CONSTRUCTION OF SCIENCE IDENTITIES AMONG STUDENTS

Introduction

When we look back at our schooldays, all of us might be able to recall our favourite subject. Mine was science, a strong reason for which was that I always scored good marks in science assessments (tests and exams). This, in my classroom and school setting, was enough for me to be termed “a good science student”. But was I really?

There were many students in my class who enjoyed experimenting with new things, who never accepted a claim without questioning it. Some of them, however, did not perform well in the assessments. This was enough to term them “unfit for science”.

Who according to my school was a good science student? What did my teacher think science was? Did she think of it as just being able to memorise facts and produce the “right” answers? This was, in fact, all that was required to do well in assessments and be called a “good science student” and sometimes even to be told, “I think you should take up science in your higher education!”

When we look at identities in a school, it would not be right to only look at the dominant ideological interests of the school and in turn of the subject. As much as we feel like this is what determines the identities of the participants, it is also very important to view how these interests function and produce a particular way of life and how these are taken up by the participants in that setting. Hence it is very important to give attention to the setting and the individual, as each setting has different ideologies and each individual can perceive them differently.

Studying Science Identity Construction

This paper is an attempt to understand science identity construction and reconstruction among students in a school. It looks at identity as an analytic lens to explore students` and teachers` views about science. Studying identity as a construct can help us in understanding how learning of, engagement
with and relation with science successfully takes place inside and outside of school classrooms. The ideas of identity and identity construction can help us develop “feeling for the learner” and lead to a productive discourse about teaching and learning (Varelas 2012).

This paper provides a sense of how both the larger structure and an individual’s agency have an impact on the construction of identities.

The following questions serve as the guiding framework in this paper:

1) What is the role of a teacher in the construction of students’ science identity?

2) What is the role of the school norms in the construction of students’ science identity and on teachers’ pedagogical approach?

3) What is the role of students’ informal experiences in the construction of science identity?

Through these questions, the paper draws some meaningful discussions about school students’ science identities and the factors that have an impact on it.

Identity is a multidimensional, multifaceted and complex construct. Identity can reflect a person’s individuality, and her distinguishing characteristics of style and personality. However, this same term can be used to characterise an individual’s membership within a context of common character, culture, behaviour and thought. Identities are lenses through which we position ourselves and our actions, and through which others position us. For example, what science means to a student or a teacher, is constantly being constructed and reconstructed through the institution called school and its activities, i.e., identity construction is closely related to learning and teaching, educating and being educated (Varelas 2012).

From the lens of social practice theory, an assumption that could be made about identity is that “people are formed in practice” (Carlone, 2012). Then one can explore what it could mean to be, say, a “good student” or a “bad student”. These labels depend on the setting and the practices that the settings follows. “Identity” is the kind of person an individual is interpreted to be in a given context. This might differ from context to context and hence is a very dynamic construct. In cases when one is labeled, the child might withhold him/herself from indulging in practices that would oppose or threaten their current identity.

We can say that the identity outcomes of any given set of practices are sometimes, not always, shaped by larger social structures. Anyone possessing
a science identity would signal (1) competence, (2) performance and (3) recognition. However, while looking at science identities in classrooms, instead of looking only from an individualistic approach, one might get better insights by looking at what larger structures expect from individuals. For example, instead of looking at “who is a good science student”, it might be better to look at “what does it mean to be a good science student in this setting”. Schools do provide a significant sense of place and resources for (science) identity development among students. There is an importance in understanding a variety of personal factors in teaching children. Student identities, as well as teacher responses to these identities, are shaped by macro-structures like gender, race and class relations.

It is important to see how learning and identity formation are interrelated. Both these involve meaning making in different ways. For identity construction, meaning making involves the development of reasoned, coordinated, coherent and meaningful ways of seeing one’s self. For content learning, meaning making lies in the development of disciplinary concepts, processes, tools and norms within practices (Varelas 2012). Learning can be looked at from two perspectives: socio-cultural and socio-political. The “socio-cultural” would include interactions among people, artifacts and ideas in cultural spaces that people shape, and are shaped by, as they act and interact within these spaces. The “socio-political” sphere involves issues of hierarchy, power and authority that affect social relations, access to ideas and positioning, which learners of a particular socially constructed racial group, ethno-linguistic affiliation, class, gender, and so forth, negotiate.

**The Study and Its Context**

The study on which this paper is based was carried out mainly through an interpretive framework (using qualitative methodology), giving more attention to conversations and experience gained over six weeks, inside and outside classroom settings. It was conducted by teaching 5th, 6th and 7th grade children for 20 sessions, classroom observations and semi-structured interviews. Both teachers and students were interviewed. The study was aimed at understanding the science culture of the selected school and the different factors that might have an impact on students’ and teachers’ (science) identity construction and reconstruction.
**The School**

The school is a charity-run school, which caters to students from socio-economically under-privileged backgrounds. The school does not charge any fees from students. It provides free food, uniforms, books and transport facilities to each of the students. It follows the Central Board of Secondary Education (CBSE) till grade 7, after which it follows the Karnataka State Board. The school has only one level intake for students, i.e., students can join the school only at kindergarten level. Students go on to study in the same school all the way till 10th grade.

**The Infrastructure**

The school is located in the north of Bangalore. The campus is quite huge and is filled with trees and plants. The school walls have paintings lined on them, most of which are painted by students themselves. The school also has a food mess.

The classrooms are well lit and spacious. Each student has his/her own chair and table. The school has science laboratories, one each for biology and chemistry. It also has a very well-resourced library that the students visit in their library hour or whenever they have free time.

**Role of a teacher in the construction of students’ science identity**

The observations to this question were based on numerous classroom observations and some informal interviews with the teachers. The observations were focused on:

- Teachers’ own understanding of science and nature of science
- Pedagogic practices used in class
- Teachers’ attitude towards students
- Teachers beliefs about students’ capacities

The following are the case studies of three teachers’ classrooms.

**Teacher 1**

This teacher has been working in the school since eight years. She did her BSc and BEd and started her career as a science teacher. She worked in two different schools before joining this school. She has been teaching science for almost 25 years now.
She has an authoritative personality, and this comes off in her classes as well. There was always explicit labelling that took place in her classes. For instance, she was teaching the topic adaptations, and there was a discussion about differences between an owl and an ostrich. There was a set of students who wanted to answer all the questions. Most students never volunteered. There was one boy in the class, Kishan (name changed), who used to give out answers very softly. The teacher could barely ever hear him; he went unnoticed all the time. In this particular discussion, he decided to put his hand up to answer the question. Maybe he felt confident about the answer he knew, maybe he wanted to feel included in the discussion. But the teacher bluntly said, “Aye, you keep quiet. Stop disturbing the class. I’m sure you have no idea about what is being done in class.” These instances instilled a sense of fear in some of the students and hence they hesitated to talk or participate in discussions in class. She believed that certain students were not meant for science.

In the same discussion, some of the answers given out by students were: “Ostrich is heavy, whereas an owl is light”; “Owl can see the color blue but ostrich cannot”; “Owl is a wise bird, whereas an ostrich isn’t”. These answers were not accepted or rejected. The teacher did not initiate any conversation to discuss these statements and just went on to dictate what she thought the right answer was. The answer she dictated was, “Owls are active at night and are called nocturnal, whereas ostriches aren’t”. There was little effort made to talk about students’ existing conceptions about any topic that was being discussed in class.

There was a lot of emphasis given on using the textbook. Every student had to keep their textbooks open at all times. Here explaining a chapter meant: asking any one student to start reading the chapter loudly from the textbook. The teacher then rephrased the same sentences with other words and some intonations in voice. For example, “Plants with weak stems that cannot stand upright and spread on the ground are called ‘Creepers’.” The words “weak” and “cannot stand” are said in a slow pace and the word “creepers” is said loudly and in an assertive tone. This way of teaching is characterised by a manner of speaking that is different from conversational speech. Words are uttered slowly, with pitch variations and so on. A lot of importance was given to how students write in their notebooks. Labelling also took place on the basis of their test scores. The teacher read out each of the student’s score loudly to the class. Students who had failed (according to the standards of the test) were insulted in front of the whole class.
The teacher said that science involves a lot of curiousness and practical work, but this did not come across in her classes. To her, being scientific meant to remember as many facts as possible. To ensure this with her students, she would sometimes ask students to collect facts about the topic being discussed and share it with the class the next day. And therefore, in her classes, only students who could give out facts about a particular topic, who scored well in tests, and who maintained neat and structured class notes felt like they liked science and might want to take up a career in it.

**Teacher 2**

This teacher has been working in this school for one year. He did his engineering before he started teaching here. He did his schooling from kindergarten to grade 12 in the same school. After graduating, when he was looking for a job, he was offered a job by the school to teach physics to grade 8 and 9 students. He also teaches mathematics to students in grade 6 and 7.

Since he himself comes from a background that all the students in the school come from, he is easily able to relate to all the children. And the children feel the same with him too. He is friendly with students and very approachable.

Each of his lessons are taught in a very different way. For instance, when he introduced the topic “light” to students, he had covered all the windows and the door with black chart paper before he asked students to enter the class. He wanted to give them a feel of how things would be without light. He then made a small hole on the cardboard on the window through which a light ray entered. He spoke about properties of light and continued the discussion from there. In this way, he tried to introduce each topic in a new and creative way. He tried to make students wonder and question. He also admitted to his students when he did not have answers to a particular question. He got back to them with the answers later.

He was also able to weave conversations in class with relevant examples that students would actually be able to relate to. For instance, when he spoke about transistors, he gave examples about the small shop close to the students’ homes that repaired electronic gadgets. He even asked them to go there and ask for something that the shopkeeper would not need anymore and bring it to class. He added that he himself had visited that shop many times as a student.

These conversations always built interest and enthusiasm in students to sustain discussions. Also through discussions, he was able to understand what students already think about these topics and tried to work upon it through further questioning and probing.
It did not matter to him how students wrote in their class notes. In fact, he did not have any structure as to how he wanted them to write in their books. He did not really look at the questions given after each of the chapter. He formed his own questions and asked students to write what they had understood.

At the end of each chapter, he conducted an activity with students, wherein he stuck a huge chart on the black board. He asked each student to come up to the board and write anything about the chapter. It could be a question, it could be something you thought was the most interesting part of the chapter, a fact, a word even. Students thoroughly enjoyed this activity.

He also did not restrict his classes to the classrooms. Sometimes he even took students to the garden.

His assessment questions did not involve questions that required students to remember or memorise words. It involved questions that required students to have actually understood the chapter. For example, in the chapter on sound, one of the questions in the assessment paper was: Before playing in a musical concert, a sitarist tries to adjust the tension and pluck the string suitably. By doing this, what is he trying to adjust?

In his class, the very fact that students were able to talk about any question that came to their mind, made them like this class. Students felt like they could relate to the examples and hence can understand better. The marks that they scored did not determine if they were good at physics. The teacher mostly did not label students in class. However, he did ask students to meet him after class to be able to discuss why they had not performed well in that assessment.

Also, because the teacher was able to relate to each student’s personal life, students felt a connection with him, and for this reason alone, sometimes students felt like they enjoyed science.

_Teacher 3_

This teacher is the head of the science department in the school. She has done her BSc and MSc in biology. She also has a BEd degree. She has been a teacher in this school for over 10 years. She teaches biology to grade 9–12 students. I only got to observe her classes for grade 9 and 10 students.

She is a friendly yet an assertive teacher. Students do not fear to ask questions in class. She encourages dialoguing by constantly telling students, “I’m happy when you ask me questions. Please ask. No question is silly!” This helps students get the courage to talk and raise questions in class. She also spends a lot of time after class hours talking to students about their personal life.
Students always feel like they can share their problems with her. Through her conversations she mentioned that to her science is all about understanding the world around us. It is about being a good observer and drawing reasons for why things are happening around us.

She likes taking students to the lab, even if they do not have the need to use any of the lab equipment. She feels changing the classroom environment might help in students move from a monotonous routine.

She tried to probe and make sure that every student in the class talked. For example, when she was teaching students about mitosis and meiosis, she posed a question, “Why does a cell divide?” Then she said every student from one particular row should give her one reason. Students had so many different answers. The answers that came up were: “To develop, to grow, to reproduce, to give a character to oneself, to reproduce, to increase in size, to increase the population, to heal our wounds, to fight diseases, to keep one healthy”.

She did not stop any student while they were talking. She gave each of them their chance and after everyone had spoken, she said, “All of you are right, we’ll have to modify your reasons a little.” This acted as an encouragement to the students and made them feel like they could all contribute to the class. This sense seemed like it was very important in order for students to develop a liking towards the subject. Students from her class were more confident that they would be able to take up a career in science. Test marks were not the only factor that determined if a student was a good science student. Here, anyone who raised questions, who gave out answers that popped up in their minds and who observed keenly was encouraged. However, sometimes, just because she had to abide by the norms of the institution, she carried out assessments that were more inclined towards scores/marks.

**Role of school norms in constructing students’ science identity and its impact on teachers’ pedagogical approach**

This question was analysed through my own teaching experience and other sources like observations inside and outside the classroom and interaction with teachers and students. There was a set of school norms that had to be followed by all students and teachers. The following are the different norms that existed, which are related to my research:

- The school management and the higher authorities expected students to write their notes in a very structured manner. They required that students wrote answers to all the questions given at the end of the chapter.
• There was a huge emphasis given to the ASSET (Assessment of Scholastic Skills through Educational Testing) test performances of the students. ASSET tests happen once a year and are based on the content that has been taught to them in the previous academic year. The test has only multiple-choice questions. The school started “preparing” students for this test about two months before the scheduled test dates. They gave students the previous year’s papers and made them solve it as a part of revision.

• There was a need to maintain absolute silence in classrooms and labs. Restrictions of movement were imposed on students in classrooms and labs.

• During their assembly, they had a discussion about a topic related to science once a week. However, the topics were dealt with very superficially. Emphasis was always on the “right” answer rather than discussing the topic in detail. Emphasis was laid on remembering facts.

These norms played a role in the construction of students’ science identities. To maintain notes in a structured manner did not give students the space to explore and express their understanding in the way they wanted. For example, in one of the classes, a student asked the teacher if he could write the answer about mitosis and meiosis through a diagram. The teacher bluntly refused and asked him to first write the definition of each term and then give examples. Instances such as these restrict students from expressing a concept in their terms.

During their ASSET revision, teachers focused on students being able to arrive at the right answer. The process/method used to arrive at the answer was never discussed. How much of a student’s complex thinking or meaning making can actually be understood by just checking the answer? Due to this method of conducting revision of ASSET tests, students never even bothered to read the question fully or make sense of a question if they thought it was even a little complicated. They would just make a guess. Students openly even admitted to it. Students also tend to start feeling that science is mostly about remembering facts and is all about arriving at the “right” answers. This also came about in the interviews of the students. To quote one student, “I’m not sure I can do engineering because science has so much to remember, and I don’t have a good memory power. And in my tests, I never get full marks for any answer. I think it will be difficult for me.”

Practices that emphasise on arriving at the right answer, which reinforce the idea that there is only one right way to carry out a process, start making students feel that science is a very rigid subject and not everyone can do it.
There are also conflicts between their normal science classes when topics are explained and the science classes when ASSET test practices takes place. It puts students in a very confused place to be able to build ideas about what science is all about.

The same is the case with a science topic being spoken about once a week in the assembly. Through these different experiences, students start feeling that science has a lot to do with remembering and that it involves coming up with one correct answer.

Going back to the first research question and drawing connections between the roles of a teacher and the school norms, we can see how school norms also pose implications on the pedagogical approaches of teachers.

Some of the teachers have been in the school for more than eight years, which is a very long time. Their tenure in the school has almost made them internalise the school norms in their daily classroom activities. For instance, with teacher 1, through observation, one could see that it comes naturally to her to make students maintain silence in class, to make them write notes in a very structured pattern and to even make them feel that there is one right answer to every question. It is, however, not possible to draw conclusions about whether these are her own beliefs from even before she joined this school or whether she has internalised them after she worked in the place for so many years.

In the case of teacher 2, however, since this is his first year in the school, he is not willing to follow the school norms. He feels that the school norms will hinder his way of teaching science, and he does not want to let that happen. Hence, he is sticking to his own methods and beliefs about science, and his pedagogy is not being affected by the school norms yet. Through conversations with the other teachers, it came about that the school management does not stop teacher 2 (for various reasons which they said they could not share with me).

Academic and disciplinary identities often become intricately fused as students try to make sense of the disciplinary practices of science in which they engage, and of the institutional norms of schools and schooling that they experience. In cases like this, students are posed with contradictory expectations from the institution, which contributes to the “academic identity”, and the science teacher, which contributes to the “disciplinary identity” (here science identity).

The underlying ideology of the academic identity that students construct is marked by control, rightness and compliance to school rules. However,
the underlying ideology of their science identity is marked by questioning, exploring and making mistakes. In the case of teacher 3, she openly admits that the school norms does not let her create a learning space that she believes in and that she wants for her classroom. Hence, these norms act as barriers to the teacher’s pedagogy.

**Role of students’ informal experiences in the construction of science identity**

Children come to schools with a lot of pre-existing experiences from home. Science as a discipline can be relevant to each student’s life in one way or the other. In classrooms, while discussing concepts in science, a much better understanding can be brought about in children by connecting the concepts to their everyday experiences.

Through classroom observations, I saw how some teachers were able to draw connections between students’ experiences from home and what was being taught in class. For instance, in teacher 3’s class, when she was talking to students about methods used for ripening of fruits, she asked the students to discuss about all the methods they used at home for the same. A very interesting conversation came up after which the teacher introduced students to the scientific reasons behind the traditional methods used for ripening of fruits.

The school also organised some community outreach programmes once a year for each grade. Grade 6 students went to a horticulture field, where they could relate to what they had been studying about plants and seeds in their chapter.

Grade 9 students (three groups chosen by the teacher on the basis of who they thought was good in chemistry) participated in a competition wherein they had to make something using the content from the chapters they had learnt in their 8th and 9th grades. For this, students went through books from the library and had many discussions with their teachers, to come to a consensus as to what they will make. One of the groups decided to make a mosquito repellant. They went through books in the library, used the Internet to find out more about it, spoke to the teachers to ask for advice and help, and then carried out the experiment by changing some factors so as to come up with the optimum mosquito repellant. Students also ended up winning the competition.

This kind of a process, where students themselves worked on each component, with the help of the teacher as a facilitator, definitely gave students a good
idea about what scientific processes look like. This exposure also added to their confidence about science as a subject and built on their science identity.

Conclusions

We often find that a lot of assumptions are made about children from minority and socio-economically backward backgrounds. They seem to be positioned at the lowest/lowest levels of learning science and mathematics. In many cases, we find teachers too making assumptions about the lack of preparation for learning science among these students. This is reflected in the way the teacher treats a student and has an impact on the science identity that the student creates for him/herself. Actual identities are a part of what people believe themselves to be. However, designated identities are based on what people expect others to be, now or in the future. In the case of this study, I saw that students have preconceived ideas about themselves and their capabilities, originating from their socio-economic background. Many feel that science is not for them because they do not know of anyone from their own background having succeeded in science. Students may also see a designated identity as inevitable for those from the same socio-economic origin or the type of future they are destined to have according to their teacher.

A teacher, therefore, plays a huge role in creating a designated identity for students and in helping their designated identities become their actual identities. A teacher’s pedagogic practices aids this process too. In case of Kishan, who himself believes that he is “bad” at science, and the teacher’s (teacher 1) designated identity for him being “he won’t be able to do well in science” does not help at all. As discussed earlier, different teachers posed different expectations from students in their classrooms. This aided each student’s behaviour in their classrooms. And hence, it also played a huge role in each student considering him/herself fit or unfit for science.

For the purpose of my study, I used identity that originates from students’ socio-economic background in place of ethnic identity. The underlying ideology of the academic identity that these students are constructing is marked by control, rightness and compliance to school rules. However, the underlying ideology of their science identity is marked by questioning, exploring and making mistakes. These contradictory expectations from the institution and the science teacher make science identity construction for the students a complex process. We find that the teacher, her pedagogical practices, the school norms and the child’s existing identity play a huge role in constructing a student’s science identity.
References


