Asian Journal of Education and e-Learning (ISSN: 2321 – 2454)
Volume 02– Issue 01, February 2014

Construction and Validation of an Instrument to Measure the Scientific Attitude of the Students, and Attitude Gain by the Application of Meaningful Learning Model of David Ausubel in Teaching Physics

Muhammad Safdar[1], Iqbal Shah[2]

[1]Vice Principal, Islamabad Model College for Boys G-6/2,
Islamabad (Pakistan)

[2] Assistant Professor Allama Iqbal Open University,
Islamabad (Pakistan)

ABSTRACT--- ***This research work was undertaken to construct and validate an instrument to measure the scientific attitude of the secondary school students, and to compare the attitude gain through the use of Meaningful learning Model of David Ausubel and traditional method of teaching physics. The research work was carried out for 35 weeks in the physical science classroom and laboratory of Government Comprehensive High School, Jhelum. The data revealed that there is a gain in the affective domain (scientific attitude) of the students in favour of Meaningful learning model. The meaningful learning model allowed the development of attitudes held by pupils simultaneously at various stages of education. These attitudes can be compared at the different stages and can be correlated with their achievement in physics in future studies.***

---

1. INTRODUCTION

Science is a system of knowledge, a process of acquiring and refining knowledge through the processes of observation and experimentation. In science, we cannot separate the cognitive factors from affective domain (that is human attitude), and cognitive domain from affective behaviour. Attitude may include cognitive and behavioural components as well. However, it is evident that attitude is an affective characteristic in which emotions are involved. According to Reid (2003), “Attitudes express our *evaluation* of something or someone. They may be based on our knowledge, our feelings and our behaviour, and they may influence future behaviour. In the context of studies in the sciences, attitudes are evaluations which may influence thinking and behaviour. An attitude must have a target. We have an attitude directed towards something or someone. Attitudes are highly complex and can affect learning extensively.”

The major contribution of science lies in the inculcation of scientific attitude among its learners through its study. Kumar (1995), includes the various aspects in the scientific attitude; (i) Making pupils open minded (ii) Helping pupils to make critical observation (iii) Developing intellectual honesty among students (iv) Developing curiosity among pupils (v) Developing unbiased and impartial thinking. So, we say that scientific attitude means; “Open mindedness”, a desire for accurate knowledge, and confidence in procedures for seeking knowledge. He further goes on to say that scientific attitude may be developed either by direct teaching in the classroom/laboratory (e.g. Making use of planned exercises, proper use of practical periods, atmosphere of the class, etc.) or by out of school experiences gained by the pupils (e. g. co-curricular activities in science, personal example of the teacher, etc.).

In the opinion of Reid & Skryabina, (2002), there are four broad areas where we might wish to explore attitudes in relation to students: (1) Attitudes towards subjects being studied; (2) Attitudes towards study itself; (3) Attitudes towards the implications arising from themes being studied; (4) The so-called scientific attitude.

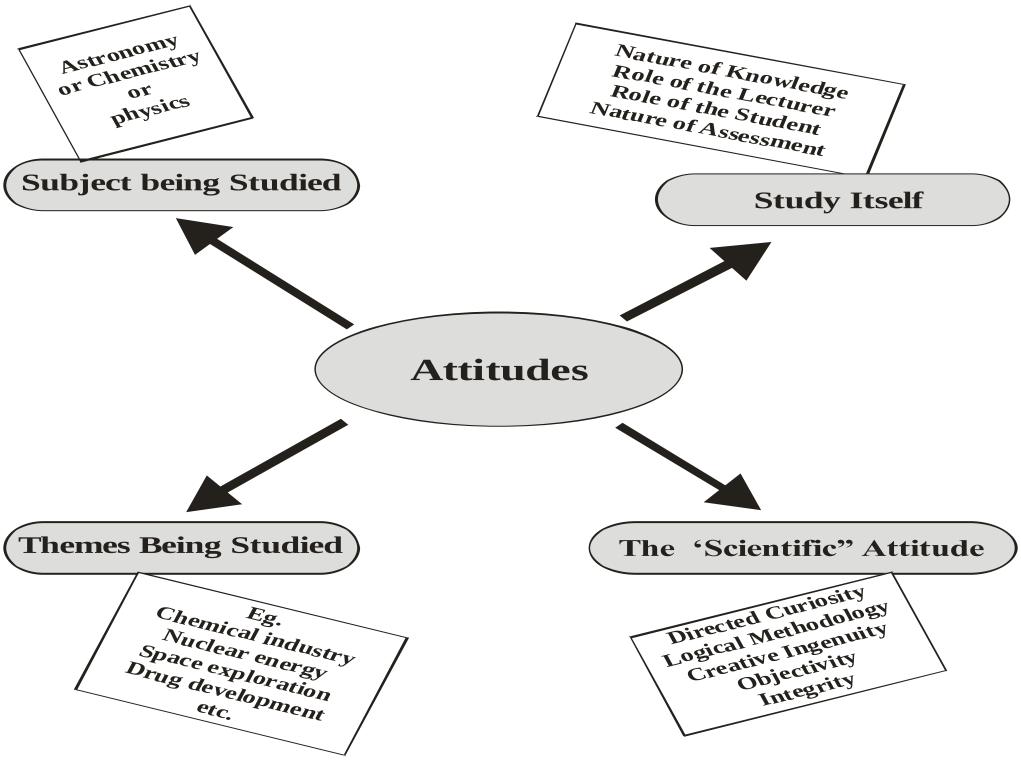
Reid (2003), states, “Attitudes are important to us because they cannot be neatly separated from study. It is a relatively quick series of steps for a student with difficulty of a topic to move from that to a belief that they cannot succeed in that topic. It is beyond them totally and they, therefore, will no longer attempt to learn in that area. A bad experience has led to a perception which has led to an evaluation and further learning is effectively blocked.” In general, attitudes in life allow us to: (a) Make sense of ourselves; (b) Make sense of the world around us; (c) Make sense of relationships. He further says, “We want our students to make intellectual sense of the world around them-that is the very nature of the subject matter of the physical sciences (and other sciences) of course; it helps them to contribute to the understanding of the world if they can also make sense of themselves and others."

A very useful analysis was carried out by Perry (1999), and this has led to a useful framework for analyzing students' attitude to work under the four headings:

(a) Student's perceptions of the nature of knowledge;
(b) Student's perceptions of the role of the lecturer in their learning;
(c) Student's perceptions of their own role in learning;
(d) Student's perceptions of the nature and role of assessment.

The above discussion can be summarized as presented in the figure 1.

Figure 1 Dimensions of Attitude: **Source**: Perry, W.G. (1999, p. 33)



Johnson (1979), states that the purpose of assessing students' attitudes is to use information to modify and improve instructional programs. Attitude should have no effect on students' grades, and teacher should not be evaluated on the basis of whether or not their students have positive attitudes, but components of instructional program such as teaching strategies and curriculum materials can be modified on the basis of the students' attitudes they promoted.

There are four approaches for ensuring that the students learned appropriate attitude and for changing inappropriate attitudes to more constructive ones: (a) the behaviourist (traditional) approach, (b) the cognitive approach, (c) the social influence approach, and (d) the structural approach.

According to traditional approaches the attitudes are formed, developed, or maintained through the processes of associations or reinforcement. This approach neglect key points like that attitudes are largely composed of meanings.

According to cognitive approach, attitudes are organized into cognitive structures according to content and meaning. And there is an internal pressure for such cognitive structures to be internally consistent and somewhat simplified so that there is an overall good "gestalt" (schema). During childhood and adolescence, students continually reorganize their self-attitude into more differentiated and integrated identities. This reorganization leads to a simple and uniform view of them.

Development of proper scientific attitude is one of the major objectives of teaching physics (and also of other pure and applied sciences). It makes the pupils open minded, helps them to make critical observations, develop in them intellectual honesty, curiosity, and unbiased impartial thinking.

Shah (2004) writes that attitudes will affect behaviour, influencing what the learner selects from the environment, how he will react to teachers, the material being used and the other students. This selection and the processing of the input of information, which follow it, are strongly influenced by the instructor's expectations, attitudes, and concepts.

2. DEVELOPMENT AND MEASUREMENT OF SCIENTIFIC ATTITUDE

Safdar (2010) states the views presented by different studies that attitudes are the outcomes of instruction, context, or experience; a few looked at the influence of attitudes on achievement and performance. Although many felt that attitudes were ascertainable, for many centuries it was thought that attitudes could not be measured. It was around 1929 when the first serious attempt was made, to be followed by the work of a researcher called Likert who has given his name to a technique which is widely used today. In this research study the researcher used this technique to measure the scientific attitude of the students.

All aspects of physics learning can contribute to attitudes towards physics, to the learning of physics, and development of the scientific attitude. There will be the cognitive aspects: what the learner knows and experiences, and understands. There will be affective aspect: does the learner like experience of the learning, the subject itself and the teacher, the courage to write and speak truth, the development of intellectual honesty and unbiased thinking. There will also be the action component in the sense of what the learner actually does (and this will include practical work i.e. experimentation) and how the learner might use the physics learned.

In order to develop scientific attitude among the students, the traditional teaching strategies and the recent Ausubelian approach should be studied thoroughly.

3. TRADITIONAL AND DAVID AUSUBEL MODEL OF TEACHING

In the traditional teaching the teachers' main focus is on memorization (rote learning). According to Vadidya, (1996), rote learning is not meaningful in the process of internalization. It is arbitrary and verbatim in nature. It stays close to the cognitive structure of the learner but do not get integrated there. Hence as a result the learner exhibits a non-successful learning set. Traditional teaching methods are fine for remembering sequences of objects (i.e. lists of structures) but do not aid the learner in understanding the relationships between the objects. Meaningful learning, therefore, is personal, idiosyncratic and involves recognition of the links between concepts. According to Novak and Gowin (1984), "Both rote and meaningful learning may be achieved no matter what instructional model is used either reception learning or discovery learning may result in meaningful learning. Therefore, it is not necessarily how information is presented but how the new information is integrated into the old knowledge structure that is crucial in order for meaningful learning to occur.

In Pakistan, traditional model of teaching is strongly discouraged in the new curriculum of science and mathematics, and first time the standards are set. Standards specifically emphasize the importance of deep understanding over the mere recall of facts, which is seen to be less important. The advocates of traditional education have criticized the new standards as slighting learning basic facts and elementary arithmetic, and replacing content with process-based skills. Basic sciences must include the mastery of concepts instead of mere memorization and the following of procedures. It must include an understanding of how to make the learning material meaningful and to use the scientific equipments in the laboratory to arrive meaningfully at solutions to problems, to verify laws, principles. Ausubel believes that "learning should progress deductively – from the general to the specific, and not inductively, as Bruner recommended (from specific to general).

Ausubel (1960), proposed his expository teaching model to encourage meaningful learning rather than rote reception learning. In his approach to learning, teacher presents material in the carefully organized sequenced and finished form. Students receive the most usable material in the most efficient way. It is most appropriate when we want to teach about the relationships among several concepts. Another consideration is the age of the students. This approach requires students to manipulate abstract ideas; this means expository teaching is more developmentally appropriate for students of elementary and secondary stages.

Ausuble learning model consists of three phases (i) presentation of an advance organizer (ii) presentation of learning task or material and (iii) strengthening the cognitive organization through integration and differentiation (by the use of examples and non-examples)."

The major instructional mechanism proposed by Ausubel is the use of advance organizers: "These organizers are introduced in advance of learning itself." Organizers may be of different kind but the researcher used this concept in the form of a question /a diagram/a model/ structure of a discipline. Ausubel (1968) stated, "In any case the advance organizers are designed to provide the "mental scaffolding" to learn new knowledge (information). Ausuble's theory consists of three phases (i) presentation of an advance organizer (ii) presentation of learning task or material and (iii) strengthening the cognitive organization through integration and differentiation (by the use of examples and non-examples)." In the light of Ausubel's teaching model, the whole content (theory and practical) was developed, and presented in the physics classroom and laboratory for the period of 35 weeks.

Table 1: *Phases of Ausubel Teaching Model*

Phase One: Advance Organizer	**Phase Two:** Presentation of Learning Task or Material	**Phase three:** Strengthening Cognitive Organization
Clarify aim of the lesson	Make the Organization of the new material explicit.	Relate new information to advance organizer
Concept mapping	Make logical order of learning material explicit.	Promote active reception learning.
Present the organizer	Present material and engage students in meaningful learning activities.	
Relate organizer to students' knowledge		

4. OBJECTIVES OF THE STUDY

1. To construct and validate an instrument to measure the scientific attitude of the secondary school students.
2. To compare the (scientific) attitude gain as developed by Ausubelian and Traditional Teaching Methods among the secondary school students.

5. CONTENT OF THE STUDY

Physics text-book for secondary classes and related prescribed practical activities (experimental work in the laboratory) was the syllabus for this study.

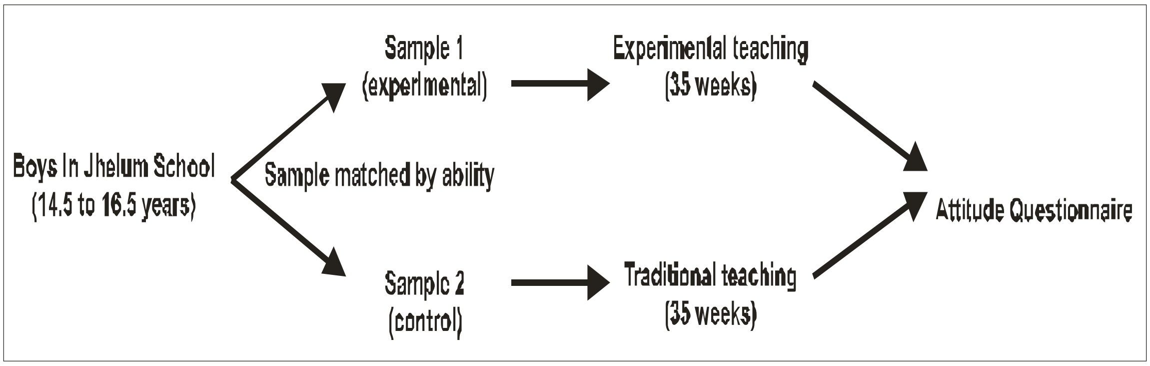
Research procedure

The research work was carried out for the period of thirty-five weeks in the secondary school physics classroom and laboratory. The experimental group was given a treatment (Ausubel's teaching strategy/meaningful learning) five days per week that is from Monday to Friday except Saturday in the physics classroom for the period of seventy minutes. At the same time the control group was taught by another science teacher. In the physics laboratory of Government Comprehensive School Jhelum the students came once per week for one and half an hour. The control group came on each Saturday from 8:30 to 10:00, and the experimental group came from 10:00 to 11:30 in the physical science laboratory for practical work.

Sample

Sample was taken from a single school due to feasibility of treatment, controlling the school environment, timetable, economy of time of experimentation and the like. The sample of the study consisted of two groups of secondary school science students of Government Comprehensive High School, Jhelum (a typical mixture of the students' population). Each group consisted of 31students. Therefore, the present study was confined to 62 secondary school science students. The selection of the dependent variables has been limited to *scientific attitude*, because this is possibly the most important outcome. The study was confined to the subject of Physics for secondary classes, as it is a typical fundamental science. All the subjects for the treatment were male students.

Study Design



Treatment variables
The teaching methods were used as treatment variables. The treatment variables consist of Ausubelian teaching model and Traditional teaching model.

Dependent variables

- Scientific attitude

Tools of the study

- Attitude scale (Instrument to measure the scientific attitude of the students)

Attitude Questionnaire (Construction and Validation)

The attitude scale (questionnaire) consisted of six dimensions/ subscales, such as curiosity, open mindedness, rationality, courage (to speak truth), objectivity, and aversion to superstition. Eight statements, four positive and four negative were constructed for each dimension (domain or subscale) of questionnaire (i.e. total 48 statements were developed)

To construct and validate the attitude scale, a mixed sample (boys and girls) of 200 secondary school students was selected from rural and urban areas. The purpose of this sample is just to validate the test items and ultimately the instrument. At the last t-test was used to reject or accept the statements. For this purpose, the frequency distribution was considered of score based upon the responses to all students. 25% of the subject (50 in this case) with the highest total score and 25% of the subjects (i.e. 50) with the lowest total scores were taken with the assumption that these two groups provide the criterion groups in term of which to evaluate the statements.

By using the above formula, the value of each statement was calculated and compared with the table value of't' at 0.05 level with degree of freedom (df) 98. The statement was accepted if the calculated value of't' for that particular statement was greater or equal than the table value otherwise it was rejected and excluded from the instrument. By applying this procedure, the researcher found the values of't' for every statement. Finally, the 28 statements were selected in such a way that two positive and two negative statements were chosen for each dimension having greater t-value.

Reliability of attitude questionnaire

Before analyzing the students' attitude it is necessary to determine the reliability of the attitude-questionnaire. The "internal consistency method" was chosen since this was the most convenient procedure to apply on this five points scale attitude-questionnaire. The chi-square test was used for the items employed. The attitude questionnaire was composed of six domains/ subscales. Each domain consists of four statements, two positive and two negative, aimed to check the consistency of the responses.

Total responses that is frequencies of the two positive statements of the first dimension/domain (curiosity) within the five point scale (from strongly agree to strongly disagree), was matched with the total responses of the two negative statements of the same dimension. This was employed until dimension number six (item number twenty-four). Then a chi-square test was applied for each two sets of responses, such as positive and negative statements of each dimension, to determine the significance of the difference between the frequencies of the two sets. The results are presented in table 2.

The significant difference of the paired responses between two sets items (positive and negative) gave us a clear picture of the extent to which they measured, consistently.

After calculating the consistency of every dimension, the reliability of the instrument/ attitude questionnaire was calculated by using formula KR-21, which was 0.88. The reliability coefficient showed that there is no significant difference in the consistency of responses between the positive and negative statements of the attitude questionnaire used in this study.

Table 2: The Consistency of Responses

Statement No.	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**CHI-SQUARE Tabulated Value At 5% LOS=9.49, And 1%LOS=13.28, df=4**
1 & 3	15	163	134	72	16	3.745<T.V
2 & 4	25	168	108	76	23	
6 & 8	20	160	120	86	14	2.187<T.V
5 & 7	27	158	110	89	16	
9 & 11	36	168	107	64	25	4.961<T.V
10 & 12	32	191	88	63	26	
13 & 16	19	116	175	70	11	7.031<T.V
14 & 15	14	103	210	55	16	
17 & 20	15	112	173	84	16	5.837<T.V
18 & 19	16	122	142	100	20	
21 & 22	16	101	222	56	15	4.152<T.V
23 & 24	15	88	215	66	16	

Statistical Procedures

Chi square was used to find the internal consistency of the attitude scale. For attitude questionnaire, the Likert scale and t-test were used for the construction and validation of the instrument to measure the scientific attitude of the students. At the end of the experiment the attitude scale was delivered to both (the experimental and control) the groups, and marked. The marks achieved by both the groups were experienced by t-test to compare the attitude gain through Ausubel’s teaching strategy.

6. DATA ANALYSIS AND DISCUSSION

Table 3 Data regarding to the marks achieved by the sample students in the attitude scale (maximum marks = 5X24 = 120)

Group	N	Mean	SD	t-value	*p*
Experimental	31	115.3	15.2	3.29	< .01
Control	30	102.5	15.4	df = 59	

The t-test was applied to evaluate whether there was any significant difference between the mean score achieved by the students in the attitude scale. The results indicated that the mean concern of the experimental group (M = 115.3, SD = 15.2) was significantly greater than the mean concern for control group (M = 102.5, SD = 15.4), t (59) = 3.29. This shows that there is a significant gain in attitude scores of students when taught through Ausubel's Teaching Strategy. It indicates that the difference in attitude is not by chance.

Results of the study presented in the above table are consistent with the views of Morgan (1985), he found the facilitating effects of Ausubel's Teaching Method on both students' achievement and attitudes as well.

Pandey, (1986) reported Ausubel's Teaching Method (advance organizer teaching) to be superior to traditional in terms of educational achievement while they were found equally effective in terms of attitude.

7. CONCLUSION

In Pakistan, the teaching strategies in science with development of mental processes, particularly their integration in the science classroom and physical science laboratories, have remained almost completely unexposed. No study has been attempted in this direction, many linked questions and issues remain unanswered. Hence, a lot of research studies need to be attempted to solve these issues and problems.

A significant gain was observed in the scientific attitude of the students in favour of the experimental group. It would seem to be reasonable to link an improvement in attitude with an improvement in learning. The learning recorded certainly has an attitudinal as well as cognitive component. Ausubelian teaching method also helps to inculcate scientific attitude among the students. In the light of the findings, it is, therefore, recommended that Ausubel Teaching model should be used specifically in the teaching of physics at secondary level to develop cognitive as well as the affective domain.

8. REFERENCES

- Ausubel, D P. (1966). Meaningful Reception Learning and Acquisition of Concepts in Analysis of Concept Learning. New York: Academic Press.
- Ausubel, D P. (1968). *Educational Psychology*: *A Cognitive View.* New York: Holt, Rinehart and Winston.
- Ausubel, D P. (1977). "Facilitation of meaningful verbal learning in the classroom". Educational Psychologist.1977.
- Ausubel, D P. and Gait, A.J.H. (1968). Retroactive Facilitation in Meaningful Verbal Learning. *Journal of Educational Psychology*. Vol. 59, No. 4.
- Ausubel, D. (1978). In defense of advance organizers: A reply to the critics. Review of Educational research, 48.
- Kumar A. (1995). *Teaching of Physical Sciences.* New Delhi: Anmol Publications Pvt.

- Ma, Xin & Kishor, N. (1997). Assessing the relationship between attitude towards Mathematics and Achievement in Mathematics. A meta-analysis Journal for Research in Mathematics Education. Vol.28, No.1
- Novak, J. D. (1984). Application of Advances in Learning Theory Philosophy of Science: The Improvement of Chemistry Teaching. *Journal of Chemistry Teaching*. 12
- Novak, J. D. (1990). "Concept maps and Vee diagrams: two meta-cognitive tools to facilitate meaningful learning". Instructional Science.1990.
- Pandey, A. (1986). Teaching Style and Concept Attainment in Science. Third survey of Research in education (1978-1983).
- Reid, N. & Skryabina, E. A. (2002). Attitude towards Physics. *Research in Science and Technological Education*. Vol. 20, No. 1, 2002.
- Reid, N. (2003). Getting started in pedagogical research, LSTN Physical science practical guide, published by LTSN Physical science center, Department of Chemistry, University of Hull.
- Safdar, M. (2010). *A comparative study of Ausubelian and Traditional methods of teaching physics at secondary school level in Pakistan*. Unpublished Ph.D thesis. Islamabad. National University of Modern Languages, Islamabad.
- Shah, I. (2004). *Making University Laboratory Work in Chemistry more Effective*. Unpublished doctoral dissertation. Glasgow: Glasgow University, Scotland.
- Vadidya N. (1996). *Science Teaching for the 21st Century*. (1st ed). New Delhi: Deep and Deep Publications.
- Zaman. (1996). *The Use of an Information Processing Model to Design and evaluate a physics undergraduate laboratory*. Unpublished doctoral dissertation. Glasgow: Glasgow University.