

ACCOMMODATING DIVERSE LEARNERS THROUGH INQUIRY ALONG WITH SIX MAJOR PRINCIPLES AT ELEMENTARY LEVEL

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Abstract

Inquiry method is generally considered an effective teaching method for learning science. However, recent researches show that it is not as effective for students lacking motivation. Similarly, science educators have to face another major challenge of student diversity which emerges due to individual differences, group differences and certain exceptionalities. Therefore, this experimental research study focuses to accommodate the diverse learners at elementary level to teach General Science (related to Physics and Biology topics) through inquiry method along with additional six major principles. It means Big Ideas, Conspicuous Strategies, Mediated Scaffolding, Strategic Integration Primed Background Knowledge and Judicious Review. When inquiry method is implemented along with these six major principles, it becomes much more effective. Therefore, in order to find out its effectiveness, four trained prospective teachers voluntarily involved to conduct this experimental research in the form of two teams (two members in each group) to teach two classes of 8th grade, with the strength of 35 and 40 students comprising of diverse learners in two separate public schools at Lahore. Both the teams were trained to prepare 20 lessons each for Physics as well as Biology topics from 8th grade General Science group. This research was completed in six weeks. Two tests of equal nature were used, as Pre-test and Post-test. On the basis of the learning outcomes of both classes, it was concluded that the inquiry method along with six major principles at elementary level was successful in accommodating the diverse learners by achieving the high academic achievements in Post-test as compared to the pre-test. This also proved that teachers' training and lesson planning for diverse learners was also effective.

Keywords: Diverse learners, Six major principles, Inquiry method, Teachers' training, lesson planning

1. INTRODUCTION

Various factors influence the very complex process of teaching and learning, for instance, students' abilities, attitudes and learning styles, teachers' abilities, knowledge and beliefs, and most important one being the learning context, have significant effects on 'what students learn' (Moreno, 2012). In spite of all above mentioned educational factors the students with diverse learning needs have been neglected in our country. Our society is based on multi-lingual system and therefore, a learner has to think in one language, write in other language and communicate in another language. For instance, Punjabi language is generally known as

a mother tongue for the people of Punjab province for communication in the society, while Urdu as a national language in the schools or at social media is very common. English is also used in schools and in elite class of the society and it is also popular for official correspondence. Due to these reasons the children living in poverty or having any disability or with limited expertise regarding the spoken skills of English/Urdu language have to face various constraints— familial, political, sociological, economic and educational—that places them at increasing social and cultural risks. To fulfill the demands of new global economy of 21st century educational leaders are expecting more from all students. To face this reality learners and educators are required to shift the focus from the mere acquisition of basic knowledge and skills to the reflective thinking and content-area-knowledge in the context of authentic problem-solving activities. Same situation has been highlighted at the international level. For instance, National Science Education Standards (1996) was guided by the premise that “science is for all the students”. This asserts that all learners irrespective of sex, age, cultural, or ethnic background, career aspirations, disabilities, or areas of interest and self-motivation in science should be able to attain high levels of scientific literacy. The most recent document of committee of science learning, Kindergarten through 8th grade, also emphasizes the acquisition of knowledge and logical skills that student must be equipped with in order to be proficient in scientific knowledge and ultimately able to become an educated citizen by taking active part in the society. (Duschl, Schweingruber, and Shouse, 2007).

It is a common misconception that for promoting learning to all students, needs only applying a package of good teaching techniques. But only expert teachers understand this notion that fundamental individual differences have much more effect on learners’ diversity. This is because the diversity deeply influences the thinking and behaviors of the students. Even if a teacher works in a mono cultural minority, he will have to focus to discuss the issues of biasness, prejudice and equity because classroom conversation permeates social issues. Therefore, to achieve a more tolerant and harmonious society, teachers have acquired the central role to work with their students regardless of having or not having culturally diverse learners in the classroom (Redman, 2007; Pang, 2005; Lee, 2002).

Family and social support for availability to more-advantage students make them less dependent on quality of schooling for initiating and sustaining at schools. In contrast the diverse learners belonging to the families with low socio-economic status are evidently more dependent on public schools for their academic achievement and educational growth (Alexander & Entwisle, 1996; Evans & Schamberg, 2009). This situation clearly depicts that the quality of schooling greatly affects the diverse learners, and this heavily demands to break the damaging processes of scientific literacy, invisibility, and innumeracy (Coyne, Kame’enui & Carnine, 2011).

Inquiry method is generally considered an effective teaching method for learning science. With the help of this method, students are being provided the opportunity to perform their experiments and to probe as well as explore for constructing their knowledge which supports the constructivist learning theories of John Dewey, Piaget, and Vygotsky. Inquiry method is most effective when students are able to apply their knowledge in their societal setting. But the activities which are given in the inquiry context are only successful if students are self-motivated by their intrinsic interest and are well equipped with the skills of curiosity to conduct their own research studies. However, recent researches show that it is not as effective for students lacking motivation. Similarly, science educators have to face another major challenge of student diversity which emerges due to individual differences, group differences and certain exceptionalities. Therefore, in this context the following six major principles have been briefly given as follows:

1. Big ideas: Major central concepts with definite principles/rules, as well as strategies or heuristics that guide the acquisition of knowledge in a very simple and efficient way.

2. Conspicuous strategies: Making the teaching strategies conspicuous by the usage of maps, models or some verbal directions which make the complex concepts more clear. In this way teaching and learning are sequenced in accordance with the perception of students.

3. Mediated scaffolding: When students feel difficulty, the teacher or the adult instructor provides support in the learning of new material. This support diminishes over the passage of time and learners’ development.

4. Strategic integration: The important step in the learning procedure, when the teacher plans his strategies in a way to integrate the new and old knowledge for triggering the process of meaning-making.

5. Primed background knowledge: In order to ensure the learning of new knowledge, teachers effectively refer to the important knowledge which has been previously acquired.

6. Judicious review: Judicious review occurs at the end of the lesson when teachers provide learners with the opportunities to apply previous knowledge for the construction of new knowledge.

Keeping in view the above mentioned six principles the researcher is aimed to investigate the worth of these principles by incorporating them to the science inquiry. Science inquiry- the process of knowing the truth- is considered to be the “central idea” of scientific knowledge. The ability of testing a hypothesis is a crucial skill with reference to truth seeking in formal, scientific atmosphere or informal context. Kuhn (1999) found that few adults have the minimal truth seeking skills required to confront their informal beliefs in an honest manner. The process needed to establish and evaluate everyday beliefs and theories are essentially the same processes used in formal scientific hypothesis testing. For this reason, science inquiry is a big idea that is relevant to a much larger range of human affairs than simply the domain of science and is one that connects across a wide range discipline.

In this context the quality of science teaching at elementary level is not up to the mark especially for diverse learners. Teachers are not well trained for science teaching and science is taught just like Urdu or Islamic studies particularly at the upper-middle school level. Now the curriculum have been revised at this level and many new concept or principles have been introduced in the syllabus of science from class 6th to 8th which were previously included in science subjects at secondary level. Therefore it is the need of time to train the science teachers especially in government schools to accommodate the students of diverse nature at this level which has become a challenge for educators. Science enquiry approach needs practical activities or laboratories for performing the experiments. This study will indicate that how science inquiry develops the curiosity in science learning in the young learners at middle school level. In future “Science for all children” concept will change the scenario of the society. An effective teaching strategy such as inquiry with six major instructional effective tools will successfully accommodate diverse learners for learning science with their own choice. Then it is hoped that more and more students will be enrolled in science subjects at secondary and higher secondary level to fulfill the demands of the scientifically skilled personnel.

2. OBJECTIVES

The common objectives of both the studies are to:

1. Find out the learning outcomes of diverse learners in general science of 8th class through pre-test and post-test of experimental group after applying six major principles of effective instructional tools of Science inquiry learning.
2. Train the prospective science teachers for knowing the effectiveness of Science Inquiry learning of 8th grade general science for diverse learners.
3. Plan the lessons for teaching of general science through science inquiry for diverse learner at elementary level.

3. RESEARCH QUESTIONS

1. How the needs of diverse learners in learning general science at 8th grade are fulfilled by applying science inquiry?
2. Does the academic achievement considerably increase by applying six major principles of instructional tools of inquiry learning for diverse learners?
3. How lesson planning in the perspective of inquiry learning enhances the achievements of diverse learners at upper middle schools level?

4. RESEARCH METHODOLOGY

This research study was carried out through two separate experimental groups by two separate research teams of prospective teachers. However, both the research teams adopted only one kind of experimental design i.e. Pre-test/ post-test of experimental group.

To conduct this research study, initially eight prospective science teachers who had completed their Masters degree in Science Education (M.S.E.d), were selected. They were divided into two groups (4 members in each team). From the entire textbook of 8th grade General Science, two types of topics were selected to conduct an experimental research:

1. Physics

2. Biology

Each research team was assigned one portion of the above mentioned content of General science. The validity was ensured in conducting two training workshops for the science teachers as research teams.

Training Workshop 1- Lesson planning for diverse learners

The principal researcher conducted two workshops.

1. In the first step, 8 prospective Science teachers were invited to participate in this 3-days workshop. At the start of the workshop all the participants were Welcomed and informed about the goals of the workshop. In this workshop, three sessions were arranged. In the first session, the topic on applying six major principles of affective instructional tools in science inquiry to accommodate diverse learners at upper middle school was discussed by the principal researcher himself. The participants were given a few topics of General Science to prepare their lesson plans according to the teaching strategy of inquiry learning in groups. They were given a common criteria to include six major principles of effective instructional tools/strategies such as:

- (i) Big ideas
- (ii) Conspicuous strategies
- (iii) Mediated scaffolding
- (iv) Strategic integration
- (v) Paired background knowledge
- (vi) Judicious review

2. In the second session, all the volunteers were trained to develop specific objectives which were discussed in the context of inquiry learning for diverse learning. All the participants were motivated to learn about the learners' diversity and to develop specific objectives according to the nature of the study.

3. In the third session, the two groups of two members each (according to their area of interest/ specialization i.e. Physics/ Biology) were given the task to prepare the four lesson plans by reviewing their mutual/individual inputs. All these lesson plans were prepared according to the criteria proposed by the principal researcher and then all these lesson plans were evaluated to ensure the unanimity among these lesson plans of the 8th grade General Science group. In this way, 'validity' was ensured for lesson planning in the first workshop and at the end of the workshop, participants were interviewed to obtain their willingness for conducting of further research.

Training Workshop 2 –Teachers training

This workshop comprised of two sessions.

1. Reviewing of lesson planning

The content of entire textbook of 8th grade related to General Science was distributed among two teams with reference to their allocated area of specialization i.e. Physics or Biology. Each research team was required to prepare 20 lesson plans each according to the approved format in the workshops. In this validity was once again ensured to meet the important condition for conducting this particular experimental research.

2. Teachers' training (Teaching learning methodology)

In this workshop, four prospective teachers were selected as researchers from among 8 participants to conduct this research. These selected research teams were required to deliver their lesson plans two times with the help of low cost materials for teaching to accommodate diverse learners. The principal researcher, made his utmost effort to train all the teachers in the context of this inquiry learning teaching methodology for the diverse learners. Thus, it was ensured that the selected trained teachers would apply six major principles of effective instructional tools in science inquiry to accommodate diverse learners for learning of general science at 8th grade.

The summary of both separate research studies has been given below:

1. Physics portion of General Science (8th class book)

This research study was experimental in nature. Two equal tests were constructed as instruments for pre-

test and post-test. Cronebach Alpha was used to check the reliability of the instruments which was obtained as 0.824. The validity of the instruments was ensured by the three experts after incorporating their opinions to improve it. Only one group of 35 diverse learners was randomly selected from 150 students of 8th grade from one school. Two trained prospective teachers taught the experimental group for 6 weeks. Three periods of 45 minutes each, per week were allocated for interaction with the experimental group. 18 lessons plans were prepared to teach Physics portion, consisting of 3 chapters of General Science. These lesson plans were developed specially applying six major principles of effective instructional tools in science inquiry to accommodate diverse learners at elementary school level (8th class).

The objectives of the study are to:

- i. Find out the learning outcomes of Physics portion of General science for teaching diverse learners through the application of six major principles of inquiry at 8th class.
- ii. Determine the effectiveness of the methodology of inquiry learning for diverse learner at upper middle school by teaching of trained prospective teachers.
- iii. Know the impact of lesson planning for applying six major principles of effective instructional tools in science inquiry for diverse learners at elementary school level.

Null Hypothesis

- a) Hypothesis (H₀1): There is no significant difference between the learning outcomes of diverse learners in pre-test and post-test of physics portion of 8th grade.
- b) Hypothesis (H₀2): There is no significant difference of teachers' training for applying six principles of effective inquiry learning for diverse learners of 8th grade.
- c) Hypothesis (H₀3): There is no significant difference of lesson planning in the perspective of six principles of effective inquiry learning of physics portion of the general science book of 8th grade.

To achieve these objectives, data was collected through developing two instruments of equal nature of physics portion of the book of general science of 8th grade. After collecting the data, the item frequencies, percentages and means of pre-test and post-test were analyzed through SPSS. However, here Paired sample t-test was used. The summary of the results is given in the following table:

Table 1: Paired sample t-test for pre-test and post-test of students of 8th grade Physics portion

	Mean	No of students	T	df	Sig(two tailed)
Pre score	6.65	35	-14.086	34	0.000
Post score	13.42	35			

Table 1 shows that t value (14.086) is significant at p<0.05 level of significance. So, null hypothesis (H₀1) that there is no significant difference between the results of diverse learners in pre-test and post-test of physics portion of 8th grade is rejected. Hence, it means that applying six major principles of effective instructional tools to science inquiry to accommodate diverse learners at upper middle school level was effective. This also automatically verified that the second and third null hypotheses (H₀2 & H₀3) were also rejected, which indicates that teacher training and lesson planning for diverse learner was successful and effectively used for teaching of the diverse learners. Inquiry method along with six major principles was effective for diverse learning and this teaching methodology also proved to be useful for higher order thinking.

Table 2: A simple comparison between results of pre-test and post-test of physics portion of general science of 8th grade can be viewed as follows:

	Pre-test	Post-test
Mean of the score	6.65	13.42
Total statements	20	20
St. deviation	8.56	7.90

Table 4 shows that mean and St. Deviation of pretest is 6.65 & 8.56 while mean & St. Deviation of posttest is 13.42 & 7.90. So it is concluded that students perform better in posttest than that of pretest by using 6 teaching strategies for diverse learners.

2. Biology Portion

This research study-2 was also carried out through experimental methodology. Two equal tests were constructed as instruments for pre-test and post-test. Cronebach Alpha was used to check the reliability of the instruments which was obtained as 0.805. The validity of the instruments was ensured by the three experts after incorporating their opinions to improve it. Only one group of 40 diverse learners was randomly selected from 130 students of 8th grade from one school. Two trained prospective teachers taught the experimental group for 6 weeks. Three periods of 45 minutes each, per week were allocated for interaction with the experimental group. 18 lessons plans were prepared to teach Biology portion, consisting of 3 chapters of General Science. These lesson plans were developed specially applying six major principles of effective instructional tools in science inquiry to accommodate diverse learners at upper middle school level.

The objectives of the study are to:

- i. Find out the learning outcomes of Biology portion of General science for teaching diverse learners through the application of six major principles of inquiry at 8th class (elementary level).
- ii. Determine the effectiveness of the methodology of inquiry learning for diverse learner at elementary level by teaching of trained prospective teachers.
- iii. Know the impact of lesson planning for applying six major principles of effective instructional tools in science inquiry for diverse learners at upper middle school level.

Null Hypothesis

a) Hypothesis (H_{01}): There is no significant difference between the learning outcomes of diverse learners in pre-test and post-test of Biology portion of 8th grade (elementary level).

b) Hypothesis (H_{02}): There is no significant difference of teachers' training for applying six principles of effective inquiry method for diverse learners of 8th grade.

c) Hypothesis (H_{03}): There is no significant difference of lesson planning in the perspective of six principles of effective inquiry learning of Biology portion of the general science book of 8th grade.

Table 3: H_{01} : There is no significant difference between the learning outcomes of pretest and posttest of Biology portion of general science of 8th grade. *Paired sample t-test for pre-score and post-score of students of 8th grade*

	Mean	No of students	t	df	Sig(two tailed)
Pre score	7.17	40	26.975	39	0.000
Post score	19.07	40			

Table 3 shows that t value (26.975) is significant at $p \leq 0.05$ level of significance. So our null hypothesis that there is no significant difference between the results of pretest and posttest of biology portion at 8th grade is rejected. Hence it is concluded that there is a significant difference between the results of pretest and posttest of biology portion at 8th grade. Hence, it means that applying six major principles of effective instructional tools to science inquiry to accommodate diverse learners at upper middle school level was effective. This also automatically verified that the second and third null hypotheses (H_{02} & H_{03}) were also rejected, which indicates that teacher training and lesson planning for diverse learner was successful and effectively used for teaching of the diverse learners. Inquiry method along with six major principles was effective for diverse learning and this teaching methodology also proved to be useful for higher order thinking.

Table 4: A simple comparison between results of pretest and posttest of biology portion of general science of 8th grade is given as follows:

Pretest	Posttest
Mean of pretest: 7.17	Mean of posttest: 19.09
Statements of pretest: 20	Statements of posttest: 20
St. deviation of pretest: 2.33	St. deviation of posttest: 1.474

Table 4 shows that mean and St. Deviation of pretest is 7.17 & 2.33 respectively while mean & St. Deviation of posttest is 19.09 & 1.474 respectively. So it is concluded that students perform better in posttest than that of pretest by using 6 teaching strategies for diverse learners.

5. CONCLUSION

On the basis of the findings of both experimental groups, for Physics and Biology it was concluded that the students performed better in post-test than in the pre-test by only using six major principles as effective teaching strategies for diverse learners. Hence, it means that applying these six major principles of effective instructional tools along with inquiry method to accommodate diverse learners at upper middle school level was effective. This also automatically verified that the second and third null hypotheses (Ho2 & Ho3) were also rejected, which indicates that teacher training and lesson planning for diverse learners was successful and this method can be effectively used for teaching of the diverse learners at elementary level. Inquiry method is an effective methodology for the learning of and teaching to the diverse learners.

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