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Implications of Social Diversity for Science Education in India

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Abstract

India is a highly diversified country with multiple languages, religions, cultures, traditions, values, etc. This diversity is represented in our classrooms as well amongst our learners. Science is often considered as a subject that is objective and has nothing to do with the background of the students but this is far from being true. This paper discusses the implications of having diversity amongst learners in a classroom on teaching especially science. The paper elucidates how diversity in terms of language, religion, gender, caste, and culture influence education with a special focus on teaching science. This has an important implication for the teachers and educators to acknowledge diversity amongst learners while teaching to make learning more enriched.

Keywords: *Science Education, Gender, Religion, Caste, Language*

Introduction

India is the largest and most plural society in the world. Here people speak multiple languages, belong to varied cultures, and profess different religions like Hinduism, Islam, Sikhism, Buddhism, Christianity, etc. It houses a vast variety of classes, castes, tribes, customs, and ethnicities. Social diversity often used interchangeably with 'plurality', 'multiculturalism', 'social differentiation' etc can be defined as the co-existence of different social groups within a given geopolitical setting. Many types of group identities constitute social diversity. According to the National Curriculum framework (2005) position paper on science teaching, the science curriculum should be an instrument of social change to decrease the divider relative to gender, caste, class, and religion. Difference blindness, a form of colour blindness is an idea that in teaching only individual students are important not their membership to a particular demographic subgroup. Teachers who practise difference blindness do not acknowledge individual differences. Consequences of this difference blindness are: The habits, prior knowledge, beliefs of mainstream students and teachers taken as the norm and all deviations are either devalued or neglected, it limits the fact that all students have their personal belief/attitude/perspective which needs to be acknowledged and valued, students have to accept school knowledge even if it contradicts their belief system. Hence it becomes important to acknowledge diversity while teaching in a science classroom or any classroom for that mater. Described below are certain types of diversity and their implications for education especially science education.

Language & Science

According to the *People of India* project of the Anthropological Survey of India, there are as many as 4,599 separate communities and nearly 325 languages and dialects in 12 distinct languages and some 24 scripts in India. India being highly diversified in terms of languages has still not been able to solve many language-related problems despite the language-based reorganization of states. The diversification of languages has some critical educational implications as it poses multiple challenges for education. There are still challenges in the implementation of the three-language formula at different levels; protection of the educational, cultural, and economic interests of the language minority groups who inadvertently have fallen in particular state territory.

Science is considered a difficult school subject because students find science words tough or unfamiliar (Oyoo, 2015). According to Merkel-Piccini (2001), science learning requires learners to have a certain learning capacity to be able to grasp its content as well as the context. If the child cannot sequence events, follow directions, or conclude, science theory can be abstract, and hard to understand. Learning science requires the mastering of the academic literacy skills specific to that discipline (Merino and Scarcella, 2005). Learning barriers associated with learners' inability to express their views are usually leaning towards language challenges. Learner's academic performance is influenced by language barriers in the long term (Elsworth, 2013). Language in science teaching could entail the medium of instruction used by the teacher, the language of the learners which could either be their mother tongue or the everyday language they use to communicate, as well as the language of scientific terminologies.

Language of teaching and learning

The teacher, as the immediate curriculum developer, has a responsibility to use a suitable level of language of instruction to accommodate the learners whose home language is not the language of instruction. It is critical for the teacher to simplify the scientific terms and use the language of science consistently and correctly without confusion. In African elementary schools, there are no formalized reading programs and reading is subsumed in the English language lesson and is taught by the language teacher. Therefore reading is not taught as a discipline rather as a tool to reinforce other language skills (Okebukola, 2008). The most significant factor in learning science and mathematics is whether students are fluent in English or not (Howie, 2003). Although many problems are presented by concepts, four areas are the most concerning namely, ambiguity, vagueness, unfamiliarity, and emotive words. Most learners are faced with such problems as a result of which the students lose the meaning of the question itself (Rossouw, 2003).

Language used by teachers

For the learners, whose language of instruction is a second language, there is an added burden of translating the language of instruction to their home language when being taught. The same learners are also faced with the added burden of thinking answers in their language and then translating them into the language of instruction before they answer them. The language changing within a lesson to create an understanding of a concept or phenomenon is referred to as code-switching. Code-switching refers to alternations of language within a single conversation, often involving switches within a single speaker turn or single sentence (Rose & Dulm, 2006). Teachers have to be considerate when asking questions and use words that

would be of easy reach to these learners. A study conducted by Brown and Ryoo (2008) found that students who learned the basic concepts of photosynthesis in ”Everyday English” before learning the scientific terms for the same, scored better on tests rather than students taught the conventional way. For instance, words like "sugar" at the beginning of the lesson can be used and changed into ”glucose” later. Also, the use of "energy pigments" initially and subsequently introducing ”chlorophyll” and ”energy pouch" as a temporary stand-in for ”chloroplast”, is a strategic approach while introducing scientific terms for the first time. This method to teach learners is called the ”content-first” approach which can help enhance the conceptual and linguistic understanding of science. Also, the use of analogy or linking to everyday items could be useful for a better understanding of concepts.

Language of Instruction

The language of instruction is the language that is used as a Medium of Instruction in schools. Brock-Utne (2006) hypothetically said, “wanting to give education without considering the medium of instruction, is like wanting to give water to a village but not considering the pipes”. Malekela (2003, Pg: 111) made a statement that ”to continue using English as a medium of instruction in post-primary education is a torture to most of the Black children”.

In India, language diversity poses several problems for learning science among students. This is especially true in India as the home language of students is not English, many face problems comprehending what is being taught in the classrooms. Learning science in a second language adds a considerable burden, particularly at the primary level. Even though students from rural schools study science in their local language up to Class X students in urban areas get less opportunity to study in local language as English is the predominant language. Even if schools allow students to study science in Hindi or other local languages, there is a dearth of study material and resources available for the teachers as well as the students which creates extra problems.

Religion& Science

Religion can be defined as a broader framework of life, a framework shared with their families, place of worship, broader cultural communities. Religion stands for the belief in supernatural beings or entities. India is a multi-religious society and wherein people practise diverse religions such as Hinduism, Christianity, Islam, Sikhism, Buddhism, Jainism, etc. The Constitution of India affirming the secular nature of our country treats all religious groups on equal terms. It grants freedom to all religious groups to hold and practise their beliefs and rituals.

Students’ religious beliefs are often contradicted in a science classroom. Some controversial topics in science can contredit the religious beliefs of the students. Some of these topics are the origin of life, creation of the universe, climate change, biological evolution especially of homo sapiens. Research conducted in Alabama on teaching evolution in a science classroom shows that teachers assign chapter on evolution to their students but do not discuss it in the class (Dean, 2005). Aguillard (1999) showed that 60% of Louisiana’s teachers take less than five days in teaching evolution. According to Smith and Scharmann (1999), science does not refute supernatural forces or the existence of God. But it does not assert the use of supernatural /metaphysical explanations in constructing knowledge. It does not mean these things do not exist it means that including them makes explanation less scientific. It does make an argument wrong or weak just not science. Hence a vivid distinction between science and non-

science provides students ”a place to stand” when conflicted with two contrasting views deciding for themselves where it fits. A study was conducted by Chunawala et al. (2013) regarding teachers’ and students’ perceptions of science & religion. It showed that students demarcate between students' scientific and religious beliefs. They also compared male & females students concerning their perceptions regarding science & religion. This paper revealed that 26% of the students considered religion not important enough to be divulged in front of strangers, whereas 43% considered it very important. This clearly indicates that religion holds immense significance in the lives of students. When asked about their families' & teachers’ beliefs about the origin of life, the majority of the students responded that they think their families would support that God is the creator of human life while the majority of students supported evolutionary explanation in the case of teachers with little or no variation in boys & girls. This clearly indicates that students can differentiate between ideas that are scientific with those that are not and are also aware of who will support what. Another finding suggests that in case of a conflict between religion and science, teachers tend to stick to their scientific explanations & defend the scientific ideas. Teachers give freedom to students to choose their own way. This study reflected an instance where teachers teach science from their perspective. The examples cited by the teachers are also based on their own religion and they are oblivious to other religions hence tend to stick to the topic only. Another study conducted by Chunawala & Birwatkar (2014) used intervention which was carried out in 3 secondary schools of Mumbai, where the topic ”Biological diversity” was taught to class VIII students so as to address the diversity in human beings (gender, religion, culture, etc). This study gets its rationale from the fact that students possess alternate conceptions about things which are a result of their personal experiences & social background. The conflict between science & religion could be difficult for child if it is not properly addressed inside the classroom The intervention included many steps: asking students to identify the diversities amongst themselves discussing non-physical differences, such as culture, ethnicity, language, belonging to a certain region and religion to break some gender-associated myths, showing a collection of human beings (men and women) from all over the world to find out the similarities & the differences between them so they can distinguish between inter-species and intra-species diversity. Kanpol (1994) pointed out the idea of establishing similarities within differences develops an empathetic understanding in a culturally diverse classroom. Similarly, the decline in forests due to humans was linked to the declining female sex ratio in India which is also cultural and not biological. Students had to match states with the respective male-female ratio on a map followed by discussions on reasons for the unequal ratios and differences in states regarding male-female ratios. The thing common in all activities was that they were based on argumentation, debate, collaborations, and student-group interactions promoting peer learning. The findings suggested that teachers had a neutral stance on gender diversity & considered science as neutral. So teachers did not feel a need to concentrate on the interests or experiences of boys and girls. Teachers did not reflect on diversity & its role in the teaching-learning process. When asked about the evidence that students made progress in the lesson taught during intervention they mainly concentrated on evaluating the performance on the oral or written form of examination and in some cases assignments. This indicates that teachers are more focused on imparting content knowledge. But they need to realise

that alternative conceptions of students and the doubts arising from them need to be catered to impart correct and holistic scientific knowledge.

Gender& Science

Gender can be defined as the socio-biological difference between man and woman. Conceptually the term 'gender' differs from 'sex', as sex refers to differences owing to physical characteristics between male and female. The educational system in India is plagued by gender disparities at all levels of education. There is a wide gender gap in education in which the female literacy is 54.16 per cent as against 75.85 per cent for males (Census, 2011).

Women's contributions to science date back centuries. But for most of the time in history, women scientists had faced barriers to opportunity and access while striving to contribute to the field. Historically, there has been inequality of representation and participation in the field of sciences. Renowned women scientists like geneticist Barbara McClintock had to overcome significant barriers in their professional journey for their work to get recognition and due credit. Despite increased opportunities in the sciences in recent years, women are still not represented in the proportion of the national demographics. It is also seen that the higher the status of the science field subfield, or position in question, the greater the degree of inequality when it comes to the representation of women. Feminist critiques of science and science education have largely been ignored in the scientific community. In a study conducted by Seymour and Hewitt (1997) to learn the reasons as to why do women drop out of university science majors and how these reasons differ from the reasons for males. One of the most common responses was that science is fundamentally meritocratic and self-correcting. So even though women have faced discrimination in the past, such inequities are being resolved now that women have equal access to the required training opportunities. The increased enrolment of women in medical and veterinary schools, where women now make up the majority of students, is often cited as evidence of the self-correcting nature of the field. Several studies show that widespread perception of science as male or masculine continues to be one of the greatest barriers to adolescent girls' willingness to pursue advanced science education or to enter scientific fields (Oakes, 1990; Rosser, 1987). Hence the perception of women regarding "science" plays a very important role. Beilock et al. (2010) proposed a mathematics anxiety hypothesis who found that the anxiety amongst teachers regarding the subject mathematics causes a drop in the performance of female students but not male students. Antecol et al. (2015) tested a hypothesis loosely based on the mathematics anxiety hypothesis. The indicator for mathematics anxiety chosen in the study conducted was whether education teachers have got a major in mathematics or a related subject as they believe that anxiety would be developed if teachers do not have good content knowledge. The issue is also important because the focus here was on the females from disadvantaged backgrounds assumed to be lacking a positive role model in the family who could challenge their notions & stereotypes. They found out that there was underachievement amongst students where female teachers had high anxiety. This is due to the fact that girls look onto their female teachers as a source of inspiration and anxiety of teachers leads to confirmation of the stereotypes that girls are bad in mathematics and they internalize this fact. But they found another significant thing that the underachievement could not just disappear but also turned into a positive outcome just by having female teachers with strong background knowledge. This according to them may be due to two reasons: teachers are well trained in mathematics so having good concep-

tual knowledge helps to transfer the same and secondly they themselves have defied the stereotypes of gender-related differences in terms of ability. So background knowledge came to be the primary important factor contributing to underachievement and secondarily the gender. Teachers might feel that they treat every student equally and do not differentiate between males and females in a classroom. The need of every individual is different irrespective of gender. Both have different educative experiences in classrooms. A study conducted by Scantlebury & Baker (2007) found that girls do not like lectures, worksheets, and 'busy' assignments and they prefer topics that have relevance to their daily lives. Girls are assigned passive roles in the class and performance-based assessments. They found that while boys used equipment for completing the tasks, the role of the girls was restricted to reading the instructions and recording the results. Teachers more often than not possess gendered perceptions of students' ability which is evident in the type of praise and expectations they have for their students. Girls were given less meaningful and less critical praise than boys. When the work done by the boys' work is applauded for being brilliant, girls' work is generally praised for its appearance and undervalued. Such unconscious behaviour on the teachers' part is harmful to the girls as they do not receive valuable feedback on their work to lead to a deeper understanding of concepts (Liu & Carless, 2006)). Therefore even gender plays a significant role in making students in a classroom different from each other. According to Jenkins & Nelson (2005), boys and girls differ in their interests in science. When students were asked to rate the topics of their interest the top-ranked items for boys were: explosive chemicals; being weightless in space; functioning of the atom bomb; biological and chemical weapons; black holes and other objects in outer space. For girls the top 5 items they would like to learn about in science were: why we dream when we are sleeping and what the dreams might mean; about cancer; how to perform first aid and use basic medical equipment; exercising to keep the body fit; about sexually transmitted diseases and their prevention. Teachers need to aware of these differences among boys and girls and try to include the experiences of both the genders wherever possible without considering them as a single entity.

Caste & Science

Caste is a system of social relations. Although caste finds its origin in the *varna* system of Hinduism, it is spread to all sections of the society and holds significance till today. Despite condemnation of several years, the caste system is still very much existent in the form of an ideology and social practices. The caste system is the root cause of many economic, political, and social problems owing to the structure of privilege and deprivation. 'Tribe' on the other hand is more of an administrative and political concept in India. The categorization of tribal groups has been done state-wise and isn't uniform. The tribal groups are much behind their non-social diversity and, tribal counterparts in terms of their educational attainment. Certain cultural specificities demarcate the tribal groups from other disadvantaged groups. The tribal people in themselves are composed of diverse groups. Our constitution has completely abolished the caste system but has established reservations in government and universities for the so-called Scheduled Castes— castes characterized by "extreme social, education and economic backwardness owing to the long-established practise of untouchability". It has made special provisions for the protection of the deprived castes mainly the Scheduled Castes (SC) and Other Backward Castes (OBC). However, discrimination against low-caste individuals based on caste remains very much part of the society, especially in rural India. In an experi-

ment carried out by Hoff and Pandey (2004) among 321 high-caste and 321 low-caste male students across India involving simple puzzles to solve, it was found that there was no difference between the performance of the students when their caste identity was hidden and a strong difference between the lower-caste and upper-caste learners when their caste identities were publicly known. A study on teacher motivation in Rajasthan finds similar stereotypes based on caste. Most of the teachers interviewed during the course of the study grumbled about teaching children belonging to scheduled caste who they considered ”dirty”. (Ramachandran et al, 2005). In a recent micro-study within the Gaya District among the Musahar children (Singh and Kumar, 2010) were asked for the rationale as to why children from marginalized communities fail, particularly those from the Musahar community, most of the teachers believed that the ”sanskara” of the Musahar children and their parents were to blame for this. This study showed that teachers still believed in the ”deficit model of learning” rather than an enabling discourse. They think of children as being ‘learning deficient’ or ‘uneducable’. As a result, they have very low or no expectation of learning achievement from these children This idea of heredity-based ‘educability’ of children is articulated through their notion of hereditary ‘sanskara’. This dependency on the home environment is detrimental to a student’s learning especially ones who are first generations learners. They fail to acknowledge the socio-economic differentiation and diversity amongst the students in a classroom. Teachers are convinced that they are non-discriminating and progressive and that they treat all children equally. However, this can be quite different from valuing each child equally. Treating each child equally would mean not recognizing, and not being sensitive to the differential learning needs and abilities of children. Such a perspective doesn't provide teachers with the skills to deal with differentiation within the classroom. They view their professional accountability in terms of just the transmission of content, without any concern for the resulting learning achievement of children. The findings of a study of an MCD school in a slum in Delhi revealed that the teachers feel that the environment of the home is the single most important factor for the child (Jain, 2006).

Although there is a dearth of studies focussing on the role of caste of students on learning science but these studies are evident enough to establish the role caste plays in a classroom. These influences can vary from teachers' attitude or motivation to students’ self motivation in studying. Hence it becomes imperative for teachers teaching science to be conscious of these influences while teaching science.

Culture & Science

A society bound with its own culture helps its inhabitants to live with a mutual corporation with each other. In other words, culture represents the social behaviour of a society with its set of values. The concept of culture encompasses the knowledge of ethics, norms, traditions, etc. Education plays a vital role in the transmission of culture from one generation to another. Education can be used as a tool to transmit social values and ideas to the coming generations. The curricula, teaching methodologies, and assessment strategies in our schools do not recognize or appreciate the notion of the importance of place in their societies (Kawagley 2006). Many people have started to recognize the limitations of a monocultural education system, leading to a more enriched and inclusive way of understanding the relationship between indigenous ways of knowing and those associated with formal education. It is a challenge for the

education system to devise a system of education for all people that respect the epistemological and pedagogical foundations provided by both indigenous and western cultural traditions. To accord significance to learning in indigenous settings, any natural phenomena taught in the classroom are best understood by students if they are first explained in the indigenous terms to which they can relate and then afterwards in western terms (Aikenhead, 2001).Western science which is taught in science classrooms is considered to be the high-status knowledge every student should learn to become a competent citizen in the society. However, the knowledge possessed by students from diverse cultures can be different from those in the mainstream. When there is a disparity between school science and students' cultures, the students suffer from bad educational experiences especially when students are compelled to accept Western science without sharing its meanings. In a class with students of diverse cultures, to achieve equity, teachers need to have knowledge of science as well as an understanding of the students' cultures (Lee & Fradd, 1998). There might be tensions when there is a difference between the ways in which science is taught in school and the diverse views of the students. (Gilbert&Yerrick, 2001; Lewis & Collins, 2001). The answer lies in the Multicultural Science Education (MSE) in this regard which can focus on curriculum or instruction in science. Proponents of Curricular Multicultural Science Education (CMSE) describe that to be sensitive to students 'knowledge and beliefs that are counter to science, one must redefine one's conceptions of science to be more inclusive of the students' cultural beliefs. Instructional Multicultural Science Education (IMSE) on the other hand stresses on crafting instructions respecting students 'cultural beliefs. Hence teachers need to endorse the fact that accepting and inculcating students' cultural beliefs would be helpful not just in dispelling any myths that children might have but also in enriching the experiences of all the students in the classroom.

Conclusion

In this paper, only the social aspects of diversity i.e. language, religion, gender, caste, and culture are discussed along with their implications for education in India. However, diversity amongst students can also be present in terms of their socio-economic status, learning styles, personal experiences, geographical origin, etc. The underpinning point being no matter what the classroom composition is, diversity is an aspect which is indispensable in a classroom therefore instead of choosing to ignore it if we acknowledge the diversity amongst learners in a science classroom or all subjects for that matter and understand its importance in education, we can enhance the learning experience of all the learners in our classroom.

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