CHAPTER-I

INTRODUCTION

1.0.0 INTRODUCTION

Research about the constructive nature of students' learning processes, about students' mental models, and students' misconceptions have important implications for teachers who wish to model scientific reasoning in an effective fashion for their students. First part of this paper concentrates on a critical review of the three most influential learning theories and constructivist view of learning and discusses the foundation upon which the constructivist theory of learning has been rooted. It seeks an answer to the question of "What are some guiding principles of constructivist thinking that we must keep in mind when we consider our role as science teachers?". The second part of this research moves toward describing the nature of students' alternative conceptions in science, the ways of changing cognitive structure, and cognitive aspects of learning and teaching science. It introduces implications for science education. It addresses how teachers might facilitate the ability of students to take control over their learning have the potential to inform teachers and researchers alike. Studies of this kind could inform teachers about the implementation of instruction designed to effect conceptual change in their students, and researchers about the role a teacher plays in bringing about these changes.

The Learning Theories of Ausubel, Piaget, and Vygotsky Three cognitive theorists who have been highly influential in understanding the process of human learning are Jean Piaget, David Ausubel, and Lev Vygotsky. Many view the theories of Piaget, Ausubel, and Vygotsky as distinctly contrasting explanations of cognitive development (learning). Ausubel and Vygotsky were more explicit in their recommendations for teaching than Piaget. However, despite different labels, strong similarities do exist between the cognitive processes described by the three theories. For Piaget, children and adults use mental patterns (schemes) to guide behaviour or cognition, and interpret new experiences or material in relation to existing schemes (Piaget, 1978). However, for new material to be assimilated, it must first fit an existing scheme. Very similarly, for Ausubel, meaningful information is stored in networks of connected facts or concepts referred to as schemata. New information, which fits into an existing schema, is more easily understood, learned, and retained than information that does not fit into an existing schema (Slavin, 1988). For both theorists then, new concepts that are well anchored by, or attached to existing schemata (or schemes) will be more readily learned and assimilated than new information relating to less established schemata. The same holds true for information not attached to any schemata at all (e.g., the case with compartmentalized, or rote learning). The aspects of Vygotsky's work that have received most attention among educators and psychologists are his arguments for the cultural basis of cognition and for the existence of a "zone of proximal development" (Moll, 1990). The latter refers to the idea that there is a zone for each learner, which is bounded on one side by the developmental threshold necessary for learning and on the other side by the upper limit of the learner's current ability to learn the material under consideration (Vygotsky, 1978). Ausubel defines rote learning as arbitrary, verbatim, non-substantive incorporation of new ideas into cognitive structure. Information does enter cognitive structure, but with no specific relevance to existing concept/propositional frameworks (Ausubel, 1963). Partly for this reason, rote learning may involve interference with previous similar learning, and exhibit some of the difficulties in patterns of recall, including fail to notice associations. When a learner encounters situations in which a learner's existing schemes cannot explain new information, existing schemes must be changed or new ones made. This process, as termed by Piaget, is accommodation. The condition leading to accommodation is known as disequilibration; that is, the state encountered by a learner in which new information does not fit an existing scheme (Slavin, 1988). The process of disequilibration and the characteristics of accommodation will further be discussed. To restore balance to the cognitive system, new schemes are developed, or old ones modified, until equilibration is reached, and the new information accommodated into the learner's view of the world. Vygotsky distinguished between (a) spontaneous or everyday concepts formed from a learner's experience and independent thinking and (b) nonspontaneous or scientific concepts taught in school (Moll, 1990). He associated scientific concepts with systematic, hierarchical knowledge as opposed to the non-systematic, unorganized knowledge gained from everyday experience.

Vygotsky believed that there is an important connection and interaction between the two; what a student is learning in school influences the course of development of concepts acquired through everyday experience and vice versa. The crucial difference between the two categories of concepts is the presence or absence of a system. Spontaneous concepts are based on particular instances and are not part of a coherent system of thought; on the other hand, scientific concepts (i.e. those learned in school) are presented and learned as part of a system of relationships. When a student has reached some understanding of the organization of concepts into a hierarchical system of interrelationships then this knowledge influences understanding of related everyday concepts by transforming and giving new direction to them. In order to elaborate the dimensions of school learning, Vygotsky (1978) described an exceptionally important concept: the zone of proximal development (ZPD). In his words, ZPD is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. Seen in this light, one may agree that prior cognitive structures are an important part of Piaget's theory of cognitive development as its existing schemes, which largely determine opportunities for disequilibration, and subsequent accommodation or conceptual change. Even more so for Ausubel, prior knowledge or existing schemata are of central importance if the learner is to meaningfully acquire new information or concepts. Ausubel postulated that meaningful learning occurs when new information is subsumed by existing relevant concepts, and these concepts undergo further change and growth (Novak, 1988). As a part of his reception learning instructional model, Ausubel further suggested that effective instruction requires the teacher to choose important or relevant information to teach, and to provide the means to help students relate this to concepts they already possess (existing schemata) (Slavin, 1988). For the student, both of these depend to a large degree on prior knowledge, or existing cognitive frameworks. Ausubel (Ausubel, Novak & Hanesian, 1978) made this abundantly clear when he stated: 'If I had to reduce all educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him/her accordingly' (p. iv). Vygotsky, too, sought to show that spontaneous concepts grow and change under the influence of instruction in scientific concepts and those scientific concepts develop fully as they incorporate related everyday concepts (How, 1993). Scientific (nonspontaneous) concepts are taught in school by means of verbal definitions and explanations or mathematical symbols and reside on a level of abstraction. In contrast, everyday concepts develop outside a definite system; in order to be understood in relation to what has been learned in school, thinking must move upward toward abstraction and generalization. The student eventually comes to see his/her spontaneous concepts as part of a system of relationships and, at the same time, comes to see how the phenomenon he/she has experienced fits into the scientific system he/she has been taught. Of course, there are also significant differences between Piagetian, Ausubelian, and Vygotskian cognitive theories. Well known is the fact that Piaget's theory is stage dependent: children as learners progress through four distinct stages of cognitive development, able to grasp concepts at increasing levels of abstraction depending on their level of maturity (Slavin, 1988). Quite differently, Ausubel's theory of how children learn concepts is not stage dependent. As mentioned above, prior knowledge in the form of cognitive schemata is the primary determinant of learning. Central to Vygotsky's thinking was the importance of language in mediating thought. The belief in the dominance of language is a fundamental difference between his view of concept development and that of Piaget. Piaget gave little attention to language and never assigned it a primary role in conceptual development. For Piaget language was a means of expressing thoughts that had already developed (Gredler, 1997). For Vygotsky language was central to the development of thought; words were the means through which thought was formed. It is important to go beyond direct experience in teaching scientific concepts and to mediate experience with words; experience alone is not enough since the experience is an isolated observation unless it is put into words and understood in a larger context (Howe, 1993). It is also clear that Ausubel favours a "top-down" approach to instruction as evidenced by his advocacy for the use of advance organizers. Piaget on the other hand, seems to have suggested a "bottom-up" approach to instruction and learning in which the learner acquires pieces of the larger picture before gaining access to an overall view. Vygotsky's idea of zone of proximal development suggests another approach to instruction, namely scaffolding (Gredler, 1997, p.103). Scaffolding occurs when a tutor (either adult or capable peer) helps the student build an extension from an existing schema into new cognitive territory through a series of small steps of which the student would not be independently capable. It involves developing a mutual understanding of each other's ideas as the extension is constructed. Eventually the tutor can withdraw, leaving the student under full control of the newly constructed extension. Despite these differences, however, three learning theories depend to varying degrees on the existing cognitive frameworks that students bring to any learning environment.

Learning progressions in science are empirically grounded and testable hypotheses about how students' understanding of, and ability to use, core scientific concepts and explanations and related scientific practices grow and become more sophisticated over time, with appropriate instruction (NRC, 2007). These hypotheses describe the pathways students are likely to follow to the mastery of core concepts. They are based on research about how students' learning actually progresses—as opposed to selecting sequences of topics and learning experiences based only on logical analysis of current disciplinary knowledge and on personal experiences in teaching. These hypotheses are then tested empirically to assess how valid they are (Does the hypothesized sequence describe a path most students actually experience given appropriate instruction?) and ultimately to assess their consequential validity (Does instruction based on the learning progression produce better results for most students?). If this work is pursued vigorously and rigorously, the end result should be a solid body of evidence about what most students are capable of achieving in school and about the particular sequence(s) of learning experiences that would lead to proficiency on the part of most students. However, it is not assumed that there is likely to be one best progression or pathway. The number and nature of productive pathways are treated as empirical questions likely to be influenced by variations in instruction and by future design and experimentation.

With the help my review of current work on the development of learning progressions in science (I focused primarily on Indian literature in this regard) made it clear that, while there is promising work on progressions in some scientific domains and practices, in most cases that work is at the initial stages of producing evidence on the degree of validity and usefulness of these progressions, and, taken together, they do not yet cover enough of the scientific content and practices that should be taught in Indian schools for them to be able to bear the full weight of replacing standards as we currently understand them.

Education policymakers around the world are recognizing that students need a broad range of skills such as communication, collaboration, and problem solving in order to thrive in the future. However, what this means in practice is not clear. Revising curricula to include these skills does not address lack of understanding of the nature of the skills or how to teach the skills. More and more education authorities are now identifying learning progressions as a potent way to help teachers plan and monitor their instruction and, as a result, enhance their students' learning. A learning progression is a carefully sequenced set of building blocks that students must master en route to mastering a more distant curricular aim. These building blocks consist of subskills and bodies of enabling knowledge. To illustrate, if a curricular aim calls for students to become skilled writers of persuasive essays, a learning progression for this aim might include a sub skill that requires students to be able to craft supporting arguments for a given position. To master this subskill, students might need bodies of knowledge that enable them to understand certain spelling and punctuation rules or to use specific vocabulary—for example, sound, valid, and justifiable—associated with argumentation. The complete learning progression for a persuasive writing skill might include a half dozen subskills.

Typically, learning progressions are constructed on the basis of some sort of backward analysis. An educator first identifies a significant curricular aim and then asks, "What does a student need to know or be able to do to master this aim?" The educator identifies one necessary building block and then asks, "What does a student need to know or be able to do to master this building block?" This sort of backward analysis can isolate the key tasks a student must accomplish on the way to mastery. Teachers should, of course, sequence the learning progression's building blocks in a pedagogically defensible order. Learning Progression describes how the skills might be demonstrated, both in their early forms and in increasingly advanced forms. It is critical for teachers to be able to identify the behaviours that relate to these skills if they are to intervene at the appropriate levels of challenge. This means that teachers need to have access to descriptions of how skills progress over time so that they can design classroom tasks that are within the zone of proximal development for their students. In this way, teachers can scaffold the learning of their students.

1.1.1 LEARNING PROGRESSION

Considerable work has been done in the cognitive and learning sciences investigating how students construct scientific knowledge (NRC, 2001, 2007, 2018). From this work, we know that 1) students often have non-scientific conceptual frameworks that they use to understand scientific phenomena (Carey, 1986; Keil, 2012; Rosengren et al., 2012); 2) students' non-scientific conceptual frameworks and ideas can persist even as they acquire scientific ideas (Kelemen and Rosset, 2009; Shtulman and Valcarcel, 2012; Evans, 2018); and 3) students' non-scientific conceptual frameworks can both hinder and facilitate scientific reasoning (Hammer et al., 2005; Keil, 2012; Coley and Tanner, 2015; Evans, 2018). For example, work investigating how students categorize materials and processes shows that they often base their categorizations on surface features (e.g., observable characteristics), whereas scientists rely on deep features (e.g., chemical or genetic similarity) to determine category membership (Gelman and Markman, 1986; Gelman and Davidson, 2013; Hesse and Anderson, 1992; Chi et al., 1994; Herrmann et al., 2013). This tendency can lead students to view biological materials or processes as being distinct, when a scientist would view those same processes as related (Modell, 2000). Students also draw on non-scientific strategies when describing causal relationships, such as using teleological (i.e., purpose-driven) or essentialist (i.e., attribute-driven) motives to explain biological phenomena, descriptions in conflict with scientific ideas of physical–causal interactions (Kelemen, 2012; Coley and Tanner, 2015; Lombroso and Vasilyeva, 2017). Teleological ideas can be tenacious and persist even when students become professional scientists in ways that can significantly impact their views of biological processes like evolution (Kelemen et al., 2013). Students can also rely on simplified assumptions to explain causal relations in complex systems that can lead them to an incorrect understanding of a system's dynamics, such as relying on deterministic instead of probabilistic causal mechanisms, linear instead of nonlinear relationships or a centralized cause with a limited number of actors instead of decentralized causes with complex or emergent interactions (Grotzer and Tutwiler, 2014). However, ideas that stem from non-scientific frameworks can also provide students with an initial way to begin constraining how organisms or materials relate in a hierarchical taxonomy that can provide a framework from which to build more scientifically rigorous ideas (Coley and Muratore, 2012). Learning progression research leverages work from the cognitive sciences by recognizing that students' understanding of scientific phenomena evolves in a myriad of ways as they work toward mastery of a topic (NRC, 2007; Corcoran et al., 2009). This understanding often builds upon intuitive or colloquial ideas that can serve as "stepping-stones" for scientific knowledge (Mohan and Plummer, 2012; Anderson, 2015). Learning progression researchers capture this diversity of ideas by administering common assessment questions to students across the grade levels of interest (e.g., freshman to senior undergraduate students; Jin and Anderson, 2012b). From the assessment responses, learning progression researchers use qualitative methods to identify the various ways students' reason about the topic of interest as they develop mastery, including non-scientific, vague, incomplete, or incorrect conceptions

Learning progressions, progress maps, developmental continuums, and learning trajectories are all terms that have been used in the literature over the past decade. While many variations on the definition exist, the concept generally refers to research-based, descriptive continuums of how students develop and demonstrate deeper, broader, and more sophisticated understanding over time.

A learning progression can visually and verbally articulate a hypothesis about how learning will typically move toward increased understanding for most students. There is currently a growing body of knowledge surrounding their purposes and use, as well as ongoing research in identifying and empirically validating content-specific learning progressions (Hess, 2010).

A conceptual view of learning progressions is one of overlapping learning zones along a continuum of learning. At the lower end of the progression are "novice" performers (at any grade level), who may (or may not) demonstrate the necessary prerequisite skills or understanding that is needed to be successful (e.g., essential skills/concepts that can be built upon over time). At the other end of the continuum are "expert" performers. Learning progressions descriptors help to "unpack" how learning might unfold for most students over time, moving from novice to expert performance (Hess, 2008).

Formative assessment is often mentioned in conjunction with learning progressions as well-designed interim assessments can "uncover thinking to show how student understanding is developing along the continuum of learning/learning progression." (Hess, 2008).

The term learning progression refers to the purposeful sequencing of teaching and learning expectations across multiple developmental stages, ages, or grade levels. The term is most commonly used in reference to learning standards—concise, clearly articulated descriptions of what students should know and be able to do at a specific stage of their education.

Learning progressions are typically categorized and organized by subject area, such as science, and they map out a specific sequence of knowledge and skills that students are expected to learn as they progress through their education.

There are two main characteristics of learning progressions:

(1) the standards described at each level are intended to address the specific learning needs and abilities of students at a particular stage of their intellectual, emotional, social, and physical development, and

(2) the standards reflect clearly articulated sequences—i.e., the learning expectations for each grade level build upon previous expectations while preparing students for more challenging concepts and more sophisticated coursework at the next level. The basic idea is to make sure that students are learning age-appropriate material (knowledge and skills that are neither too advanced nor too rudimentary), and that teachers are sequencing learning effectively and avoiding the inadvertent repetition of material that was taught in earlier grades.

It should also be noted that learning progressions may be more accelerated or less accelerated relative to one another. For example, in some European and Asian countries students learn algebra during their middle-school years, while it has been more common in the United States for students to begin taking algebra courses in high school. Depending on the sequencing of standards and progressions, students may be taught concepts sooner or later in their education. For a related discussion, see acceleration.

Learning Progressions are sometimes referred to as learning continua or developmental progressions. Although standards and curricula are often prioritized in educational documentation, it is the progress toward the standards and meeting curricular goals that is important. This "progress" can be seen as a roadmap which supports instructional planning. Because curricula are typically written in discrete topics and for discrete year levels, it can provide the illusion that these comprise very separate sets of knowledge or skills. In fact, these topics need to be linked, with broad connections. Heritage refers to "sequence", "continuity", and "coherence" as implicit in the notion of learning progression. It is not sufficient for a teacher to know only the curriculum being taught in her grade—she must understand what the students learned before, and what they will need to engage with after—in order to ensure deep learning. Learning progressions can describe the sequence of learning in a domain over many years for "big ideas"; or just a term's work with a greater degree of specificity

Progressions have been developed based on drawing data from multiple sources. A scientific approach would include developing a set of hypotheses about how an area of expertise develops, followed by collection of data to identify the degree of fit of evidence to the theory. In reality, many progressions have emerged from a more historical approach, due to common knowledge about learning sequences. With 21st century skills, we lack the latter and there are limited resources available for the former.

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Advances in research about how people learn are increasingly intended to be connected to the practices of teaching. The work on learning progressions is a promising line of research because of its potential to build a bridge between research on learning and school classroom practice. Being a relatively new term, many definitions of the term are buzzing around. Regardless of the different definitions being found in the literature, learning progressions are a useful tool for describing the steps in people's learning regarding an idea in a specific context.

According to Corcoran et al. (2009), there are five fundamental features of learning progressions: 1. They characterize students thinking about "big ideas" of science. 2. They describe how students' reason when engaged in scientific practices. 3. They guide the development of learning goals that are connected to student thinking. 4. They characterize the breadth of student ideas about a central idea of science. 5. They are connected to a related set of assessment instruments that target key performances and track student learning.

1.1.2 IMPORTANCE OF LIEARNING PROGRESSION

Learning progressions are essential tools for understanding students' progress in their learning. In the classroom, learning progressions enable teachers to identify where students are at in their learning and convert student assessment results into meaningful descriptions of their learning progress.

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learning and convert student assessment results into meaningful descriptions of their learning progress. This understanding is essential for informing next steps in teaching and learning, to ensure that every student is making progress, whatever their ability.

1.2.0 LEARNING ANALYTICS

Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs.

Generally speaking, learning analytics refers to the collection and analysis of data about learners and their environments for the purpose of understanding and improving learning outcomes.

Learning analytics is where big data meets traditional quantitative methods in education. Governments, universities, testing organizations, and massive open online course providers are collecting data about learners and how they learn. All that data, however, has been mostly untapped until the fairly recent development of the methods and tools to do so.

Much of the data currently available does not come in neat, well-organized, and collected formats. It exists in varied forms across systems and locations. Analysts today need the skills to access and transform this data, so we can better understand not only what students know, but how they know it. Learning analytics and educational data mining are the tools to transform this data into knowledge and lead, in the end, to improved education.

The Horizon Report: 2019 Higher Education Edition, produced by the EDUCAUSE Learning Initiative, identifies learning analytics as one of the digital strategies and technologies expected to enter mainstream use in the near future. As such, skilled data analysts are needed to support these analytics-driven initiatives and bring about institutional success.

"One of the driving forces behind the growth in the learning analytics field is that educational institutions are now facing the challenge of limited resources and increased accountability, which are propelling creativity and discovery," says Melisa LaCroix, a database administrator and North-eastern University alumna. "The analytics programs that were once reserved for big businesses are now being widely used in higher education and K-12 institutions to measure student growth, inform curriculum decisions, and identify students at risk for failing a course or program."

In addition to these practical uses of learning analytics, the practice is often used to:

- Measure key indicators of student performance

- Support student development
- Understand and improve the effectiveness of teaching practices
- Inform institutional decisions and strategy

Instead, any learning analytics initiative should be complemented by strong communication between the analyst and educators in order to successfully leverage the insights gleaned by the effort.

"To build a successful learning analytics program at an educational institution, it's important to engage and inform school leaders, listen to the needs of teachers and students, and educate users on how to consume and act on the data that's presented. Teachers and administrators will only be committed to data-driven decision making if they can see its value and are educated about how to turn insights gleaned from data into action."

1.2.1 IMPLICATION OF LEARNING ANALYTICS

Learning analytics are web-based measurements and reporting about student learning that is intended to help teachers improve the knowledge and skill acquisition of their students. This maximizes student learning potential while enhancing teaching and delivery methods. Though its application to education is relatively new, scientific disciplines have been using it for over forty years.

Curriculum Mapping and Competency Determination

In curriculum mapping, we identify what we have already taught students and what to teach next. It is a collection process that typically analyses the processes and assessments employed for core and content by subject and grade level. With learning analytics, we immediately know how effective our instructional methods were for a particular unit before moving on.

Personalized Learning and Interventions

With the data provided, we can analyse how particular students performed based on their own learning patterns, taking into consideration their gifts and challenges, prior performance, and any other factors we care to monitor. We can even use learning analytics to tailor learning to a student's or group of students' particular interests. For example, should we see that a particular class of students absorbed and retained the content with greater mastery when other subjects were integrated, or classes were held outdoors, or learning was inquiry-based, we may decide to expand upon those efforts.

Behaviour Prediction

Learning analytics helps educators determine how well students have mastered content and through what means, and also can assess a student's risk level. Identifying blocks of students who may have academic or behavioural challenges helps educators to develop the interventions to prevent them while predicting success can help students reach their full potential.

1.3.0 WHAT IS SCIENCE?

Science is a dynamic, expanding body of knowledge, covering new domains of experiences. It is a human endeavour to understand the world by building - up conceptual models on the basis of observations and thus arriving at theories, laws and principles. In a progressive society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition. People today are faced with an increasingly fast - changing world where the most important skills are flexibility, innovation and creativity. These different imperatives have to be kept in mind in shaping science education. Good science education is true to the child, true to life and true to the discipline.

Science has made an immense contribution in uplifting human society, filling our minds with knowledge and intelligence. It helped us notice the marvels of mother nature to which we were previously oblivious. It also reminded us that we are just an infinitesimally small part of this ever-expanding universe. Right from invention of wheels to building a supercomputer, science has made our lives easier while we enjoy the comfort of everyday life.

Science explores the lawful, patterned behaviours of nature, and so I would say that phenomena that are not part of these patterns are outside the world of science. What the religious world calls "miracles" are exceptions to the lawful behaviours of nature, and are therefore outside of science. Of course, there are also many phenomena that fall in the Gray area between "science" and "not science", but this is generally a matter of semantics.

I would NOT say that events like the theoretical "Big Bang" are outside of science -- they are well-informed theories, and not simply guesses or speculation. Although we cannot observe the universe's beginnings directly, we can replicate many of the same or similar behaviours in the laboratory, and confirm whether such an event is compatible with what we have already observed. It is in this way that theoretical events in the world of science are *not* similar to events claimed to have happened under supernatural influence. Although scientists do sometimes have to extrapolate from observational evidence, these theoretical events must still be compatible with what we already know empirically about the universe.

1.3.1 IMPORTANCE OF LEARNING SCIENCE

Science is one of the most important channels of knowledge. It has a specific role, as well as a variety of functions for the benefit of our society: creating new knowledge, improving education, and increasing the quality of our lives. Science must respond to societal needs and global challenges. Beyond the potential scientific breakthroughs, there are individual benefits to learning science, such as developing our ability to ask questions, collect information, organize and test our ideas, solve problems, and apply what we learn. Even more, science offers a powerful platform for building confidence, developing communication skills, and making sense of the world around us—a world that is increasingly shaped by science and technology. Science also involves a lot of communication with other people and develops patience and perseverance in children. Finding answers to their countless "why" questions push children to research and form their own opinions instead of taking others' for granted. While it's easy to go along with another child's answer or pull out a smartphone and do a quick internet search to know why the leaves fall from the trees, a healthy dose of scepticism can take children farther as they explore the world around them and tackle some of its challenging questions. [†]

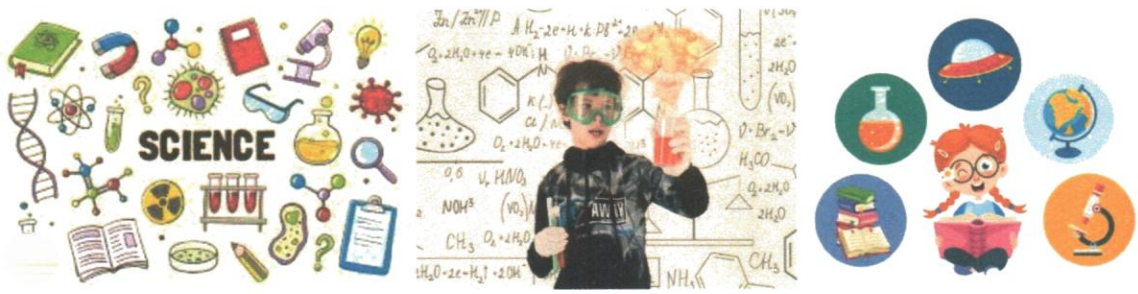

Figure no. 1.1: Importance of learning science

1.3.2 IMPORTANCE OF SCIENCE IN SCHOOL CURRICULUM

We are surrounded by technology and the products of science every day. Public policy decisions that affect every aspect of our lives are based on scientific evidence. And, of course, the immensely complex natural world that surrounds us illustrates infinite scientific concepts. As children grow up in an increasingly technologically and scientifically advanced world, they need to be scientifically literate to succeed. Ideally, teaching the scientific method to students is teaching them how to think, learn, solve problems and make informed decisions. These skills are integral to every aspect of a student's education and life, from school to career. With a graduate degree in science education.

Science is everywhere. A student rides to school on a bus, and in that instance alone, there are many examples of technology based on the scientific method. The school bus is a product of many areas of science and technology, including mechanical engineering and innovation. The systems of roads, lights, sidewalks and other infrastructure are carefully designed by civil engineers and planners. The smartphone in the student's hand is a miracle of modern computer engineering. Outside the window, trees turn sunlight into stored energy and create the oxygen we need to survive. Whether "natural" or human-derived, every aspect of a student's life is filled with science — from their own internal biology to the flat-screen TV in the living room.

Scientific Literacy

Scientific literacy remains a topic of concern in education today (Hodson, 2006). This term has been used to mold the science curriculum, and it has become a main goal in schools across the U.S. The ideas that surround scientific literacy are seen as highly desirable for all students and usually are implemented beginning in the primary grades. —Since the term scientific literacy first appeared in the US educational literature nearly half a century ago, in papers by Paul Hurd (1958) and Richard McCurdy (1958), there have been numerous attempts to define it "(p. 293). While there is no absolute definition to clearly define the term, scientific literacy, often there are familiar details found within each individual definition. What Is Scientific Literacy? As a result of the many explanations of what scientific literacy is, all of the following should be included in the definition as a whole. 1. A general understanding of some of the fundamental ideas, principles, and theories of science 2. Some knowledge of the ways in which scientific knowledge is generated, validated, and disseminated 3. Some ability to interpret data and evaluate their validity and reliability 4. A critical understanding of the aims and goals of science and technology, including their historical roots and the values they embody 5. An appreciation of the interrelationships among science, technology, society, and the environment 6. An interest in science and the capacity to update and acquire new scientific and technological knowledge in the future. (Hodson, 2006, p. 294).

Scientific Inquiry and Scientific Method

Perhaps even more important than specific examples of science in our lives are the ways we use scientific thought, method and inquiry to come to our decisions. This is not necessarily a conscious thing. The human need to solve problems can arise from curiosity or from necessity. The process of inquiry is how we find answers and substantiate those answers. In the fields of hard science, the process of inquiry is more direct and finite: Take a question; use evidence to form an explanation; connect that explanation to existing knowledge; and communicate that evidence-based explanation. Experimentation based on the scientific method follows a similar course: Combine a scientific question with research to construct a hypothesis; conduct experiments to test that hypothesis; evaluate the results to draw conclusions; and communicate those conclusions.

Critical Thinking

Although inquiry and the scientific method are integral to science education and practice, every decision we make is based on these processes. Natural human curiosity and necessity lead to asking questions (What is the problem?), constructing a hypothesis (How do I solve it?), testing it with evidence and evaluating the result (Did the solution work?), and making future decisions based on that result.

This is problem-solving: using critical thinking and evidence to create solutions and make decisions. Problem-solving and critical thinking are two of the most important skills students learn in school. They are essential to making good decisions that lead to achievement and success during and after school. Yet, although they are nearly synonymous, scientific inquiry in schools is not always explicitly tied to problem-solving and critical thinking. The process students learn when creating, executing, evaluating and communicating the results of an experiment can be applied to any challenge they face in school, from proving a point in a persuasive essay to developing a photo in the darkroom. In this way, science is one of the most important subjects' students' study, because it gives them the critical thinking skills they need in every subject.

The Importance of Science in Early Education

Governmental guidelines and tests often focus on middle and high school-level STEM (science, technology, engineering and math) education. Yet, many educators believe science education should begin much earlier. Not only does science education teach young learners problem-solving skills that will help them throughout their schooling, it also engages them in science from the start. Kids usually form a basic opinion about the sciences shortly after beginning school. If this is a negative opinion, it can be hard to engage those students in science as they grow older. Engaging young students with exciting material and experiences motivates them to learn and pursue the sciences throughout school.

Science education is one of the most important subjects in school due to its relevance to students' lives and the universally applicable problem-solving and critical thinking skills it uses and develops. These are lifelong skills that allow students to generate ideas, weigh decisions intelligently and even understand the evidence behind public policy-making. Teaching technological literacy, critical thinking and problem-solving through science education gives students the skills and knowledge they need to succeed in school and beyond.

The processes and ideas of science are of great importance to everybody in three ways. The first is in their personal lives, for example, so that they can validly identify the components of a healthy life-style. The second is in their civic lives, so that they take an informed part in social decisions, for example on future options for electricity supply. The third is in their economic lives, where they need to be able to respond positively to changes in the science-related aspects of their employment. If the major purpose of science education is to increase the flow of specialist scientists, technologists and engineers, it could be argued that young people with a special talent in science should be identified as early as possible and provided with a separate, specialized, and highly focused science education. We do not agree. Such people share the general need for a broad science education and should not be cut off from it. In any case, there are no valid and reliable ways in which such young people may be identified. Some who show early, unless school science explicitly engages with the enthusiasm and concerns of the many groupings that make up today's students, will lose their interest. Accordingly, it needs to grapple with how it can respond positively to the wide diversity of student concerns. It must think how to better address women, those who hold strong religious views, those who have little cultural capital, and those whose current or recent roots lie outside Western societies. All too little is known systematically about these issues. A conundrum for science educators is that school students are being turned off school science lessons, yet the same students are often engaged by science outside the classroom. Science in science museums, hands-on centers, zoos and botanical gardens is often seen as exciting, challenging and uplifting. Newspapers and magazines offer rich sources of science information including debates about controversial current issues. Multichannel television and the internet have spawned sources of high-quality and attractively packaged information about science and issues of relevance to young people5. We are also living in a golden age of popular science book publishing, with a wealth of high-quality science books for children as well as adults. Students of school age spend about two-thirds of their waking lives outside formal schooling. Yet science educators tend to ignore the crucial influences that experiences outside school have on students' beliefs, attitudes and motivation to learn. They often see these influences only as a source of misconceptions. Out of classroom contexts can add to and improve the learning of science in several ways6. They can promote the understanding and integration of science concepts. Falk and Dierking7 have reviewed studies that show that science museum visits can lead to improved understanding of such classic school science concepts as force and motion, an improvement measured by tests of knowledge before and after visits. They are also an opportunity to engage in science activities that would not be possible in the school laboratory either because of safety considerations or because they are too complex. Examples include launching rockets, performing ecological surveys, observing the night sky, and large-scale experiments with combustion. How these activities contribute to students' knowledge of the processes of science is still not clear. And they can provide access to rare material and to 'big' science. Science museums, botanic gardens, zoos and science industries provide opportunities for students to see yesterdays and today's science in use. Artifacts and collections, and the stories associated with them, help teach about the ways in which scientific and technological knowledge has been generated and about the social enterprise in which those who engage in this work operate. Here too, the exact contribution to school science is unclear. Such activities also provide opportunities for science activities which are less constrained by school bells and lesson times. Work can be more extensive and there are more opportunities for students to take responsibility for themselves and others, to work in teams and to consider their effects on the environment.

1.4.0 SCIENCE CURRICULUM AT SECONDARY LEVEL

In the present times, the laws and principles of science find application, not only in our daily life but also in every walk of life. As a result, Science and Technology have become an integral part of human life and culture. Scientific knowledge which is growing day by day is a powerful tool for solving our problems. This knowledge also contributes towards the national productivity. However, a word of caution misuse of scientific knowledge, indiscriminate use of natural resources leading to depletion of natural resources and environmental pollution can lead to dire consequences. The proper and sensible use of science and technology can achieve the twin goals of 'development' and 'improvement' is of utmost importance. In the light of this, it is becoming increasingly necessary for all to be aware of the basics of science and technology, as also its application in the interest of human welfare.

COURSE STRUCTURE

The present curriculum contains 7 modules. All modules are compulsory for all learners. Each module has been divided into units or lessons. The number of lessons, suggested study time and marks allocated for each is as follows:

Name of the Modules	No. of Lessons	Study Hours	Mark Allotted for Modules
Measurement in science	1	04	**04**
Matter in our Surroundings	7	54	**22**
Moving Things	3	24	**07**
Energy	7	52	**15**
The Living world	7	47	**15**
Natural Resources	3	26	**10**

Humans and Environment	4	33	**12**
Total	**32**	**240**	**85**

Table no. 1.1: Description of course structure of class IX Science

1.4.1 NEED OF SCIENCE IN DAY-TO-DAY LIFE

The present era is the era of science. Science has undoubtedly done a great service to mankind. Man, a rational being, has been curious to explore mysteries of nature and this led to many discoveries being made in various parts of the world. But he is never satisfied with the acquired knowledge and is always keen to unravel mysteries of the universe. He has conquered the land and air. His incredible lust for knowledge has revolutionized human life and raised the standard of life. He was able to invent innumerable ways of making his life comfortable and happy. Every sphere of life has been revolutionized by science.

There have been innumerable inventions. One of the greatest inventions is the invention of medicines. There has been a series of tests carried out using animals as subjects and various medicines have been tried out on these animals to check their efficacy. Many fatal diseases can now be cured because we have the drug to fight those diseases. It has reduced the rate of infant mortality and increased the life span. Before these inventions millions of people died for lack of medical care.

Science has given us many machines that have made our lives very comfortable. Buses, cars, sewing machines, mixes, grinders, etc. are all machines that are used every day by us and the discovery of electricity has made it possible for us to change night into day and summer into a comfortable cool season

It is now easy to cultivate fields as we have tractors. New forms of irrigation are now being employed. It is easier to protect the crops because of the use of various chemicals and pesticides. Even mosquitoes can be driven away because of the discoveries made in science.

It has enabled man to entertain himself in many ways. TV, radio, video and the cinema are all popular means of entertainment. Besides entertainment they educate the masses. Today the computer has made life even easier for us. The press, the means of communication, etc. have all improved because of science and its gifts to us.

1.5.0 INNOVATIVE TEACHING IN SCIENCE FOR IMPROVING THE LEARNING PROGRESSION

School students are naturally curious, which makes science an ideal subject for them to learn. Science allows students to explore their world and discover new things. It is also an active subject, containing activities such as hands-on labs and experiments. This makes science wellsuited to active younger children. Science is an important part of the foundation for education for all children. While most feel that Science in education is a necessity, they tend to use it as a tool for reaching a specific target or personal mark, after which there is no further need to seek greater education. Nonetheless, the importance of education in society is indispensable and cohering, which is why society and knowledge cannot be ever separated into two distinct entities. In this research I have chosen the Constructivist approach as an innovative teaching method that helps me to enhance the learning progression in science of class IX students by using this process.

1.6.0 CONSTRUCTIVIST APPROACH

The philosophy of constructivism say that learners will construct their own unique meanings for concepts, so it is not at all reasonable to evaluate students as to how well they have all met some normative goal.

Constructivism is an important learning theory that educators use to help their students learn. Constructivism is based on the idea that people actively construct or make their own knowledge, and that reality is determined by your experiences as a learner. Basically, learners use their previous knowledge as a foundation and build on it with new things that they learn. So, everyone's individual experiences make their learning unique to them.

Constructivism is crucial to understand as an educator because it influences the way all of your students learn. Teachers and instructors that understand the constructivist learning theory understand that their students bring their own unique experiences to the classroom every day. Their background and previous knowledge impact how they are able to learn. Educators are able to use constructivist learning theory to help their students understand their previous knowledge. If you're a current or aspiring educator, it's important to get the education and credentials you need. But it's also important to understand learning theories and how they impact you and your students. This guide will tell you more about the constructivist learning theory and how it helps you as a teacher.

Figure no.2.1: Traditional teaching vs. Constructivist teaching

1.6.1 PRINCIPLES OF CONSTRUCTIVISM

There are many specific elements and principles of constructivism that shape the way the theory works and applies to students. Learn about the different principles of constructivism and how they make up the whole theory.

- Knowledge is constructed. This is the basic principle, meaning that knowledge is built upon another knowledge. Students take pieces and put them together in their own unique way, building something different than what another student will build. The student's previous knowledge, experiences, beliefs, and insights are all important foundations for their continued learning.
- People learn to learn, as they learn. Learning involves constructing meaning and systems of meaning. For example, if a student is learning the chronology of dates for a series of historical events, at the same time they are learning the meaning of chronology. If a student is writing a paper about history, they are also learning principles of grammar and writing as well. Each thing we learn gives us a better understanding of other things in the future.
- Learning is an active process. Learning involves sensory input to construct meaning. The learner needs to do something in order to learn, it's not a passive activity. Learners need to engage in the world so they are actively involved in their own learning and development. You can't just sit and expect to be told things and learn, you need to engage in discussions, reading, activities, etc.
- Learning is a social activity. Learning is directly associated to our connection with other people. Our teachers, our family, or peers, and our acquaintances impact our learning. Educators are more likely to be successful as they understand that peer involvement is key in learning. Isolating learnings isn't the best way to help students learn and grow together. Progressive education recognizes that social interaction is key to learning and they use conversation, interaction, and group applications to help students retain their knowledge.
- Learning is contextual. Students don't learn isolated facts and theories separate from the rest of our lives—we learn in ways connected to things we already know, what we believe, and more. The things we learn and the points we tend to remember are connected to the things going on around us.

- Knowledge is personal. Because constructivism is based on your own experiences and beliefs, knowledge becomes a personal affair. Each person will have their own prior knowledge and experiences to bring to the table. So, the way and things people learn and gain from education will all be very different.
- Learning exists in the mind. Hands-on experiences and physical actions are necessary for learning, but those elements aren't enough. Engaging the mind is key to successful learning. Learning needs to involve activities for the minds, not just our hands. Mental experiences are needed for retaining knowledge.
- Motivation is key to learning. Students are unable to learn if they are unmotivated. Educators need to have ways to engage and motivate learners to activate their minds and help them be excited about education. Without motivation, it's difficult for learners to reach into their past experience and make connections for new learning.

1.6.2 TYPES OF CONSTRUCTIVISM

There are different types of constructivism that educators can use to find success with this learning theory.

- Cognitive. Cognitive constructivism focuses on the idea that learning should be related to the learner's stage of cognitive development. These methods work to help students in learning new information by connecting it to things they already know, enabling them to make modifications in their existing intelligence to accommodate the new information. Cognitive constructivism comes from the work of Jean Piaget and his research on cognitive development in children.
- Social. Social constructivism focuses on the collaborative nature of learning. Knowledge develops from how people interact with each other, their culture, and society at large. Students rely on others to help create their building blocks, and learning from others helps them construct their own knowledge and reality. Social constructivism comes from Lev Vygotsky, and is closely connected to cognitive constructivism with the added element of societal and peer influence.
- Radical. Radical constructivism is very different from cognitive and social constructivism. It focuses on the idea that learners and the knowledge they construct tell us nothing real, only help us function in our environment. The overall idea is that knowledge is invented, not discovered. The things we bring to the table make it

impossible for us to have truth, only interpretations of knowledge. This theory was developed by Ernst von Glaser Feld in 1974.

1.6.3 CONSTRUCTIVIST APPROACH ACTIVITIES FOR LEARNING IN SCIENCE

Constructivist Teaching is based on constructivist learning theory. Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. Learners are the makers of meaning and knowledge.

Constructivist believes in learning by doing method. Only those activities must be practiced in the classroom, which can encourage experimentation, direct experience, creativity, reasoning, positive attitude etc.

Experimentation

Experimentation always allows the children to face the reality. It develops the reasoning, analytic skills, thinking, accuracy and scientific temper etc.

Example:

Natural Indicators and their Results in Acidic and Basic Solution.

Problem Solving Activities

Teacher must encourage problem solving activities in the classroom. Problems always develop intellect and innovativeness among the children.

Project Method

Learning is not possible without the involvement of children. Project method helps a child to understand the problem and find the practical solution. Project method develops:

•Data collection

•Presentation skills

•Observation

•Inference

Direct Experience

It is the role of teacher to select that activity which can provide direct experience to the learners.

Example:

Collect the leaves of ten medicinal plants and write their uses.

Research Projects:

Students research a topic and can present their findings to the class. It always helps in the collection of data and respect for others research. It develops the correlation, innovativeness, creativity, judgment etc.

Example:

if a teacher gives a research project on Diabetes and assign them to do five case studies in the research project. When a child will meet five different patients, he will come to know:

•Name of their doctor

•Their nutrition

•Their life styles

•Symptoms of disease

•Medication

1.7.0 STATEMENT OF THE PROBLEM

Learning is simply the process of adjusting our mental models to accommodate new experiences. The term refers to the idea that individuals, through their interaction with the environment, construct their own knowledge and meaning (Fosnot, 1996). Construction indicates that each learner individually and socially constructs meaning as he/she learns. Constructing meaning is learning. The constructivist perspective provides strategies for promoting learning by all. This metaphor of construction comes from the idea that humans are builders, shapers, and designers, who throughout history have created artifacts from the pots to skyscrapers. The emphasis of the constructivist theory is on the PROCESS rather than the PRODUCT of learning. Constructivist approach that helps a teacher to teach in an innovative process in the classroom. In this research while I was teaching standard IX students of Kendrapara district of Odisha, I felt disconnected at my class, then I tried to find out the problems what are the problems they face then when I was discussing with them about science most of the students they said "science is a hard subject and it is difficult" then I was trying to do an experiment in both the sections like I was taking one section as experimental group and another section as control group , I was started teaching an innovative manner in experimental group students in Constructivist approach and control group in traditional method and I was giving them 45 days treatment and tried to find out the results of benefits of teaching.

In a Constructivist approach, the students determine how much they have learned as well as the process by which they learned. It changes the dynamics of the traditional classroom by empowering the learner as the focus and architect of the learning process while redefining the role of the instructor to be a guide and helper, rather than the source and conduct of knowledge.

1.8.0 RATIONALE OF THE STUDY

Our teachers are following/practicing the behavioural approach in teaching. They consider learners as the passive receiver of the information. The classroom is managed in an authoritarian manner. Teachers dominate the class. Students are compelled/forced to draw conclusions as per the directives of the teacher. They are not empowered to make their own decisions. Therefore, learning becomes a burden for the learners or of no use in their day-to-day life. Education is liberation. Providing direction not the decision should be the function of education. Learners have to construct their own knowledge as per their previous experiences and the cultures in which they live in. Constructivist Approach considers the learners as "the creator of their own knowledge". Therefore, the Italian philosopher Giambattita Vico precisely and elegantly said "God knows the world because he created it; human beings can only know what they have made themselves". A Constructivist approach uses content to accomplish this, while a teacher-centered approach just covers all the content that can fit into the course. It is more important that the students learn how to use their acquired knowledge rather than know all the facts presented in the vacuum of a classroom. As we examine factors related to the construction of knowledge, we find two focal points: that of cognitive constructivism and that of social constructivism. Cognitive constructivists focus on the cognitive processes associated with constructing knowledge as individuals make sense of new information with which they are confronted. Social constructivists concern themselves with the social and cultural processes at work (Windschitl, 2002). Learners are active creators of their own knowledge by asking questions, exploring subjects, and constantly assessing what and how they know. Each new knowledge must be reconciled with prior understanding; else false models (previous knowledge/paradigms) continue to prevail. Teachings through 5-E model, pupil generated experiments, real-world problem solving, discussion, debate, brainstorming, gamify learning, foster collaboration with group projects, Learner develop the content have to be used in this approach. There is a need to shift from the behavioural approach to Constructivist approach of teaching. Therefore, a study was needed in the area of teaching Science through an approach (Constructivist) and to find its effectiveness in terms of the variables in terms of Achievement and attitude towards science.

1.9.0 PUORPOSE OF THE STUDY

The purpose of the study was to examine how explicit progression in learning strategies impacted ninth grade science classes. Science education is extremely important and this knowledge contributes to the development of a well-rounded individual. Science is a part of everyday life and, thus, it is vital for students to have sufficient background knowledge. The purpose of this dissertation will be to develop learning progression in science and an example of effective instruction to teachers. Teachers will have a concrete reference, which will allow them to see how the elements of effective teaching are incorporated into an interactive series of lessons, so that they will be able to apply it to their own classroom activities.

1.10.0 OBJECTIVES OF THE STUDY

- To study the learning progression in science of class IX students of Kendrapara district.
- To study the attitude towards science of class IX students of Kendrapara district.
- To study the treatment, gender and their interaction on learning progression in science of Kendrapara district.
- To study the treatment, gender and their interaction on attitude towards science of class IX students of Kendrapara district.

1.11.0 HYPOTHESIS

- There is no significant effect of Treatment on adjusted mean score of Achievement in Science of students taught through Constructivist approach and Traditional Approach when previous years' science score is taken as covariate.
- There is no significant effect of Gender on adjusted mean score of Achievement in Science of students taught through Constructivist approach and Traditional Approach when previous years' Science score is taken as covariate.
- There is no significant interaction of Treatment and Gender on adjusted mean score of Achievement in Science of students taught through Constructivist approach and Traditional Approach when previous years' Science score is taken as covariate.
- There is no significant effect of Treatment on adjusted mean score of Achievement in Science of students taught through Constructivist approach and Traditional Approach when previous years' Science score is taken as covariate.
- There is no significant effect of Attitude towards science on adjusted mean score of Achievement in Science of students taught through Constructivist approach and Traditional Approach when previous years' Science score is taken as covariate.
- There is no significant interaction of Treatment and attitude towards science on adjusted mean Science score of Achievement in a of students taught through Constructivist approach and Traditional Approach when previous years' Science score is taken as covariate.

- ❖ There is no significant effect of Treatment on Achievement in Science Subject of Class IX students when their Pre–test Scores of Achievements in Science Subject was taken as covariate.
- ❖ There is no significant effect of Gender on Achievement in Science Subject of Class IX students when Pre –test Scores of Achievements in Science Subject was taken as covariate.
- ❖ There is no significant interaction of Treatment and Gender on Overall Achievement in Science Subject of Class IX students when Pre –test Scores of Overall Achievement in Science Subject was taken as covariate.

1.12.0 OPERATIONAL DEFINATIONS

Learning: - Acquiring knowledge and skills and having them readily available from memory so you can make sense of future problems and opportunities.

Teaching: - Teaching is one of the instruments of education and a special function is to impart understanding and skill. The main function of teaching is to make learning effective. The learning process would get completed as a result of teaching. So, teaching and learning are very closely related.

Teaching-Learning Process: - It is the most powerful instrument of education to bring out desired changes in the students.

Curriculum: - Refers to a course of study at school or university and the subjects making up a course.

Learning Progression: - The term learning progression refers to the purposeful sequencing of teaching and learning expectations across multiple developmental stages, ages, or grade levels. The term is most commonly used in reference to learning standards—concise, clearly articulated descriptions of what students should know and be able to do at a specific stage of their education.

Learning Analytics: - Learning Analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs. As a research and teaching field, Learning Analytics sits at the convergence of Learning (e.g., educational research, learning and assessment sciences, educational technology), Analytics (e.g., statistics, visualization, computer/data sciences, artificial intelligence),

Science: - Science, any system of knowledge that is concerned with the physical world and its phenomena and that entails unbiased observations and systematic experimentation. In general, a science involves a pursuit of knowledge covering general truths or the operations of fundamental laws.

Achievement in Science: - In the present study Achievement refers to the extent to which the students of IX standard grasping the subject matter of science.

Constructivist approach: - Constructivism is an important learning theory that educators use to help their students learn. Constructivism is based on the idea that people actively construct or make their own knowledge, and that reality is determined by your experiences as a learner.

Scientific Attitude: - Scientific attitude is the most important outcome of science teaching and which enables us to think rationally. It is the combination of many qualities and virtues which is reflected through the behaviour and action of the person

Treatment: - In an experiment, the factor (also called an independent variable) is an explanatory variable manipulated by the experimenter. Each factor has two or more levels, i.e., different values of the factor. Combinations of factor levels are called treatments.

Gender: - Gender refers to the socially constructed roles, behaviors, expressions and identities of girls, women, boys, men, and gender diverse people. It influences how people perceive themselves and each other, how they act and interact, and the distribution of power and resources in society.

Interaction: - Interaction is a kind of action that occurs as two or more objects have an effect upon one another. The idea of a two-way effect is essential in the concept of interaction, as opposed to a one-way causal effect. Closely related terms are interactivity and interconnectivity, of which the latter deals with the interactions of interactions within systems: combinations of many simple interactions can lead to surprising emergent phenomena. Interaction has different tailored meanings in various sciences.

1.13.0 DELIMINATIONS OF THE STUDY

The study will be conducted under the following constraints-

1. The student was selected randomly from the selected schools of Kendrapara District.

2. The content was restricted to the 9th class science syllabus prescribed by CBSE, NEW DELHI.

3. Only 45 days treatment was provided to the student for the research.

4. The sample was taken by limited students of Kendrapara District.

5. The Medium of Instruction was provided to the students was English.

6. Lesson Plan was developed in English.

1.14.0 SUMMARY

In this chapter 1 The history of science education has changed dramatically throughout the centuries. At first, simply being able to read and write was considered acceptable. Eventually, as technology became more demanding, the views on education began to change. A common goal among educators was to encourage students to act like scientists. Ultimately, this new way of thinking led to the notion of scientific literacy for all students, which is still a topic of debate today. Many teachers, today, lack the ability and knowledge to teach science in an effective way. Thus, the purpose of this project will be to provide a science unit plan on whether to demonstrate the elements of effective instruction for teachers to reference and apply to their own teaching methods. Developing scientific attitude skills among learners. Learning progression in science must be enhanced and teachers should apply the innovative teaching styles for the progression of students' performance and get their interest in learning science. In Chapter-II Review of literature will be presented to provide the background of a) Learning progression in science education b) learning analytics c) best practices of teaching d) how to develop contents.