Measurement of Errors and Misconceptions

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Abstract:

Despite the best efforts made by teachers, students do not grasp fundamental ideas covered in the class. The research studies indicate that a lot of researches have been done to diagnose errors and misconceptions among students to enhance students' understanding and better performance. All the errors are not misconceptions so it is important to identify the errors patterns on one hand and misconceptions on the other hand so that learning takes place in a correct and holistic manner. Many tools were used by different researchers to identify errors and misconceptions such as discussions, interviews, multiple choice tests, two tier tests and three tier tests etc. All these tools are discussed in this paper along with their benefits and limitations. This paper will help the future researchers and educators to identify the errors and misconceptions and it will also help to enhance the performance of the students in exams.

Keywords: *Errors, misconceptions, two tier tests, three tier tests.*

I. INTRODUCTION

There are four pillars of education, (i) Learning to know, (ii) Learning to do, (iii) Learning to live together, (iv) Learning to search for inner self (UNESCO Report on Education In 21st Century). But, to achieve it we will have to humanize our education and make it relevant to the pupil's real world which may envisage development of curriculum on the basis of the life experiences. The primary task of education must include the transaction of activities, which need be simple, clear and unequivocal, so as to eliminate doubt, uncertainty ad difficulty. Secondly, it conducts tests which aim at discovering what the students actually know and how far they are capable of applying the knowledge in their lives and activities. Many researches were carried out in various school subjects to identify the naive ideas of students that can create learning difficulties for students and ultimately causing low achievement (Ross, 2004; Yen et al. 2004).

It is a well known fact that despite the best efforts made by teachers, students do not grasp fundamental ideas covered in the class. Even some of the students give the right responses but are only using correctly memorized words. When questioned more closely these students reveal their failure to understand fully the underlying concepts (Mestre, 1999). Hestene and Halloun(1995) and Eryilmaz and Surmeli (2002) revealed that sometimes students give correct answers but they do not have scientific conceptions. In contrast to it, sometimes students give incorrect answers but when questioned deeply these students reveal the correct scientific conceptions.

II. ERRORS AND MISCONCEPTIONS

Barrass (1984) wrote of 'mistakes' or 'errors' and 'misconceptions' or 'misleading ideas' and is of the view that only teachers and brighter students can correct errors in learning of concepts. Lawrenz (1986) investigated in-service elementary school teacher's understanding of some physical science concepts and found that some of the errors were due

to lack of content knowledge but that others were indicative of serious misconceptions. Error is the state of departing from truth (21st Century Dictionary, 2004). Educators who were interested in conceptual development have used a variety of terms to describe the situation in which students' ideas differ from those of scientists about a concept, like student's misconceptions, naive theories, alternative conceptions and alternative frameworks (Blosser, 1987). Misconceptions are a problem for two reasons. First, they interfere with learning when students use them to interpret new experiences. Second, students are emotionally and intellectually attached to their misconceptions, because they have actively constructed them. Hence, students give up their misconceptions, which can have such a harmful effect on learning, only with great reluctant (Mestre, 1999). It may be pointed out that students make many types of errors in tests but all errors are not misconceptions, some errors may be due to objectively false conceptions (when the student gives incorrect answer and incorrect reason for a particular concept) which may produce misconception and therefore, it is important to identify the errors patterns on one hand and misconceptions on the other hand so that learning takes place in a correct and holistic manner.

III. MEASUREMENT OF ERRORS AND MISCONCEPTIONS

To identify errors and misconceptions various types of tools are used by teachers and researchers. Here some of these tools will be discussed:

- The researches seem to show that the first step in diffusing errors and misconceptions is to detect them by assessing their prior knowledge through informal quizzes, flow charts, concept maps and discussions that encourage students' freedom of expression (Debra, 2000).

- General achievement test attempts to assess students' performance in school subjects in terms of single score

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and the test does not identify specific errors and weaknesses etc. The diagnostic achievement tests, on the other hand intend to discover specific deficiencies in learning. Researchers have developed diagnostic tests for measuring students' understanding of conceptions for a long time. The most commonly used diagnostic tests can be listed as interviews and multiple choice tests. Each tool is selected for some advantages.

• Interviews have the advantage over multiple choice tests in terms of flexibility and depth of the investigation (Osborne and Gilbert, 1980; Beichner, 1994).However, interviews can be conducted with a limited number of students for generalization and they consume plenty of time.

• On the other hand, multiple choice tests can be administered to a large number of students at a time for generalization and responses can easily be analyzed although they cannot investigate the students' responses deeply and can detect only the most frequently appearing errors (Rollnick and Mahooana, 1999).

• Therefore, Beichner (1994) argued that the ideal course of action is to use both of these diagnostic tools in the multiple choice test development process for minimizing the disadvantages of each tool. In fact before Beichner (1994) emphasized, interviews had already been conducted in the process of developing a multiple choice test. Mechanics Diagnostic Test was developed by Halloun and Hestenes (1985), purely on the basis of interviews to identify errors and misconceptions.

• The multi-tier concept achievement test has the ability to assess students' performance in the subject, errors committed by students in the test (wrong answers in the first tier) and to differentiate misconceptions from lack of knowledge as the sources of errors. Another type of diagnostic tool is the two-tier test which was developed by Treagust (1988). In a two-tier test, the first tier presents a multiple choice content question and the second tier presents a set of reasons for the given answer in the first tier. In the design of this type of diagnostic tool, interviews were also conducted to form a list of misconceptions, which are used as distracters in the second tier. Several two-tier diagnostic tests have been developed and are described in literature (Haslam and Treagust, 1987; Tan and Treagust, 1999; Treagust, 2006). Nonetheless, Griffard and Wandersee (2001) used a two-tier test that had been developed by Haslam and Treagust (1987) in their study and criticized it. They claimed that the instrument items actually diagnose isolated errors in a conceptual framework rather than the robust naive theories because the test items were based on scientifically correct propositions from the concept map which had been used in the design of the test, that is, the participants were not allowed to give their reasons in the test. The researchers also emphasized that the test results overestimate the percentage of misconceptions because gap in knowledge (lack of knowledge) cannot be distinguished from misconceptions and argued for a three tier test to objectively identify errors and misconceptions.

• Eryilmaz and Surmeli (2002) developed a three-tier test, the third tier seeking level of confidence of students to assess students' misconceptions concerning heat and temperature. As a result of the study, it can be said that three-tier tests have the advantage over the two-tier tests in discriminating lack of knowledge from their misconceptions by means of third tier items which assess how confident the students are about their responses for the first and second tiers. Some three-tier tests have been described in the literature (Griffard and Wandersee, 2001; Eryilmaz and Surmeli,2002; Haki, 2005; Kutluay, 2005; Kukukozar and Kocakulah, 2007; Baweja,M,2008). This test consists of test items to be responded on three tiers. First tier includes multiple choice items and required students to select correct answer. Each question had one correct answer and three distracters. Second tier required students to write reason of the response. While third tier asked students about their confidence for the answer of former two tiers. Total achievement score of each student was calculated according to the students' multiple choice item scores, reasoning part scores and the confidence level scores together. The scoring pattern in these tests was as under:

• The number of correct answers in the first, second and third tier were calculated and that gave the correct answers, true conceptions and complete understanding of the concept.

• In the same way if student gave wrong answer in first tier, second tier and third tier, errors, objectively false conceptions and misconceptions were calculated depending upon the wrong answers in first two tiers and confidence in third tier.

Misconceptions: It is important to say that even if a students' choice selection for the first two tiers indicated wrong answer it was not accepted as a misconception unless the students clarified his/her confidence in the third tier. The percentage of the misconceptions according to the all the three tires was estimated and the number of misconceptions for each questions for all the three tires was calculated.

In this type of the test the proportion of right answers decreases as the tier of the test increases and the percentage of students having wrong answers decreased as the tier of the test was increased.

IV. CONCLUSION

The discussion of these methods of identifying errors and misconceptions will provide new ways to identify the errors and misconceptions prevailing among students and will enhance the probability of better achievement. It will also provide a lead to future researchers to pursue their research in the field. It will provide new direction in teaching-learning process for the educational practitioners.

V. REFERENCES

• Barrass, Robert (1984). Some misconceptions and misunderstandings perpetuated by teachers and text books of biology, *Journal of Biological Education,* 18,201 -205.

• Baweja, M. (2008). A study of errors and misconceptions in science at secondary school stage, *Ph.D. Thesis in Education,* Panjab University, Chandigarh.

- Beichner, R.J. (1994). Testing student interpretation of kinematics graphs, *American Journal of Physics,* 62(8), 750-762.

- Blosser, Patricia, E. (1987). Science misconceptions: research and some implications for the teaching of science to elementary school students, ERIC/SMEAC, *Science Education Digest No. 1.*

- Debra, Myhill (2000). Misconceptions and difficulties in the acquisition of metalinguistic knowledge, Language and Education, 14 (3), 151-163.

- Eryilmaz, A and Surmeli, E. (2002). Identifying students' misconception on heat and temperature through three tier questions, Paper presented at the 5th National Conference on Science and Mathematics Education, on line, http://www.fedu.metu.edu.tr/ufbmek-5/b_kitabi/pdf/fizik/bildiri/t110dd.pdf.

- Griffard, P.B., and Wandersee, J.H. (2001). The two-tier instrument on photosynthesis: what does it diagnose? *International Journal of Science Education,* 23(10), 1039-1052.

- Haki, Pesman. (2005). Development of a three tier test to assess ninth grade students' misconceptions about simple electric circuits, *M.Sc. Thesis,* Middle East Technical University.

- Halloun, I. and Hestenes, D. (1985). Common sense concepts about motion, *American Journal of Physics,* 53,1056-1065.

- Haslam, F. and Treagust, D. (1987). Diagnosing secondary student's misconceptions of photosynthesis and respiration in plants using a two tier multiple choice instrument, *Journal of Biological Education,* 21(3), 203-211.

- Hestenes, D. and Halloun, R.L. (1995). Interpreting the force concept inventory, *The Physics Teacher,* 33, 502-506.

- Kucukozer, H. and Kocakulah, S. (2007). Secondary school students' misconceptions about simple electric circuits, *Journal of Turkish Science Education,* 4(1).

- Kutluay, Y. (2005). Diagnostics of eleventh grade students' misconceptions about geometric optic by a three tier test, *Master of Science,* Department of secondary Science and Mathematics Education, Middle East Technical University.

- Lawrenz, Frances (1986). Misconceptions of physical science concepts among elementary school teachers, *School Science and Mathematics,* 86, 654-660.

- Mestre, J. (1999). Misconceptions in mathematics-research,(on line) http://www.penpages.psu.edu/penpages_reference/28504/285073220.html.

- Osborne, R.J., Bell, B.F. and Gilbert, J.K. (1980). Science teaching and children's views of the world, *European Journal of Science Education,* 5(1), 1-14.

- Rollnick, M. and Mahooana, P.P.(1999). A quick and effective way of diagnosing student difficulties: two tier from simple multiple choice questions, *African Journal of Chemistry,* 52(4), 161-164.

- Ross, Judy (2004). Misconception research paper (1-4), On line http://www.esu.edu/sps/Dean/judy_ross.htm

- Tan, K.C.D., Goh, N.K., Chia, L.S. and Treagust, D.F. (2002). Development and application of a two-tier multiple choice diagnostic instrument to assess high school students' understanding of inorganic chemistry qualitative analysis, *Journal of Research in Science Teaching,* 39(4), 283-301.

- Treagust, David F. (1988). Development and use of diagnostic tests to evaluate students' misconceptions in science, *International Journal of Science Education,* 10(2), 159-169.

- UNESCO (1996). Learning: The treasure within, Paris ; UNESCO.

- Yen, Chiung-Fen; Yao, Tsung-Wei; Yu-Chihchiu (2004). Alternative conceptions in animal classification focusing on amphibians and reptiles: a cross age study, *International Journal of Science and Mathematics Education,* 2, 159-174.