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STUDENTS' ALTERNATIVE CONCEPTIONS ABOUT "ENERGY" AND "LIVING"AND INSTRUCTIONAL STRATEGIES FOR CONCEPTUAL CHANGE TEACHING

ABSTRACT

This article reports the results of the investigations of alternative conceptions of students about 'Energy' and 'Living' and the effectiveness of short term training of science teachers in the use of instructional strategies for changing students' conceptions. The alternative conceptions of 184 students of 6th, 8th, and 10th classes from four Government high schools of Quetta regarding 'Energy' and 'Living' were investigated through Interview about Instances (IAI) approach. The alternative conceptions of the sample students about 'Energy' and 'Living' were found to be similar to alternative conceptions held by students of different nationalities / regions as reported in international research literature. The alternative conceptions of the sample students were found to be at variance with the scientists' conceptions as stated in the standard textbooks of science. The socio economic background of students did not have any relation with their alternative conceptions. No significant differences were found in the alternative conceptions of the students of different ages or classes. It was found that the alternative conceptions of the experimental group students about 'Energy' and 'Living' were similar to the alternative conceptions of the control group students. These findings call for developing and using diagnostic techniques to elicit students' alternative conceptions and for developing a repertoire of context based effective science instructional strategies.

Key Words: Alternative Conceptions, Science Concepts, Instructional Strategies, Conceptual Change, Effective Instruction, Energy and Living.

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INTRODUCTION

Various views and theories of learning have been presented during the 20th century. The traditional behaviorist views of learning have thought of learning as being primarily a passive, receptive and reproductive process (Shuell, 1987). Cognitive views about human learning emphasize that learning is an active, constructive and goal oriented process. What and how much an individual learns depend on the activities in which he or she is engaged. Learning involves much more than passively responding to the environment. The cognitive views of learning also acknowledge the role of various meta-cognitive processes such as planning and setting the goals, the selection of stimuli, and attempts by the learner to organize the material they are learning and generation or construction of appropriate responses (Osborne and Wittrock 1983).

While a reasonable amount of information is available on the way in which simpler forms of learning take place, we know much less about the psychological mechanisms and process that are responsible for meaningful cognitive learning and environmental conditions that can encourage conceptual change as a result of formal instruction.

Our understanding of the importance of the ideas and explanations held by students prior to classroom instruction has been improving as result of the findings of research in science education and other cognitive sciences since the early 1970s. Ausubel has contended that, "The most important single factor influencing learning is what the learner already knows" (Ausubel, D.P. 1968 pp 4). Ausubel has also mentioned the importance of alternative conceptions in the process of learning, and had noted that these conceptions are surprisingly tenacious and resistant to change (Ausubel, D. P. 2000). In the context of emerging conceptions of learning, the purpose of education can be looked upon as evolving and adopting appropriate instructional strategies for helping students in acquiring meaningful understanding of the subject matter. This understanding can be attained when new information is integrated with existing concepts thereby evolving new and more useful concepts.

This study attempted to elicit the alternative conceptions regarding the concept areas of 'Energy' and 'Living" using "Interview about Instances" method. The present study had attempted to develop valid and economical techniques for studying students' prior conceptions. The classroom teachers may use these techniques to understand the importance of prior knowledge and cognitive structures of their students. Another significant aspect of the study was to suggest appropriate instructional strategies to bring about desired modifications in the alternative conceptions of the students. The science teachers can develop appropriate teaching strategies to link the knowledge and information to be taught to the alternative conceptions held by their students, thereby making the acquisition of meaningful learning possible.

Principles of learning

The research literature on learning has been synthesized in the National Research Council report: *How People Learn: Brain, Mind, Experience, and School* (Bransford, John D., et al. 1999). Three fundamental and well-established principles of learning that have been emphasized in '*How People Learn'*. These principles are particularly important for teachers to understand and to be incorporated into teaching practices. The three fundamental principles of learning are:

1. Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.
2. To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.
3. A "meta-cognitive" approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them.

Although the research findings about the above principles of learning have clear implications for instructional practice, these implications are not specific enough to be immediately useful for the classroom teachers. While if is expected that teachers should fully understand the importance students' prior conceptions, at the same time they need to understand the typical alternative conceptions held by the students with respect to the topic being taught.

Implications of the principles for teaching and learning

Although the above mentioned learning principles appear to be simple yet they have profound implications for teaching and teacher preparation.

1. ***Teachers must bring out the pre-existing understandings of their students which they carry into the classroom and should work with these pre-existing conceptions.***

This would require that the learners are not viewed as empty vessels being filled with knowledge provided by the teacher. Instead, the teacher must actively bring students' prior thinking out by developing appropriate classroom tasks and conditions. Students' initial conceptions should provide the foundation on which the required formal understanding of the subject matter is built.

2. ***Teachers must teach the selected subject matter in depth. They must provide many examples in which the same concept is at work and they should built a firm foundation for factual knowledge.***

This would require that superficial coverage of all topics in a subject is replaced with in-depth coverage of fewer topics allowing key concepts in the discipline are fully understood by the students. There must be a sufficient number of in-depth study cases to allow students to fully understand the main concepts in a discipline. This would require active distribution of the curriculum across school year.

3. Guiding the students about the use of Meta-cognitive skills should be integrated into the curriculum and instruction in a variety of subject areas.

Because many students may be unaware of the importance meta-cognition it is often neglected by them unless teachers explicitly emphasize these processes. An emphasis on meta-cognition needs to be integrated into instruction in each of the disciplines. Integrating the use of meta-cognitive skills in instruction can enhance student's achievement and develop in students the ability to learn independently.

Teaching for conceptual change

Conceptual change has been defined in a variety of ways. Chi and Roscoe (2002) and DiSessa (2002) have defined conceptual change as a learning process whereby an existing conception, idea, or belief held by a student about how the world works are changed and restructured, away from the existing alternative conception toward the dominant concepts held by the experts in the related field. Chi (1997) has differentiated between normal conceptual change and radical conceptual change. Vosniadou (1994) considers that normal conceptual change takes place with a form of *weak restructuring* with elements of *enrichment* of pre-existing knowledge and the radical conceptual change involves *strong* or *radical restructuring* with elements of *revision* of prior knowledge and interpretative frameworks.

A review of research literature regarding effective science instruction in science has indicated following essential features of effective science teaching (Tytler, R., 2001):

- *Students are encouraged to actively engage with ideas and evidences*:
- *Students are challenged to develop meaningful understandings*:
- *Science is linked with students' lives and interests*:
- *Students' individual learning needs and preferences are catered for*:
- *Assessment is linked with the science learning strategy*:
- *The nature of science is represented in classroom instruction*:
- *The science classrooms are linked with the society*:
- *Varied learning technologies are used for their potentialities*:

RESEARCH QUESTIONS

The following research questions were addressed in this study:

- What are different alternative conceptions, held by sample students with respect to "Energy" and "Living"?
- What valid and reliable paper and pencil group technique can be used for studying the alternative conceptions of the students in selected concept areas?
- What is the effectiveness of the proposed instructional strategies for conceptual change in the alternative conceptions of students regarding selected science concepts areas?

METHODOLOGY

Instruments

The alternative conceptions of the selected sample of students were investigated by using Interview about Instances (IAI) approach (Osborne & Gilbert, 1980, Watts, 1983). The IAI approach is based on face-to-face interview with the respondent. The alternative conceptions regarding the concept of "Energy" and "Living" were investigated by using two decks of picture cards (14 cards for "Energy" and 19 cards for "Living"). The respondent was shown a card from a deck of cards and was asked to give his views with respect to the situation depicted on the card in response to semi structured interview questions asked by the researcher. The audio-recorded interviews were transcribed verbatim. The interview transcripts were analyzed to identify response categories on the basis of commonalities found in the alternative conceptions indicated in the responses of the students. The information regarding socioeconomic background, age and family of the students included in the sample were collected at the end of each interview.

Conceptual-diagnostic test

A written group "paper and pencil" test in Urdu language was developed to investigate the alternative conceptions of

students regarding the concepts of "Energy" and "Living". This conceptual-diagnostic type of test aimed to assess students' conceptual understanding of key ideas in 'Energy' and 'Living' concept areas. The format of the test was multiple-choice. The test was based on two-tiered type of questions. The two-tiered type of questions asked students to explain the reason or reasons for choosing a particular response from a multiple-choice test item. The test items related to the concept of "Energy" were based on twelve real situations shown in small pictures and described verbally in the beginning of each set of test items related to that picture. The total number of test items related to concept of Energy was seventy nine. The second section of the test relating to the concept of Living comprised MCQs and two tier open-response short answer questions based on small pictures of living and nonliving things. The total number of test items related to concept of Living was forty two.

Field testing of interview instances and conceptual diagnostic test

The picture cards used to elicit the alternative conceptions of the students through IAI approach were field tested with students, of class 6th, 8th, and 10th in Government Sandeman High School Quetta. The field-testing of the instances yielded an estimate of time (20 minutes for one interview) required for the IAI method. The conceptual diagnostic test was also field tested to ascertain its validity, reliability and practicability. It was found that test provided valid and reliable information about the alternative conceptions of students about the selected science concept areas and was quite practical.

Sample

The sample for this study was selected from four Government High Schools of Quetta city. The sample schools were selected randomly from the alphabetical list of Government Boys High Schools. All the Government Boys High Schools in Quetta city were generally comparable with respect to physical facilities, qualifications and experience of teaching staff, and socioeconomic background of the students. The sample of the

students of Classes 6th, 8th, and 10th was selected randomly from the attendance register of the class using the tables of random numbers.

Table 1: The number of sample students

Concept	No. of Interviews	Class	GBHS Muslimabad	GB Technical HS	GB Special HS	GBHS Killi Sheikhan	Total
Living	92	6th	5	8	9	7	29
		8th	7	8	9	8	32
		10th	7	8	9	7	31
Energy	92	6th	6	7	9	7	29
		8th	7	8	8	8	31
		10th	7	8	9	8	32

Conceptual framework of instructional strategies for conceptual change teaching

In order to study the effectiveness of instructional strategies for conceptual change in students' alternative conceptions, a conceptual framework was developed on the basis of extensive review of research literature. This framework provides practical guidelines for designing appropriate instructional strategies for science teaching in our secondary schools. The following paragraphs give an outline of the proposed conceptual framework for instructional strategies.

There is an emerging perspective of science education as a result of world wide reform efforts in the light of recent contributions of researches on students' alternative conceptions in science, (Adams, A. D., & Griffards, P. B. 2001), students' learning styles (Ballone, and Czerniak, 2001), constructivist science teaching (Schulte, P.L. 1996, Yore, L.D. 2001, Glasersfeld, 2003), science teacher education,(Craven, J. A. and Penick, J. 2001, AbuSharbain, E. 2002), constructivist learning models, (Appleton, Ken. 1990), role of learning environment and the use of assessment that inform instruction and cultivate meaningful learning by students (Ormrod, J.E. 2000). Various models and strategies for conceptual change teaching have also been proposed (Scott, Asoko, Driver, 1992, Crawley and Pedersen 2002).

There were many teaching sequences proposed as a consequence of continuing research into children's conceptions. They draw strength from both the theoretical perspective of various versions of constructivism, and also the empirical findings from student conceptions research. R. Tytler (2002) has referred to these approaches as Constructivist/Conceptual Change (C/CC) approaches. The critical elements in all these schemes (e.g. The Learning Cycle, The Generative Learning Model, The Interactive Approach, Japanese Science Structures,) are that students' prior conceptions are taken as the starting points, that they are encouraged to reflect on their understandings and to test and if necessary modify these in the light of evidence (often involving challenging activities), and that the classroom structure encourages the exchange of ideas and the arriving at consensus views. These general principles were powerfully stated by the 'Children's Learning in Science' group in the UK as follows:

- *Provide opportunities for the students to make their own ideas explicit:* Use students' own language, give them opportunities to share ideas and encourage clarification of ideas.
- *Provide experiences which relate to students' prior ideas*: Encourage student to extend their knowledge of phenomena, provide opportunities for them to make links between phenomena, and provide experiences which challenge their ideas.
- *Give opportunities for students to think about experiences:* Provide opportunities for imaginative thinking, encourage reflection on alternative models and theories.
- *Give opportunities for children to try out new ideas:* Allow students to gain confidence in trying out new ideas in a variety of contexts, both familiar and new. Use a variety of teaching / learning strategies.
- *Encourage children to reflect on changes to their ideas:* Encourage student to be aware of advances in their thinking and provide opportunities for them to identify changes in their ideas.

- *Provide a supportive learning environment:* Encourage students to put forward their own ideas and to listen to each other. Avoid always creating the impression that there is only one 'right answer'.

There were three main lessons learnt from current broad knowledge base on effective teaching strategies for conceptual change in students' conceptions. Firstly, the importance of listening to students, and encouraging their active engagement in acknowledging and evaluating their own ideas; It was clear that effective teaching in science should incorporate strategies for identifying, acknowledging and challenging students' non-scientific conceptions. Secondly, then there was the need to build up effective activities and strategies, for the range of science content areas and for different year levels, that are productive for exploring and challenging students' conceptions. Thirdly, the insights of socio-cultural views of knowledge construction (Vygotsky, L.S. 1997) emphasized the collaborative process of meaning making that must occur in classrooms and the variety of roles this implies for the teacher in framing, challenging and clarifying ideas.

Training of experimental schools science teachers

In line with the above perspective on effective instructional strategies, a six-day training package was prepared for the science teachers of two experimental group government secondary schools to test the effectiveness of the proposed instructional strategies for conceptual change in the alternative conceptions of students regarding selected science concepts areas. At the successful completion of the training, the selected science teachers were expected to be able to:

a. Describe the significance of students' alternative concepts in science.
b. Use the principles of learning and teaching in their instruction
c. Plan and implement their daily lessons according to proposed "Constructivist / Conceptual Change" instructional strategies.

d. Use their knowledge and skills to improve science instruction in their schools through reflective practice.

The science teachers of two experimental schools who were teaching the subjects of Physics, Chemistry, and Biology to 9th and 10th classes participated in the six day training program. The number of science teachers who participated in the training program was 16.

Teaching of related chapters of 9th class Physics and Biology textbooks in the experimental and control group classes of selected schools

The science teachers of the two experimental schools who were teaching the subjects Physics and Biology to a section of class 9 were asked to teach the related chapter of the textbook using the proposed instructional strategies they had learned during the training and according to the lesson plans prepared during the training workshop. It was assumed and expected that the science teachers of the experimental group schools would use the proposed instructional strategies which were included in the training package. The science teachers of the experimental and control group schools who were teaching the subject of Physics to class 9th taught the Chapter No. 8 entitled "Work, Power, and Energy" to their respective classes. The science teachers of the experimental and control group schools who were teaching the subject of Biology to class 9th taught the Chapter No. 3 entitled "Classification of Living Organisms" to their respective classes.

Administration of the written group test for alternative conceptions about chemical change to the experimental and control group classes

A randomly selected sample (25% of the registered students) of the students of various sections of class 9 of the experimental and control group schools was selected for the administration of the post test. The written group diagnostic test for identifying alternative conceptions about 'Energy' and 'Living' were used as the post tests.

RESULTS

Alternative conceptions of students regarding "energy"

Following alternative conceptions about 'Energy' were found among the sample students:

Energy is the ability of a body / system to do work. Energy is force / weight. Energy is an ability of a body for motion. No energy in non living things only weight. There are many different kinds of energy; Light, Heat, Electricity, Food, Potential Energy and Kinetic Energy etc. There is energy in animals (e.g. cow). Animals get energy by eating and use energy in moving. Sun has light and heat energy because Sun moves. Sun gives energy to every thing. Plants (Grass) have energy because plants are living. Water gives energy to plants. No energy in electrical appliances (Television) when these are off. Electrical appliances (Television) have energy due to their weight. Earth and Moon both have energy because these are revolving. God has given energy to Earth and Moon. Moon gets energy from Earth. There is natural energy in the wind. Yacht has energy of man and wind. Boat's energy is used in moving (sailing). Wind has power to push (the sails). Man gives energy to machines (winding clock). Energy is stored in the machines. Moving things (objects / Jack) have energy while no Energy in stationary objects (Car on Jack). The bicycle has no energy. The man has energy. The energy is stored in the bicycle because of earlier pedalling and speed. The moving bicycle has energy. Energy is produced when candle is burning. Wax has energy of burning. Wax has potential chemical energy which is converted into Light / heat. The rock or the table has no energy these have only weight. Table has energy because it can carry heavy weights. There is no energy in the rock if it is placed on the ground. It only has weight. The rock and the table have potential energy. All living things (Weight Lifter, Bird) have energy. Living things get energy from food / water / movement (exercise). Moving objects (car on the road) have energy. Petrol / diesel are converted into energy of motion (kinetic energy). Moving car has energy which comes from the engine, petrol or diesel. Most of the students (47%) held the conception that Man's

energy decreases while climbing the stairs while some students considered that Man's energy decreases while climbing the stairs. Very few students (2%) held the conception that potential energy of man increases because of increased height.

Alternative conceptions of students about 'living'

Following alternative conceptions about 'Living' were found among the sample students:

Majority of the sample students (95% – 100%) was able to categorize 14 pictures of living and non living things (such as book, boy, bird, bicycle, fish, tree,) correctly but majority of the sample students did not correctly categorize the pictures of 'Fire', 'Sun', 'Clouds', 'River', and 'Burning Candle' as non-living things.

Most frequently mentioned characteristic which was used to categorize an object as living or nonliving was the presence or absence of perceived ability of the object for self movement (e.g. 'Boy' is a living thing because it could move on its own and 'Book' is nonliving as it can not move on its own. No self movement.). Almost one fourth of the sample students categorized the burning Fire as a living thing and one of the frequently given reasons was that the flames have movements. The characteristic of Movement was used as basis for categorization as living thing more emphatically in the instance of Sun. Majority of the sample students had the alternative conception that Sun moves by itself and therefore they categorized it as living. Similarly movement was used as a reason to by a small number of sample students when they categorized the Stone as living thing when it is thrown and it is going in air. The percentage of students who categorized the Stone as a living thing slightly increased from 0.0% to 6.82%.

The instances of 'Clouds' and 'River' were found to be more revealing about the alternative conceptions of the students about living and the reasons for categorizing the objects as Living or Nonliving. A majority of the sample students categorized the Clouds as a living thing. Majority of the students said that as clouds moved from one place to another therefore they had categorized the clouds as living thing. In the case of instance of 'River', almost half of the students categorized the 'River' as a

living thing while other half of the students (46.46%) categorized the River as nonliving. When the students who categorized the River as living thing, were asked to give reasons, almost all of these students said that the water in the river flows by itself. The characteristic of 'movement' of water in the river formed the basis of their categorization. When the students were asked to describe how water in the river flows; various alternative conceptions were identified. Majority of the responses were that the water in the river flows by itself while some students responded that the water coming from behind pushes the water ahead. Another category of alternative conceptions were that water in the river flows because of wind.

The instance of 'Burning Candle' also indicated that the characteristic of 'movement' was one of most frequently used basis for deciding whether the instance under consideration was living or nonliving. Most of the students considered candle as a living thing when it was burning because of the movement of the flame of the burning candle. Many students categorized the burning candle as living because it provided light and other benefits. This alternative conception indicated that the usefulness of an object was used as a characteristic for categorizing the instance as living thing.

Another most frequently mentioned characteristic of living things was taking food. In case of the instances of 'Boy', 'Bird', 'Snail (Keera)', 'Fish', 'Spider', and 'Butterfly' the most frequently and most commonly mentioned reason for categorizing these objects as living things was their attribute of taking food. Many students when categorized the 'Car' or the 'Burning Candle' as living things mentioned that petrol or wax was a "food" for these objects along with the reason that these objects were considered useful things.

The sample students most frequently mentioned the characteristic of 'Self Movement" as the most distinguishing attribute of living things. The other characteristics mentioned were 'Takes Food', 'Respiration', and 'Growth'. When the students were asked to tell other characteristics after their first

responses, the sample students mentioned the characteristics of having 'offspring' comparatively more frequently than the other characteristics. It was interesting to note that not a single student mentioned 'Excretion' as a characteristic of living things.

The alternative conceptions about 'Energy' and 'Living' concepts held by the sample students in this study were found to be quite similar to alternative conceptions held by students of different nationalities / regions as reported in international research literature (see for example; Duit, R. & Treagust, D. P. (2003), Fensham, P. J. (2004), Fisher, K., Anderson, D. et al (2000), Hills, G.L.C. (1989), Libarkin, Julie C. et al.(2005**),** Liu, Xiufeng., Ebenezer, J., & Fraser, D.M. (2002), Tao, P.K. & Gunstone, R.F. (1997), Tytler, R. (2002),). Similarly no significant differences were found among the students of different ages or classes (6^{th}, 8^{th}, and 10^{th},). The socio economic back ground of students did not appear to have any relation with the alternative conceptions.

Effectiveness of proposed instructional strategies for conceptual change in students' alternative conceptions

The sample students of class 9 of the experimental and control group schools were taught the relevant chapters of the textbooks of Physics and Biology by their respective teachers. The science teachers of the experimental were asked to teach the related chapter of the chemistry textbook using the proposed instructional strategies they had learned during the training workshop whereas the science teachers of the control group schools taught the relevant chapters using their usual teaching methods. The written group diagnostic test for identifying alternative conceptions about 'Energy' and 'Living' were used as the Post Tests to measure difference in the alternative conceptions of the experimental and control group students as indicated by the achievement score on the diagnostic test.

The alternative conceptions of the experimental school students (M = 26.597, SD = 4.697) regarding 'Energy' were similar to the alternative conceptions of the control group students (M = 25.802, SD = 4) even after they were taught the concept of 'Energy' by the teachers who received six day training about the proposed

instructional strategies for conceptual change teaching. This difference was not significant, t (∝) = 0.265536, p < .05, two-tailed. The hypothesis (H_1) that alternative conceptions of students who receive instruction through proposed instructional strategies were closer to scientists' concepts than those who were not taught through these strategies was rejected.

The t-Test for unmatched groups 'energy' concept

	Number of Scores		Mean of Scores		Standard deviation	
E-Group	nE	67	YE	26.597	sE	4.697
C-Group	nC	91	YC	25.802	sC	4

Obtained *t*-value 0.265536

The alternative conceptions of the experimental school students (M = 18.91, SD = 3.88) regarding 'Living' were similar to the alternative conceptions of the control group students (M = 19.34, SD = 3.53) even after they were taught the concept of 'Living' by the teachers who received six day training about the proposed instructional strategies for conceptual change teaching. This difference was not significant, t (∝) = 0.486489, p < .05, two-tailed. The hypothesis (H_1) that alternative conceptions of students who receive instruction through proposed instructional strategies were closer to scientists' concepts than those who were not taught through these strategies was rejected.

The t-Test for unmatched groups 'Living' concept

	Number of Scores		Mean of Scores		Standard deviation	
E-Group	nE	67	YE	18.91	sE	3.88
C-Group	nC	91	YC	19.34	sC	3.53

Obtained t-value 0.486489
Tabled t-value 1.96

DISCUSSION

It was found that the alternative conceptions of the experimental school students regarding selected science concepts were similar to the alternative conceptions of the control group students even after they were taught these concepts by the

teachers who had received six day training about the proposed instructional strategies for conceptual change teaching. The design and procedure of this study did not include any collection of data regarding the implementation of proposed instructional strategies in the experimental classrooms. The remarks and exit notes of the science teachers who attended the training showed positive attitudes and commitment towards using the proposed instructional strategies in their classes. The contents of training package were carefully selected on the basis of their reported effectiveness from evidence based research literature of science education and science teaching (see for example; Duit, R. & Treagust, D. P. (2003), Blank, L. (2000), Bransford, John D., et al. (1999), and Zirbel, E. L. (2004). The research literature has abundantly supported the effectiveness of proposed instructional strategies which were included in the six day training package.

The impact of short term training on the classroom practices of the teachers have been discussed by Bell and Gilbert (1996) and it is pointed out that the long term impact of educational development programs seems to depend mainly on contextual aspects. Briscoe, 1991 suggested that teachers invariably find themselves teaching in the same way that they have done prior to engaging in professional development activities. Howe and Stubbs (1996) suggested that the exact outcomes of teacher professional development activities cannot be specified in advance. It also has been reported by the physics education researches that traditional instruction is mostly ineffective in changing these alternative conceptions as they are resistant to change and are persistent over time (Eryilmaz, 2002).

The implementation and the use of conceptual change teaching strategies in the science classrooms has been found to be associated with the availability of special instructional materials and also with use of performance tests to measure the conceptual change and not only with the short term training of science teachers (see for example Smith, E. L., Blakeslee, T. D., and Anderson, C. W. 2006). Kirschner, Paul A., Sweller, John, & Clark, Richard E. (2006) have raised concerns about the effectiveness of Constructivist, Discovery, Problem-Based, Experiential, and

Inquiry-Based Teaching which provide only minimal guidance during instruction. They were of the view that although these instructional approaches were very popular yet these were less effective and less efficient. The final remark is that science students should be provided with direct instructional guidance (Mayer 2004) on the alternative conceptions and should not be left with existing conceptions and science teachers should provide information that fully explains the concepts that students are required to learn and such classroom activities should be made essential part of instructional strategies that are compatible with required conceptual changes and understandings.

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