

Higher Secondary Biology Instruction in Pakistan in Constructivist Perspectives

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Abstract

The main objective of this study was to investigate the higher secondary biology instruction in Pakistan in light of constructivism. The present study is concerned with, the examination of higher secondary biology instruction, taking into account constructivism as a learning theory, that can be largely examined without considering broader philosophical or the epistemological standpoint of constructivism. Two hundred biology teachers, and one thousand biology students, from one hundred higher secondary schools/colleges were randomly selected out of five districts of Punjab. A questionnaire was developed and used for the collection of data from both kind of respondents (i.e., higher secondary biology teachers, and the higher secondary biology students). The questionnaire was primarily structured to keep the study within the predefined boundaries. Analysis and interpretation was done after data collection. Findings of the study were that constructive understanding occurs in the brains of learners, and teachers can assist their students in enabling more valid understanding to be constructed. Evidence from the present study showed that those teachers who were aware of this, was minimal. Teachers tended to lecture/use telling as an instruction method and were purveyors of knowledge to be memorized and recalled later. Though teachers do use different teaching strategies in addition, but this was minimal. There was little evidence of the teacher acting as a facilitator, guide or mentor to enhance learning, although teachers and students both seem to say that higher secondary teachers take care of students' previous knowledge, and use that prior knowledge to update their current learning. It is found that higher secondary biology students are more positive to consider that their teachers do help them in carrying out different learning tasks. It is also found from the response of students and teachers, that teachers offer support to them and give feedback when and where required, but to a lesser extent.

Keywords: Higher secondary biology instruction, constructivism, science education curriculum

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Introduction

In recent decades, science education is dominated by constructivism, which has been seen as an attractive word in science education learning environment in schools & colleges (Fensham, 1992& 2004). Colburn (2000) notes that the term “constructivism” has multiple meanings, which should be used with caution (Sjøberg, 2007). The term ‘constructivism’ is used so differently in educational literature, that it can be seen by a number of educators as a revelation, revolutionary passé; irrelevant; and despicable by different educators. It is used widely and in complex ways (Duit, 1995; &Phillips, 2000a), for example, it is used to describe learning and teaching, as well as curricula and assessment (Gil-Pérez et al, 2002& Furbish, 2005). However, constructivism has also been strongly opposed by many critics (Solomon, 1994; Scerri, 2003; Matthews, 1993&2000) who consider it an empty mantra; a fad or fashion (Erikson, 2001) while some still see that constructivism continues to be the dominant research program in science education (Taber, 2009a; Sjøberg, 2007).

Many educators say that cognitive revolution in learning theories against behaviorism simply lead to constructivism. Constructivism was compounded (a theory of learning or knowledge or as a philosophy etc) and confuses others. Constructivism is considered by many in various ways, which needs to be separated (Matthews, 2000). Constructivism is actually a learning theory but it can be considered a model of learning or assessment. Some consider it a general label for a group of cognitive learning theories that rests on the belief, that learner construct knowledge himself with an active process of development. Constructivist learning theory is an input by famous educators such as Piaget, Vygotsky, Bruner, Ausubel, Kelly and others. Berube (2008) says that, constructivism as a philosophy or an epistemology is a fraught with controversy and disagreement, but constructivism as a learning theory, serves as a valid model.

Educators use qualifiers when they refer to constructivism. Constructivism (as a learning theory) related to Piaget or Ausubel is often called personal or psychological constructivism; whereas constructivist perspective related to Vygotsky, and Solomon are called social constructivism; similarly Bruner’s constructivism is termed as ‘cognitive constructivism’; other examples of constructivism are the ‘contextual constructivism’ (Cobern 1993), ‘socio-transformative constructivism’ (Rodriguez, 1998), and ‘socio-cultural constructivism’ (Tobin 1998; Branco & Valsiner 2004).

Whilst recognizing different types of constructivism, it is important to highlight that the present study is an analysis of higher secondary biology instruction considering psychological form of constructivism as a learning theory that can largely be examined without referring to philosophical or epistemological stances usually related with constructivism by Bredo and others. Here, constructivism should be considered as a perspective on teaching-learning, which admits that learning occurs as a result of self regulated process of construction of new knowledge or new representation of knowledge basing on prior models with new updated insights by learners themselves.

Constructivism emphasizes on students' active role i.e., engaging in appropriate cognitive processing during teaching and learning process to build new updated construction in their learning, makes it a "student-centered learning perspective" and helps to shift center of learning from the instructors or coach towards students. It causes current reforms in classrooms to change the role of teachers from authority to guide, where they have to help students in discovering meaning themselves (Cey, 2001).

The Role of Teacher in Constructivist Perspective

Constructivism also requires a modification or change in role of teachers. A constructivist teacher has six essential duties as noted by Collins, Brown, and Newman (1989):

- *Modeling*: In modeling, the teacher performs a teaching task so that the student can observe and build a conceptual model of the process.
- *Coaching*: The teachers observe the students as they carry out an educational task and offer hints, feedbacks, and modeling when it is required.
- *Scaffolding*: Scaffolding is the metaphor for cognitive structure. At the initial stages of the learning process, the learner seems to function best with high structure, using teacher-provided cues, specific explanations, and organizing strategies to make sense of the problem, and to engage in its solution. As the learner progresses, he or she needs less scaffolding; the goal is to fade gradually, to turn over the entire process to the learner, so that he or she becomes self-regulating. Constructivist teachers must produce chances for peer scaffolding, and teacher-directed scaffolding, which allows student to communicate with each other to enhance meaning making and to fill in gaps of knowledge levels within a classroom. Expository teachers often considered hesitant to modify their role.

- *Articulation:* Here teachers help students to articulate their knowledge and their reasoning processes, to make the cognitive process visible.
- *Reflection:* At this stage, teachers help students to reflect about their process and compare them with those of an expert or another student. Constructivist instruction is particularly supportive for students who face difficulties in learning. Change in teachers' role, as described above, can efficiently express to learners that what they think and say matters, and learning depends on them. (Lee 2004)
- *Exploration:* At this final step, the teacher uses explorations, pushing students to do problem solving on their own, to frame questions, and to find answers. If a teacher uses errors committed by student to provide them feedback to reduce their misconception, it will increase their understanding levels.

Wise & O'Neill (2009) suggest that constructivist instructional moves include explanation, feedback, help, modeling, scaffolding, procedural direction, and others. Constructivism has many positive features which can help instruction:

- It hits upon what students already know
- It asks students questions
- Cognitively engages students

But critics of constructivism note that these good pedagogical features are not new, and have been known since Socrates' time. History is filled with such catchy 'ideas', but their endorsement results in the form of educational or cultural confusions. Constructivist opponents say that learning does not require any intended teacher; it can be a spontaneous activity without a teacher. It can be resulting from an experience – sometimes intentionally or vice versa with regards to their own targets or goals, whereas teaching or instruction is an intentional effort of trying to impact upon learning (Kirschner, Sweller & Clark, 2006). Duschl & Duncan (2009) write in "*Constructivist Instruction*" that constructivist instruction needs *building* understanding and *incorporating* the new knowledge, with the help of *scaffolding* and *guided instruction*. They added that it is different from '*Direct Instruction*' of what's right and what's wrong. Here it is important to see that whether students are actively engaged with their prior knowledge in learning environment and they are sharing their ideas through communication or using other active involvement techniques which can keep them active mentally and physically.

Constructivist Instruction: Two Distinct Perspectives

The critics of constructivism (or the followers of ‘Direct Instruction’ paradigm) think that constructivist instruction means:

- Instruction with indistinct learning goals;
- Unstructured lessons;
- Open ended student doings or activities; minimal input from teachers; and
- Learning one kind only i.e., personal which may not or may not match desired knowledge. (Kirschner, Sweller & Clark, 2006)

On the other hand if it is understood from within the constructivist paradigm, the proponents say that constructivist instruction means:

- Instruction or teaching with more broader aims rather than focusing on very specific learning objectives;
- Interactive, flexible and dialogic process of teaching that builds upon the students’ thinking, prior concepts and activities;
- Aim of education here is more wide i.e., learning of complex knowledge in comparatively unstructured domains with ample time to explore problem, giving students chance to use their own imagination;
- Teaching includes use of a variety of strategies and techniques, ranging from locating appropriate problems along with provision of suitable learning resources, organizing group activities, helping students to replicate their prior knowledge etc, as well as to provide direct source of information when and where required. (Taber, 2009)

Millar (1989) concludes that science should be taught in whatever way is most likely to engage the active involvement of learners. For better science learning, teacher should make students feel willing to do intellectual work of constructing and followed by reconstructing meaning for themselves (Mayer, 2009). The constructivist model of learning is one which may or may not carry necessary message about models of instruction (Mayer, 2009). Psychologically, research shows that active involvement of students in their learning process may lead to better understanding, use and retention of that knowledge. In a constructivist class lot can be wasted, but a good constructivist teacher can handle such situations occurring during the teaching-learning processes. (Bektas & Taber 2009)

Constructivism refers to a theory about how students can learn; or it is an array of different pedagogical strategies as far as constructivist instruction is concerned (Colburn, 2000). Critics have pointed out that constructivist epistemology (subjectivism, relativism and skepticism) is inconsistent with science (Scerri, 2003; Matthews, 2000; and Furbish, 20005). It has also been criticized that its ontology (idealism) is inconsistent with science. One can say that constructivists' epistemology and science epistemology are different from one another when they are related to science education. (Scerri, 2003)

The constructivism as a learning theory has faced enormous implications. It is usually criticized to be a theory about learning with flawed pedagogical practices and strategies, while supporters of constructivism claim that though it is a learning theory not a theory of teaching but it utilizes different strategies like activity based teaching discovery teaching methods and inquiry based instructions etc., in other words many so-called fads in education now have a firm, research-supported foundations. Constructivism generally helps us to rethink and reform our old practices into constructivist's teaching learning processes (Fosnot & Perry 2005; Tobias & Duffy, 2009a).

The teachers and instructors of today have to face challenge in teaching their students how to construct (scientific models) themselves from their prior knowledge, and to understand value of application of that knowledge; and, to use 'them' (Driver et al. 1994). Mayer (2004) in his, "Three Strikes and You are Out" review of discovery learning, says that the evidence has favored a guided approach to learning. Minimally-guided learning is not only ineffective for most of the students but it may cause some harms to some of the students, while on the other hand direct guidance designs are specifically supportive for the cognitive processing required for learning (Kirschner, Sweller & Clark, 2006). It is also important to note that:-

- If assumed prior knowledge is absent or not active properly then it is expected that new knowledge will not be built properly (meaningfully).
- If the students' prior ideas consist of alternate concepts, or if they are active to some extent or improper, newly built knowledge may get wrong directions.
- Constructivist techniques can even seem to be deceptive and manipulative so it is needed to deploy constructivist techniques wisely.
- How can a teacher create an appropriate targeted constructivist response to learners' difficulty? Which challenge to recognize for different kinds of knowledge?
- Classroom teachers are facing more hardships in implementing constructivists teaching or instruction.

Science Education and Constructivism in Pakistan

Constructivism has never been adopted officially as a learning perspective at higher secondary science education level in Pakistan, though it is adopted officially as a learning theory in National Curriculum for General Science Grade III to VIII (2006) showing learner centered perspectives, and less emphasis on teacher controlled learning environment. Teacher training program at different level, also seem to offer instructional guidance incorporating student centered approaches (Govt. of Pakistan, 2006, & 2009), which have widely under discussion without or without understanding what constructivist learning theory is, reflecting what most teachers in Pakistan and other parts of world have believe it... is just a good practice of teaching.

In the present scenario, where countries are paying attention strongly to science education, a developing country like Pakistan, also needs a good science education curriculum to cope with the present standard of developed countries. Obviously there must be knowledge-based curriculum of current scientific aptitude, to affect the teaching and learning of a subject to be taught from the secondary to higher secondary level of education. In Pakistan, review of curricula was done in 2006 with the aim to give a uniform curriculum format consisting of standard, benchmarks and learning outcomes, focusing upon *primacy of students' experiences, their voices and their active involvement in the process of learning*" (Govt. of Pak, 2006).

Bowers (2007), a constructivist critic, writes that twenty nine countries outside west were caught in trauma of constructivism, introducing this perspective in their education system (teacher education programs school education etc.). Constructivist theories of learning had already inspired the teacher education programs in English-speaking countries (Bowers, 2007). Moreover, constructivism has been adopted, to some extent, in New Zealand (Aeotora) to offer a student centered curriculum which is a bit flexible and responsive to the student's needs in different learning institutions, would seem to be somewhat different from the largely 'content-free' notion of constructivist inquiry teaching which has been characterized as a danger (Cromer, 1997). On the other hand, it offers, at least in principle, the possibility of a very inclusive, student-centered science learning experience (Coll, 2007). In England, Taber (2009) says that key principles of constructivist teaching have been adopted at least into a range of 'teacher education' and 'science teaching' policy and guidance documents. Canada (Ontario), Thailand, Greece, Turkey, and some areas of USA, India, and Taiwan, have adopted constructivism officially. In Pakistan, it is officially recognized leaning theory in science education.

Problem Statement

Implementation of science education curriculum has been undergoing a major transformation towards more learner-sensitive perspectives in Pakistan (Govt. of Pakistan, 2006), and in many countries around the world. However, according to Tobias & Duffy, (2009) there are signs of consensus developing more towards constructivist pedagogical practices. Teacher centered perspective still dominate in Pakistan (Kayani 2002, & Naeemulla, 2007). On the other hand researchers of the world seem to claim that; constructivism has made an effect on curricula of science and mathematics, in many parts of the world (Duit, 1995 and Taber, 2009). However, traditional science education instruction has offered us “transmission of knowledge” paradigm. Here a question arises that, whether the science instruction has now reach to constructivist teaching learning. Constructivism tell us about how student can be engage by teachers in some meaningful construction of knowledge i.e., other than memorization or recall of facts. Thus, the motivating force behind this study was to explore to what extent, and whether the existing higher secondary teaching is based on a learner centered (constructivists) perspective. Therefore, it was aimed to study higher secondary science education instruction in Pakistan in the light of constructivism.

The objective of the study was to investigate instruction of higher secondary biology in Pakistan in light of constructivism.

Method

This was a descriptive-survey study. The researcher conducted surveys through a specially constructed questionnaire, which was made available to all the respondents. All the biology teachers and students of higher secondary institutions in Pakistan constituted the population of this research. Data was collected from teachers and students to know their perceptions about teaching-learning, using the questionnaire which contained questions that allow insight to the extent that teaching practices might be considered constructivist.

The sample

Two hundred teachers and one thousand students from one hundred institutions of five districts of the Punjab were selected as sample of the study. Keeping in view the total number of institutions, hundred higher secondary schools/ colleges were randomly selected from Rawalpindi, Lahore, Faisalabad, Multan and Bahawalpur. Twenty higher secondary level institutes were selected from each city.

Two teachers and ten students from each institute were selected randomly as a sample to administer the questionnaire. Sampling of higher secondary schools/colleges and sampling of teachers and students, was done by using the random sampling method

Data collection

The prime subject of this research study, were higher secondary biology teachers, and students. The instruments were delivered personally to the respondents. The filled responses were also collected through personal visits to the respective institutions, teachers and students mentioned in the sample of the study.

Data analysis

Data collected, with the help of research instruments, was tabulated. It was analyzed and interpreted in the light of the objectives of the study. Data has been analyzed and interpreted using chi square (as a contingency test), one of most widely used statistical test to compare two groups or variables. It has to be recognized that any survey conducted, shows what the respondents say. This either may or may not match reality exactly, because the experience of respondents may not reflect the actual situation. Nonetheless, the picture obtained will be useful as comparison of two groups is being presented, to show how the two groups actually see things. The study seeks to cover some aspects of existing higher secondary biology instruction from a perspective of constructivism.

Table 1: *Teachers begin the lesson to see prior knowledge of students*

S.#	Statements	Respondents	Max	Mod	Sum	Min	NAA	Total	χ^2 (df)
1	Start with their old ideas	Teachers	18	20	55	89	18	200	35.7(4)
		Students	64	276	274	288	98	1000	p < 0.001
2	Understand their old ideas	Teachers	16	22	59	81	22	200	25.0(4)
		Students	54	271	276	312	87	1000	p < 0.001

Table 1 indicates that the pattern of difference in both questions is slightly more complex. Students seem to be moderately sure that teachers help by starting with students previous ideas, and they are also more sure that teachers try to understand the students' ideas with help of their prior knowledge. Jarvinen (1998) states that a learner must be given opportunities by the teachers to use raw material to enquire about their own ideas, and to relate them with other ideas to improve understanding and knowledge and this provides them an opportunity to learn "how to learn"

Table 2: *Teachers act as a coach or guide*

S.#	Statements	Respondents	Max	Mod	Som	Min	NAA	Total	χ^2 (df)
1	To carry out a task	Teachers	22	43	51	62	22	200	16.0(4)
		Students	89	132	301	289	189	1000	p < 0.001
2	Offer hints and feedbacks when required	Teachers	24	29	53	69	25	200	11.7(4)
		Students	78	139	319	275	189	1000	p < 0.001

Table 2 gives the impression that biology students are more positive to consider that their teachers help them in carrying out a task. It also seems from the response of students, that teachers offer support to them, and give feedback when and where required during their studies, but, here they are less positive in comparison to the first statement. Wilson (1995) describes a class can be a constructivist where students may do learning activities by using variety of information resources and tools in groups supporting each other, in their pursuit of learning goals and problem-solving activities.

Table 3: *Teachers teach students to*

S.#	Statements	Respondents	Max	Mod	Som	Min	NAA	Total	χ^2 (df)
1	Relate ideas to each other	Teachers	11	24	69	71	25	200	23.2(3)
		Students	143	201	299	255	102	1000	p < 0.001
2	Think about real life problems	Teachers	13	16	72	73	26	200	42.8(4)
		Students	56	251	246	249	198	1000	p < 0.001
3	Share with others ideas	Teachers	19	25	61	66	29	200	11.1(4)
		Students	125	199	289	244	143	1000	p < 0.001
4	Find work in the class interesting	Teachers	21	23	63	74	19	200	28.3(4)
		Students	65	104	231	342	258	1000	p < 0.001
5	Make sense of ideas in Biology	Teachers	17	40	61	62	20	200	50.1(4)
		Students	70	103	187	342	298	1000	p < 0.001
6	Make up their own problems to investigate	Teachers	10	18	48	67	57	200	63.5(3)
		Students	79	289	287	215	130	1000	p < 0.001

The result from the above six statements suggest that students seem to agree more than teachers, that higher secondary biology teachers help students to relate ideas to each other regarding different concepts of biology, and students are more 'sure' that they start to think about those ideas resembling real life problems. Students share their ideas with other students. On the other hand, students find work in the class less interesting, and they find it comparatively difficult to make sense of ideas in Biology, or to make up their own problems being harder. Dougiamas (1998) says good teaching is not based on what students store by rote memorization but on the other hand it gives them chances to analyze, explore, collaborate, share, build and generate, based on what they know (Moar, 1999). It may be the simple characteristic of this type of instruction.

Table 4: *Teachers use as teaching strategy: Lecturing*

S.#	Statements	Respondents	Max	Mod	Som	Min	NAA	Total	χ^2 (df)
1.	Lecture method	Teachers	41	76	53	21	09	200	4.0(3) ^{NS}
		Students	265	374	241	77	43	1000	p < 0.001

Both the groups hold positive views. Teachers and students both tend to agree that lecturing/telling is mostly used in the instruction method by higher secondary biology teachers.

Findings

The study focuses around the higher secondary science instruction in the constructivists' perspective. The learners' interest and learning are central theme of constructivist instruction, and in contrast, to expository instruction which reflects memory is most important. Tobias and Duffy (2009) highlight that in science education, if question is which type of instruction... than answer may be the traditionalist or direct instruction, whereas Duschl and Duncan (2009), take the constructivist view, and say that teaching science is centrally about theory building, and learners also need to be able to engage in activities such as modeling, arguing and evaluating, in order to assess knowledge claims and restructure knowledge via conceptual change. Findings of the present study were:

- Constructing understanding occurs in the brain of learners, but teachers can assist in enabling more valid understanding to be constructed. Evidence from the present study shows that teachers who were aware of this were minimal.
- Teachers tended to lecture/use telling as instruction, and were purveyors of knowledge to be memorized and recalled later. Teachers, though do use different teaching strategies in addition, but this was minimal.
- There was little evidence of the teacher acting as a facilitator, guide or mentor to enhance learning, although teachers and students both seem to say, that higher secondary teachers take care of students previous knowledge, and use that prior knowledge to update their current learning.
- It was found that higher secondary biology students are more positive to consider that their teachers help them in carrying out different learning tasks. It also found from the responses of students and teachers, that teachers offer support to them and give feedback when and where required to a lesser extent.
- Both teachers and students suggest that the teaching does provide an opportunity to link student's prior knowledge to current learning, but to a limited extent; however this also helps students to interact with learning.
- Sadly, most teaching was lecturing using chalk and talk, although a wider range was sought by teachers and students. It is important to note that even those listening to a lecture are still constructing their own understanding. Teachers felt they were helping students by shaping, thinking, helping, modeling ideas and concepts, but there was little evidence to support this claim.

Conclusion

In the light of results discussed, the following conclusions were made. There are several key areas where changes need to be introduced:

1. The learner is the fundamental focus of any education system, and he/she must be given importance while formulating teaching strategies and learning material.

2. Constructivism enjoyed support for decades just because of search of educators for better teaching and learning (Perkins 1999). Traditional methods have a number of shortfalls in many areas e.g., students and understanding and rote learning across ages and grades (Gardner 1991). It was concluded that some elements of constructivism were present in different features of the teaching-learning process at higher secondary level in Pakistan, but their presence was found not to be realized clearly as the constructivist approach.
3. The higher secondary science education curriculum should be more student-centered, reflecting the needs of the learner.
4. Teachers need to be encouraged to widen the range of approaches they use in their teaching.
5. Teachers need more time, probably by reducing curriculum overload, so that they can address issues of conceptual understanding, and the wider range of skills that their students need.
6. Teachers need to be affirmed and supported by means of professional development through training, reading and research. Teachers need to be given the freedom to develop their teaching skills, and not circumscribed by overloaded curricula and rote-recall examination system, as well as having to use inappropriate textbooks.
7. Constructivism has been found to be a good description of learning, when learning is seen as understanding. There is now a need to examine information processing, with its powerful predictive insights, and see how it can guide future curriculum planning.

Recommendations

1. It was recommended that to make higher secondary biology instruction successful, and if constructivist instruction is used, incorporates direct instruction where appropriate, focus of which should be more on the learner and his/her learning needs. The teacher should adopt teaching strategies which make biology instruction as a facilitative learning environment.
2. In Pakistan there are overcrowded classes, and if they are taught by constructivist methods it can produce better results.

3. Working teachers and future researchers could follow this research to find out how guided instruction strategies or constructivist teaching methods can be used to enhance students constructive learning (both cognitive and personal) in educational institutions.

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