A search into areas of science teacher instructional preferences expected in new generation classrooms

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Abstract
Teaching, considered to be the noblest profession, is a demanding and complex task by itself. Effective teaching is at the heart of science education. Science teaching is a composite profession requiring knowledge and skills in both science and education. It is a challenge, especially in today’s world of knowledge explosion, where information is available at one’s finger tips. The learners of today differ significantly from those of the past. Engaged, motivated, self-directed and diverse learning styles characterize the new generation learners. Hence, modern science teachers need to strive continuously to grow and change, personally and professionally, to meet the diverse needs of their students, school, community, and profession. In the new generation classrooms, science teachers need to orchestrate lessons so that all students have equal opportunities to participate in learning activities. A search has been done to identify the areas of science teacher instructional preferences required to stimulate a learner-centric new generation science classroom. Science teachers, who mirror these science teacher instructional preference categories to accomplish the expected science learning outcomes, are the need of the hour.

Keywords: Science Teacher, Science Teaching, New Generation Learners, New Generation Classrooms, Instructional Preferences

1 Introduction
Science has revolutionized human life and has proved indispensable for the existence of man. It is well accepted that science and technology serve as the principal instrument that determine the standard of living of human beings in a global society. The importance of science and technology in today’s world is overwhelming and therefore the education system throughout the world has to gear itself to provide the required training in scientific skills to meet this growing challenge. The emerging new society demands a human to have developed higher rationality based on the scientific method. Science education is a discipline that reveals systematic and scientific results towards meeting the needs of individuals and society. In the past, teachers were the major source of knowledge, the leader and educator of their students’ school life. In today’s world of knowledge
explosion, it is difficult for education planners and teachers to keep pace with the expanding knowledge. Studies have revealed that the commonly used strategy for teaching science at the school level is the lecture method which lacks efficiency in providing the essential learning outcomes. The children of today, the new generation learners differ significantly from those of the past. They often have to identify scientific principles and their applications around them in their daily life. So, in the school level itself they should be taught ‘how to know’ rather than ‘what to know’. The science teacher needs to be prepared to effectively engage students in concrete manipulative activities that will lead to the development of desired concepts through investigation and analysis of experience. Hence, innovative, learner-centered methods of teaching contribute largely towards the expected learning outcomes in science. To engage the new generation learners, science teachers must have theoretical and practical knowledge and abilities about science, learning, teaching and technological expertise. Science teachers are expected to be facilitators whose main task is to set goals and organize the learning process accordingly. The instructional preferences adopted by the science teachers in their classrooms determine their role as facilitators of learning, rather than educators.

2 Science Teacher Instructional Preference Categories

The twenty first century classroom should be a place where students get to start exploring their world, discovering their passion, applying what they know and beginning to experience the impact they can have (NSES)[1]. Study has been done to explore the areas of science teacher instructional preferences expected in the new generation science classroom and ten science teacher instructional preference categories were identified (Sheeba)[2]. These were found to be crucial in stimulating a learner-centric science classroom to accomplish the expected learning outcomes in science. Talented and skilled science teachers who practice them could prove to be instrumental in assisting the new generation learners to experience science as a creative endeavour. The following identified ten science teacher instructional preference categories are schematically represented in figure 1.

1. Teacher-Pupil Interaction Dynamics
2. Flexible cum Viable Instructional Strategy Integration
3. Process Skill Application in Procedures
4. Technology Wowed Procedural Enrichment
5. Adaptation of Multi-Pronged Assessment Techniques
6. Adoption of the Spirit of Inter-Disciplinarity
7. Styles of Meta-Cognitive Strengthening
8. Professional Growth and Auto-Empowerment
9. Influence of Life-Skill Integration
10. Preference for Quality of Life Enhancement
2.1 Teacher-Pupil Interaction Dynamics

The success of school life largely depends on the teacher-pupil interaction and cohesive interpersonal relationships. Actions of teachers are deeply influenced by their understanding of and relationships with students. In the science classroom environment, the interpersonal relationship between the science teacher and pupils is an important element contributing to the learning process of pupils. Teachers, who foster positive relationships with their pupils, create classroom environments more conducive to learning and meet pupils' developmental, emotional and academic needs. The development of pupils’ cognitive and affective competencies largely depends on the quality of teacher-pupil interaction. Healthy relationships with children are a precondition for effective teaching as it helps teachers to motivate and control children’s behavior and learning attitudes (Pianta)[3]. Positive teacher-pupil relationships draw pupils into the process of learning and promote their desire to learn. A significant body of research indicates that academic achievement and student behaviour are influenced by the quality of the teacher and student interactions.
relationship (Jones)[4]. A common approach by which a teacher can initiate the interaction in a classroom is by asking questions. Science being a subject that arouses the curiosity of the pupils, the healthy communication between the pupil and the science teacher serves as a connection between the two, which provides a better atmosphere for a classroom environment. Meaningful feedback and assessment mechanism also must form part of an efficient teacher-pupil interaction in the new generation science classrooms.

2.2 Flexible cum Viable Instructional Strategy Integration
The best teachers tend not only to be goal-focused, but are also flexible and reflective. These characteristics allow them to relate to students and also help to modify and improve their practices. Science teachers need to create a community of diverse learners who extract meaning from their science experiences and possess a disposition for further exploration and learning. For this, science teachers have to provide learning experiences through multiple styles of interaction strategies. The many modes of classroom interaction styles adopted by a science teacher makes use of the possibilities of techniques and tactics like questioning, discussing, solving problems, inquiring, field trips, projects, brainstorming, concept mapping, model building, role playing, game-playing, simulating, electronic media, written reporting of investigative techniques and data, cooperative and collaborative learning (NSTA)[5]. In order to effectively handle the new generation classroom, science teachers have to design and manage learning environments that provide students with the time, space, and resources needed for learning science. The teacher also has to create opportunities for students to take responsibility for their own learning, individually and as members of groups. As there is more exposure to internet connectivity and increasing use of personal computers in schools and homes, Information and Communication Technology (ICT) shows renewed promise as a powerful tool for science education. Teachers also must acquire talent and interest in the design and use of e-content suitable for the twenty first century learners.

2.3 Process Skill Application in Procedures
Science process skills are a set of broadly transferable abilities, appropriate to many science disciplines and reflective of the behavior of scientists (SAPA)[6]. They are a reflection of the methods used by scientists while generating information on science. Science Process Skills are the building blocks of critical thinking and inquiry in science (Ostlund)[7]. These important skills include the processes which can be applied in almost every stage of life, and which should be possessed and used by any individual in scientific literate societies to increase the quality and standard of life. Therefore, these skills affect the personal, social, and global lives of individuals. Students who learn through inquiry gain a deeper understanding of the resulting concepts than when the same concepts are presented through lectures. Scientific inquiry is the heart of science and science learning. Inquiry into authentic questions generated from student experiences is the central strategy for teaching science. Teachers who use inquiry effectively tend to be more indirect, asking more open-ended questions, leading rather than directing, and stimulating more student-to-student discussion (Brophy, Good)[8]. Teachers of science have to engage the new generation learners both in studies of various means of scientific inquiry and in active learning through scientific inquiry. At all stages of inquiry, teachers need to guide, focus, challenge, and encourage them, individually and collaboratively, to observe, ask questions, design inquiries, collect and interpret data, in order to develop concepts and relationships from empirical experiences. A strong
faith and practice in process oriented teaching and learning has to become the cardinal philosophy that guides the whole actions of a science teacher in and outside the classroom.

2.4 Technology Wowed Procedural Enrichment
A single development and invention in science and technology at a far distant place has an unprecedented influence even in our locality. Distance and time are two variables to be visualized and operated from a different perspective today than the past. The science classroom environment is also not an exception to this phenomenon. The impact of digital technologies on science education is becoming more pervasive than any curricular or instructional innovation in the past. Technology provides a means to good science instruction but is not an end in itself. Modern information technologies can be used as tools for focusing instruction and providing students with an interactive, educational environment. Technology-augmented activities help students perceive the relevance of science to their personal experiences. Science teachers need to explore what technology offers for meaningful science teaching and learning. Science teachers have to access common sources of information like newspapers, magazines, televised reports etc, to relate their instruction to contemporary issues and events. They need to know how to effectively use various resources such as news media, libraries, resource centers and the Internet. Science teachers in the modern technological world should know how to use appropriate technology including, but not limited to, computers and computer peripherals, both to enhance learning and to relate the use of technology to science. In addition to using technology in the science generation classroom, teachers also have to ensure that students understand the role technology plays in professional science. The emerging practice of edutainment and edupreneurship must be well acquired by the science teachers while engaging the new generation learners.

2.5 Adaptation of Multi-Pronged Assessment Techniques
Assessment and learning are two sides of the same coin. Assessments define in measurable terms what teachers should teach and students should learn. The routine assessment programmes in schools mostly evaluates the total achievement in science gained through rote memorization. They do not have any scope for the appraisal of the pupil’s understanding of the processes of science. Recent focus on higher-order skills has made assessments more sophisticated and varied. Modern assessments have to probe for students understanding, reasoning, and application of new knowledge developed through inquiry. Instruction and assessment must be practiced collaterally by a science teacher to realize meaningful classroom interaction patterns. It is assessment that mirrors and measures students' performances in 'real-life' tasks and situations (Hart)[9]. Good assessment strategies help students learn about their strengths and weaknesses. Teachers of science need to construct and use effective assessment strategies to determine the achievement and progress of learners. They have to assess students fairly and equitably using multiple assessment tools and techniques. Variety in assessment strategies not only include implementation of varied kind of traditional and modern assessments tools, but also a comprehensive coverage of assessment of various faculties of human development - cognitive, affective and psychomotor. Science teachers need to use those results to guide and modify instruction and to use them as vehicles for engaging students in reflective self-analysis of their own work. Possibility of self and peer assessments could also be explored to evaluate the new generation learners.
2.6 Adoption of the Spirit of Inter-disciplinarity

Interdisciplinary teaching is a method, or set of methods, used to teach a unit across different curricular disciplines. No subject can be taught in isolation. Inter-disciplinarity and collaboration are the thumb rules of classroom practices today; not only in Sciences but in all branches of knowledge. Inter-disciplinary approach facilitates conceptual clarity and effective structuring of scientific knowledge. Interdisciplinary/cross-curricular teaching provides a meaningful way in which students can use knowledge learned in one context as a knowledge base in other contexts in and out of school (Collins, Brown, Newman)[10]. It increases motivation for learning and their level of engagement and also provides the conditions under which effective learning occurs. The pathways of correlation that a science teacher is expected to utilize in his/her classroom are (a) correlation within science (b) correlation among the different subjects (c) correlation between the science and life outside. Hence, science teachers must be able to make conceptual connections within and across science disciplines, as well as to other school subjects, so as to strive for maximum degree of correlation which makes the teaching-learning process more realistic and interesting for the new generation learners.

2.7 Styles of Meta-Cognitive Strengthening

Meta-Cognition refers to one’s knowledge concerning one’s own cognitive processes or anything related to them. Quite simply, meta-cognition is thinking about thinking; which leads one to academic success and problem solving ability (Theide, Anderson, Therriault)[11]. Any process in which students examine the method that they are using to retrieve, develop or expand information is deemed to be metacognitive in nature. Metacognitive strengthening helps the students to regulate their cognitive tactics and strategies in order to construct meaning from their new learning. Hence, the interaction styles adopted by a science teacher must give due consideration to the metacognitive strengthening of the students. Prompting students with procedural questions may help foster metacognitive strengthening. Rather than helping the students to arrive at fixed answers as solutions to the stimuli provided by the teacher, they must be encouraged to probe into various options of responses through critical thinking. Facilitating creative expressions will help the students to be more and more independent learners and problem solvers. Acquaintance with investigative encounters using issue-based problem solving strategies and familiarization of routes of learning how to learn science rather than memorizing the product of science will contribute much in the metacognitive strengthening of the new generation learners.

2.8 Professional Growth and Auto-Empowerment

For a science teacher, professional development is a continuous, lifelong process. A desire for continued professional growth and auto-empowerment is an essential quality for a science teacher to exhibit effective teacher performance. The urge of a science teacher who earnestly engages in self-competency enhancement activities is demonstrated by his/her participation in professional enhancement programmes and related avenues. Exemplary processes for growth must have an amalgamation of technical skill enhancement with a one set of professional virtues (Sergiovanni)[12]. Adoption of appraisal strategies like peer and student evaluation procedures and self evaluation through journaling are essential for enhancing professional competencies. Reflective practices aiming at leadership quality exhibition resulting in performance level which goes beyond minimum level of work requirements is largely expected from science teachers of the
contemporary age. Science teachers need to introduce themselves to scientific literature, media, and technological resources that expand their science knowledge and their ability to access further knowledge. More over, they need to be trained in integrating life skills through their teaching. Conducting classroom based research, an inquiry through novel experimentations in the field, collaborative discussion of findings and experiences with peers and collaborating stakeholders are characteristics of the much needed professional growth and self-guided empowerment of science teachers of the twenty-first century.

2.9 Influence of Life-Skill Integration

The World Health Organization has defined life-skills as the abilities for adaptive and positive behaviour that enable individuals to deal effectively with the demands and challenges of everyday life. Life-skills are essentially those abilities that help promote mental well-being and competence in young people as they face the realities of life. Life-skills include the skills the student needs to be successful in society. Every education system has to provide support for the development of life skills among its students in order to enable them function effectively in society. Teaching life-skills is an important part of education, especially at the secondary level where the learners are in their adolescent stage. Life skills is not a subject to be taught in isolation. It is to be integrated with other school subjects and science is no exception. Life skills empower young people to take proactive action to protect them and promote healthy and desirable social relationships. With proper orientation in life skills, the pupil will able to explore alternatives, weigh pros and cons and make rational decisions in solving each problem or issue as it arises. Without life-skills, students will not be able to apply what they have learned at school, to their everyday life. Developing life-skills helps adolescents to translate their knowledge into proper actions, attitudes and values into healthy personal and social behaviour, enthusiasm and emotional integrity to prioritizing of their needs and wants. Hence, training in life-skills must form an indispensable part of teacher activities in the new generation science classrooms. The science teacher has to extend a helping hand to the learners to learn how to take better care of them by incorporating awareness on life-skill applications through their lessons.

2.10 Preference for Quality of Life Enhancement

Science is a powerful tool of social change and cultural modification. Hence learning of science must pave way for social revolution and reduction of socioeconomic divide. Training in healthy practices of life leading to social harmony and sustainable development must begin from science classrooms. Fighting against social evils of untouchability and discrimination based on race, caste, language, religion, colour, creed, gender and geographical location – are to be practiced by the science teachers in the new generation classrooms. Hence science teachers are expected to be models of scientific attitude. Students are often confronted with questions in their lives that require scientific information and scientific ways of thinking for informed decision making. Use of scientific understanding when dealing with personal and societal issues would help students to arrive at a rational judgment on how to manage shared resources—such as air, water and environment. In order to enhance the quality of life, science teachers need to impart awareness among the new generation learners about the interface of science, technology and society, sensitize them, especially to the issues of environment and health and enable them to acquire practical knowledge and skills to enter the world of work. This forms a part of the greater responsibility of
the twenty-first century science teacher. The awesome responsibilities of a science teacher as a career guru and lifestyle consultant for the new generation learners are widely recognized.

3 Conclusion
Teaching and teachers are at the centre of reforms in science education. Studies have highlighted the role of a science teacher in being instrumental in moulding his/her students fit for the twenty-first century. The science teacher and the classroom practices contribute fairly well towards this end. The experience of the science teacher, an orientation to emerging educational practices, excellent science laboratory facilities at school coupled with the following affective components - scientific attitude, a bend of mind towards academic research, intrinsic motivation for autoempowerment, a strong will to overcome professional lethargy, a concern for the science learner as a future citizen in the competitive world, an obligation to improve the quality of science education - are a few essential components that would help the science teacher to make a difference. Thus, a generation of teachers, who help their students to become independent learners, who provide them with motivation and interest for life-long learning and emphasize the science teacher instructional preference categories, seems vital for the new generation classrooms.

4 References


**BIOGRAPHY**

I, (SHEEBA. M.N.) am a young researcher with high profile academic excellence (M.Sc., M.Phil., M.Ed.) having experience in teaching Chemistry to secondary and tertiary level students, and training of science student teachers. I am born and brought up in the educationally elite state of Kerala, better known as *The God’s Own Country*. After qualifying the National Eligibility Testing (the national level entrance examination conducted by the University Grants Commission, New Delhi, India to qualify for admission in Ph.D research and/or university level teaching jobs in India), I have registered for the Ph.D program in the faculty of Education, (University of Kerala) with the support of U.G.C. Junior Research Fellowship scheme. I have submitted the Ph.D research thesis on the topic, “Relation of achievement in science and certain context variables with comprehensive science process measures at the secondary school level”, to the University of Kerala and awaiting declaration of result.