



Elevating Science Education through Indigenous Teaching Practices

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Abstract: *Science is connected with individual's life as learning of science facilitates individual to become more critical and creative. For effective learning of science involvement of students with multi-sensory. As a result, learning of science education is always emphasized in India. In Indigenous knowledge and practices, Science education is deeply rooted. For the concepts learning, the learning style of the learners was emphasized, by considering it teaching strategies were selected. Teaching practices were more directed towards the holistic development of learners, in science education also these practices were pretended for better learning outcomes. More discussion and debate among the learners enhance their mental capabilities to think beyond a certain level. Indian knowledge system explicated teaching strategies associated with multiple philosophies. Nyaya philosophy was reflected in science education because the characteristics of both are logical reasoning of the concepts. Presumption, observation, analogy and verbal association are the techniques of reasoning which are related to science education. These techniques and its application in the subject makes more contextualization of indigenous science education, research trends in the teaching practices of science education also provides the base of applicability of science education in the modern scenario. Research trends make the similarity to the indigenous teaching practices of science and provides the scope of improvement in science education. Guru Shishya tradition has the cultural background which imbibes the values and ethics in learners. In this paper elevation of science education through the realm of Indigenous glance with current scenario of it, is given in detail.*

Keywords: *Science Education, Indian Knowledge, Indigenous Teaching Practices.*

Introduction: The Science Education field is expanding day by day with the continuation of discoveries and innovations being done across the world. In this rapid scenario of Science and Technology the innovations have reached the point where they can easily replace the human beings; as it already crossed the strength and tendencies of the human beings. With this dynamic nature of science, applicability of science is highly recommended to uphold the working pattern of the people and the society. Some new innovations are based on the central theory of the indigenous literature. As the atomic theory is based on the theory of Rishi Kanad on atoms and in Vaisheshik Darshan he described about Gravity. It is proven in numbers of research studies that the root of science education is deeply accumulated with Indian Knowledge and Values. Teaching of this prestigious science education required innovative techniques and methods of teaching which are based on indigenous practices. It can be demonstration, activity based, inquiry based, problem solving, higher order thinking, story-telling with examples, experimentation, abbreviation making, discussion, puzzles, exhibition, frequently asked questions with answers, field visit and so forth techniques and methods used to enhance the

interest to learn and to teach science education. These methods and techniques are more beneficial than the lecture method; as it utilises multiple senses in the process of learning. Applicability of science education in real life is totally based on the awareness and practices of science. As the current scenario of digital and modern technology leads to the modern practices of teaching science like demonstration through video, coding and programming.

Indigenous realm of Science Education: Since the ancient time period Science is the leading subject in the view of Vedic literature. Interconnections among the nature consists sky, seas and earth with the living beings; there must be a balance among all to sustain living organisms. The Indian Vedic and Non-Vedic literature were diverse in its rich content and specifically science the foremost subject to interlink with other subjects. Atharva Veda, Ayurveda, Yajurveda, Charak Samhita, Sushrut Samhita, Rasa Shastra, Mahabharat, Vaisheshika Darshan, Brihat Samhita and Dhanavantari Shastra are the rich source of science. Concepts of science are rooted in the scriptures of ancient India like, formation of rainbow, properties of metals, mining process of metals, purification of gold, making of alloy, machineries, planets and its movement, circumference of earth, comets, moon and its position, cause of eclipse, centre of solar system, solar energy, aeronautical science, protection of aircrafts, manufacture of fabric, stambhyantra, extraction of mercury, pathology, embryology, arteries and its functioning, flow of blood, cross section of iris, plastic surgery of nose, intestinal surgery, kidney stone removal, test tube baby concept, osmosis, photosynthesis and many more are the essence of the science education.

Indigenous Teaching Practices for Science Education: Basically, in education three parts are important for the process of teaching and learning. In the Indian context अध्ययन means to go near to Guru, उपनयन means to go near and acceptance of Shishya by Guru and विनय means to direct in a specific direction. These three parts are also the base of science education as well, on that basis various strategies and concepts of teaching science in ancient period were done. Science Education has various concepts and to teach that was based on the nature of the discipline. Some concepts are taught through puzzles, some through formulas and equations, some through analysis, analogy and storytelling techniques in science education at the time of the ancient era. These techniques have specific objectives for the holistic development of the learners.

The Nyaya Darshan is based on the basic principle of logical reasoning. In this Darshan four types of teaching techniques are described which can be elevated in science education.

1. **Presumption technique-** The term of the technique exposes the meaning that the knowledge is generated on the basis of previous knowledge. For example, in science education on the basis of the colour of a solution, it predicts the substance present in the solution.

This technique has three sub-techniques which differentiate the timing of the presumption on the basis of some evidence.

- पूर्ववत् (as before)- This sub-technique shows the cause first and on the basis of that we are presuming the effects of it. For example, by the addition of sodium hydroxide in hydrochloric acid, we predict that the colour may change.
- शेषवत् (as after)- this sub-technique shows the effect or outcome first and on the basis of that we are presuming the cause which is done before and due to that this effect can be seen. For example, the pure crystals are obtained from a substance then on that basis we can presume that the process of crystallisation was done after the synthesis of the substance.
- सामान्यतोद्दृष्टम् (as simultaneous)-this sub-technique shows the general cause and effect relationship simultaneously seen. For example, the salt is dissolved in the water then simultaneously the solid

particles become dissolved and the solution becomes more concentrated. On the basis of this simultaneous process, we can say that the generalised statement; the salt is dissolved in the water.

As per the Nyaya Darshan the learning relies on the presumptions where the learning is not possible through the direct observable logic. Another technique of this philosophy is Direct observable technique.

2. **Observable technique** - The term shows the meaning in which by the observation of something, some process and product. This technique is dependent on the perception of the observer; as the perception is built up on the basis of sensory experiences. For example, the process of growing herbs from seeds which gives live experience through the various senses and on the basis of that the perception can build up.

In this context of Nyaya, two categories are discriminated on the basis of nature and characteristics; 1) Nirvikalpa and 2) Savikalpa. Nirvikalpa is related to the five senses through which the reasoning process is done. Savikalpa is related to the conscience including mind, ego and intellect; through that the perception is build up. Savikalpa leads to analysis, synthesis and classification through which one can build their own perception and on that basis the cognition of an individual is build up. There is a connection between sensation and perception; through the sensation the perception is created and all the senses are connected with the mind, ego and intellect. In this context the teaching learning of science is associated for example; identification of the substance in chemical science is based on these two contexts. Observation of the substance on first experience gives the external characteristics like appearance, colour, texture and odour after the recognition of these characteristics the conscience is developed and leads to make the perception of the substance than mind cognises and analysis the internal characteristics of the substance.

3. **Technique of Analogy/ Resemblance:** This technique is building relationship between the known and knowable; from the known one can analyse the general characteristic of knowable and the previous knowledge is playing the important role to relate this analogy of knowable and known. In science education; on the basis of previous knowledge further discovery and invention can be done. For example, in the synthesis of new drug is been based on the theoretical and practical applicability of the previous existed drug. The analogues of the drug have been developed on the basis of prologue of drug.
4. **Technique of Verbal Association-** This technique is commonly used in the teaching learning of science education; in which verbal association in terms of oral and written form the knowledge can be transmitted. This leads to the concrete form of the knowledge as it comprises the face-to-face interaction and provides supportive evidence to the matter through which manifestation of the knowledge is being done. For example; the water is boiling and at certain point of temperature it is converting in the vapour, this shows the manifestation of knowledge. Manifestation in science education can be done through the question answer, explanation, definition, illustration, puzzle, riddles and demonstration.

These are the indigenous techniques of teaching of science education; the methods and techniques of evaluation to these practices are also different. It emphasizes the evaluation of external and internal perceived knowledge and comprehension regarding the concepts. That elevates the science education at certain level of betterment and cater the needs of science education.

Research Trends in Teaching Practices of Science Education: In this scenario teaching practices of science education is more towards the approach of holistic development of the learners. Not only the knowledge aspect but the level of understanding, application of knowledge in real life and hands on practices to enhance the skill development is emphasized in science education. The technological advancements in science education are more facilitating the prosperity of science. Teaching practices are the bridge between the scientific advancement and the curiosity of learners to learn new knowledge and skills. Project method,

collaborative learning, demonstration, field trips, inquire method, problem solving, decision making, design thinking, organic living, storytelling, illustration with examples, situational learning and technological integration in learning are the trending practices of science education. A study on *Understanding and explaining pedagogical problem solving: a video-based grounded theory study of classroom pedagogy. It concludes the Extended Pedagogy Analysis Framework and Pedagogical Problem Typology can help during pedagogy analysis to identify, understand and explain common and less common types of pedagogical problem. Novice-expert strategic dialogue can struggle for want of a shared vocabulary. This research design works with younger and older children.*(Riordan, 2021)The outcome of the study exposes the suggestive ways to solve the pedagogical problems in science education.

A study on *Effect of environmental factors on students' interest in STEM careers: The mediating role of self-efficacy. The results of the survey demonstrated that the effects of family influences and out-of-school time learning experiences on interest in STEM careers were fully mediated by self-efficacy except for media influences that affected interest both directly and indirectly via self-efficacy (partial mediator). Inside-of-school learning experiences did not affect self-efficacy and interest in STEM careers.STEM learning experiences through informal modality are better predictors of students' interest in STEM careers. Improving formal STEM learning is imperative to ensure that STEM careers are promoted to all school students in a systemic manner.*(Halim, 2021)This study relates the role of self-efficacy and student's interest in STEM education and in the career development in STEM education this can be helpful to the teachers and learners. These kind of research studies give directions for further research in the teaching practices of STEM education and catering the goods in science education. Teaching practices are been evolved in this digital era of education, for that the coding is popular, indigenous literature also consisting the coding. As the grammar of Ashtadhyayi literature has Maheshwar Sutra on which the origin of coding is found. Teaching practices should be focusing on this digital scenario and cater the needs of this scenario. The more research studies need to be done in the field of science education and teaching practices of it.

Application of Indigenous Teaching Practices in Current Scenario: Indigenous teaching practices are making connections with Indian ethos and culture in the education system. Teaching learning process of the ancient period was more of the Guru Shishya traditions; Shishyas were going to Ashrams for a number of the years and far away from the home background. The interaction between Guru and Shishya was of holistic education and disciplinary education; in that the focus on personal development was very intended to be done. Field visits, task-based learning, problem solving, meditative practices and yoga education; the science behind these all learnings was imbibed thoroughly to the Shishyas. The techniques of teaching were more observation, recitation, explanation, presumption and activity based. In the current scenario these teaching practices are also confined and useful; with the time and advancements teaching practices are modified. Some of the techniques are to be focused in this scenario for science education like recitation and activity-based teaching. As modern techniques of teaching science education are somewhere harmful for the environment, like the experimentation of chemical science requires synthetic chemicals which are causing air, water and soil pollution. But same practices were done with the usage of natural chemicals which is useful to the environment and sustainability of it.

Indigenous teaching practices are indulged with values, morals and ethics that are more towards the preservation of nature and heritage. Indigenous game-based approach of teaching is more applicable in this scenario where the learners are bound with the virtual mode. This resists the physical and natural development of the learner; in science education also it is applicable that the game based pedagogies need to develop more which enhances the cognitive and psychomotor skills.

Conclusion: Indigenous teaching practices are catering the needs of global scenario of education. Teachers and their teaching competencies are most important in science education because it fulfills the gap between learners and the new approach. In science education teaching practices plays important role for the

embellishment of logical reasoning skills. Nyaya philosophy offers an important indigenous perspective for science education by emphasizing logical reasoning, observation, analogy, inference and verbal evidence. These methods promote critical thinking and deeper conceptual understanding while linking scientific learning with the Indian knowledge tradition. The Guru–Shishya tradition enriches education by fostering values, ethics, discipline, and the holistic development of learners. The integration of indigenous approaches with modern science pedagogy can make learning more relevant, contextual and learner-centred. Hence, combining indigenous knowledge systems with contemporary educational practices provides considerable potential for advancing and enriching science education. Applicability of science in the ancient scenario was very important but in the modern scenario that science with novel research studies and in education its teaching practices are enhancing the glory of the knowledge. More research studies will upgrade the science education at more advance level.

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