Journal of Elementary Education
Vol.23, No. 1 pp. 1-12

Scientific Concepts of Hearing and Deaf Students of Grade VIII

Bushra Akram*
Rabia Mehboob & Anum Ajaz**
Rukhsana Bashir***

Abstract

This study investigated and compared the scientific concepts of hearing and deaf students of grade VIII. For this purpose a curriculum based test of scientific concepts was developed. Pilot study was conducted on 15 hearing and 15 deaf students in order to select the items on the basis of item analysis. Initially 70 items were developed. After item analysis 32 items were selected. These items were administered on 50 hearing and 50 deaf students in final study. The data analysis showed that hearing students are more proficient in scientific concepts as compared to their deaf counterparts. No difference was located in the scientific concepts of the participants on the basis of their schools. The possible causes of poor performance on the behalf of students with deafness are poor facilities such as science labs and traditional teaching methods.

Key Words: Deaf; scientific concepts; reasoning.

*Assistant Professor, Department of Psychology, University of Gujrat, Gujrat – Pakistan.
Email: bushra.akram@uog.edu.pk
** University of Management and Technology Lahore.
Email: rabia@yahoo.com , numijaz@hotmail.com
*** Assistant Professor, Department of Special Education, University of the Punjab, Lahore.
Email: rukhsana.dse@pu.edu.pk

Introduction

Science is the one of the most important subject which is taught in our schools. It possesses great value in our education as well as in our lives. It will not be wrong if we call today's world, a world of science and technology. Science is a subject which takes part in the growth of the minds of children. It gives satisfaction and answers to the questions rising in their minds and it helps to adjust in their environment. It makes us able and facilitates us to think about our self and others and how to relate the world around them. It has major contribution in developing a feeling of personal delicacy and hygiene. Therefore science education must be oriented towards acquisition of skills, self and social empowerment (Kyle, 1986).

Science refers to a systematic process of acquiring knowledge. This system uses observation and experimentation to describe and explain natural phenomena. Less formally, the word science often describes any systematic field of study or the knowledge gained from it. It is widely acknowledged that science can and does make a significant contribution to the learning experiences of deaf children not only in the development of scientific knowledge, concepts and skills but also increase their self-esteem and self-concept (Cahn, 2006).

The scientific concept is the scientific theory, principal or law that is the basis of your lab. It is an explanation of why and how a specific natural phenomenon occurs or a logical, mathematical statement describing the consistency that applies to the phenomenon. It may come from philosophy, logic, economics or other analytical enterprises, as long as it is a rigorous conceptual tool that may be summed up concisely understanding the world. According to Wells (1994) scientific concepts also differ from everyday concepts in the manner in which they are acquired. Unlike everyday concepts, which Vygotsky (1978) suggests are learnt spontaneously by the child through the social interaction that occurs in the course of engagement in jointly undertaken activities in his or her immediate community, scientific concepts can only be acquired as a result of deliberate and systematic instruction in an educational setting**.**

Therefore it is assumed here on the basis of above mentioned discussion that the development of the scientific concept occurs as part of the educational process. In which a unique form of systematic cooperation between the teacher and the child should be constituted. The maturation of the child's higher mental functions occurs in this cooperative process, that is, it occurs through the adult's assistance and participation. Therefore scientific concept is an abstract or general idea inferred or derived from a specific instance. Something understands and retained in the mind from experience, reasoning and imagination a generalization or abstraction of a

particular set of instances or occurrences (Wells, 1994). The explanation of these three components of a scientific concept is given below.

Scientific reasoning includes the ability to solve problems through the analysis of quantitative empirical data. The mind processes the perception of an object through analysis, comparison and synthesis: that's how experience is formed. It is important not just for institutional scientific research. Although it is true that scientists use specialized theories (e.g. quantum physics) which non-scientists do not have to use in everyday life. But many of the principles of reasoning (e.g. rules for identifying causes) are applicable also to everyday life. Even if we are not scientists, we need to make use of good reasoning to explain, predict, and control the events around us. When we want to jump start our career, protect our investments, improve our health, we need to gather evidence to find an effective way which is likely to achieve our aims.

Scientific Reasoning may develop through the methods of scientific inquiry including hypothesis formation and testing, systematic observation and analysis of quantitative data. The methods help students understand how technology and science will affect their lives, the environment and their culture. The goal of scientific reasoning courses should be to develop critical thinking skills for evaluating scientific information, which will enable our students to use these principles in making personal decisions and engage intelligently in debates about scientific and technological issues that will affect their lives.

An experience is a methodical procedure carried out with the goal of verifying, falsifying, or establishing the validity of a hypothesis. Experiments vary greatly in their goal and scale, but always rely on repeatable procedure and logical analysis of the results. Current scientific experience is indirect. Perception and experience become separated through the rational activity of the mind. Humans have the capacity to watch their mind. Everybody can watch their thoughts and emotions. Through watching them we can become aware of the way they influence our experiences. This awareness creates a direct connection between perceiving and experiencing, so experience becomes direct. The mind processes the perception of an object through analysis, comparison and synthesis: that's how experience is formed. Experienced objects are different: nature, the human body and its sensations, emotions, images and thoughts.

According to Sweet (1991) the abstractness of a concept is related to how the concept can be experienced. Abstraction is where physical observation and manipulation are not possible e.g., atom, star, fission and fusion. Generalizations or

abstractions are summary statements of relationships between concepts, cause and effect, or summary statements of predictions of future relationships. Therefore, they provide a way to consolidate information to make it more usable and easier to remember. Laws, principals, and theories are all kinds of generalizations. These generalizations require the connection of concepts by a relationship. Relationships can only be built with direct observational evidence and reasoning. Good teaching practices will mediate both.

Deafness refers to both complete (deafness) and partial loss (hard of hearing) of the ability to hear. Moores (2001) defined deafness and hard of hearing in the following words: "Deafness means a hearing impairment that is so severe that the child is impaired in processing linguistic information through hearing, with or without amplification that adversely affects a child's educational performance. Hard of hearing means a hearing impairment that is so severe that the child is impaired in processing linguistic information through hearing, with or without amplification that may not adversely affects a child's educational performance"(p. 10).

Roald & Mikalsen (2000) showed that younger deaf children have conceptions of scientific facts similar to those of their hearing peers, but that the scientific knowledge of deaf high school students tends to deviate significantly from hearing students. Those differences follow, at least in part, from deaf students' lack of experience with scientific reasoning and the mental models necessary for understanding and integrating new scientific facts (Hammer, 1996). Although one might expect that instructors and sign language interpreters could help to fill gaps in deaf students' knowledge and encourage the use of appropriate information processing strategies in classroom settings, interpreter training programs do not teach their students about the developmental or academic characteristics of deaf learners, and most mainstream teachers are unaware of either the needs or the strengths of their deaf students (Ramsey, 1997).

Roald (2002) found that a comprehensive discussion of a topic using sign language prior to the reading of the textbook is very helpful in promoting scientific concepts of deaf people. Similarly Land & Steely (2003) concluded that the interactive multimedia and web-based curriculum materials yielded significantly greater knowledge gains in science of deaf students as compared to traditional classroom experiences. Further Brown, Babb, Johnson, Scheifele, Lang, Zheng, Monte & LaPorta (2002) found that a student based problem solving approach is particularly helpful in developing thinking skills and problem-solving skills in the students.

In Pakistan a few studies conducted on the scientific concepts of deaf students so far. Shah and Anjum (2009) concluded that basic scientific concepts were not clear among hearing impaired children and misconceptions were found. Similarly Iqbal and Sharif (2006) conducted a study of problems faced by deaf children in learning of science at grade VIII. They concluded that the traditional science curriculum and teaching methods used in Pakistan are the main reasons of poor science concepts of deaf children. The researchers suggested the use of laboratory and hands on activities should be practiced in order to develop scientific concepts among deaf students.

Objectives of the study

The current study was conducted to:

a. Know the levels of scientific concepts of both hearing and deaf students of grade VIII.
b. Compare the scientific concepts of the hearing and deaf students of grade VIII on the basis of their schools.

Questions of the study

The following questions will be answered:

a. Is there any difference between the scientific concepts of hearing and deaf students?
b. Is there any difference between the scientific concepts of hearing and deaf students on the basis of their schools?

Method

In this study 50 hearing (male=35, female=15) and 50 deaf students (male=30, female=20) of grade VIII were selected. The deaf students were recruited through purposive sampling technique because they are less in proportion as compared to hearing students therefore simple random sampling was used for hearing students. The data was collected from 3 schools for deaf children. These schools did not have any science laboratories whereas the schools for hearing children had science labs. The schools for deaf and hearing participants were selected conveniently.

The researchers developed a science curriculum based test. The items were developed according to the above discussed three components of scientific concept;

Reasoning, Abstraction and Experience placed it according to Bloom's Taxonomy (Table 1).

Table 1
Table of specification

	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
Experience	65,66,38	13, 35,42	31,40,29	28,41,63, 59	43,44, 53,54,60	5,18,24,25 32,47	24
Reasoning	2,7,10,26, 67,69	3,4,8,12,34	22,55,68	16,17,57	8,49,52	50, 70,46	23
Abstraction	9,23	19,36,37	27,33,39, 48,62	11,14,30, 45,56	1,15,20, 21	6 ,51, 58,64	23
Total	11	11	11	12	12	13	70

The researcher constructed a test of 70 items. It was applied on the 15 hearing and 15 deaf students of grade VIII. The purpose of the pilot test is to assess the reliability of the test as well as to select appropriate items through item analysis. Reliability of the pilot testing was 0.79. After data collection items were analyzed. Each of the correct item was given 1 score while the wrong and un-attempted items were assigned 0 score. However negative marking was not imposed on wrong answers. Item analysis was conducted on 70 items. In the result 32 items were selected on the basis of discrimination value of 0.25. Out of 32 items 25 had ≥ 0.3 discrimination value. Thirty two items have been selected for the final study while keeping in view 0.25 discrimination value. Only 7 items have 0.25 discrimination value while rest of items showed ≥ 0.3 discrimination value. During final study the selected 32 items were administered on 50 hearing and 50 deaf students. The data were collected, coded and analyzed on SPSS V. 16. Internal consistency of the final test was 0.8. Latter on finding, conclusions and recommendations were made by the researcher.

Results

The questions of the study were answered by administering and interpreting appropriate statistics on SPSS.

Q1: Is there any difference between the scientific concepts of hearing and deaf students of grade VIII?

This question was answered by administering t-Test on total scores and three components of scientific concept. The results showed that there is a significant difference between two groups on the total Score (t= 12.21, sig=.0001), reasoning (t=7.27, sig=.0001), experience (t=6.56, sig=.0001) as well as on abstraction

(t= 6.23, sig=.0001).The Mean and SD values showed that hearing respondents are more competent on scientific experience, reasoning and abstraction than deaf students (Table 2).

Table 2
Means, standard deviations and t-values of hearing (n=50) and deaf students (n=50) on the test of scientific concepts.

Scientific Concept	Respondents	Mean	SD	t-value	Sig
Total	Deaf	8.54	2.36	12.21	.0001
	Hearing	14.50	2.50		
Reasoning	Deaf	3.08	1.61	7.27	.0001
	Hearing	5.54	1.76		
Experience	Deaf	1.92	1.04	6.56	.0001
	Hearing	3.38	1.17		
Abstraction	Deaf	3.54	1.69	6.23	.0001
	Hearing	5.58	1.57		

Q2: What is the difference between the scientific concepts of hearing and deaf students on the basis of their schools?

The scientific concepts of hearing and deaf students are not different on the basis of their schools. The possible reason is the similar physical environment and teaching methods in their schools. The schools of deaf children did not have labs and other equipment for conducting experiments whereas hearing schools were equipped with these facilities (Table 3).

Table 3
One way analysis of variance on deaf (n=50) and hearing participants (n=50) based on their school

	SS	Df	MS	F	Sig
Deaf					
Between groups	43.259	5	8.652	1.435	.231
Within groups	265.241	44	6.028		
Total	308.500	49			
Hearing					
Between groups	66.825	6	11.138	2.307	.071
With in groups	207.595	43	4.828		
Total	274.420	49			

Discussion

The results of the study indicated that the hearing students scored higher on the science test as compared to their deaf counter parts. Literature review showed that currently deaf participants are not being involved in scientific education and experiments as they are not given opportunity to use laboratories in schools. The teachers and parents believe that they cannot learn scientific concepts because of their hearing loss whereas a few studies showed that they can learn scientific concept when they are involved in first-hand exploration and investigation. Some studies have demonstrated that deaf individual have a variety of visual-spatial advantages over hearing individuals, although some of those differences are the functions of sign language fluency rather than auditory deprivation (Bellugi, Klima, & Hickok, 2010; Corina , Kritchevsky, & Bellugi, 1996 ; Emmorey, Klima, & Hickok, 1998; Emmorey, Kosslyn, & Bellugi, 1993; Proksch & Bavelier, 2002).

Iding (2000) argued that the use of dynamic visual displays to accompany instructors' verbal descriptions is especially helpful for learning about "scientific principles or processes that must be visualized in order to be understood." More generally, studies involving hearing students have shown that simultaneous presentation of verbal and nonverbal materials facilitates information integration, resulting in faster learning, better retention, and a greater likelihood of application (James, 2008; Presno, 1997). Students who have less content knowledge relating to a lecture the situation of most deaf students will particularly benefit from combined materials (Mayer & Morena, 1998). This opportunity is not available to hearing impaired learners, however, because of their dependence on visual reception of language through sign language, real-time text, or speech reading (Johnson, 1991). Thus, while there is an evidence that concurrent, multimodal information processing is advantageous for learning, multimedia classrooms functionally require consecutive processing by deaf students, alternating their attention between instructor/interpreters and visual materials, a situation known to impede learning. One result of the heterogeneity found among hearing impaired students is considerable variability in their conceptual and content knowledge, educational histories, and approaches to learning (Hammer, 1996). McIntosh, Sulzen, Reeder and Kidd (1994) argued that deaf students' learning of science, in particular, would be affected by (a) the fact that, as children, they would have had fewer opportunities for the unstructured play in which incidental learning occurs; (b) their tendency toward an external locus of control; and (c) their instrumental dependence. As a result, McIntosh et al. (1994) argued that hearing impaired students may be less likely to engage in "discovery learning," less likely to engage spontaneously in mental or empirical experimentation, and more likely to treat scientific facts as unrelated pieces of information, rather than seeking commonality (Marschark, Convertino, & LaRock, 2006; Ottem, 1980).

More generally, a variety of studies have demonstrated that deaf students are less likely than hearing students to make connecting inferences while reading or problem solving and less likely to automatically process relations among concepts or multiple stimulus dimensions (Marschark & Wauters, 2008 ; Ottem, 1980). As a result, deaf students' conceptual knowledge often appears to be less strongly and richly interconnected than that of hearing peers (McEvoy, Marschark, & Nelson, 1999). Recent findings (Richardson, MacLeod-Gallinger, McKee & Long, 2000; Marschark, Pelz, Convertino, Sapere, Arndt ME & Seewagen, 2005) indicate that deaf students feel difficulty in linking classroom lectures to reading materials due to lack of automatic integrative processing among concepts during learning and the stakeholders are relatively unaware of that fact.

Recommendations

On the basis of the findings of the study, the researchers have made the following recommendation:

a. The government should arrange pre and in-service training for science teachers so that they may use modern teaching material, lab equipment and teaching methods while teaching science.
b. Teacher should clearly explain abstract concepts to children with hearing impairment by the help of concrete examples where possible.
c. Teacher should provide opportunities to the students with hearing impairment to learn scientific concepts through learning by doing.
d. Government should build new laboratories as well as supply necessary and special equipment to conduct science experiments in the schools of students with hearing impairment.
e. Collaboration between the teachers as well as in parents can play an important role in developing scientific concepts of the children with hearing impairment.
f. An awareness program should be started to make the parents, teachers and other community members understand that the individuals with hearing impairment are able to learn the scientific concepts.

References

Bellugi, U., Klima, E. S., & Hickok (2010). Brain organization: Clues from deaf signers with left or right hemisphere lesions. In L. Clara (Ed)., *Gesture and Word*. Lisbon: Portugal.

Brown, S., Babb, I., Johnson, P. R., Scheifele, P. M., Lang, H. G., Zheng, D., Monte, D. U., & LaPorta, M. (2002). *Classroom of the Sea: Problem-based learning for the deaf Proceedings of the International Conference on Computers in Education.* Retrieved from http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=& arnumber=1186240

Cahn, R. (2006). *Help your children learn science with science made simple:* Retrieved from www.sciencemadesimple.com/science definition.html.

Corina, D. P., Kritchevsky, M. & Bellugi, U. (1996). Visual language processing and unilateral neglect: Evidence from American Sign Language. *Cognitive Neuropsychology, 13*(3), 321-356.

Emmorey, K., Klima, E. S., & Hickok, G. (1998). Mental rotation within linguistic and non-linguistic domains in users of American sign language. *Cognition, 68*, 221-246. (PMID: 9852666)

Emmorey, K., Kosslyn, S. M., & Bellugi, U. (1993). Visual imagery and visual-spatial language: Enhanced imagery abilities in deaf and hearing ASL signers. *Cognition, 46* (2), 139-81. (PMID: 8432094)

Iding, M. K. (2000). Is seeing believing? Features of effective multimedia for learning science. *International journal of instructional media*, *27*, 403-451

Iqbal, S., & Sharif, A (2006). *A study of problems faced by children with hearing impaired in learning science of VIII grade.* (Unpublished thesis): University of the Punjab, Pakistan.

Hammer, D. (1996). Misconceptions or p-prims: How many alternative perspectives of cognitive structure influence instructional perceptions and intentions? *Journal of the Learning Sciences*, 5, 97-128.

James, T. (2008). Science Education for Everyone: Why and What?. *Liberal Education; 94* (2) 6-11.

Johnson K. (1991). Miscommunication in interpreted classroom interaction. *Sign Language Studies*. *70*, 1–34.

Kyle, J. (1986). *Sign processes in deaf people's working memory Final MRC report*. Bristol, UK: University of Bristol.

Lang, H.G. & Steely, D. (2003). Web-based science instruction for deaf students: What research says to the teacher. *Instructional Science*, *31*, 277-298

Marschark, M., Wauters, L. (2008). *Deaf cognition: Foundations and outcomes, Language comprehension and learning by deaf students*, eds Marschark M, Hauser PC Oxford University Press, New York, pp 309–350.

Marschark, M. & Hauser, P. (2008). Cognitive underpinnings of learning by deaf and hard-of-hearing students: Differences, diversity, and directions. In M. Marschark & P. C. Hauser (Eds.), *Deaf cognition: Foundations and outcomes* (pp. 3-23). New York: Oxford University Press.

Marschark, M., Convertino, C., & LaRock, D. (2006). Optimizing academic performance of deaf students: Access, opportunities, and outcomes. In D. F. Moores & D. S. Martin (Eds.), *Deaf learners: New developments in curriculum and instruction* (pp. 179-200). Washington, D.C.: Gallaudet University Press.

Marschark, M., Pelz, J., Convertino, C., Sapere, P., Arndt, M. E & Seewagen, R. (2005). Classroom interpreting and visual information processing in mainstream education for deaf students: Live or Memorex?. *American Educational Research Journal, 42*: 727–762.

Mayer, R. A., & Moreno, R. (2002). Aids to computer-based multimedia learning: *Learning and Instruction*: 107-119.

McIntosh, R. A., Sulzen, L., Reeder, K. & Kidd, D., H. (1994). Making Science accessible to Deaf students. *American Annals of the Deaf*; 5, 480-484.

Meadows, S., & Cashdan, A. (1988). *Helping children learn*. London, Fulton.

Moores, D. (2001). *Educating the deaf*. Boston: Houghton Mifflin.

Nazir, M. & Iram, S.(2001). *A study of the scientific concepts of hearing impaired children of class 7th*. (Unpublished thesis) University of the Punjab, Pakistan.

Ottem, E (1980). An analysis of cognitive studies with deaf subjects. *American Annals of the Deaf. 125*, 564–575.

Presno C. (1997). Bruner's three forms of representation revisited: Action, pictures, and words for effective computer instruction. *Journal of Instructional Psychology. 24*:112–118.

Proksch, J., & Bavelier, D. (2002). Changes in the spatial distribution of visual attention after early deafness. *Journal of Cognitive Neuroscience*. *14*, 1–5.

Ramsey, C. (1997). *Deaf children in public schools*. Washington: Gallaudet University Press.

Richardson J., T., E., MacLeod-Gallinger, J., McKee, B. G., & Long, G. L. (2000). Approaches to studying in deaf and hearing students in higher education. *Journal of Deaf Studies and Deaf Education, 5:*156–173.

Roald, I. (2002). Norwegian deaf teachers' reflections on their science education: Implications for instruction. *Journal of Deaf Studies and Deaf Education*, *7*, 57-73.

Roald, I., & Mikalsen, O. (2000). What are the Earth and the heavenly bodies like? A study of objectual conceptions among Norwegian deaf and hearing pupils. *International Journal of Science Education*, *22*(4), 337–355.

Shash, A., M., & Anjum, N., A. (2009). *A study of general science concepts of students with hearing impairment at secondary level*. (Unpublished thesis) University of the Punjab, Pakistan.

Sweet, R. (1991). Canadian proprietary correspondence schools: Some issues of access and technology. *Journal of Distance Education,* 6(1), 42-63.

Vygotsky, L., S. (1978). Interaction between learning and development In: Macdonald, C. (2004). *Teaching and Learning: Educational Theory*. University of Witwatersrand. South Africa.

Wells, G. (1994). *Learning and teaching scientific concepts*: Vygotsky's ideas revisited. Retrieved from http://people.ucsc.edu/~gwells/Files/Papers_Folder/ ScientificConcepts.pdf