CHAPTER - I

INTRODUCTION

1.0.0 INTODUCTION

Science is a dynamic, expanding body of knowledge, covering ever-new domains of experience. In a progressive forward-looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition (National Curriculum Framework, 2005). In other words, society directly or indirectly depends on products and services that are developed with the help of science and technology. Innovations in Science and Technology have changed the way we live, move, communicate, work and play. Meanwhile, news headlines on global warming, environmental protection, cloning or genetically engineered food all deal with science-based issues that directly affect our lives (International Council for Science (ICSU), Paris (2011). In the present scenario, people are faced with a rapidly changing world. To cope up with emerging challenges and for bringing up the standards of living, education of science and technology has become a matter of great concern internationally. Scientific and technological literacy for all citizens is a stated goal of most modern nations; the production of more and better scientists and technologists is seen as a way of competing in the economic arena and as primary means of human condition. One of the biggest tasks facing those addressing the challenge of sustainable development, both in developed and developing countries, is the need to generate the capacity to apply science and technology to this goal (ICSU, 2002). There is no doubt that effective science education can serve as a mean for solving existing as well as upcoming global problems. These different imperatives have to be kept in mind in shaping science education in order to be meaningful in school. Quality assurance procedure is mandatory in all education institution. The main aim of quality assurance is student satisfaction of teaching. In a study, five interrelated definition of "quality" were identified- quality as exception, as perfection, as fitness for purpose, as value for money and as transformative.

1.1.0 LEARNING ANALYTICS

Learning Analytics is an approach that is the collection, analysis and reporting of performance data for the purpose of understanding and optimizing learning outcomes. Learning environment is seen as a complex system containing many elements that can impact the ways of student learning. In this study the term "teaching" refer to any activity that aimed to improve learning.

The use of analytics to discover important learning phenomena (e.g. moment of learning or misconception) and portray learners' experiences and behaviors is evident and commonly accepted due to the pervasiveness of learning technologies. Learning analytics holds a critical role in understanding human learning, teaching, and education, by identifying and validating relevant measures of processes, outcomes, and activities. In addition, learning analytics supports and promotes evidence based practices derived from evaluation and assessment of learners' progress, motivation, attitudes, and satisfaction. However, learning analytics lacks theoretical orientation that can assist researchers to explain inconsistencies, avoid misinterpretations, and consider and clarify any contextual conditions (e.g. instructional, sociological, psychological, etc.) that affect learning. Moreover, Reimann highlights that "a theoretical approaches to learning analytics might produce misconceptions because it is the logical (and ethical) error of using descriptions of the past as prescriptions for the future". Consequently, without theoretical grounding of learning analytics and contextual interpretation of the collected data, learning analytics design capabilities are limited. From this perspective, learning design is utterly important as it provides the framework for analyzing and interpreting data, learner's behavior, and successful or inefficient learning patterns.

1.2.0 LEARNING PROGRESSION

Recently, learning progressions have taken a more prominent role in the national discussion on science education. With the arrival of the Next Generation Science Standards (NGSS), teachers are beginning to hear more about learning progressions and how they can support their teaching and student learning. To prepare for this change it is helpful to understand about learning progressions are and its development.

Learning progressions describe the path students may take as they work towards mastery of a scientific concept. Developed through extensive observation, learning progressions move away from assumptions about how students learn. Instead, student work, interviews, and other data sources are used to generate a picture of how students learn over time. By focusing on the actual ideas students start with and how these ideas change, it is possible to improve teaching and learning.

In many ways, the work developing learning progressions has just begun. While the number of resources is expanding quickly, there are few well-tested and -developed learning progressions available to science teachers

Learning Progressions focus on how students learn and develop increasing sophistication in their domain knowledge, thus articulating the pathway and conceptual milestones, that students need to reach on their way towards achieving the target standards. Essential elements of learning progressions include-

- The notion of learning as developmental something that happens over time.
- The importance of instruction in facilitating the movement of learners across the learning continuum as they progress from novice to more experts in their thinking and conceptual understanding.

Learning progressions are descriptions of the successively more sophisticated ways of thinking about a topic that can follow one another as children learn about and investigate a topic over a broad span of time (e.g., 6 to 8 years). They are crucially dependent on instructional practices if they are to occur. That is, traditional instruction does not enable most children to attain a good understanding of scientific frameworks or practices, but there is evidence that the proposed learning sequences could occur with appropriate instructional practices.

The more effective instructional practices aim to build understanding through involving students in a variety of practices, including gathering data through observation or experiment, representing data, reasoning—with oneself and others—about what data mean, and applying key ideas to new situations. At the same time, bringing about understanding of scientific frameworks is difficult, so innovative instructional practice is most effective when sustained over a period of time. The timescale of most innovative teaching interventions has typically been relatively short (on the order of 2 or 3 months for a specific topic). Thus, our ideas about longer term learning progressions are conjectural—ideas about how understanding could be developed given sustained and appropriate instructional practices—while at the same time based on research syntheses and open to empirical investigation in future research. That is, they are plausible hypotheses, greatly constrained by the findings of research. More specifically:

Learning progressions are anchored on one end by what is known about the concepts and reasoning of students entering school. There is now a very extensive research base at this end , although much of it is not widely known or used by the science education community, which often relies on older (outdated) characterizations of preschool and elementary schoolchildren's competence from the (earlier) developmental literature.

At the other end, Learning Progressions are anchored by societal expectations (values) about what society wants middle school students to understand about science. They are also constrained by research-based conceptual and social analyses of the structure of the disciplinary knowledge and practice that is to be learned. Analysis of disciplinary knowledge is important in helping to identify the core ideas in science—those of greatest explanatory power and scope—that it may be most important to teach, because they provide central frameworks for further learning. Examples of such core ideas are the atomic-molecular theory of matter and evolutionary theories of life's diversity. In addition, analysis of disciplinary knowledge helps identify the network of ideas and practices on which those core ideas rest, and hence what will be important component ideas to develop as part of their construction.

Learning progressions propose the intermediate understandings between these anchor points that are reasonably coherent networks of ideas and practices and that contribute to building a more mature understanding. It is important to note that some of the important precursor ideas may not look like the later ideas, yet they crucially contribute to their construction. For example, realizing that objects are composed of materials and have some properties because they are made of that material is a critical first step toward understanding atomic-molecular theory. By thinking hard about what initial understandings need to be drawn on in developing new understandings, learning progressions highlight important precursor understandings that might otherwise be overlooked by teachers and educators.

The intellectual exercise of constructing learning progressions requires one to synthesize results

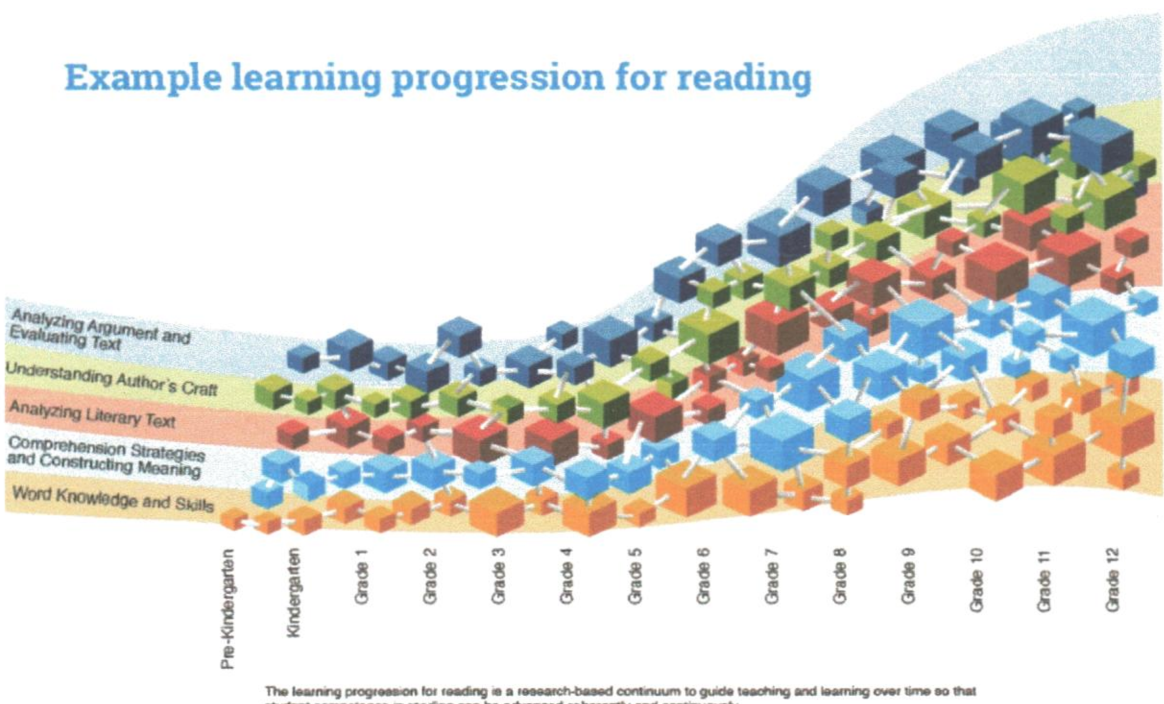

Fig. 1.1: Learning Progression in Reading

from disparate (often short-term) studies in ways that begin to address questions of how longer term learning may occur; learning progressions suggest priorities for future research, including the need for engaging in longer term studies based on best bets suggested by these research syntheses; and

they present research results in ways that make their implications for policy and practice apparent. Ultimately, well-tested ideas about learning progressions could provide much needed guidance for both the design of instructional sequences and large-scale and classroom-based assessments.

In simplified terms, learning progressions provide a teachable order of skills. They differ from scopes and sequences in those learning progressions are networks of ideas and practices that reflect the interconnected nature of learning. Learning progressions incorporate both the vertical alignment of skills within a domain and the horizontal alignment of skills across multiple domains. For example, learning progressions recognize that the prerequisites for a specific skill may be in a different domain entirely. A learning progression may also show that skills that at first appear unrelated are often learned concurrently.

Learning progressions can come in all shapes and sizes; they could describe only the steps from one standard to another, or they could encompass the entirety of a child's pre-K–12 education. It is critically important to note that there is no one "universal" or "best" learning progression. Think of it this way: With mapping software, there are often multiple routes between two points. The same is true with learning; even the best learning progression will represent only one of many possible routes a student could take. Good learning progressions will describe a "commonly traveled" path that generally works for most students. Great learning progressions will put the educator in the driver's seat and allow her to make informed course adjustments as needed.

1.2.1 Key Aspects of Learning Progression

The learning progression approach has four characteristics that are mostly absent from accounts of domain-general developmental sequences and current standards documents.

Use of the current research base: Learning progressions should make systematic use of current research on children's learning to suggest how well-grounded conceptual understanding can develop.

Interconnected strands of scientific proficiency*:* Learning progressions consider the interaction among the strands of scientific proficiency in building understanding (know, use, and interpret scientific explanations of the natural world; generate and evaluate scientific evidence and explanations; understand the nature and development of scientific knowledge; participate productively in scientific practices and discourse) and always involve students with meaningful questions and investigations of the natural world.

Organization of conceptual knowledge around core ideas: Learning progressions recognize that the first strand of scientific proficiency (understanding and using scientific explanations) involves far more than learning lists of facts. Scientific understanding is organized around conceptual frameworks and models that have broad explanatory power. The purpose of concepts is to extend understanding—to allow one to predict, understand, and explain phenomena one experiences in the world—as well as to solve important problems. It is therefore important to explicitly recognize these frameworks and to help children develop them through instruction that involves model building and conceptual change.

Recognizing multiple sequences and web-like growth*:* Learning progressions recognize that all students will follow not one general sequence, but multiple (often interacting) sequences around important disciplinary-specific core ideas. The challenge is to document and describe paths that work as well as to investigate possible trade-offs in choosing different paths.

Learning progressions can be used to inform development of standards, to guide curriculum development, to build large scale assessment, to help teachers conduct formative assessment and to help teachers in their own professional development.

One area Educational Testing Service (ETS) researchers are exploring is that of learning progressions — the stages or steps that theory suggests most students go through as they progress toward mastering an important competency, like a key concept, process, strategy, practice or habit of mind. So far, ETS researchers have developed learning progressions in mathematics, English language arts and science. The Norman O. Frederiksen Chair in Assessment Innovation holder Randy Bennett at ETS says "Researchers are trying to assemble a body of progressions that offer likely paths to proficiency in a significant portion of the domains that are taught in school."

1.2.2 Uses of Learning Progressions

Learning progressions can be used

- To inform development of standards.
- To guide curriculum development.
- To build large scale assessment.
- To help teachers conduct formative assessment.
- To help teachers in their own professional development.

TEACHER DEVELOPMENT

LPs have recognized potential for supporting teachers' preparation, practices, and professional growth (Furtak, Thompson, Braaten, & Windschitl, 2012). The promise of LPs for teacher development lies in their potential for increasing teachers' pedagogical content knowledge (Shulman, 1986) and providing them with a "pedagogical vision" (Furtak et al., 2012, p. 428), that is, a progression of content and practices that can be developed over time and a deeper understanding of how students learn and develop more sophisticated understanding in a domain, which can guide their instructional decisions. To be useful for teacher development, LPs should be accompanied by tools (e.g., assessments, feedback strategies) that support and scaffold teachers' practice (Furtak et al, 2012). The grain size of the LP should allow teachers to set goals, both for themselves and for their students, and imagine the next steps in their teaching.

Given the different characteristics of LPs needed to support these multiple potential uses, the purpose of this research was to devise a framework to serve as a tool to determine whether an LP is appropriate for its intended use(s). In the sections that follow, we discuss the development of the framework and parameters and how the parameters are related to intended uses of an LP.

STANDARDS DEVELOPMENT

LPs can provide added coherence, empirical grounding, and cognitive depth to standards (Foster & Wiser, 2012). Gotwals (2012) identified four criteria for an LP to be useful for informing standards: (a) it must cover a broad range of content and center on core ideas, which are ideas that scientists *Kobrin et al., 2015* think are important; (b) it must have a lower anchor that takes into account students' preconceptions in a domain; (c) it must have an upper anchor that is empirically shown to be attainable by students graduating high school; and (d) it must include empirically based milestones that represent the major stages of conceptual development toward the upper anchor. To be useful for informing standards, an LP also needs to have a relatively large grain size (i.e., the amount of content in a stage or level or the size of the shift between levels) and should span multiple years or grade levels.

Curriculum Development

As LPs represent hypotheses about the instruction and experiences that should effectively enable students' conceptual development, they can be used as a framework for curriculum development by helping curriculum developers understand when, and in what order and intensity, specific content and skills should be taught (Corcoran et al., 2009). In addition, student misconceptions can be linked to specific curricular activities enabling teachers to probe student understanding and address those misconceptions (Davis & Krajcik, 2005).

In order for an LP to be useful for curriculum development (and increase the likelihood of producing effective curricula with fewer cycles of testing and refinement), a strong research base is essential (Wiser, Smith, & Doubler, 2012). An LP also needs clearly defined levels of achievement (intermediate knowledge states), including a description of the lower anchor which represents the knowledge or naïve conceptions that students have before receiving instruction. The lower anchor is especially important because LP-based approaches to curriculum design assume "not only that students' initial ideas are meaningful but also that they are the only basis on which to build further understanding" (Wiser et al., 2012, p. 397). Many researchers agree that instruction-assisted learning is an important component of an LP (Duschl, Maeng, & Sezen, 2011); however, not all LPs include specific instructional interventions. In most cases, a wide range of curricular sequences could be derived from a single LP. Therefore, it would be pragmatic to empirically examine different curriculum sequences to determine which are most successful in helping students move to higher levels of the LP.

1.2.3 How learning progressions help teachers teach

If we take an example that learning progression for proportional reasoning (or ratios) starts at the first level with qualitative reasoning, where a student can make general judgments about ratios. Level two demonstrates progress to simple quantitative reasoning. By level three, the student can use multiplicative reasoning, and by level four, the student is able to flexibly select from a range of strategies to work with ratios. When it comes to developing proportional reasoning, research shows that children might incorrectly believe that five-sixth is equal to two-thirds since the two quantities in each ratio differ by one, says Leslie Nabors Oláh, a Managing Research Scientist at ETS. "It's very important for teachers to understand the thinking behind this 'wrong answer,'" Oláh says, "because they can then know how to address this misunderstanding with instruction."

The ratio example shows very well how using developmental research can help teachers plan curricula better. Teachers also can gain information about their students' progress that can help them better differentiate instruction. In addition, assessments developed through a learning-progressions model can more accurately identify areas in which students may be struggling. This process helps teachers better understand what students need so that they can apply an appropriate intervention.

Learning-progressions information can be especially helpful for teachers of students who are underperforming. These teachers can find it "quite depressing" to view their students' performance only through a standards-based test lens, says Oláh. "You talk about things like, 'Oh, 80 percent of my kids are not meeting the standards.'" On the other hand, learning progression tests can show that students do have some precursor skills and may be making progress so teachers can see areas of understanding from which to build.

Caroline Wylie, Research Director at ETS says, however, not all or even many teachers know about learning progressions. She says the subject is not often taught in schools of education, although ETS sometimes does professional development workshops for teachers on the topic. Often when we show learning progressions to teachers, there is this moment of recognition 'Oh, right! I've seen that!' but maybe they haven't had a name for it says Wylie. "For me essentially that am what learning progressions are, a way of providing teachers with these schemas for not just how the topics connect together, but showing how expertise within the topic develops."

ETS is working on developing more "teacher-facing" educational material about learning progressions, says Wylie. The teachers should shift from, 'This is a correct answer; this is an incorrect answer to more nuanced thinking: 'OK, so this is the kind of understanding that students have right now; how do I build on that understanding to move them along to deepen their learning?'"

1.2.4 How does one can use a learning progression?

To get the most out of a learning progression, an educator must first understand how learning progressions relate to assessment and instruction. Returning to our roadmap metaphor, academic standards describe the places students must go. Learning progressions identify possible paths students are likely to travel. Instruction is the fuel that moves students along those paths. And assessment is the GPS locator—it tells educators exactly *where* students are at a specific moment in time.

Great assessments will also show how fast those students are progressing, if they're moving at comparable speeds to their peers, and whether they're accelerating or decelerating—and may even predict where they'll be at a future time and if they're on track to reach their learning goals. When an assessment is linked with a learning progression, a student's score places them within the learning progression. While the assessment can identify which skills a student has learned or even mastered, the learning progression can provide the educator insights into which skills a student is likely ready to learn. It answers the question, "What's next?"

Learning progressions show the way forward

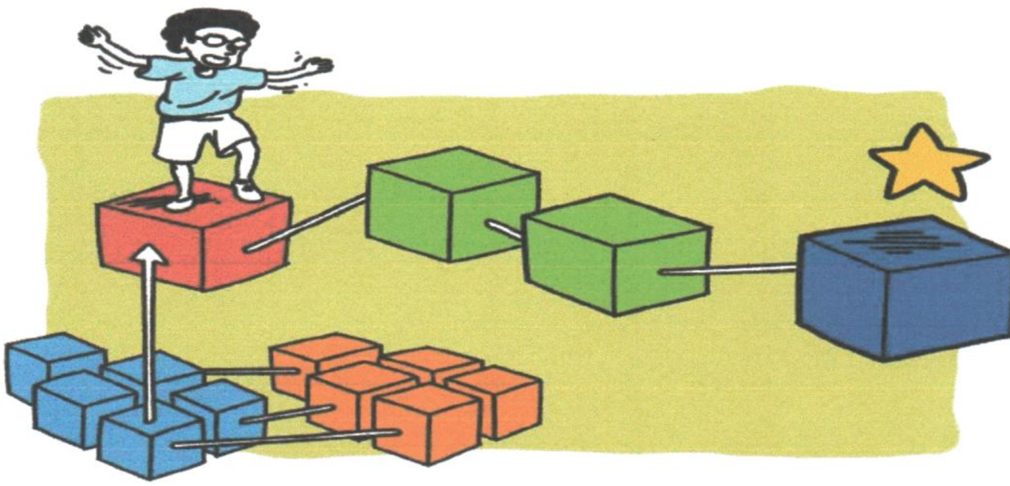

Fig. 1.2: Learning Progression showing Forward Steps

In this way, learning progressions provide a way for assessments to do more than just report on learning that has occurred so far. As Margaret Heritage and Frederic Mosher have stated, "if assessments are seen as standing outside regular instruction, no matter how substantively informative and educative they are … they are very unlikely to be incorporated into and have a beneficial effect on teaching." Learning progressions are how assessments get "inside" instruction. The combination of the two allows assessments to meaningfully inform instruction.

Educators can use learning progressions to plan or modify instruction to make sure that students are getting the right instruction and content at the right time. If an educator knows she needs to teach a specific skill, she can use the learning progression to look backward and see what prerequisites are needed for that skill. She may also seek out other skills that can be taught alongside her selected skill for more efficient and interconnected teaching, avoiding the repetitious learning than can occur when individual skills are taught in isolation.

For a student who is lagging far behind peers and needs to catch up quickly, a learning progression can identify which skills are the "building blocks" that students need not just for success in their current grade but to succeed in future grades as well (for example, a student will struggle to progress in math if they cannot multiply by 5, but not knowing how to count in a base-5 or quinary numeral system is likely to be less of a roadblock). As a result, the teacher can better concentrate her time and instruction on these focuses skills to help the student reach grade level more quickly.

Well-designed learning progressions are often paired with useful resources, such as detailed descriptions or examples of each skill, approaches to teaching the skill for students with different learning needs (such as English Language Learners), information about how the skill relates to domain-level expectations and state standards, and even instructional materials to help teach the skill as well as activities that give students practice with the skill.

Having assessments and resources linked directly to skills within the larger context of the learning progression is ideal for personalized learning, as it allows for educators to quickly see where students are in relation to one another and to the larger learning goals, determine the next best steps to move each student's learning forward, and find tailored resources that match a student's specific skill level and learning needs—and ensure that all students are consistently moving toward the same set of grade-level goals, even if they are on different paths.

However, not all learning progressions are well designed—and even an exceptionally well-designed learning progression may lead you and your students astray if it's not designed to meet your specific needs and goals.

1.2.5 Finding the right learning progression

The key is finding a learning progression that's not just well designed—it should also be designed in a way that matches how you will implement and use it with students.

First, it's very unlikely that you will be selecting a learning progression as a stand-alone resource. Moreover, your learning progression should be tightly linked to your assessment—otherwise you will have no reliable way to place your students in the learning progression. This means that evaluating learning progressions should be a nonnegotiable part of your overall assessment selection process.

What about assessments without a learning progression? Learning progressions are how assessment data gets "inside" instruction; without a learning progression, it is difficult for assessment to meaningfully inform instruction. Outside of summative assessments—designed to report on past learning rather than guide future instruction.

With that in mind, we should look for a high-quality learning progression that is:

- Based on research about how students learn and what they need to learn to be ready for the challenges of college, career, and citizenship

- Built and reviewed by educational researchers and subject matter experts, with guidance and advice from independent consultants and content specialists
- Empirically validated using real-world student data to make sure the learning progression reflects students' actual (observed) order of skill development and that assessment scores are appropriately mapped to the learning progression
- Continually updated based on new research, changes in academic standards, ongoing data collection and validation efforts, and observations from experts in the field

However, even the highest-quality learning progression in the world may be a poor choice if it's not actually a good fit for your specific needs. In the United States, one of the biggest and most important factors impacting fit is state standards.

Just as there is frequently more than one route to a single destination, there are many skills that can be taught and learned in different, equally logical orders. Different states often choose different orders for the same skills, some add skills that others remove, and many call the same skill by different names. Each learning progression presents one *possible* order or "roadmap" of learning—but that doesn't mean it's the *only* order out there or that it necessarily matches the order found in your state's standards.

Fig. 1.3: Foundation of Learning Progression

"There is no single, universally accepted and absolutely correct learning progression." — W. James Popham

Using a learning progression that is built for another state can be a bit like trying to navigate your way around one state using a map of a completely different state. Some may find it quite difficult to reach their destination in time.

Learning progression should be a helpful tool that suggests a logical, easy-to-follow route to success with state standards. It should not be an obstacle course that forces to constantly zig and zag between another state's requirements and own state's standards.

Taking things one step further, learning progression should support a flexible approach to learning. After all, one knows their students better than any learning progression ever will. The learning progression doesn't teach students. It won't monitor their work to see if they understood the concept taught yesterday. It can't decide what is a realistic goal for a student. Only the teacher can do that. But learning progression should make doing all of that easier.

"It is what the teachers actually do in the classroom that is ultimately responsible for 'learning' in our schools."
— Mark Wilson

Look for learning progressions that one can interact with—one should be able to look forward and backward within the learning progression to understand how skills can develop. One will want to be able to search for specific skills or standards across the entire learning progression and then find related resources. Their learning progression should also allow bundle of skills together for instructional purposes, or ungroup any skills to teach discretely if need be. After all, the learning progression is only the roadmap— a teacher is the one actually driving the car.

1.2.6 Challenges in Designing a Learning Progression

In the development of learning progressions that are research-based and reflect the variety of ways that children can learn meaningfully about a topic, there are three challenges, none of which can be completely overcome with the existing research base:

- Describing a student's knowledge and practice at a given point in the learning progression,
- Describing a succession of ways students can understand a topic that shows connections between ways and respect constraints on their learning abilities.
- Describing the variety of possibilities for meaningful learning for students with different personal and cultural resources or different instructional histories.

We discuss each of these challenges below.

We wish to develop descriptions of students' knowledge and practice that will ultimately include all four strands of scientific proficiency and that recognize the complex organization of meaningful scientific knowledge and practice. Furthermore, we would like to describe children's knowledge and practice in ways that help us to see the continuities—and the discontinuities—between the reasoning of children of different ages. Inevitably, these descriptions must fail in some way; no organizational scheme can fully capture the organization of a child's knowledge or its connections with her practices, with systems and phenomena in the material world, and with developmental changes over time. The various approaches to describing core ideas and strands in children's reasoning discussed in this book represent various compromises that emphasize some aspects of the organization of their reasoning while obscuring others.

In addition to describing children's knowledge and practice at a given age, learning progressions aspire to describe how that knowledge and practice could change over time, with successive understandings representing an achievable advance from earlier ones. This presents multiple challenges. We wish to describe both continuities and discontinuities in children's thinking, as well as successional trends over time. The choices we make will inevitably emphasize some of those continuities and discontinuities while obscuring others. In addition, each phase must represent an achievable advance from the one before. The strongest evidence for a suggested advance comes in the form of teaching experiments that demonstrate how students can move from one set of understandings to the next or longitudinal studies showing systematic progressions in students' understanding. When this kind of empirical evidence is not available, we can suggest stages that represent reasonable advances across all four strands of scientific proficiency.

Finally, no single learning progression will be ideal for all children, since they have different instructional histories, bring different personal and cultural resources to the process of learning science, and learn in different social and material environments. The best learning progressions are those that make effective use of the resources available to different children and in different environments. This is the challenge that we are farthest from responding to effectively with the current research base.

1.2.7 Alignment with standards

Another part of research into learning progressions maps them to standards, such as the Common Core State Standards or alternative state standards. Learning progressions and state standards are not the same, says Oláh. "The standards are where you need to get to," she says. "The learning progressions are a way to think about how students get there."

It can be challenging to align to the standards sometimes, because there is "not a grade-to-grade equivalent" with learning progressions. Students may be expected by the Common Core to know particular elements of fractions by a certain grade, for example, but conceptually that might be more challenging than other aspects at a later grade.

Going forward, researchers are looking at how to identify and expand lower levels of progressions to help underserved and underperforming students. When a learning progression is created, it describes the skills and understandings that students are expected to have at each stage on their path to mastery. The skills and understandings broken down into more specific information about what the student has mastered and what he or she still needs to know.

"We'd like to be able to try and differentiate students who are at level one more finely," says Bennett, "so that we can better describe to teachers what it is they know, and are able to do, and what it is that might be valuable for them to work on next." "We have resources for teachers that articulate what learning-progression skills are and how they develop," says Wylie. "And we have tasks to give teachers that go along with those resources that are not just worksheets for rote learning but problems that students can more deeply engage with."

A big advantage of learning progressions is that they reflect student abilities "across a wide continuum of achievement levels, whether a student is on grade-level or not," says Laitusis. "You can't advance education or assessment without the building blocks of where you are going and what the purpose is. "Learning progressions," Laitusis continues, "provide a framework for identifying and arranging those building blocks."

1.2.8 How Can Learning Progressions Support Teaching and Learning of 21st Century Skills?

"By its very nature, learning involves progression," stated Margaret Heritage in a 2008 paper written for the Council of Chief State School Officers (CCSSO). Much learning tends to follow an expected path—or progression—where more complex skills are built on foundational skills. For example, gross motor development in the early years tends to follow a typical trajectory. First, children learn to sit on their own, then crawl, then stand and then take some steps before taking off and running. Not all children will do this of course—some may go from sitting to standing without crawling in between! Also, not all learning develops in a nice predictable linear pathway—sometimes a separate, but inter-related area of learning needs to act as a trigger for us in our current learning. Not with standing, in many areas of learning, such as science, we have been able to use knowledge of learning paths in traditional academic learning to structure curricula.

And here is the rub. We don't know a great deal about the "typical" development of many of these 21st century skills in which society is currently interested. Much less is known about how 21st century skills progress from basic forms to complex forms than we know about literacy or numeracy. Therefore, we don't currently have the roadmaps for guiding teachers in what might be expected of students at different levels of skill, and how they might move students from one level to the next.

Although we develop many transferable skills naturally as we mature, the views of global organizations and employer groups are that many of our school graduates have not developed these sufficiently to contribute in a changing and dynamic world. Education systems now need to deliberately design a new teaching approach to ensure that not only the skills are modeled in the classroom, but that there is also an opportunity to provide more explicit teaching of these. We need to move beyond stating, "We want students to be good collaborators or good problem solvers" to asking, "What do we mean when we say collaboration or problem solving? What does that look like? How should we expect students to develop and change over time?"

1.3.0 SCIENTIFIC ATTITUDE

In order to determine the learners' quality, the important parameters are scientific attitude, scientific aptitude and scientific knowledge. These parameters also significance in mastermind the experimental studies in the current scientific world. Learning science not only holds its importance in scientific contemporary society but also helps in building the nation. Scientific thinking and attitude towards science is necessary to develop scientific knowledge. Scientific attitude may be an act in a certain way or expression of feelings or thoughts. Honesty, objectivity, respect for evidence, open-mindness, critical thinking, questioning attitude, logical thinking, tolerance of uncertainty, willingness to change options etc are the attributes of scientific attitude.

Study of science develops our reasoning power, concentration, imagination and fiction less attitudes. Science doesn't accept anything without proof which triggers genius minds to think about new concepts and to prove them using their intelligence. Both quality and quantity of different elements of life can be improved by science. Science also can be defined as the organized body of knowledge which attempts to explain all natural and manmade phenomena. Kothari commission has clearly mentioned in their report that, "Science and Mathematics are the subjects that should be taught on a compulsory basis to all pupils as a part of general education during the first ten years of teaching." One of the main objectives of science learning is to inculcate scientific attitude. There is a scale for measurement of attitude of students toward science called science attitude scale. The main purpose of the scale is to know if the pupil have developed favorable attitude towards science learning or not. Thruston defined attitude a combination of both positive and negative objects associated with some psychological aspect. A psychological aspect according to him may be a person, a religion, a community, an institution, a system, a minority community or a political party.

1.4.0 STATEMENT OF THE PROBLEM

Today's education is basically focusing on quality education and overall development of child. Since science is a subject which often think as a difficult one for most of the students and hence they develop a fear towards it. There is many more development in the educational pedagogy and new techniques are developed to make the lessons easier for the child. There is a need of studying the mentality of the students and the problems they are facing in ground level.

Also in the locality, where I was conducting the research is the area where I was born and had my secondary education. I also faced many problems during my study days like understanding the concepts easily rather than rote learning, hearing the teacher's voice clearly, communication with teachers, practical knowledge rather than theoretical concept etc. To have a better understanding in science specially one should have learn its practical aspect and do the experimentation, but due to lack of infrastructure, teaching learning resources, scientific instruments and a proper science lab , it becomes difficult for a teacher to teach science.

Science is an very easy subject if explained and understood the basics of it, but students often find it difficult may be due to lack of interest, which is because they are unable to understand the concepts of science well. To make them understand the concepts we can take help of the TLMs, ICT, different scientific models, movies etc. it is necessary to choose a material wisely as per the student's interest while teaching science.

By studying their progress in learning science, we can have a constant eye on them, by which we can learn where the problem lies and which scientific concepts are often find difficult by the students and why. We can also study the individual differences among the students, which will help us to plan accordingly. So I decided to have a study to see if now also same problem present among the students regarding science and use some techniques to see if they worked to solve the problem and studied their progress basically in science subject.

1.5.0 RATIONAL OF THE STUDY

Vidan Gynnild (2017, Learning analytics and task design in science education) explained that generally students were successful at conducting calculations, but struggling when being asked conceptual and theoretical questions, further analysis demonstrated a lack of alignment between tasks posed in exercise and at the exam. Due to some interventions like change in curriculum, a theoretical midtermtest etc failure rates were greatly reduced.

Ivan Salinas (2009, Learning progressions in Science evaluation: two approaches for development) identified two approaches for learning progression. 1st approach constructs a progression in terms of levels, being its extreme the lower anchor and upper anchor and having a strong empirical component in the depiction of the progression. The 2nd approach have stronger analytical component to define and construct the progression, presenting connections among elements of the progression by levels and threads while resting mainly in previous research for validating its analysis of progress on learning.

Bransford, Brown and Cocking (2000, Advances in research) stated how people learn are increasingly related t the practice of teaching. Learning progression is an useful tool for describing the steps of learning of a specific topic.

Claesgens, Scalise, Draney, Wilson and Stacy (2002) developed a project called "Living by Chemistry" for the secondary school level. The purpose was to bring conceptual change theory into practice in the teaching and learning of chemistry. The framework focused on describing the progression of student understanding.

1.6.0 OBJECTIVES

- ✓ To study the learning progression in science of class 9th students of Jajpur district.
- ✓ To study the attitude towards science of class 9th students of Jajpur district.
- ✓ To study the effect of Treatment, Gender and their interaction on Achievement in Science of Class IX students by taking their previous year Achievement in Science as covariate.

1.7.0 HYPOTHESIS

- ➢ There is no significant effect of Treatment on Achievement in Science Subject of Class IX students when their Pre–test Scores of Achievement 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 Achievement 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.

1.8.0 DELEMETATION OF THE STUDY

The study will be conducted under the following constrains-

- The student will be selected randomly from the selected schools of Jajpur district
- The contents will be restricted to class 8th Science syllabus prescribed by Govt. of Odisha.
- Only 45 days treatment will be provided.
- The sample will be limited to the students of Jajpur district.
- Medium of instruction will be odia.
- Lesson plan will be developed in Odia.

1.9.0 OPERATIONAL DEFINITIONS

Learning analytics: Learning Analytics is an approach that is the collection, analysis and reporting of performance data for the purpose of understanding and optimizing learning outcomes.

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.

Scientific Attitude: In the present study, scientific attitude refer to the scientific attitude and scientific temper how help them and how the practices used by the students of IX standard in solving the scientific inquiries in science.