Development and Validation of a Scale to Measure Physics Laboratory Attitude Level of University Students

Namudar İzzet Kurbanoğlu[1] ve Ahmet Akın[2]

[1]Sakarya University Faculty of Education,
Department of Science Education, SAKARYA-TURKEY

[2]Sakarya University Faculty of Education Department of
Psychological Counseling and Guidance, SAKARYA-TURKEY

(*Submitted:* 21-01-2014)

Abstract

The aim of this research is to develop a scale for measuring physics laboratory attitudes. Factor analytic evidence from a sample (n=503) of university physics students shows the Physics Laboratory Attitude Scale is a uni-dimensional scale. The amount of total variance explained by one factor was nearly 59%. Factor loadings of the items ranged from .70 to .91. For convergent validity the relationships between the physics laboratory attitudes and self-efficacy related to learning and performance was found as .21. The internal consistency reliability coefficient of the scale, using Cronbach alpha was .94. Overall findings demonstrated that this scale had high validity and reliability scores and that it may be used as an efficient instrument in order to assess attitude level of physics laboratory students.

1. Introduction

Introductory physics is a required course for many sciences such as engineering, chemistry, mathematics, and of course, physics. Furthermore physics, a typical introductory course for most engineering, science, and mathematics students, provides a context for which students can study change in a concrete setting. Physics education starts in the fourth grade as science courses, and it continues all through high school and university. Also, physics is taught in many academic programs such as chemistry, biology, medicine, dentistry, pharmacology, environmental sciences, engineering, and architecture as a compulsory course at university level. However, students traditionally have difficulty with physics courses [1]. As a result, many students change their major after failing physics several times [2].

Introductory physics requires a laboratory to accompany the lecture sequence. There are a variety of improvements [3, 4] designed for introductory physics laboratories that show promise for improving student learning. Laboratory experiences have always been important components for the reinforcement and understanding of physics concepts. Therefore, laboratory application should be considered more seriously to make learning in physics lessons reach higher degrees than just knowledge and comprehension level.

Laboratory activities [5, 6, 7, 8], have a crucial role in the science curriculum, and science educators have proposed that many benefits accrue from engaging students in science laboratory activities. In addition, it was suggested that inquiry-centred laboratories have the potential to enhance students' meaningful learning, conceptual understanding, and their understanding of the nature of science [9]. According to Hershey [10], laboratory experiences provide students with the important experience of meeting "nature as it is, rather than in idealized form" and [11, 12] and with the opportunity to develop skills in scientific investigation and inquiry. Moreover, these experiences provide support for high-order learning skills that include observing, planning an experiment, asking relevant questions, hypothesizing, and analyzing experimental results [13, 14].

The learning in the introductory physics laboratory is related to several variables and attitude is one of these variables. Attitudes, like academic achievement, are important outcomes of science education in secondary school and university [15]. Researchers [16, 17, 18, 19] have confirmed that attitudes are linked with academic achievement. An attitude may be defined as a predisposition to respond in a favorable or unfavorable manner with respect to a given attitude object. The development of students' positive attitudes regarding science as a school subject is one of the major responsibilities of every science teacher [20].

Most of the researches on the attitude have concluded that student's attitude is an integral part of learning and that it should, therefore, become an essential component of physics concept learning pedagogy. According to Schibeci [21], attitudes toward science involve an attitude object such as "science" or "science lessons," "laboratory work" [19]. Efficiency of learning physics concept depends on students' attitudes towards physics laboratory. Ensuring that students develop positive attitudes towards physics laboratory will enhance students' abilities to learn physics topics. When tools are developed for measuring the dimensions of the factors affecting the learning of concepts in introductory physics such as attitude, physics teaching will reach the intended destination. Thus, the purpose of this study is to develop an assessment tool in order to be used to measure the attitudes of college students towards physics laboratory.

2. Methodology of Research

Participants: In an attempt to obtain a wide variation in responses, efforts were made to obtain respondents from six different universities, Turkey. Participants were 503 university students (273 male, 230 female) from department of physics who enrolled physics laboratory course.

Scale Development: The Physics Laboratory Attitude Scale was designed to measure the attitudes of students who take physics laboratory course. A total thirteen items were written. Respondents were asked to respond to each item using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The scale items are included in Table 2. Demographic information also was requested, including gender and department and university information.

3. Measures

Self-efficacy Related to Learning and Performance: Self-efficacy was measured by using the Turkish version of the Self-efficacy related to learning and performance subscale of the Motivated Strategies for Learning Questionnaire (MSLQ) [22]. Turkish adaptation of this scale had been done by

Büyüköztürk, Akgün, Özkahveci, and Demirel [23]. The Self-efficacy subscale consists of eight items and each item was rated on a 7-point scale (1= not at all true for me to 7= very true for me). As a result of factor analysis in construct validity, it was found that factor loadings of items were between .52 to .65. In the reliability study, the internal consistency alpha coefficient was calculated .86.

Procedures: Physics laboratory classes (ranging in size from 20 to 30 students) were selected randomly by the on-site data collector at the six universities. The scale was administered in a group format to each physics laboratory courses the first and second semesters during the 2011-2012 academic years. Prior to administration of measures, all participants were told about purposes of the study and administration typically required 10 to 15 minutes. The person administering the scale collected and returned the scales to the researcher. Completion of the questionnaires was anonymous and there was a guarantee of confidentiality. The instruments were administered to the students in groups in the classrooms. Analysis of the data took place in two ways: (a) calculating item total correlation estimates for item analysis to identify any faulty items, obtaining internal consistency reliability estimates of the scale scores and b) testing the construct validity by exploratory factor analysis and the convergent validity by estimating the relationship between physics laboratory attitude and self-efficacy related to learning and performance subscale of the motivated strategies for learning questionnaire.

4. Results of Research

Item Analysis and Reliability: The corrected item-total correlations of the 13 items ranged from .64 to .76. Estimated Cronbach's reliabilities were .94. Table 1 shows means, standard deviations, and the item total correlations of the 13 items.

Table 1: Means, standard deviations, and item–total correlations of the draft Physics Laboratory Attitude Scale

Items	$\overline{X}$	**SD**	***rjx***	Items	$\overline{X}$	**SD**	***rjx***
Q1	4,50	0,80	.64	Q8	4,53	0,79	.76
Q2	4,45	0,82	.72	Q9	4,41	0,83	.75
Q3	4,53	0,79	.72	Q10	4,30	0,92	.76
Q4	3,98	1,00	.65	Q11	4,47	0,85	.75
Q5	4,28	0,86	.75	Q12	4,30	0,91	.69
Q6	4,34	0,89	.71	Q13	4,42	0,89	.73
Q7	4,31	0,90	.75				

	Items	Factor loadings
Q1	Making experiments in physics class increases my interest to the subject.	0.70
Q2	Learning new information while having physics experiments.	0.77
Q3	Without doing physics experiments the information will not be permanent.	0.77
Q4*	Making experiment in physics lesson does not affect my performance in a positive way.	0.70
Q5	Laboratory experiment teaches how to work with discipline.	0.79

Table 2: Items and principal components un-rotated factor/structure component matrix solution of the Physics Laboratory Attitude Scale

Q6	Having more physics laboratory will increase my interest.	0.76
Q7	Laboratory works makes me more practical in my daily life.	0.80
Q8*	Physics experiments do not affect the learning of the physical terms.	0.81
Q9	It is hard to learn physical terms without doing experiment.	0.79
Q10	Physics lessons should have more laboratory work.	0.80
Q11	Having laboratory experiment will contribute to the development of mental and manual ability.	0.79
Q12	It is more interesting to learn physical terms by doing experiments.	0.74
Q13*	Doing experiments in physics courses reduces my interest in the subject.	0.78

*Negatively keyed items.

Construct Validity: For construct validity, exploratory factor analysis was conducted to validate the underlying structure of the model. Prior to the conduct of exploratory factor analysis, Kaiser-Meyer-Olkin (KMO) statistic and Bartlett's Test of Sphericity was calculated. The KMO value (KMO=.952) indicated that the degree of common variance among the variables was marvelous.

The Bartlett's test of sphericity indicated a Chi square 4789.335 with an observed significance level of $p<.001$. Based on the results, it was inferred that the relationship between the variables was strong and appropriate for factor analysis. One factor explained 59% of variance. All of the items had factor structure coefficients exceeding an absolute value of 0.30.

Convergent Validity: Convergent validity of the Physics Laboratory Attitude Scale scores was assessed via correlation with the self-efficacy related to learning and performance scale. The Physics Laboratory Attitude Scale correlated positively with the self-efficacy related to learning and performance subscale of the motivated strategies for learning questionnaire (r =.21).

5. Discussion

Physics laboratory is one of the most important courses for undergraduate students majoring in applied chemistry, polymer chemistry, material chemistry, chemical engineering, life science, and environmental engineering and science. Therefore, in this study it was developed an assessment tool in order to be used to measure the attitude level of college students' towards physics laboratory.

Based on the principle of measuring physics laboratory attitude by a global scale, we proposed a thirteen-item global measure of physics laboratory attitude. The proposed physics laboratory attitude scale was examined with a sample of 503 university students. In general, the physics laboratory attitude scores demonstrated good internal reliability, construct validity, and convergent validity. Specifically, the physics laboratory attitude correlated moderately with self-efficacy related to learning and performance. As a result, it can be said that this scale had high validity and reliability scores. Therefore, the physics laboratory attitude scale could serve as a useful tool for engineering, chemistry, mathematics, and of course, physics fields to collect information about the physics laboratory attitude levels of students. However, further studies that will use the physics laboratory attitude scale are important for its measurement force.

References:

[1] Byun, T., Ha, S. and Lee, G. (2008). Identifying student difficulty in problem solving process via theframework of the house model, *Proceedings of the Physics Education Research Conference* (Vol.1064, pp. 87-90). Edmonton, Alberta: AIP.

[2] Tuminaro, J. and Redish, E. (2004). *Understanding students' poor performance on mathematical problem solving in physics,* Paper presented at the Physics Education Research Conference.

[3] Hake, R. R. (1998). Socratic pedagogy in the introductory physics laboratory, *Am. J. Phys.* **66**: 64-74.

[4] Laws, P. W, Sokoloff, D. R. and Thornton, R. K. (1995). *Real Time Physics,* (OR: Vernier Software).

[5] Hofstein, A., and Lunetta, V. N. (1982). The role of the laboratory in science teaching: neglected aspects of research, Review of Educational Research, **52**: 201–217.

[6] Hofstein, A. and Lunetta, V. N. (2004). The laboratory in science education: foundations for the twenty-first century, Science Education, **88**: 28–54.

[7] Lunetta, V. N. (1998). The school science laboratory: Historical perspectives and context forn contemporary teaching. In B. Fraser & K. G. Tobin. (Eds.), *International handbook of science education* (pp.249-262). Dodrecht, The Netherlands: Kluwer.

[8] Tobin, K. G. (1990). Research on science laboratory activities. In pursuit of better questions and answers to improve learning, School Science and Mathematics, **90**: 403–418.

[9] Taitelbaum, D., Mamlok-Naaman, R., Carmeli, M. and Hofstein, A. (2008). Evidence for teachers' change while Participating in a continuous professional development programme and implementing the inquiry approach in the chemistry laboratory. International Journal of Science Education, **30**(5): 593–617.

[10] Hersey, T. (1990). *Teacher's guide to advanced placement courses in physics: Physics B and Physics C.* New York: Advanced Placement Program, The College Board.

[11] Hoffer, T., Radke, J. and Lord, R. (1992). Qualitative/quantitative study of the effectiveness of computer-assisted interactive video instruction: The hyperiodic table of elements. Journal of Computers in Mathematics and Science Teaching, **11**: 3–12.

[12] Shymansky, J., Kyle, W. and Alport, J. (1983). The effects of new science curricula on student performance, Journal of Research in Science Teaching, **20**: 387–404.

[13] Bybee, R. (2000). Teaching science as inquiry. In J. Minstrel and E. H. Van Zee (Eds.), Inquiring into inquiry learning and teaching in science. Washington: AAAS.

[14] Hofstein, A., Shore, R. and Kipnis, M. (2004). Providing high school chemistry students with opportunities to develop learning skills in an inquiry-type laboratory: a case study. International Journal of Science Education, **26**: 47–62.

[15] Cheung, D. (2009). Students' Attitudes toward Chemistry Lessons: The Interaction Effect between Grade Level and Gender, Research in Science Education, **39**: 75–91.

[16] Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991, Journal of Research in Science Teaching, **32**: 387–398.

[17] Freedman, M. P. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge, Journal of Research in Science Teaching, **34**(4): 343–357.

[18] Bennett, J., Rollnick, M., Green, G. and White, M. (2001). The development and use of an instrument to assess students' attitude to the study of chemistry, International Journal of Science Education, **23**(8): 833–845.

[19] Salta, K. and Tzougraki, C. (2004). Attitudes toward Chemistry among Eleventh Grade Students in High Schools in Greece, Science Education, **88**: 535.

[20] Oskamp, S. and Schultz, P. W. (2005). Attitudes and opinions (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

[21] Schibeci, R. A. (1983). Selecting appropriate attitudinal objectives for school science, Science Education, **67**: 595-603.
[22] Pintrich, P. R., Smith, D. A. F., Garcia, T. and McKeachie, W. J. (1991). *A manual for the use of the motivated strategies for learning.* Michigan: School of Education Building, The University of Michigan. (ERIC Document Reproduction Service No. ED338122).
[23] Büyüköztürk, Ş., Akgün, Ö., Özkahveci, Ö. and Demirel, F. (2004). The validity and reliability study of the Turkish version of the Motivated Strategies for Learning Questionnaire, Educational Science: Theory and Practice, **4**(2): 207–239.