CHAPTER - II

REVIEW OF THE RELATED LITERATURE

The field Learning Progression in Research is a new field, which requires much attention as it is very important to know about the progress of a child. By recording the progress one can see if the techniques and tools, they are using working or not. There are some works that some researchers did which are really nice. Some of them are -

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 midterm test etc. failure rates were greatly reduced.

Ivan Salinas (2009, Learning progressions in Science evaluation: two approaches for development) identified two approaches for learning progression. 1^{st} 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 2^{nd} 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 to the practice of teaching. Learning progression is a 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.

Masters and Forster (1996, as quoted in Hess, 2008) stated learning progressions as "a picture of the path student typically follows as they learn a description of skills, understandings and knowledge in the sequence in which they typically develop.

Wilson and Berthental (National Research Council, 2006) defined learning progressions as descriptions of successively more sophisticated ways of thinking about an idea that follow one another as student learn, they layout in words and example what it means to move towards more expert understanding.

Pierson, Clark and Kelly (2019) in their paper "Learning Progressions and Science practices: Theories of practicing content, epistemic practices and social dimensions of learning" explains well about learning progressions and practice oriented science education. They supported the development of science practices and also suggested ways for next steps and future research in this field.

In science education research, this practice turn requires careful consideration of the ways that students can be situated in social contexts to support the appropriation and transformation of disciplinary knowledge and practices (Ford and Forman 2006; Engle and Conant 2010). In order to facilitate the design of learning environments that support students in developing disciplinary practices and epistemologies, researchers have proposed learning progressions for science practices. For example, the Next Generation Science Standards offer developmental trajectories for each of their eight Science and Engineering Practices (NGSS Lead States 2013). As another example, Schwarz and colleagues have developed and refined a learning progression for modeling epistemologies and practices (Fortus et al. 2016; Schwarz et al. 2009; Schwarz et al. 2012).

Guy-Gaytán, Gouvea, Griesmer, and Passmore explain that learning progressions shape curricular materials, which in turn affect students' development of science practices, and they propose that learning progressions could be further leveraged to support the enactment of these curricula in the context of teacher professional development. They argue that researchers and curriculum developers need examples of what science practices look like in classrooms; otherwise, they will struggle to design curricula that support authentic engagement in science practices, particularly in terms of supporting students' epistemic agency. Focusing on the practice of modeling, Guy-Gaytán and colleagues illustrate tensions between curriculum developers' aims to engage students in modeling as an epistemic practice and teachers' aims to ensure that students are learning about scientific content. They argue that while learning progressions may be useful in designing curricula to support epistemic practices, the enactment of those curricula may not align with curriculum developers' objectives. Specifically, they illustrate the ways that teachers' enactments of practice-oriented curricula can be characterized as what Miller et al. (2018, p. 1056) have described as "complacent enactments" of the practice-oriented instruction, positioning students as passive recipients of science concepts rather than as active collaborators in the creation of new content.

Hardahl and colleagues' stance implies that learning progressions could be developed to describe a linear process through which students' ideas about producing phenomena might progress. These learning progressions would likely attend to students' epistemic understandings of the role of materiality in producing phenomena. Rather than creating learning progressions that frame producing phenomena as explicit content, another approach might acknowledge that there are important aspects of science learning, like producing phenomena that extend beyond content learning and that researchers and educators should attend to these practices in their designs for learning and in their analyses.

Hardahl, Wickman, and Caiman raise concerns about the ways that traditional representations of science learning background important aspects of science practice. They argue that students' practices for producing phenomena are often overlooked in science education research, even though producing phenomena is a key component of professional science. To foreground this component of science practice, Hardahl and colleagues argue that materiality should be explicitly addressed in science teaching and in designs for learning. They argue that practices for producing phenomena, including practices related to tinkering and manual labor, should be explicitly taught as physics content. They argue that this approach makes tacit content accessible to all students and also helps them understand how knowledge is created in science and technology fields.

Pandiavadiru P. and Sridhar R. (2016, Conflux Journal of Education) in their paper shared the result of their research work, where they measured student's scientific attitude, aptitude and knowledge at the secondary level for further research work in determining learner's quality and also their mastery in experiment studies in the present scientific world.

Merrit et al. (2008) proposes a learning progression regarding the Particle Model of Matter for sixth graders. The purpose of the study was to describe the changes in students understanding of the Particle Model of Matter during the implementation of an eight-week model-based curriculum. The researchers started by developing a learning progression according to prior research and science logic. Pre and post- tests were designed in order to monitor students' performance. They continued by applying the eight-week unit called "How can I smell things from distance," which is part of the Investigating and Questioning our World through Science and Technology (IQWST) project (Krajcik, McNeill & Reiser, 2008), and gathering data about how students construct and change models of the nature of matter during that time span, and b) activity sheets they could collect (43 total). The next step was analyzing students' pre- and post- tests, the 43 activity sheets, and the models constructed by students at three different moments during the development of the unit: in lessons one, five and fifteenth.

Tai and Sheppard (2009) described their work on developing a learning progression for students' understanding of combustion. They used a cross-age design and a questionnaire having knowledge and cognitive abilities questions applied to 1,237 Taiwanese students from grades sixth trough twelve and university students. Based on the responses, the researchers found six patterns of progression in students' understanding of combustion, called 1) gradual increase, 2) stepwise increase, 3) persistent misunderstanding, 4) early misunderstanding, 5) varied misunderstanding, and 6) reverse-V understanding. The patterns are the interpretation of the graphics resulting from plotting students' grade level against percentage of correct answers in the questionnaire. The researchers focus on analyzing the age-related and non-age-related patterns, but the authors do not present a learning progression. Furthermore, they use the term conceptual trajectories as synonym to learning progression.

Bindia Rani(2018) in her paper titled "science attitude analysis among secondary school students of Yamunanagar region in relation to their achievement in general science" analyzed her research findings and stated Science as an important part of our life for which it has made an integral part of curriculum. Teaching of science is not purposeful if it fails to develop the scientific knowledge, scientific attitude, various skills and methods to solve problems in day to day life. Science has helped in developing various values like intellectual value, practical value, cultural value, vocational value and democratic value which make a one complete human being of better value. Sometimes, there is more achievement in science among students, but they do not possess positive scientific attitude. This justifies the importance of study the attitude of students towards science in relation to their achievement in general science. In the present investigation, no significant relation between science attitude and achievement in general science among rural high school all students Boys only Girls only has been observed.

Schweingruber, 2006 explained educational policy, the Learning Progressions are powerful for re-envisioning standards, large scale and classroom assessment, curricula, and instruction grounded in current research on science learning. Developing future standards based on Learning Progressions could give a more accurate account about what research says regarding students learning and how that links with the expectations posed by societal institutions. For example, Krajcik, Shin, Stevens, and Short (2009) have proposed the necessary requirements in order to link Learning Progressions to inform K-12 coherent curriculum development. In another example, progress maps in Chile, despite their alignment with the definition of Learning Progressions, could be taken as an initial effort in order to promote a shifting toward more research-based classroom practice.

Progress map is a term that provokes confusion because of its relation to the topic. Masters and Forster (1996) discussing on developmental assessment stated that "a progress map describes the nature of development in an area of learning and thus serves as a frame of reference for monitoring individual growth." Pellegrino, Chudowsky and Glacer (2001) understand progress maps as models of learning which intention is to serve as a basis for the design of both large scale and classroom assessment. "Progress maps provide a description of skills, understandings, and knowledge in the sequence in which they typically develop a picture of what it means to improve over time in an area learning" (Pellegrino et al.). Wilson and Bertenthal (NRC, 2006) define a progress map as "a continuum that describes in broad strokes a possible path for the development of science understanding over the course of 13 years of education. It can also be used for tracking and reporting students' progress in ways that are similar to those used by physicians or parents for tracking changes in height and weight over time".

Conceptual trajectory is another term, used by Driver, Leach, Scott, & Wood Robinson (1994) in reference to cross-age curricular studies. Drawing from an evolutionary perspective, learning in a domain can be seen as a "progress through a sequence of conceptualizations which portray significant steps in the way knowledge within the given domain is represented" (Driver et al.,) which is called conceptual trajectory. In Driver et al.'s words, the conceptual trajectory does not describe individual pathway in reasoning, but indicate broadly "the nature of the changes in reasoning which may be demonstrated by students in particular curricular settings." This term, as said before, has also been used as synonym with Learning Progressions (Tai & Sheppard, 2009), which may led to confusion about how to use the term Learning Progressions. However, there is some research associated with the term, which may be worth to compare and contrast to the increasing body of research that has been associated with Learning Progressions.

Rajib Mukhopadhyay (2013) explained well the importance of conducting scientific attitude, scientific aptitude and scientific knowledge are the vital parameters in order to determine the learners' quality and also significance in mastermind the experimental studies in the present scientific educational world. The significance of science learning is more important in the context of the scientific contemporary society and also helps learner to contribute significantly for the development of nation.

To develop knowledge and field of science, inculcation of scientific attitude, scientific thinking and attitude towards science is essential was defined by Ram Niwas *et al.*, 2015.

A study conducted by University of Alberta concluded that scientific attitude is a disposition to act in a certain way or a demonstration of feelings and or thoughts. The attributes of scientific attitudes are honesty, objectivity, respect for evidence, open-mindedness, critical-mindedness, questioning attitude, tolerance of uncertainty, willingness to change opinion etc.

Thruston (1948) defined attitude as the degree of positive and negative effect associated with some psychological object. A psychological object, according to him, may be a person, a religion, an institution, a community, a system, a minority community or a political party. Many attitude scales were prepared in past time decades to study the attitude of people towards such issues as co-education, capital punishment communism, U.N.O. etc. Various scales for measuring attitudes of teachers towards teaching (Ahluwalia, 1976), guidance services (Baker, 1967), towards science and scientists (Sood, 1975), towards microteaching (Passi & Lalitha, 1977) have been given. The scales for measuring the attitude of students and teachers towards academic disciplines have also become popular.

Mosher (2011) noted that LPs can provide evidence to the education system on what is reasonable to expect from most students, which may not only inform standards, but can also facilitate discussion of what kinds of resources and instruction are realistic to help most of them meet higher standards. However, Foster and Wiser (2012) clearly described the challenges in using LPs to inform standards, citing the standards revision process undertaken by the Massachusetts Department of Education in 2009. For example, one key challenge was establishing the upper anchor because there was tension between aspirational statements regarding what students should know at certain points in time and empirical evidence showing what students can realistically master in those timeframes.

As noted in several national assessment policy documents like National Research Council, 2006 and National Assessment Governing Board, 2011, LPs can be very useful for assessment design and are being recommended for new large-scale assessment frameworks, including the National Assessment of Educational Progress and assessments based on the Next Generation Science Standards.

Alonzo, Neidorf, & Anderson (2012) stated that LPs may be used to align large-scale assessments with current research on how students learn and may represent a new vision where assessments are organized around a smaller number of core concepts that show continuity across grade levels and are assessed in greater depth.

Alonzo et al. (2012) provided other cautions in implementing an LP-based approach to large-scale assessment systems, citing key conceptual and procedural differences in item development, item analysis and evaluation, the design of operational assessments, and scoring and reporting. For example, large-scale assessment items are typically developed using pre-determined specifications.

Conversely, an LP-based approach to item development requires an iterative process whereby items are developed and pilot tested, and data are used to refine both the items and the LP itself. In addition, large-scale assessments typically have broad content coverage and items are developed to adequately cover the content domain. In contrast, LP-based assessments require overrepresenting specific or discrete content areas to get adequate measurement for each achievement level on the LP.

Chatti et al. Greller and Drachsler identified six critical dimensions of leaning analytics that need to be covered by the design to ensure use of learning analytics in an "educationally beneficial way". Another conceptual four dimensional framework proposed by Martinez et al. provides guidelines how to design learning analytics technologies that will address orchestration challenges utilizing data from interactive surfaces. Finally, a new conceptual framework (Orchestrating Learning Analytics - OrLA) is proposed to overcome the gap in the adoption of learning analytics innovations by supporting inter-stakeholder dialogue at the practitioner level.

As an emerging field of study, an increasing number of case studies relevant to the implementation of LA in higher education have been published. However, only a small number of reviews summarize these individual case studies. Among them, Dyckhoff (2011) reviewed the research questions and methods of these studies. The findings showed that existing studies have focussed on six types of research questions: qualitative evaluation; quantitative measures of use and attendance; differentiation between groups of students; differentiation between learning offerings; data consolidation; and effectiveness. The research methods used include online surveys, log files, observations, group interviews, students' class attendance, eye tracking, and the analysis of examination grades. Based on the results, suggestions were given on LA indicators for improving teaching.

Papamitsiou and Economides (2014) focussed on the impacts of LA and educational data mining on adaptive learning. They reviewed the experimental case studies between 2008 and 2013, and identified four distinct categories, namely, pedagogy-oriented issues, contextualization of learning, networked learning, and the handling of educational resources.

Also, Nunn et al. (2016) discussed LA's methods, benefits, and challenges. It was found that the methods used included visual data analysis, social network analysis, semantic analysis, and educational data mining. The benefits of LA were seen to revolve around targeted course offerings; curriculum development; student learning outcomes; behaviours and processes; personalized learning; improvements in instructor performance;post-educational employment opportunities; and enhancement of educational research. The challenges included the tracking, collection, evaluation and analysis of data, as well as a lack of connection to learning science, the need for learning environment optimization, and issues concerning ethics and privacy.

Focussing on computer science courses, Ihantola et al. (2015) surveyed LA case studies in terms of their goals, approaches, contexts, subjects, tasks, data and collection, and methods of analysis. The goals were related to students, programming, and the learning environment. The approaches included case studies, constructive research, experimental studies, and survey research. They also found that most of the research work was undertaken in a course context, with the number of subjects ranging from 10 to 265,000, with 64 per cent of the studies having 500 or fewer subjects. In most of the studies, students were required to complete multiple programming tasks. Over 60 per cent of the studies used automated data collection that logged students' actions, and a variety of data analysis methods such as descriptive and inferential statistics.

Since its first mention in the Horizon Report 2012 (Johnson et al. 2012), Learning Analytics has gained an increasing relevance. Learning Analytics is defined as "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". Another definition given by Siemens (2010) stated "the use of intelligent data, learner-produced data, and analysis models to discover information and social connection, and to predict and advise on learning".

The Horizon Report 2013 identified Learning Analytics as one of the most important trends in technology-enhanced learning and teaching. Therefore, it is not surprising, that Learning Analytics is the subject of many scientific papers. The research and improvement of Learning Analytics involves doing the development, the use and integration of new processes and tools to improve the performance of teaching and learning of individual students and of teachers. Learning Analytics focuses specifically on the process of learning.

Due to its connections with digital teaching and learning, Johnson et al.(2013) defined Learning Analytics as an interdisciplinary research field with connections to the field of teaching and learning research, computer science and statistics. The available data is collected, analyzed and the gained insights are used to understand the behavior of the students to provide them additional support.

Greller et al. (2014) stated that key concern of Learning Analytics is the gathering and analyzation of data as well as the setting of appropriate interventions to improve the learners learning experience. Campbell et al.(2007) introduced "actionable intelligence" from data mining, which is supporting the teaching and learning and provides ideas for customization, tutoring and intervention within the learning environment.

After reading all the related literature about the topic Learning Progression, I found that there is very less work held in this field especially in India. So I thought it will be good to work in this field as it has more scope and also the results and findings may be helpful and beneficial for the student's development and society.