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Developing a Scale to Measure Attitude towards Science Learning among School Students

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Abstract

Attitude towards science has attracted lot of attentions from researchers in the past and is still widely researched. Consequently, a large number of tools are available for measuring attitude towards science covering different dimensions of attitude. The reported variation is usually attributed to uniqueness of socio-economic and cultural aspects of society. This argument provided basis for developing attitude towards science learning *(AtSL)* which should be contextually relevant. Moreover it seems that majority of the scales available are used by the researcher once in their research and not probably meant to be developed as standards scale. Therefore their psychometric properties are not reported. A questionnaire of 54 items was developed and data was collected from 464 students of five government schools, varying in district, gender and class. Exploratory Factor Analysis clustered items into four sub-factors. The positive, strong and significant correlation of each sub-factor with total *AtSL* showed that sub-factors contribute towards measurement of main construct while relatively weaker inter-factor correlation indicated mutual independence of each sub-factor. The scale reliability was $\alpha = 0.86$, whereas range of α for sub-factors ranged between 0.75-0.61.

Keywords: Measuring attitude, Learning science, School students

Introduction

Attitude is one of those constructs which has attracted the attention of the researchers in education. Concerns about attitude towards science are not new (Osborne, Simon & Collins, 2003) and generating positive attitude towards science among students is an important goal of science education (TIMSS, 1999; Ministry of Education, 2009). Similarly the endorsement of a positive attitude toward science has remained one of an important aim of the curriculum at school level (Aiken & Aiken, 1969; Koballa, 1988; Laforgia, 1988).The importance to study attitudes is well established now because holding positive attitudes has positive relationship with increased enrolment in science courses, science achievement and interest in scientific careers (Carey & Shavelson, 1988). The students having positive attitudes towards learning science are more expected to have planning to engage in future learning behaviours in science subjects (Norwich & Duncan, 1990).

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Students' attitude towards science at secondary and elementary schools were extensively studied by Gardner (1975), Frazer and Walberg (1981); Banu (1986); Ramsden (1998); Kelly, (1986); Nisimov, (n.d.); Morrell and Lederman (1998); Hadden and Johnstone, (1983); George, (2000); Myers and Fouts (1992) either/both by quantitative or qualitative method. These researchers provided revealing insight regarding attitude towards science and most of them have reported positive attitude of students towards science (Osborn et al, 2003). The importance and role of attitude towards science can be recognized from these findings showing positive relationship of attitude towards science and achievement, and students with more positive attitude towards science having sustainable learning and it makes them want to continue with those subjects they enjoy (Pell & Jarvis, 2001).

Weinburgh **(**2000**)** has noted that there is increase in trend to measure attitude towards science over last 30 years. A range of instruments are published for measuring attitude towards science from various dimensions. A large number of sub-constructs/factors are associated with attitude which at times added ambiguity more than clarity to the understanding of the construct (Koballa, 1988). Therefore it is important to define 'attitude' before any further discussion. Gardner (1975b) defined attitude towards science as, "Learned predisposition to evaluate ….. objects, people, actions, situations or propositions involved in learning science" (p. 2). Klopfer (1971) was of the view that showing favourable attitude towards science and scientists, considering thought as scientific enquiry, enjoyment in science learning experiences, changing the attitude towards scientific reasoning, interest in science related activities and science careers are all treated as attitude towards science. Literature on 'attitude' has several more definitions containing more or less same elements. Blalock, Lichtenstein, Owen, Pruski, Marshall, & Toepperwein (2008) carried out a comprehensive review of this area and categorize attitude towards science into four areas; *a) attitude towards science, b) scientific attitude, c) the nature of science, and; d) scientific career interests.*

Keeping in view the diversity of sub-constructs associated with the construct of attitude, developing a scale for measurements of attitude towards science becomes a complex task. This will be quite helpful to briefly review the structure and psychometric properties of some of the widely used instruments for measurement of attitude towards science at this stage. Renmin, Raymonan, Susan and Hanexia (1998) developed an attitude scale of 25 statements. These statements were further classified into 8 factors. Cronhbach alpha for whole sample was 0.87. Reiss **(**2004**)** used an observational technique to measure the attitude towards science. Weinburgh (2000) used ATSI (attitude towards science inventory) of 48 items. George (2000) working on the application of latent variable growth modelling, pointed out a questionnaire to collect data regarding students attitude

towards science. TOSRA (Test of Science Related Attitude) by Frazer (1981) was standardized and its translated version in national language (Urdu) was used in Pakistani context by Rana (2002). Other than these reasonably widely used instruments, some published instruments are available which were used only once by the researcher in their studies. These include attitude towards science scale by Nisimor (n.d.); Parkinson, Hendley, Tanner and Stables (1998) and; Nasir and Kono (2004).

The analyses of the reported research instruments are evidence that first, majority of researches are dealing with attitude towards science and a few researchers are regarding the attitude towards science learning. Although some reported research instruments regarding attitude towards science have considered learning as sub-factor of the whole scales/research instruments. Second important aspect, can be concluded from the review, that there are very limited number of researches that have multiple studies of the same sample. Third aspect is the replication of the validated instruments throughout the world, like use of TOSRA in United States, Pakistan etc. This use of research instruments questioned the socio-economic and cultural aspects of the sample. The fourth aspect is the techniques of measuring attitude i.e. questionnaire, inventory, interviews and observations, reflecting the complexity of this construct.

Although these instruments were not adopted, review of the contents, format and scale were helpful in conceiving the shape of the attitude scale developed for this research. Keeping in view the demand of research in Pakistani perspectives and nature of the sample, it was decided to develop an attitude towards science learning scale in Urdu (National language).

Method and Procedure

The attitude scales presently available in the literature are either in English or are not suitable to use in Pakistani schools. Another factor is that the translated research instruments, if not properly translated or validated, may not convey the same theme of the statements even due to difference in cultures. The major purpose of this research was to develop and validate an Attitude towards Science Learning Scale *(AtSL)* that can be confidently used in students of schools in Pakistan.

Method

This section describes the details regarding the participants, stages of instrument development, instrument details and data analysis.

Sample

The sample was comprised of 464 students from government sector urban schools. All students from grade 8^{th} and 9^{th} were taken in sample from

nine conveniently selected schools. The selected schools were socio-economically similar to majority of the government schools of Punjab. The further detail of the sample is as follows;

Table 1
Distribution of participants by gender and district

District	Gender	Government Schools		Total
		9th grade	8th grade	
Lahore	Male	17	59	76
	Female	61	76	137
Sargodha	Male	73	93	166
	Female	-	85	85
Total		151	313	464

The 242 male and 222 female students of two Districts i.e. Lahore district (213 students) and Sargodha district (251 students) of 8th and 9th grade participated in the research.

Development of the Instrument

An attitude scale comprising of 54 statements was initially developed in national language Urdu. Some of these statements were directly conceived form the existing attitude scales. The remaining statements were developed in context of Pakistani schools' students. These statements were further discussed with two Ph. D. students having more than 11 years of experience in teaching science and have majored in psychology during their doctoral course work. Each statement had a six-point Likert response, i.e. Always, Frequently, Usually, Often, Sometimes, and Never. It was named as Attitude towards Science Learning Scale (*AtSL*).

Procedure

Head teachers of selected schools were contacted and after having the consent and discussion with respective class teachers the data was collected from respective grades of each school, the researcher himself visited the 9 schools of both districts (Sargodha & Lahore).and administered the attitude towards science learning scale (*AtSL*) for standardization of administration procedure for controlling external sources of error. Before filling the *AtSL*, the purpose of the research was explained and their willingness to participate in the research was inquired from the students.

Results

Construct validity of the research instruments can be measured through reduction of data (inter-rater validity method) or factor analysis method. In

Table 2
Factor analysis of attitude towards science learning scale

No.	Statements	*Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
8	I complete the science homework before going to play.	**0.706**	0.097	0.075	-0.025	-0.032
6	I can focus the science lesson during the whole class.	**0.593**	0.070	0.150	0.116	0.212
12	While studying science class, I fully concentrate on the topic.	**0.524**	0.317	0.124	0.209	0.050
11	During science lectures, I comprehend important points.	**0.477**	0.308	0.089	0.127	0.337
3	I understand science lessons taught by the teacher in the class.	**0.454**	0.113	0.043	0.372	0.266
7	I revise the science lesson daily at home.	**0.389**	0.339	-0.001	0.366	-0.062
1	I follow a regular schedule to study science subject(s) at home.	**0.363**	0.240	0.123	0.043	0.284
13	I usually allocate most of the time to the subject of science as I like it more than other subjects.	0.237	**0.702**	0.011	0.115	0.077
24	I like science lessons.	-0.016	**0.632**	0.288	0.140	0.228
2	I like to learn science because it is an interesting subject.	0.186	**0.622**	0.111	0.131	0.339
9	I feel real pleasure in science class.	0.385	**0.546**	0.194	0.092	0.110
15	My desire to attain success in science subject, urges me for more hard work.	0.186	**0.545**	-0.004	0.177	-0.230
19	The lessons taught in science classes are not interesting.	0.251	-0.060	**0.668**	0.096	0.005
22	I don't find it interesting to discuss science topics after the school time.	0.007	0.092	**0.636**	0.072	0.045
16	Science lessons become a source of boredom for me.	-0.019	0.294	**0.616**	-0.003	0.047
23	I don't take interest to complete my homework of science subject(s).	0.201	0.127	**0.593**	-0.012	-0.010
20	I can't understand the science lessons, after the class.	0.013	-0.097	**0.566**	0.452	0.000
17	Any topic(s) that I can't understand during the science class, I consult the teacher.	0.308	0.089	0.101	**0.690**	-0.048
18	The important point that teacher explain during teaching, help me in learning.	-0.038	0.183	0.124	**0.662**	0.202
14	Whenever I want to ask any thing about science subject, I immediately consult to the teachers.	0.412	0.222	-0.081	**0.578**	-0.032
21	I prefer opting science subject in next classes.	-0.110	0.339	0.318	**0.467**	0.139
5	I can explain science lessons in my own words.	0.280	-0.061	0.122	0.115	**0.665**
10	I usually relate the previously learned lessons with new science lessons.	0.233	0.158	-0.088	-0.078	**0.660**
4	I like watching science film on television.	-0.106	0.085	0.010	0.092	**0.659**

N=464 variations **explained** 50.01% **Extraction Method:** Principal Component Analysis. **Rotation Method:** Varimax with Kaiser Normalization. ***Factors:** F1= Keenness to Learn Science, F2= Enjoyment in Science Learning, F3= Disinterest, F4= Teacher Interaction

Pakistan, a small amount of research work is available regarding attitude towards science and science learning, reflecting the absence of research experts in this field. So it was difficult to get the interrater validity of this scale. Alternatively factor analysis (explanatory method of analysis) was used to decide the loadings of the statements of *AtSL*.

Factor analysis has reduced the statements into five factors. The serial number in Table 2 represents the original number of items in the *AtSL*. The original statements were in URDU language, table 2 is showing English translation for understanding of the foreign readers. Factor 5 consisted of only three statements, it was decided to reconsider these three statements, and statement 5 (I can explain science lessons in my own words) and statement 10 (I usually relate the previously learned lessons with new science lessons) were included in factor "Keenness to Learn Science (F1)" because when these statements were added in this factor, it did not affect its Cronbach alpha (0.75), and it is also evident from loadings of the statements 5 and 10 that after factor 5, both statements were loaded on factor "Keenness to Learn Science (F1)".The items with minimum factor loading 0.35 were accepted as valid.

Table 3
Factors, focus, items, their reliability and example statement

Factor No	Factor Name	Focus	Item number (as in the scale)	Reliability α	Example Statements
1	Keenness to Learn science	Self-focusing, content and class focusing, planning about science learning.	1,3,6,7,8,11, 12, 5,10	0.75	I can focus on science ideas throughout the entire period.
2	Enjoyment in Science Learning	Giving importance, liking and feeling pleasure	2,9,13,15,24	0.74	I get really pleasure from science learning.
3	Disinterest	Boring and incompletion of homework, avoiding discussion.	16, 19, 20, 22, 23	0.61	Science lessons are boring.
4	Teacher Interaction	Taking initiative in discussion and clarification with class teacher.	14, 17, 18, 21	0.66	Whenever I need to know anything about science, I ask from my teacher.

N=464 Cronbach alpha (α) of the scale = 0.86

Statement 4 (I like watching science films) was seen to be invalid within the Pakistani context because students in Pakistani scenario were unlikely to experience many scientific films. So this statement was finally excluded from the final analysis.

The Cronbach's alpha of the attitude towards science learning scale was 0.86 that represents very strong reliability of the research instrument (Hogan, 2003). Relationship of factors with other factors and with total scale is explored in table 4. For this purpose, the negative statements of factor Disinterest (statements no.16, 19, 20, 22, 23) were reversely coded.

Table 4
Relationship between AtSL and its sub-factors

Factors	No. of items	Mean	SD	F1	F2	F3	F4
Keenness to Learn science	9	42.55	7.31	---	0.58*	0.32*	0.48*
Enjoyment in Science Learning	5	24.69	5.02	---	---	0.34*	0.49*
Disinterest†	5	22.68	5.26	---	---	---	0.36*
Teacher Interaction	4	19.89	4.28	---	---	---	---
Total‡	23	109.61	17	0.93*	0.97*	0.96*	0.97*

*p<0.01 † Statements were reversed coded for analysis N=464
‡Correlation of every factor with total scores was calculated by excluding sum of items of concerned factor.

Table 4 describes the correlation among factors, and factors with overall sum of attitude scale. The inter-factor relationships are less strong than each factors contribution to the total scale which showed that each factor contributes into the scale but still its independence is established because of weaker relationship with other factors.

Table 5
Details of finally selected statements of *AtSL* Scale

Statement No.	Aspect of Attitude	Scale Factor	Correlate item With total corr.	Nature of Statement
2	Affective	2	0.627	Positive
9	Affective	2	0.606	Positive
15	Affective	2	0.336	Positive
16	Affective	3	0.332	Negative
19	Affective	3	0.433	Negative
21	Affective	4	0.424	Positive
22	Affective	3	0.316	Negative
23	Affective	3	0.553	Negative
24	Affective	2	0.592	Positive
1	Behaviour	1	0.426	Positive
7	Behaviour	1	0.549	Positive
8	Behaviour	1	0.442	Positive
13	Behaviour	2	0.502	Positive
14	Behaviour	4	0.546	Positive
17	Behaviour	4	0.580	Positive
3	Cognitive	1	0.512	Positive
5	Cognitive	5	0.415	Positive
6	Cognitive	1	0.526	Positive
10	Cognitive	5	0.387	Positive
11	Cognitive	1	0.527	Positive
12	Cognitive	1	0.532	Positive
18	Cognitive	4	0.533	Positive
20	Cognitive	3	0.338	Negative

On the basis of above discussed psychometric properties, finally 23 statements (18 positive and 5 negative statements) were selected for attitude towards science learning scale (*AtSL*). Each statement has five options i.e., Always, Usually, Often, Rarely and Never as shown in table 5;

Discussion

It is quite often debated that number of students opting for science is declining in many countries of the world. Students are inclined towards opting soft subjects like social sciences, humanities etc. A similar trend is visible in Pakistan as well. There are several reasons for this trend. The researchers usually attribute it to improper teaching, boring curriculum, disinterest among students etc.

If investigated meaningfully, these factors are sources which lead to decreasing attitude towards science learning that is one of the major contributors in student choice to select science as subject and subsequently performance in science. There has been several tools and studies conducted in developed countries to find the attitude of students towards science learning and reported evidence that change in attitude towards science is important factor in selection of science as subject and profession (Nasir & Kono, 2004).

Promotion of learning of science among students at all levels of education has been the prime focuses of the educational policy 2009-10. So, there is need to explore different factors that possibly have any effect on science learning especially at school level and attitude is one of these factors. Attitude towards science learning can help us to understand the present trend of the students and will also help to explore the differences among school students on the basis of gender, locality, paternal qualification and occupation.

Although many attitude scales are available, the problem is that these scales are developed in other languages and translation itself does not ensure the reliability and validity of the research instruments. Similarly Blalock et al (2008) are of the view that most of the attitude scales reported in different research studies lack psychometric properties. The *AtSL* is an attempt to overcome these problems and a validated attitude scale at school level in Pakistani perspectives is reported in this study.

The attitude scale initially consisted of 54 statements and it was ensured that every aspect of attitude towards science learning made its representation in final scale. Along with that alternative statements for every construct were also included in the scale. The use of exploratory analysis allowed refraining from traditionally used labels and indicators for measuring attitude. The indicators/statements were reduced to groups on the basis of their factor loading and then common thread linking the items was labelled through carefully reading the statements. Furthermore, the length of the scale (23

items) was intentionally kept medium to make it user friendly for teachers and students. It was kept it mind that use of scale in classroom should not take much of teacher's time. It has been consistently noticed that students lose concentration and do not respond seriously if the number of items in a scale are too many. There is hardly any specific suggestion about the acceptable number of statements in scale with reference to age of the students but it is commonly said that concentration span varies with age group of the students. It was consciously decided to keep the number of items less than 25 to increase the probability of students reading each statement carefully and responding meaningfully. During reliability and factor analysis, the fact was kept in mind that at least four statements should be there to measure any construct in this attitude scale, and making psychometric properties of this attitude scale more acceptable.

The AtSL is a short attitude scale as compared to long and multipurpose/ factors scales like TOSRA etc. The four factors (Keenness to Learn Science, Enjoyment in Science Learning, Teacher Interaction and Disinterest) of this scale are major indicators of attitude towards science learning in socio-economic and cultural perspectives of Pakistan.

As the sample of this study was only focused on government schools, so the scale has further potential to make it generalizable by including private sector schools and colleges for Pakistani educational scenario.

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