagree

Prior achievement were assessed by 2 multiple-choice type items given below. In these items students may take minimum 1 and maximum 5 points representing the students' achievement value.

* What was your last year physics grade?

( ) Very Good (85-100) ( ) Good (70-84)

( ) Middle (55-69)   ( ) Can Pass (45-54)

( ) Failure (0-44)

* What was your secondary school science grade?

( ) Very Good (85-100) ( ) Good (70-84)

( ) Middle (55-69)   ( ) Can Pass (45-54)

( ) Failure (0-44)

Another independent variable achievement in math and attitudes towards math were measured by 2 items. One of which was a multiple-choice and the other one was a likert-type item shown below.

* What was your last year mathematics grade?

( ) Very Good (85-100) ( ) Good (70-84)

( ) Middle (55-69)   ( ) Can Pass (45-54)

( ) Failure (0-44)

* I like mathematics.

(5)   Strongly Agree

(4)   Agree

(3)   Neutral

(2)   Disagree

(1)   Strongly Disagree

In one of this item we tried to take students' last year math scores and in the other one we tried to take opinion whether he likes math or not. Although students' achievement in and attitudes towards math may not be the same, they are highly related to each other. Therefore, they were combined in one variable in order to decrease

colinearity problem in the MRC analysis. Students may take maximum 5 and minimum 1 points from each item. For the independent variable cumulative GPA we asked 1 item to take last years' overall score given below.

> * If you remember, write your cGPA in the blank. If not, mark the appropriate alternative below.
>
> ....(Ex: 3.41)

( ) 0–0.99 ( ) 1–1.99 ( ) 2–2.29 ( ) 3–3.99 ( ) 4-5

In this item students could take minimum 1 and maximum 5 points. For the last independent variable students' future occupation, we asked 1 item to take the students' ideas whether they think they will use physics in their future occupation or not by the help of likert-type item below.

> * There is a relation between my future occupation and the physics.
>
> (5) Strongly Agree
>
> (4) Agree
>
> (3) Neutral
>
> (2) Disagree
>
> (1) Strongly Disagree

Validity evidences of the scales were collected in two ways. Firstly, face validity evidences were collected by the help of our instructors in our university. Then, we found the content-related validity by preparing the items according to the main and the sub-titles by paying attention to the matching of the items with the main and sub-titles.

2.3. PROCEDURE

We performed a pilot study with 100 students from different grade levels to identify the factors affecting students' attitudes toward physics. We asked the question "Why do you like or dislike physics?". They answered the question on a paper and we collected them. By the help of these answers we identified the factors. Then, we began to make literature review and collected information about the previous related studies. Meanwhile, we started to develop three scales; Physics Attitude Scale, Socioeconomic Status Scale and Locus of Control Scale. They were administered to 5 high school students in order to be sure that the items were understandable. After correcting instrument by means of this pilot application, we administred the instrument to 317 10th and 11th grade students who take the physics course in some inner city and suburban high schools in Ankara during the 1998-1999 school year. The collected data were entered to the computer and using the programs Microsoft Excel and SPSS we performed statistical analyses.

3. RESULTS

In Table 1, the descriptive statistics for dependent and independent variables of the study are given.

Table 1. Descriptive Analysis of Students' Attitudes Toward Physics, Socioeconomic Status, Locus of Control, Prior Achievement, Cumulative GPA, Future Occupation, and Mathematics Achievement. (n=317)

	StAtt	SES	LoC	PrAch	cGPA	FutOcc	AchMa
Mean	88.63	45.99	25.22	8.40	4.43	3.55	8.29
Median	90.00	45.00	25.00	9.00	4.00	4.00	9.00
Mode	92.00	42.00	26.00	9.00	5.00	4.00	10.00
Standard Deviation	16.09	8.82	3.44	1.40	0.64	1.29	1.56
Minimum	20.00	24.00	15.00	4.00	0.00	0.00	3.00
Maximum	120.00	67.00	36.00	10.00	5.00	5.00	10.00

According to the mean, median, and mode values in Table 1, scores from the attitude scale have a right-skewed distribution. That is, results are indicating that most of the students have high scores in the physics attitude scale. Therefore, it can be concluded that most of the students in this study have a positive attitude toward physics. The scores of the socioeconomic status have a normal distribution. The mean is about 46 out of 71. This means that students' SES are above the average. Locus of Control of the students also has a normal distribution. So it means that most of the students partially believe in the external effects (chance) and partially inner effects (hardworking). When we analyze prior achievement, the data show that most of the students are high achievers. Also looking to the data of students' cumulative GPA, we can make the same conclusion. The maximum cGPA is 5 and most of the students' cGPAs are very close to that value with a mean of 4.43 and a standard deviation of 0.64. Moreover, it can be seen from Table 1 that most of the students have high mathematical achievement. The data indicating the students' future occupation have a right-skewed distribution. So most of the students have a positive consideration about the relations of physics and the future occupation.

Table 2 shows the statistical analyses investigating the combined effect of six independent variables on the dependent variable; students' attitudes toward physics.

Table 2. MRC Results for Combined Effect of Socioeconomic Status, Locus of Control, Prior Achievement, Cumulative GPA and Future Occupation and Achievement in Mathematics.

Regression Statistics				
Multiple R	0.546			
R Square	0.298			
Adjusted R Square	0.284			
Standard Error	13.606			
Observations	317			
	df	SS	MS	F	Significance F
Regression	6	24305.4	4050.9	21.9	0.000
Residual	310	57384.4	185.1		
Total	316	81689.8			

It can be clearly seen from Table 2 that, there exists a medium correlation between students' attitudes toward physics and the combined 6 independent variables; locus of control, socioeconomic status, cumulative GPA, prior achievement, future occupation and achievement in mathematics (0.546). As the Table indicates, 6 variables together explain a significant amount of variances in the students' attitude scores. This result is statistically significant at the 0.05 level of significance. In addition, these factors can explain 29.8 % of the variances in the students' attitude scores. In other words, 70.2 % of the variances in the students' attitude scores can not be explained by these 6 variables. The unique effect of each independent variable can be seen in Table 3.

Table 3. Results of Multiple Regression Analysis for Investigating the Effects of Six Variables

	Coefficients	Standard Error	t ratio	P-value
Intercept	24.24	7.85	3.09	0.002*
SES	0.12	0.09	1.29	0.197
LoC	0.88	0.23	3.81	0.000*
PrAch	1.87	0.66	2.82	0.005*
cGPA	-1.66	1.50	-1.11	0.267
FutOccu	4.48	0.61	7.31	0.000*
AchMat	1.51	0.60	2.54	0.012*

Locus of control has a significant effect on the students' attitudes toward physics. This result is statistically significant at the 0.05 level of significance. It means that students who relate their achievement to themselves tend to have positive attitudes toward physics. Prior achievement and achievement in math also have significant effects on students' attitudes toward physics. This result is significant at the 0.05 level of significance. Therefore, the high achiever students have more positive attitudes toward physics. Achievement in math also seems to be significant effect. So, if a student has no problem with mathematics, most probably he has a positive attitude toward physics. Future occupation also has a significant

effect on the students' attitudes toward physics. This result is statistically significant at the 0.05 level of significance. That is, they think that there is a strong relationship between their future occupation and physics. Although there is a good correlation between students' attitudes toward physics and the combined 6 independent variables, unique effects of SES and cGPA are not significant at the 0.05 level of significance.

Using Table 3, multiple regression equation can be written in order to estimate students' attitude scores from 6 independent variables, locus of control, socioeconomic status, cumulative GPA, prior achievement, future occupation and achievement in mathematics. This equation is written below.

$$Y = 0.12*X_1 + 0.88*X_2 + 1.87*X_3 - 1.66*X_4 + 4.48*X_5 + 1.51*X_6 + 24.24$$

Where Y represents the predicted attitude scores. X1, X2, X3, X4, X5 and X6 represent socioeconomic status, locus of control, prior achievement, cumulative GPA, future occupation and achievement in math scores.

4. DISCUSSION AND CONCLUSIONS

In this research, the factors affecting the students' attitudes toward physics were studied. The effects of 6 factors namely socioeconomic status, prior achievement, cumulative GPA, future occupation, locus of control and achievement in math on the students' attitudes toward physics were analyzed.

Students' prior achievement was found to be a significant factor effecting the students' attitudes toward physics. This result is very close to the results of Peterson and Carlson [12]. They stated that achievement results in positive attitudes and probably not the reverse. In addition to this, Gardner [7] performed a research and found that pupils who are achievement-motivated tend to maintain more favorable attitudes to physics.

As this study demonstrated, cumulative GPA and SES do not have a significant effect on students' attitudes toward physics. It is not consistent with the earlier findings and it may be resulted from the correlation among the independent variables, but achievement in math has a significant effect on the students' attitudes toward physics. Rottmann and Hudson [6] also stated that performance in physics is strongly affected by the mathematics abilities.

Our study demonstrated that students' locus of control is a significant factor affecting the students' attitudes toward physics. It is in agreement with the findings of Talton and Simpson [3]. They shortly stated that students with a strong positive regard for their own abilities to learn have a more positive attitude toward science. Consequently, students' future occupation has also a significant effect on his attitudes toward physics, Oliver and Anderson [13] also state that students tend to make their best in order to achieve their favorable career.

We can make some comments by means of these findings. First, it is difficult to change the socioeconomic status of a student but a close relationship can be established between the students and the teachers. By doing so, we hope that teachers will be able to minimize the failure of a child who has a low socioeconomic status. Second, there are guidance services in most of the schools. If these services can do their best for the children we think those students' locus of control and their knowledge about the occupations will get higher and so they will be more successful. Third, another important factor is the mathematics achievement. Mathematics is essential for physics but it is not enough to be successful in physics. So, more attention can be paid for mathematics firstly by the mathematics teacher and secondly by the physics teacher. For instance, physics teacher may stress the mathematical concept related with the subject when needed and he or she may be in a close contact with the mathematics teacher. Otherwise, the students can only be partially successful in physics.

REFERENCES

1. Butcher, H.J. "The structure of abilities, interest and personality in 1000 Scottish School children." **British Journal of Educational Psychology,** 39(2), 154-165 (1969).

2. Frances, M.S. and Cheryl, O.H. "Relationship of Family Support and Ethnic Minority Students' Achievement in Science and Mathematics." **Science Education,** 8, 111-113 (1996).

3. Talton, E.L. and Simpson, R.D. "Relationship of attitudes toward self, family, and school with attitude toward science among adolescents." **Science Education,** 70(4), 365-374 (1986).

4. Schibeci, R.A. and Riley, J.P. "Influence of students' backgrounds and perceptions on science attitudes and achievement." **Paper presented at the annual meeting of the American Educational Research Association,** Montreal, P. Q., Canada, (1983).

5. Gogolin, L. and Swartz, F. "A quantitative and Qualitative Inquiry into the attitudes toward science of nonscience college students." **Journal of Research in Science Teaching,** 29(5), 487-504 (1992).

6. Hudson, H.T. and Rottmann R.M. "Correlation between performance in physics and prior Mathematics knowledge." **Journal of Research in Science Teaching,** 18(4), 291-294 (1981).

7. Gardner, P.L. "Attitude toward science." **Studies in Science Education,** 2, 1-41 (1975).

8. Haladyna, T., Olsen, R. and Shaughnessy, J. "Relationships of student, teacher and learning environment variables to attitudes toward science" **Science Education,** 66(5), 671-687 (1982).

9. Elmer, G.R. "Attitude Toward Physics in the High School Curriculum." **American Journal of Physics,** 44 (4), 333-435 (1976).

10. Doruk, H. "A Case Study on Evaluating the Content Based Competency of Preservice Physics Teachers" **Unpublished Master Thesis,** METU, Ankara, (1992).

11. Eryılmaz, A. "Students' Preconceptions in Introductory Mechanics" **Unpublished Master Thesis,** METU, Ankara (1992).

12. Peterson, R. W. and Carlson, G. R. "A summary of research in science education" **Science Education,** 63 (whole issue) (1979).

13. Schibeci, R.A. and Riley, J.P. "Influence of students' backgrounds and perceptions on science attitudes and achievement." **Journal of Research in Science Teaching,** 23(3), 177-187 (1986).

14. Oliver, J.S. and Anderson, N.D. "Science teaching as a career choice of junior high school student" **Science Education,** 70(2), 93-103 (1986).

15. Çağlar, D. "Öğretmen Yetiştiren Kurumlara Öğretmen Yetiştirme", **Çağdaş Eğitim,** 241, 37-40 (1998)

16. Borg, S. "The Good Teacher Trainer", **The Teacher Trainer,** 12(2), 7-10 (1998)

17. Başer, M. "Kavram Değiştirme Yönteminin Öğrencinin Isı ve Sıcaklık Kavramlarını Anlamalarına ve Fen Tutumlarına Etkisi", **Unpublished Master Thesis,** METU, (1996)

18. Tamir, P., Arzi, A. and Zloto, D. "Attitudes of Israeli High School Students Towards Physics", **Science Education,** 58, 75-86 (1974)