

Exploration of Constructive Learning through Science Curriculum at Primary Level

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Abstract

Constructivist education embodies the ideals of cognitive conflict and resolution through intervention. Science is the study of physical environment through observation and personal experience. Our national educational policies have many times reiterated the importance and promotion of the scientific and technological education. The aim of this research was to explore grade 5 science curriculum of private schools in Abbottabad and highlight constructive elements of impact, elicitation, intervention, reformulation, and reflection listed by Ross, Lakin and McKechnie (2010). The elements were searched in the four major components of the curriculum namely: objectives, contents, methodology and evaluation. The present research has been focused on exploring the extent to which the constructive skills are made part of the four major curriculum aspects (Tyler, 1949). The study was qualitative in nature and observed the lesson plans, textbook, project work and other school facilities through a checklist. The teachers and the primary school heads were interviewed to elaborate the methods and sources of learning at school. The data collected was then analyzed by Miles and Huberman (as cited in Creswell, 1994) Thematic Analysis technique. Data was displayed in tables after data reduction. To conclude, curriculum of the schools under study showed presence of constructive elements that the study outlined as variables. However, the levels to which both schools included these elements as a part of their curriculum varied from lesson to lesson. However, the study found the curriculum of both schools to be greatly close to the constructive methods of learning in all four aspects.

Keywords: Constructive Learning, Science curriculum, Primary level of education

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Introduction

It is a common observation that on achieving a certain age the toddlers start to demand to do things on their own. This is a natural way to learn to do things. A child would want to pour the glass of water on his own, or spread the butter on his own toast himself, even demand to do the things that the child might not be able to do at that time. The urge to practically perform to learn is in the child's nature. Loxley (2010) pointed in his book "Teaching Primary Science" that children devise their mechanisms to learn during their everyday experiences. They build ideas and opinions about their surroundings based on these everyday experiences.

Nature of the study of science embodies doubt, observation, experiment and then the conclusion. The ideas are generated and then tested and verified. The role of the teacher here is to present these scientific ideas to the student and allow them to test the ideas. The important elements of the classroom for learning are "clarity of expression": in sharing the scientific ideas; "order": necessary decorum to perform the experiment; "standards": to maintain effectiveness; "fairness": of conduct; "participation": of every child in the process; "support": wherever is needed; "interest": to keep the experiment going; "environment and safety". A classroom where these elements exist embodies the scientific method of learning and promotes constructivist learning (Ross, Lakin & McKechnie, 2010).

Experiential learning involves the students in the actual process and allows them to connect to the world around them and be truly educated. The student in this way carries out the experiment in the real environment and reaches the reasoning stage as the outcomes of the experiment. Thus, education cannot be separated from life as life itself is education.

Education has seen many trends; and theories keep emerging on how to teach and how not to teach. The factor that remains constant is the child who learns no matter what school of thought he is attending. The leap of human mind from accepting everything from God to making things happen for themselves was a phenomenal development. The choice to do things knowingly and the ability to make decision transformed the way we educate our kids. John Locke recognized the child as an eager ingénue who is ready to learn and discover knowledge (Thomas, 2013). The empiricist looked at the child as a clean slate who would experience the world through senses and learn by discovery and experiences. It is important for the educators to find out how the child learns because only then they can facilitate learning and give it a desired direction.

This study aims to seek and explore the Dewey's inspired constructive learning elements in the curriculums of private schools. The researcher studied two of the largest private schools namely Beaconhouse School System and The City School in Abbottabad. The schools were chosen because both follow Cambridge Curriculum and are ranked high among the private school setups. Moreover, they have wide presence throughout the country. The study explored the material, the methods, and current practices of the learning environment in these schools. What constitutes "Science Curriculum and how it is handled, who teaches it and what are the methodologies?" remained the focus of the study. The concept of Dewey of educating the "whole child" and preparing the child for life rather than getting certificates was the core thought behind this exploratory study. Whether the curriculum can be aptly called constructive in nature or is it derived from it.

Beaconhouse School System is a private school system mostly operating throughout Pakistan. The Beaconhouse Primary School Curriculum is modeled after the Scottish Curriculum and the UK National Curriculum and covers classes I to VIII. The international curriculum has been contextualized and adapted to local needs. (<https://www.beaconhouse.net/>)

The City School (TCS) is an independent Pakistani education company established in 1978. The City School has more than 160 school campuses in 49 cities across Pakistan. It is an English medium Secondary School. Its Primary School curriculum is derived from the UK's National Curriculum, while its secondary education is divided between the local Pakistani curriculum and the Cambridge regulated international General Certificate of Education (GCE) programs. The City School Curriculum and Methodology is designed taking special care of the primary student moving onto the elementary and secondary level and further entering the GCE examinations. The City School has integrated the digital media and ICT in their curriculum and are delivering online education efficiently with convenience. (<https://thecityschool.edu.pk/>)

Experiential and constructivist education embodies the ideals of cognitive conflict and resolution through intervention (Loxley et al., 2010). Science is the study of physical environment, gained through observation and personal experience. Our national educational policies have many a time reiterated the importance and promotion of the science and technological education. However, we still lag in imparting science learning in pure investigative and experiential spirit. Science evolved as a body of knowledge through experiment. The subject when taught in classrooms theoretically, following lecture method fails to do justice to the spirit of scientific method. The need to explore the extent to which the popular private schools of the country are teaching science in the true sense of scientific method lays at the base of this study. This exploratory

case study has identified the presence of the components of constructive learning method in the present science curriculum at primary level at private schools in Abbottabad, Pakistan. The data gathered in this study is likely to provide a good basis to promote the constructivist methods of science instruction for development of true scientific spirit of investigation and reflection in pupils at an early age. Many students do not opt science after high school, thus this constructive learning of integrated science curriculum equips the students with a good knowledge and understanding of the scientific phenomena around them (Halai, 2008).

Objectives of the Study

- a) To explore the constructive elements of learning in current primary science curriculum in private schools.
- b) To identify the characteristic constructivist components in the primary science curriculum in private schools.

Research Questions

1. Did the current primary science curriculum follow the constructive learning approach?
2. Was the current primary science curriculum composed of the constructive elements?
3. To what extent did the current primary science curriculum reflect the constructivist teaching strategies (in lesson plans)?
4. In what ways was the current science primary textbook designed on the constructive approach?

Conceptual Framework

	Variables/Indicators	Operational Definitions
Constructive Learning Elements	Impact	Starter activity, first information in reference to the lesson presented by the teacher
	Elicitation	Extracting prior knowledge of the students, by asking intelligent and directional questions
	Intervention	Presentation of the lesson by involving in active learning activities of the scientific topic to get lesson objectives
	Reformulation	Development of learning through interactive teaching methods and effective demonstration, group and whole class discussion
	Reflection	Plenaries to consolidate pupils' learning at the end of the lesson

(Ross, Lakin & McKechnie, 2010, pg. 57)

Review of Literature

A stand-up comedian Hassan18 posted on social media that teachers advise reading Shakespeare to become wise, however Shakespeare never read Shakespeare to become Shakespeare. The sender must be a constructivist at heart believing in the child's ability to construct their own knowledge. Constructivism stands on the foundation of experience, and hands on learning. Where the child undergoes firsthand experiences and makes discoveries instead of being told what a certain phenomenon is. Constructivism doesn't undermine the importance of the body of knowledge gathered through the ages, it only focuses on the child rediscovering the same facts for themselves through self-experiences. A constructivist instructor creates an environment where the learning is facilitated by involvement of the child (Loxley, et al., 2010).

Swiss Psychologist Jean Piaget (Pope, 2008) used his own children as subjects to perform natural experiments to determine the nature of learning in children. He concluded basing on his observations in intelligence testing that child thinks differently from an adult. Piaget noted that children pass through the following four stages of thinking:

- Sensor motor Stage: from birth to two years of age; child learns important concepts of "object permanence" through movement and senses.
- Preoperational Stage: from two years old to seven years old; egocentric child sees the world through his senses and cares less about how others see it.
- Concrete Operational Stage: from seven to eleven; child makes sense of concrete concepts like time, space, and quantity.
- Formal Operational Stage: from eleven upwards; here abstract and logical thought develops (Pope B.B, 2008).

Piagetian Theory of Cognitive Development brought understanding of how children think and enlightened educators towards learning – constructing their world of experiences as they go through (or do not go through) specific stages of development. This has come to be known as Constructivism due to its emphasis on children constructing individual worlds for themselves.

The child gathers knowledge from two major sources; first, the child acquires through interacting with the environment called "intuitive knowledge" (Dewey, 1938). Its foundation is self-experiences of the child. The second source is "formal instruction" disciplined knowledge gained

under the school authorities. This source of knowledge is directed by clearly defined goals.

In support of the constructivist ideology Blake and Pope (2008) write (in their article “Developmental Psychology: Incorporating Piaget’s and Vygotsky’s Theories in Classrooms”) that Jean Piaget, born in 1896 was a psychologist with biological orientation. He expressed that “cognitive structures which are basic, interconnected psychological systems enable people to process information by connecting it with prior knowledge and experience, finding patterns and relationships, identifying rules, and generating abstract principles relevant in different applications” (page. 59). This is the reflection of his belief in operative knowledge, which rests on the idea of knowledge constructed through change and transformation. Working in Alfred Binet’s laboratory he started taking interest in the errors made by children. He observed the possibility of these errors not completely occurring randomly. Piaget belonged to the “constructivism perspective that sees learning as construction” (Dahl, 1996).

Glanz (2010) writes in “Revisiting Dewey Best Practices for Educating the Whole Child Today” that Dewey proposed an education that focuses on the development of the whole child: “intellectually, morally, aesthetically, and socially”. Dewey saw intelligence as “the ability to solve real problems and based his curricula on experiential learning”. Dewey’s philosophy is a common cliché. Ask a teacher about it and the immediate response would be “Learning by doing”. Dewey has contributed by specifying effective ways of sequencing and arranging curriculum, selection of connected content, assessing students’ prior knowledge, and suggestions to create opportunities for students to undertake learning experiences and devised methods development of intelligence.

In *Democracy and Education* (Dewey, 1916), Dewey emphasized that students are not “empty vessels” and educators cannot fill them with scraps of knowledge, opposing to this view students construct knowledge by making use of their individual abilities by connecting the world of reality, environment and their ideas. His idea of the growth of the whole child encompasses vital subjects of sciences, social studies, fine arts and playtime. He stated that subject matter is conceived and transmitted to the posterity through social interaction thus learning is social in nature. Further, he asserted “curriculum should be selected based on promoting growth and improving present conditions for the greatest numbers of human beings, not just as a justification for preserving traditional power centers.”

John Dewey is regarded as important precursor for social constructivism by many theorists. He gave the foundations of educational

perspective in constructivism. Kersten Reich (2007) sees Jean Piaget as the precursor of constructive psychology. Vygotsky has also been influential in English-speaking communities. His significance has been elaborated by Jerome Bruner, who had been a beacon for constructive oriented teaching and learning theorists. These hold important place in today's constructive discussions. Experience bearing strong connotations of activity is the basis of pragmatic concept in Dewey's constructivism. Learning by experience and interactions enable learners to use the process again in the future actions. Dewey according to Reich (2007) set a vivid criterion as the basis of constructivist learning and teaching.

Learning by Doing: education begins with doing something; it provides necessary training of sense perception, memory, imagination, and judgment.

Context: learning occurs within a context, through interactions in an environment. Interactions take place between "learners and other learners, between learners and teachers, between learners and subject matter". (Reich, 2007, p.12)

Democracy in Education: it entails freedom and participation. Learning environment must provide opportunities to every individual to inquire interpret and make judgments. It can be established by extensive participation.

Interaction: communication within a supportive community must promote chances to interact specially for the less privileged in the teaching and learning environment. The communication does not entail merely the subject matter but also the living environment and cultural context of learning. Dewey saw a clear relationship between action and participation. Action alone is not enough; it must be followed by reflection essentially. There is a special place of imagination in the entire process of learning experience. (Reich, 2007, p.22)

Constructivism thus makes sense of how the accumulation and assimilation of information results in construction of knowledge through experience, unlike traditionalists, who merely focus on accumulation of knowledge.

Dewey (1916) in "Democracy and Education" promulgated the idea that democracy is not reserved as an ideology of politics only, but it is rather, "a mode of associated living, a conjoint communicated experience" (Dewey, p.101). Dewey saw school as the site to foster society on the high principles of equality and freedom, where people intermingle irrespective of their background or ability. Learners were not passive receivers, instead they were self-reliant, critical thinkers who can act and modify according to newly posed social conditions.

In *Experience and Education* (Dewey, 1938) stated that teachers through their instruction must provide individuality of experience to each pupil. “Inquiry-based learning” has firm grounds in constructive way of learning and teaching. The basic ingredients are discussion on prior knowledge of the student, elaboration on prior knowledge, reconstruction of new knowledge, relating the knowledge to context and stimulation of curiosity related to knowledge presented.

Reflection is regarded as a means of development of intelligence by Dewey, thinking allows learners to practice self-control of impulses. Metacognition provides the students with awareness and ability to reflect on the learning and improve performance in the process by highlighting their weaknesses and strengths.

Methodology

The research was a descriptive case study. A case study research method is suitable when the researcher wishes to explore the current trends and practices or an explanatory question. It is the appropriate choice to explore teaching and learning process remaining within the parameters of the curriculum. Following is an example of a study that used the case study research approach.

Mills (1988) asked, how do central office personnel, principals, and teachers manage and cope with multiple innovations? and studied educational change in one American school district. Mills described and analyzed how change functioned and what functions it served in this district. The function of change was viewed from the perspectives of central office personnel (e.g., superintendent, director of research and evaluation, program coordinators), principals, and teachers as they coped with and managed multiple innovations, including the introduction of kindergartens to elementary schools, the continuation of a program for at-risk students, and the use of the California Achievement Test (CAT) scores to drive school improvement efforts. Mills used qualitative data collection techniques including participant observation, interviewing, written sources of data, and non-written sources of data. The study in the same pattern followed the analysis of the textbook and lesson plans (written data) and interviewing (science teachers and coordinators) in one city of Abbottabad for constructive elements in private Cambridge school system grade 5 curriculum. The research presents a descriptive account of the margins drawn in the curriculum around the theoretical and practical aspects of learning in science at primary level. (Gay, Mills, & Airasian, p. 445).

Through a guided five step process of the constructive teaching method adapted from Ross, Lakin and McKechnie (2010 p.57), the lesson plans and the textbook were analyzed to determine the probability of using hands on teaching methods remaining within the framework of syllabus compliance and timelines. The study explored how far this method is included in the lessons and to what extent the inclusion of constructive method is guided by the textbook.

Delimitations

The study was based on the science curriculum of grade 5 of private schools in Abbottabad.

- The study was focused on the textbook for the analysis purposes.
- The study was particularistic and conceptual and cannot be generalized to the populations other than the private schools' curriculum or others using the same textbook to some extent.

Data Sources

The research intended to explore the science curriculum at primary level, the textbook and other educational materials used in the classroom by the teachers and students. Data Sources of the study constitute:

- Science grade 5 Textbooks
- Science Grade 5 Workbooks
- Science Grade 5 Worksheets
- Lesson plans prepared by the science teachers of Grade 5

Participants of the Study

The Science Subject teachers at Primary level and the Heads of Primary School were interviewed for the study.

- 2 Science teachers of Grade 5
- 2 Heads of School Primary level

As per the research design of the study two units (bounded system/private schools in Abbottabad) were selected. Participants were purposefully selected and were four in number; fewer as compared to quantitative studies. The researcher took the liberty of hand picking of The City School and the Beaconhouse School System for the study, as both the schools have placed themselves as the only few of schools that have implemented the concept of Project Learning in the true sense of the word "experiential learning". Moreover, both the schools are nationally renowned for their curriculum and are high ranked among academicians. The schools are not

specific to any one city but have presence in many cities in the country Gay, Mills, and Airasian, (2012) suggests that criterion sampling techniques are suitable for the qualitative research to achieve specific study objectives, which served as the guide to the researcher in determining sampling style and size. The schools have presence in almost all the big and small cities of the country unlike a few other private schools that have presence in merely one or a couple more cities. The researcher relied on the written and verbal accounts gathered by the participants along with other resources of data collection.

There is one primary school branch in Abbottabad, of Beaconhouse School and The City School. The following participants were selected:

- 2 Science teachers of grade 5
- Science textbook of grade 5
- 5 Science Lesson plans of grade 5
- 2 Heads of Primary Schools

Gay, Mills, and Airasian (2012) remarked that no hard and fast rules apply to the selection of correct number of participants in a qualitative study. The First indicator, where the selected participants represent the population in general and second indicator when the information gathered from participants appear redundant due to repetition of the same answers from varied participants the number is accepted as sufficient. Since the school teachers teaching the same science textbook, following the same lesson plans, and applying the same methods – provided sufficient responses to answer the research questions. The patterns observed were repetitive and reinforced the same findings.

Development of Research Instrument

Semi Structured Interview

The study included individual, person-to-person interaction. To get a clear picture of the curriculum the researcher gathered the data directly from the participants. The more the time spent with the participants the better the understanding of the currently practiced curriculum developed based upon the interaction of the participants. Stake (2010), states that the qualitative researcher works without imposing an organizing structure and does not make assumptions about the findings while collecting the evidence. The focus of the qualitative researcher is on flexibility of the research design to gather as detailed data as possible in the given setting.

Interview Module

The research required to look into the private schools and their curriculum. The systems and how they have been managing their science classes, their science teachers and how do they understand their curriculum and its needs to be implemented in true spirit.

The interview module was designed in three contextual divisions: first part focused on ice breaking and familiarization with the management. Their constructive ideology and the aspects that are appreciated in the system were explored. Their appreciation for the project work and how they perceive the projects must be designed and performed in the classroom. The researcher also intended to find out whether the science teachers were inducted based on being trained and professionally qualified as a teacher or the school believes in the hiring the teachers and training them according to their methodologies and curriculum needs. The second part of the interview focused on the specific information about the science lessons and classes particulars, how many minutes per class, how many classes per week, how many lessons in laboratory, whether demonstration for every concept or just a few selected ones, and how does the school handle the time constraint. The third part of the interview gathered information on assessment schedules and techniques adopted by the teachers and the school. The interview also questioned about the schools' policy and the teachers' methods of handling inquisitive nature of the child. Researcher asked the teachers of their preferred constructive elements that they find useful in the classroom and are often utilized by them in the classroom. It also inquired about the constructive design of the textbook and how far the teacher does know and uses it in the learning of the child.

In the end the researcher asked for suggestions and inquired if there is anything which can help the study explore the constructive nature of the curriculum and has not been asked by the researcher. The interviews were taken from the heads of schools, science teachers and were administered before the checklists.

Checklist

The following areas were included in the checklist to determine the presence of constructivist components in the textbook of science at primary level:

Impact: the textbook and teacher preparedness were noted in the first part of the checklist. How the lesson was planned and aided by the supportive material. How interest and curiosity were generated and

whether prior knowledge and new information conflict occurs at the onset of the lesson.

Elicitation: the second part of the checklist moves further into the lesson plan and checks child involvement in the lesson. How much time and materials are used here at this stage of the lesson. Do the teachers gather all possible responses of the students and allow the students to share opinions among each other?

Intervention: the third part of the checklist observes the area where the new idea is introduced by the teacher, how it is brought to the students, does the teacher rely on mere verbal description or listening, reading, watching, and performing is also adopted at this stage of the lesson.

Reformulation: Now that prior knowledge is gathered, and new idea also presented how the teacher does formulate the new idea in the place of their prior beliefs. This cognitive shift requires time and evidence and it also require to be immediately assessed whether the students have moved ahead in their knowledge, or they still aren't convinced that the new idea is close to the fact or not. Are there any demonstrations or practical performances included? Does the lesson relate the concept to the everyday life?

Reflection: this is the last part of the checklist that gathers data on the last part of the lesson. The recapitulation and how it is done, the tools used for the purpose and parallels from everyday life highlighted.

The checklists were filled by the teachers. The lesson plans, textbook and syllabus breakdown were consulted at the time of filling the checklist. (Appendix II)

Validity of Data

The data was gathered through interview as well as guided observation of the text. The teachers, and the section heads were interviewed to ensure the validity of data collected through inclusion of multiplicity of sources as advised by Creswell (2012). Thus, to acquire valid and reliable data multiple methods and sources of gathering data were adopted. The Lesson Plans, the Teaching Guide, the Worksheets of the students, the Notebooks were observed for over ensuring that the sources correlate in the data.

Experts' opinions were gathered to validate the interview module as well as the checklists before administering them to the participants.

Data Analysis

The four basic components of Curriculum by Ralph Tyler (1949) namely Objectives, Contents, Methodology, and the Evaluation were studied under two research questions of exploring and identifying constructive

components. The conversations with the Heads of the schools were detailed and elaborated the school philosophy of teaching and learning environment. The special features of the curriculum and common practices were highlighted.

Variables

Ross, Lakin and McKechnie (2010) wrote in their book “Teaching Secondary Science: Constructing Meaning and Developing Understanding” on the values of hands-on practical experiences as a method of instruction in classroom and how these help students make sense of the environment. The authors presented the following five aspects of constructive approach and method of instruction. This study focused on these five variables and built a relationship among these and four basic elements of the curriculum.

- Impact: material (textbook lesson presented to the child)
- Elicitation: background ideas (time given to the assessment of prior knowledge of the child on the same topic in the lesson plan)
- Intervention: new ideas/ skills presented (the new topic/ concept presented through book and lesson plan)
- Demonstration: or practical performance used to come to this reformulation in the lesson plan and textbook).
- Reflection: ideas/ skills used and applied (practical and project work done on each topic and every child)

It was an exploratory conversation with the heads of the primary school sections of both the Beaconhouse School System and The City School. The conversation began with general discussion on Constructive Elements of Educational Paradigm. The questions were open ended and were framed to collect relevant data without leading the responses in any direction.

There is no doubt that both the schools were practicing the constructive methods of teaching and learning, however; the word constructivism came as a surprise to them. Brainstorming as a tool to stimulate curiosity and challenge the child’s current schema was appreciated by The City School teacher. The Beaconhouse School Head appreciated the aspect of extracting prior knowledge to have a clear picture of where the child stands to take the lesson further. Brainstorming was appreciated at both the schools and was a commonly used tool for formative assessment as well as directional brainstorming to lead the pupils towards the new concept planned in the lesson.

Personal Constructive Ideology

To Beaconhouse School System Head was “reliability of a lesson to child’s personal experience” she further elaborated it by giving example that if the teacher has to teach solar system, she must begin with the sun that the child can see every day and the planet earth where they live. The City School Teacher also expressed a similar opinion on posing challenging question from the student’s daily life experience. Reflection on the questions was taken in the light of the student’s prior knowledge and reformulation of the new idea replacing the prior one through experience and knowledge. The City School Head mentioned that they have adopted the Inverted Bloom’s Taxonomy approach where they encourage and instill the higher order thinking skills of analyzing, evaluating, and creating in students and focus more on these in comparison to the lower order thinking skills to remember understanding and apply. Another very interesting fact was mentioned by The City School Head that they train their teachers to raise “intelligent questions”. This not only serves as a form of day-to-day assessment of the child’s learning but also instigates research mindedness in the students and lays foundations of curiosity and generates ideas for project works.

Project Work

At Beaconhouse School System the frequency of major projects is once each term, and every chapter may have at least one small project or more depending upon the topic and needs of the students.

Clubs and Societies:

The Beaconhouse School System has special clubs and societies that are responsible of various curricular and co-curricular activities. These activities are fun based and are related to everyday life. Examples of the activities done by the students in these clubs are making of slime, party poppers, water dispenser, table fans, and candles.

The City Schools gets projects done twice a year for every subject. And as far as experiential learning is concerned the students make one investigation for each topic.

Trainings

The researcher found out that both the schools conduct regular training workshops to train their teachers. These workshops are conducted by their respective education departments and are specially designed to keep their

relevant curricula in mind. The City Schools offers School Based Initial Training upon induction of new teachers whether trained or untrained previously. There is another course PGCC- Post Graduate Certificate Course. The courses are related to planning class, time management and curriculum execution. When a new teacher is inducted, she receives SBITT – School Based Initial Teacher Training. Both trainings are related to planning, class management and curriculum executions.

At Beaconhouse School System, it is one of the core duties of the head of the school to train the teachers; moreover, they also have subject specific trainings for the teachers as well as a dedicated internal training department at regional office that operates the school group. Curriculum Coordinators, Regional officers and the school group has a certain number of schools under them, where they go to train teachers according to subject specific needs of the campuses.

Lesson Plan

Third part of the interview focused on the lesson plan structure and its evaluation. The evaluation was aimed at pointing the constructive elements present in the lesson plans. Ross, Lakin and McKechnie (2010) have made a list of seven vital elements that must constitute a lesson plan to make it constructive in learning settings.

Fundamental Skills for Constructive Learning

Ross, Lakin and McKechnie listed these eight skills that as fundamental to constructive learning: Enquiry, information processing, problem solving, creative thinking, critical thinking, evaluation skills, Meta cognition and assessment. Students building their own ideas or constructing ideas about the world around them, is the founding principle of the constructivist approach.

Enquiry – Assessment of previous knowledge

No matter how new a concept is, there is a probability that the child might have some previously conceived ideas and opinions related to it. A good lesson plan begins with eliciting this information from the students to check whether the child has any previous knowledge of the concept.

Now the previous knowledge and the new ideas presented in the lesson and experienced in the environment have created a problem in the child's mind. It raises doubts and calls for clarity in favor of the new idea against the previous knowledge. The lesson plan must allow the child time and aid wherever possible with supporting evidence towards problem solving. The

child must move from the first ideas about the phenomenon towards the newly presented scientific facts.

Creative Thinking

Science learning and teaching is a continuous process of exploring how ideas develop and how the students understand it. They may be doing verbally or experientially – this depends on the lesson plan. A good plan has to indicate the misconceptions held by the students and supporting pupils in developing their understanding of what actually is.

Reasoning/Critical Thinking

The lesson presents an idea that may conform to or challenge the child's previous knowledge on the same topic. A constructive lesson plan must allow the child to think over it, challenge the previous knowledge with the new ideas presented and experience the truth – thus formulate the new idea based on experience and critical thinking. The constructive lesson plan gives margins to students to critically process the information at hand.

Evaluation Skill

The lesson plan exposes the child to information, helps him understand it and then provides time to think and evaluate through reasoning and critical thinking over the idea presented. This is a mature thinking process where experiencing the idea in controlled setting helps the student develop the skill for life.

Metacognition (Thinking about thinking)

The constructive lesson plan doesn't end at evaluation. When the child has reached a conclusion through critical analysis; the constructivist ideology provides them with processing ideas for the aspects like application of the concept in everyday life and how it can be improved. Thus, thinking (metacognition) is the key to constructive lesson plan.

Assessment

Constructive learning involves an ongoing self-assessment as well as formative and summative assessments done by the teachers in the classroom and at the end of the year as well.

Lesson Specifications

The Beaconhouse School System was found to have a special six-day cycle for a lesson. There are 5 working days in a week, starting from Monday till Friday – however each lesson has an additional sixth day to

conclude the lesson or any other activity related to it. The Science teacher mentioned in the interview that the kids are aware of these 6 days cycle and lessons are planned accordingly. This 6-day timetable gives them time for any lesson. One class span for forty minutes. And there is a club period (two periods of 40 minutes joined to make one period of 80 minutes) in one cycle.

The Beaconhouse School System lesson plan has distributed the lesson time as follows: a 5-minute intro is followed by 10 minutes of reading and explanation, 5 minutes are given to demonstration (if needed) peer learning through group work/discussion is also given 5 minutes, homework assignment is discussed in next 5 minutes before the last 5 minutes for recap. Starting from AFL till the recapitulation of the lesson it is a very child centered process involving activities and practical work.

The City School has dedicated a single period of 35 minutes for primary section science class a week. Four of these classes are taken in the classroom and a day is reserved for experiential learning in the Laboratory.

Laboratory

The Beaconhouse teacher informed that they do not have separate room specifically used as science lab, however; there are Science Kits that are issued to the schools along with the curriculum to fulfill the needs of lessons. Thus, the lab in Beaconhouse School is used when the topics are related to practical work. For example, once they put a section of a stem under the digital microscope and showed the image on a large screen to the students to make the experience interesting.

The City School takes its students to the lab once every week. The day is reserved for “Practical learning” or as they call it “Action Plan”. The teacher provides the materials to all the students and gives them a guideline of the task they are to perform. The students perform the experiment note down their finding on sheets and further a “Discussion” is held on the various findings report created by each student. It is the conclusive part of the lesson where multiple findings are discussed among the students.

Child Involvement

The Beaconhouse School System has child’s safety concerns as the highest priority, the teacher guides the students on Dos and Don’ts of the material. For instance, when the students learnt about Magnets the teacher guided them on not taking them close to the television to avoid damage to the screen. Thus, the precautions are taught before the child is allowed to participate in the practical demonstrations. The Primary School Head

mentioned that chemicals and acids for instance are dangerous and are used with caution under teachers' supervision. It was also mentioned that students are also taken "Out in the Field" to relate the lesson to their everyday life. The City School Curriculum demands the child to be involved, the teachers are mere facilitators who let the kids lead the course of their learning. The lesson begins with questions and teacher discusses all probable answers to the question. The Science teacher claims to have never provided a ready-made answer to the child. A query sets an array of related questions leading them to find out the answer.

Assessment

AFL – Assessment for Learning; term used at The Beaconhouse School System has an elaborated strategy attached to it. The teachers have given their student a three colour strategy as in traffic lights. Green means the students have understood. Yellow means they understood a bit and a bit remained unclear and red means they didn't understand it and it needs to be taught again. The kids actually reflect what they have learnt by showing the relevant colour in accordance with their learning of each concept. Thus, a formative assessment is a continuous task at Beaconhouse School System.

The curriculum has an Assessment schedule – a system of day-to-day Assessment which is immediate. A term "CAT: Common Assessment Task" is assigned for the purpose which means a test type of assessment at the end of every unit.

Annual Exams begin from grades IV and V that fall at the end of the academic year at Beaconhouse School System. At The City School, they have two terms for assessments. AFL – Assessment for Learning as followed by the Beaconhouse School as well which is immediate and formative in nature. AOL – Assessment of Learning includes class tests, weekly quizzes, monthly assessments, and Mid & Final Term Examinations.

Homework Assignment

The Beaconhouse School System uses the homework as a tool to assess what the child has understood of the lesson. Homework is based on what is taught in the classroom. The child is required to manage the homework independently.

The City School Science Teacher mentioned that she spares 3-4 minutes for reflection and advises them to think over it at home and

provide the answers in next class/ next day. The homework is given thrice a week, task is pre-discussed in the class. It varies from teacher to teacher, how they manipulate their class time for formative assessment and what remedial measures they adopt to ensure the learning of all the students based on the results of their regular formative assessments done in the classrooms.

The Interview concluded with the question about the constructive elements the teachers have found in their textbooks. The BSS Science Textbook has a heading “What you have learnt” at the end of the chapter. The heading summarizes the main points of the lesson and concepts in the chapter. The teacher is guided to follow the curriculum not the textbook because there are attainment targets different from the book because they make the teacher discover and search for material other than the textbook. It expands the subject area and includes the latest research of the recent times. Thus, the textbook serves as a resource book and curriculum expands it beyond the book.

The City School has a software “Exploring Science” that is part of the curriculum of grade V. The software includes activities related to the topics in the textbook. The software is designed to facilitate activity-based learning. The child independently handles all the queries and responds with the findings and observations learnt.

The Beaconhouse School System Textbook

Textbook is the guide that the student keeps referring to during study. Wherever the child faces confusion, textbook provides the required facts to fill in the missing information. Ideally speaking the textbook alone should be explanatory enough for the understanding of the concepts with images and examples. However, it is used as a resource to support the lessons taught at school. It also serves as a starting point for further research on the mentioned topics.

The Beaconhouse School System composes its curriculum internally and the books are not available at the shops for sale over the counter. The study pack is issued to the students by the school at their addresses assigned by the parents at the time of admission. For grade V Science curriculum there is a textbook which contains information on the topics, supportive illustrations, activities that can be immediately done individually by the students then in there during the lesson. The lesson plan can lead the discussion by collecting different experiences and bringing the discussion to the conclusion that is experimented in the next pages under the segment “Try it Out!” the students practice the phenomena

and experience the static charges. Further the under the heading “Uses of static electricity” its beneficial nature is introduced, and picture of real-time examples are shown.

“What you have learnt” summarizes the entire content of the chapter in bullets and gives the students pithy material for assignment and assessment purposes.

“Using and Saving Electricity”: Once the concept is clear and the students have understood the phenomenon and have experienced it through practical as well. The chapter then describes its uses in everyday life. The uses of electricity and how it is produced and how it has made our daily life comfortable and made things for us.

“Try it out” gives a checklist for the students to review their general practices towards saving the electricity. These are the prominent heading and the components that make the whole chapter in the textbook.

The BSS Science Workbook

There is a Workbook along with the Science textbook in the syllabus, for the reporting of the practical work and its findings. All the chapters are numbered and titled exactly the same way as they appear in the textbook. The only difference is that this is entirely for the experiential learning purposes. The activities here are in context with the information shared in the textbook. The first activity gathers previous experience knowledge. It is related to the fact shared in the introduction part of the chapter: Electricity. Thus, establishing the fact that one can experience static charge in everyday life when the weather is dry. Once the fact has been established in the minds of the students the lesson than inquiries about the reason that could cause the phenomena.

The Textbook and Workbook are supported by the Notebook work where the students are given contextual questions and are required to write answers. The notebook comprises of the subjective notes based on information provided during the explanation in the class lesson and the textbook material.

Beaconhouse Science Worksheets

The Worksheets are also part of the Science Curriculum and a serve the purpose of reinforcement of the previously taught lesson. These require the observations reporting and recalling the information learnt in the textbook and practiced in the workbook. Worksheets stimulate curiosity and interest in the students, and they recall the learning in order to fill the

required field on info. These are generally in objective format. These may be used as quiz or class test for Evaluation of learning done.

The City School Textbook

Exploring Science 5 by Penny Johnson and Mark Levesley; material written by Alan Edminston—Textbook is published by Edinburgh Gate, Harlow Essex for Primary School and is adopted by The City School for Grade V. The book comes with a guide to use: “How the Course works”, “For the teacher – in detail”, “For the pupil – in detail”,

The content in the unit is divided into three main categories of must know, should know, and could know. However, the students cannot tell the difference but the teachers through the teaching guides. Should know is the content that most of the class will learn in the lesson, must know is a good starter for weak students and could know are for more able students. The textbook is composed taking into consideration a mixed ability classroom. There is something for every child in every chapter to learn from and carry forward.

The fact file is part of every unit which tells the students about the contributions of the scientists in the relevant field of the topic in history. How science developed through ages and what contributions have been made by the scientists. At times timelines of the important inventions are also given in this section.

There are numbered questions in each unit and as the unit progresses further the questions increase in the difficulty level. There are boxes that present interesting fact from everyday life related to the topic. The headings/ titles are followed by the topic questions; these questions serve as a stimulant for class discussions on the topics.

There is a “glossary” at the back of the book which provides the meanings and pronunciation of the word. Almost every unit has an investigating page which has concept cartoon which can be used for class discussion or enactment of the concept. Along with these there are quizzes in “Quick Quiz” sheets, “Summary Sheets” help the students in quick recap of vital information shared in the unit. There is “End of Unit Tests” for the Assessment of Learning.

The book is very interactive and makes use of multiple skills and capabilities of the students in each lesson. The images the information boxes the content divided into three levels of difficulty, all contribute to the child’s interest and involvement in the lesson. The glossary builds the vocabulary, and the summary sheets provide consolidated information for the preparation of the quiz or assessment: “End of unit test”. The students

can independently handle the textbook as a resource of information and with teacher's input the learning outcomes are made achievable.

The BSS Sample Lesson Plans

The Lesson plan followed these main headings and developed the lesson under them. Day, date, and topic are the basic information. Learning Outcomes are followed by the strategies/methods. The methods are further divided into "Introduction, Development, and Homework (H.W) assignment". The entire lesson has been assigned time slots for each activity. The lesson plan also notes the resources required for the lesson. And Assessment of the learning done is the last part of the lesson plan.

TCS – Teaching Guide of Lesson Plans

The Teaching Guide is called "Copy Master" at TCS. It guides the teacher on how to use the material provided in the textbook. The main features of the teaching guide listed under the heading of "How the course works" are as follows:

- Expectations and Where the Unit Fits in tells us about the teaching objectives in detail.
- Resources have specific notes on individual practical and activities.
- Learning Outcomes are given for each topic.
- Key Vocabulary gives words and their definitions.
- Possible Teaching Activities covered in topic notes and teacher demonstrations.
- Points to note safety notes or extension ideas and student Worksheets are referred in this area.

How Course Works

It gives the overview of the textbook and helps the teacher understand what the authors intended to achieve from the textbook. Each technical aspect is explained and the details of the sections of the book are mentioned here in this segment.

The Book is accompanied by a CD for interactive learning. The CD contains the activities and Audio-Visual aids on the topics. It integrates the ICT learning along with the pure scientific topics like "Gases around Us" or "Investigating Sounds". This integration is a prominent feature of TCS Science Curriculum.

For The Pupil this section provides guidelines to the teacher to help the students better understand the textbook and maximize the learning outcomes. The textbook segments like “Must know” and “You Should Know” box. This indicates the learning that the students must have done during the study of that lesson.

Some of the Techniques mentioned in the Teaching Guide are as follows:

“Plus, Minus and Interesting” (PMI): students generate a plus, minus or an interesting remark on a provided statement by the teacher. There are no right or wrong answers in this activity. It is for ice breaking and encouraging student to participate in the activity.

“Consider All Possibilities” (CAP): students are given a problem that has several solutions and are encouraged to discover all probable options.

“Odd One Out”: the students are required to choose the odd option among the presented solution for a situation. It helps the Meta cognition and critical thinking skill development in the students.

“Know, Want to Know, learned” (KWL): before the actual lesson begins, the students may list the things they know about the phenomena under study, and the areas that they would like to know about the topic and after the learning session the students write what they have learnt from the lesson. This is high order thinking skill and develops critical thinking among the students.

“Concept Maps” are also called Mind Maps, are good for showing the inter-relation of the topic learnt. The students read the text and may fill in the missing information during the activity. Students may even construct their own mind maps and for less able students the boxes with some of the links already provided may help them complete the information.

“Visual Auditory Kinaesthetic” (VAKi): Students learn by seeing, hearing, and doing, thus multi sensorial learning is the best. Diagrammatical or image of the concept accompanied by the Audio-Visual Aid maximizes the learning of the students.

TCS – Sample Lesson Plan:

Learning Objectives are listed in measurable and identifiable terms with clear description of the learning area the students are supposed to acquire. The objectives are so exhaustively listed that it is very easy for the teacher to plan her lesson towards achieving the learning outcomes.

Skills Development Opportunities:

By integrating learning experience into science curriculum TCS Science lesson plans very elaborately list the skills in the lesson plans under the headings of investigative skills, literacy skills, numeracy skills, ICT skills and thinking skills. The skills listed are then attached to the activities with the page numbers on the Pupils Book (Textbook).

Teaching ideas and notes:

Teaching ideas and notes are also provided in the Copy Master Guide, the starter activities for brainstorming or extracting previous knowledge of the student, the learning activities, the misconceptions of the students about the current topic, Homework Assignment and Plenary (reflection/metacognition) are also listed. The details are provided leaving little effort for the teachers in planning but more in implementing in entirety.

Practical Work:

Practical work related to the topic is also included in the box at the end of the lesson plan. The experiments are given to apply the knowledge gathered in the lesson giving the students the opportunity to implement and practice the skills learnt in the lesson. The queries raised during the lesson for discussion or during the practical work are answered at the end of the lesson enabling the teacher to confirm their answers for their accuracy and confidence to deliver correct knowledge. The lesson plan end with suggestions for future endeavors on the same topic. The chapter is divided in smaller units for the ease of planning and implementing them in the assigned period time. Multiple methods and techniques are suggested to suit the mixed ability student group.

Checklist Analysis

The Checklist was used to check the frequency of the occurrence of various methods in lesson plans. The checklist themes based on the five variables of Impact, elicitation, intervention, reformulation, and reflection (Ross, Lakin and McKechnie, 2010). The Science teachers were given the checklists and filled the data as they perceived the elements were present in their curriculum. The teachers found all the aspects mentioned in the checklist prominently present in their curriculum.

Results/ Findings

The task of the research was to explore the presence of constructive elements in the primary Science curriculum taught at private schools. The data was gathered from the four aspects Objectives, Content/Material, Methodology and Evaluation - that comprise the curriculum. The case study of the private schools discovered that both the schools are following the same methods and achieving their academic objectives, the textbook and other teaching material is carefully selected to prepare the students for the times they live in.

The Four Cs of education namely: Communication, Collaboration, Critical thinking, and Creativity (Taddei, 2015) are followed in lesson plans and the students are groomed and trained to respond to the questions and situations simulated in the classroom for learning. The student-centered approach dominates the classroom, where teacher designs her lesson plans to engage the students in practical work. The curriculum is not only constructive in nature but also many latest trends in education are also adopted. The teachers are regularly trained to meet the demands of the curriculum teaching requirements.

Discussion

It was observed during the data collection that both the private schools have developed their curriculum by combining the various sources. The Textbook is perceived as an aid to learning. Students focus on it for learning the information by heart for the Summative Assessments. Self-Assessment is never ending component of the both the curriculums; BSS Lesson Plan shows Know, Want to Know and I've Learnt table which takes the students on a journey where they reflect on the lessons learnt and observations made and what further areas they can further discover in the course of their education.

TCS lesson plan is a perfect for mixed ability groups, as it segregates the learning points under Must Know: for weak students; Should Know: for majority of students in the class and Could Know: for more able students. It is one lesson plan that fits all in the controlled learning environment created by the Constructivist Instructor to achieve learning outcomes set by the curriculum. Textbook for them serves as a platform that brings together prior learning of the child and new information that is to be taught. Workbooks provides kids plans for small experiments that they can either perform or observe either in lab or on multimedia for experiential learning. Notebooks serves as tools for Formative and

Summative Assessments. Notes taken by students also help them in reflection and learning. Project work is their hands on learning tool that brings the ideas to life and makes learning interesting and practical to the children. Worksheets are utilized for recording of observations. It gives a quick recall to the information collected for reference purposes and serves to reflect on it once the child has performed the practical work and recorded the findings

The most interesting fact that was observed during the study was that there is no information that is not related to Everyday life. All learning begins from the observations taken from day-to-day life of students and these further lead to associations with ideas and concepts in the textbook and further elaborated to increase the learning experience of the child.

The researcher found the methods and content very constructivist in nature and the teachers' awareness of the implementation of these methods was also perceived to be satisfactory.

Conclusion

The research was based on the exploration of progressive nature of constructive elements in the science curriculum of grade 5 at eminent private schools. The importance of constructive methods of instruction for science curriculum cannot be over emphasized. The nature of science as a subject and the foundation of scientific method are the teaching fundamentals of constructive approach. It was explored that private schools under study were successfully implementing the constructive methods. The research questions were answered in affirmative; yes, the curriculum follows the constructive approach, and displays constructive elements. The lesson plan and textbook reflect the constructive approach as well. However, this must be remembered that some aspects are found more in one lesson and other aspect more in other lesson. The aspects vary according to suit the topic needs and requirements. This again is very progressive method of adopting the constructive approach.

The exploratory study revealed that the science deserves to be taught through challenging the misconceptions, experiencing the phenomena, replicating by changing the situations and evaluating through rediscovery. The Constructive design aptly teaches the science and serves the demands of the nature of the subject.

Recommendations

The exploratory study has revealed aspects of the curriculum that were known to the specific schools and were not shared openly. However, the study now can be furthered by quantifying the constructivist elements in effort to promote their usefulness in instruction.

The study may also be replicated on public school science curriculum to find out the extent to which their curriculum has absorbed and adopted the constructive elements of instruction.

The study has explored how science is taught at Beaconhouse School System and The City School. The presence and extent of their presence has been explored and it is recommended that the students be given sufficient time for Reflection after the lesson to make the lessons more constructive experiences.

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