

Reflective Pedagogy for Engaging Prospective Mathematics Teachers

Haneet Gandhi

The Central Institute of Education (C.I.E), University of Delhi, India¹ was perhaps the first institute to recognise the need of educating teachers before they enter the profession of teaching. Ever since its inception, CIE pioneers in taking a lead in all education related areas which are critical, essential and meet the futurist vision. This ideology gets reflected in all curricular and co-curricular aspects of CIE. One such vision can be seen in the way CIE envisioned discipline-specific pedagogy in the two-year B.Ed.. Programme.

In the 2015, when a transition was made to the two-year Bachelor's programme of Education (B.Ed - two year), CIE took a visionary decision to have two stream-based pedagogy courses rather than having a subject-based pedagogy course. To elaborate, it means, every student enrolled in the Two-year B. Ed. programme at CIE, studies two pedagogy courses which orients her/him to the broader perspectives of the disciplines. In one of the pedagogy courses, students² study the nuances related to the nature and philosophy of a stream and in the other, details of teaching a subject at the school level is dealt with. Switching to stream-based pedagogy courses has given a wider outlook to perceiving school education.

Teaching these stream-based pedagogy courses to prospective teachers is further a unique and worthwhile aspect which needs to be talked about. In the case of prospective teachers there is an element of revisiting the disciplinary knowledge they are already familiar with. When we teach children in school our objective is to teach unfamiliar, new content in interesting ways, whereas when it comes to teaching prospective teachers two aspects need to be kept in mind- one, related to reorienting the pre-service teachers to the school content they have already studied; and second, to teach them the pedagogies they can adopt for transacting that content in an effective and interesting manner to school children. In a B.Ed. programme, we try to amalgamate these two aspects in a very short period of time. Within a period of two years, the prospective teachers are required to revisit their subject related content and to also learn discipline-specific pedagogical strategies.

Covering all these is a challenging task for any teacher educator. In this paper, I am going to discuss some of the teaching practices that most of the pedagogy teacher educators have adopted to combat this challenge. In this article, the focus will be on sharing the teaching strategies which are adopted particularly with the B.Ed. Mathematics Pedagogy Courses at CIE. The paper will elaborate on the practices that have been proved to be effective in a) re-orienting the prospective mathematics B.Ed students to the mathematical content they are already familiar with, and b) helping them understand the tenants of teaching school mathematical content to children.

1. Central Institute of Education is now known as Department of Education
2. In this paper, 'students' means pre-service or prospective teachers (or student-teachers) who are enrolled in the Pedagogy of Mathematics course of B.Ed. The term 'children' is used for pupils studying in schools.

Professor Haneet Gandhi, Department of Education (C.I.E), University of Delhi

The Context

Students who join a teacher education programme are already Bachelors or Masters in a discipline; which means, we may easily presume that the B.Ed. students are comfortable in handling their discipline-specific content knowledge. However, over the years, I have realised, particularly in the case of mathematics, that often these students lack in their mathematical content knowledge. Many times, we see students coming to B.Ed. with a shaky knowledge of mathematics. Over the years, they have been conditioned to seeing only the procedural aspect of mathematics. They associate doing mathematics to memorising formulae and finding answers only. Being a Teacher Educator of Mathematics, I find it a challenge to break this myth. They need to be shown merit in building conceptual knowledge over procedural knowhow. With every batch, I foresee a huge challenge of re-inducting my students to the already known content but with a different perspective. I hold my classes with an objective of igniting their thoughts and pushing them to self-analyse their past learning experiences. Gandhi (2016) opines that teachers (both in-service and pre-service) need to be given avenues for delving in tasks in a mathematical way. Within their training programmes, they must be engaged in acts of conjecturing, communicating, reasoning, debating, and making connections. The experiences must be organised in a meta-knowledgable way which is analogous to the pedagogical content knowledge required at school level (Chick & Beswick, 2013).

Some Practices of Teaching Prospective Mathematics Teachers

In this section, I will share some of the teaching strategies which I use in my B.Ed. Pedagogy of Mathematics course. In the two-year B.Ed. curriculum, there are two papers on Pedagogy of Mathematics. In one, the students study generic ideas related to what mathematical thinking is, how must children be taught, how children learn, aspects related to mathematics curriculum and assessment. In the second paper, they study the pedagogical content knowledge of various concepts. Most of the ideas shared below are related to re-orienting students to the school content knowledge, studied as part of the second paper of Pedagogy of Mathematics.

Research-based discussions

Education is a matter of building perspectives. There is nothing completely right nor anything totally wrong. It is, therefore, important to present multiple perspectives to the students so that they may see the arguments with a rational mind. The students must be presented with varied debates and deliberations to help them build an objective outlook. This is possible by sharing a wide variety of differentiated research-based ideas.

I plan my classes much in advance to select one or two research-based readings on a topic which would help me build the discourse in a meaningful manner. Care is taken to pick articles that present contrasting views on a topic. For example, teaching of fractions has always been a much celebrated area of research in the community of mathematics educators. Varied perspectives on how fractions should be taught have been shared by different researchers. It is a good idea to choose two research articles with contrasting recommendations on building the idea of fractions in the class.

The readings are given to the students much in advance, say at least two weeks prior to the discussion period. In the class time, the students come prepared with their arguments. They present the ideas expressed in the

research articles, share their own views and experiences in the context of the readings. The discourse gets strengthened with justifications and convincing statements. Often, students are seen quoting their learnings and relating to their past experiences. At times, they also reflect and candidly express if they were taught fractions in such creative ways. Towards the end of the discussions, they are asked to select a preferred way of teaching fractions to be supported with valid justifications.

At times, it is also a good idea to pick the tasks/questions from the research articles directly and administer them on the students. Such exercises help in knowing student's ideas, their beliefs, notions, and misconceptions related to that particular topic.

Using History of Mathematics

Within the training period of B.Ed students, it is important to make them open listeners, receptive to other's views and ideas. This is possible when the students themselves delve in the situations of getting mathematised. There is a need "to create situations for teachers to 'experience Mathematics' which, in turn, will strengthen their mathematical knowledge. It is these choices of experiences that make the subject memorable, one that is cherished lifelong" Gandhi (2016).

One of the ways of making students empathetic is to give them open-ended, research-based learning experiences. In our classes, we undertake a lot of examples from the history of mathematics. We talk about evolutions of concepts. Here's an illustration of how we handle the conceptual development of Hindu-Arabic system. To understand the Hindu-Arabic system, we begin by studying the numeration systems of various civilisations such as the Roman System, Egyptian System and Mayan System. The students are asked to identify the strengths and weakness of these numeration systems. Questions based on why a numeration system perished?, what conceptual ideas made a numeration system mathematical rigorous?, what makes the Hindu-Arabic system most popular and such are discussed.

Classes based on historical evolution of concepts are particularly very interesting and fruitful. In these classes the students get opportunities to reason, make arguments and conjectures, and platforms to convince their fellow classmates. All these acts are closely related to thinking mathematically. As such, one also get to see earlier ideas getting deconstructed with establishment of new profound understanding of some of the most elementary concepts.

Re-learning by conceptual challenging

Mathematics is subjected to a very chronic (mis) belief. It is believed that mathematics is all about memorisation of algorithms and finding answers to problems. The procedural outlook dominates the conceptual knowhow. With my B.Ed students, I try hard to break this myth. It is my earnest wish to bring them close to the conceptual underpinnings rather than following monotonous procedures mindlessly.

I know the students are familiar with the school mathematical content. They know what geometry, algebra, number system, trigonometry, probability etc are. They are abreast in solving questions in the content areas. They now need to learn effective pedagogies of these content areas. Therefore, to probe deeper into the foundational ideas of the content it is good to revisit the basic definitions. One example which I can state here is related to differentiating between fractions and ratio. Since the representation of fraction and

ratio are similar, students often lack in stating the conceptual difference between the two concepts. Posing questions which trigger a feeling of challenge among the students sets a very lively atmosphere in the classes. Cognitive challenges make students question their own understandings. They realise what they assumed they knew was actually unknown to them. Making a known unknown motivates them to explore, relearn and reflect on.

Another anecdote related to initiating cognitive challenge occurs when we do geometry. The prospective mathematics teachers are well versed with Euclidean Geometry. They have studied it in school as well as in their college courses. So, to redo Euclidean Geometry will be an extremely trivial thing to them. To keep up their interests, there is a need to evolve the pedagogy. While doing geometry I do not talk of Euclidean Geometry because I know they will give me textbook based definitions. Instead, I pick Non-Euclidean Geometry and probe students to make analogies between the two geometries. We pick the fundamental assumptions of Non-Euclidean Geometry and make connections to discern what works and what doesn't work in both the geometries. By indulging in this exercise, the students not only get familiarised to Non-Euclidean Geometry, they also get avenues to hone their previous understanding and misconceptions related to Euclidean Geometry.

Such exercises make students empathetic towards their children's learning. They realise how learning a new concept is a hard endeavour that requires deeper digging.

Assignments

Giving assignments is also a very interesting task. The assignments are never decided by the teacher educator. The idea of an assignment emerges through a collective dialogue. During the discussion of a topic, we often feel a need to delve in it further. It is at this junction that we think of doing assignments. The need of assignments emerge from the topics under discussion. It is always contextualised. One can say, designing assignments in our classes happens in a very democratic way.

We not only decide the nature of the assignment but also the phases and timeline of completing it. The entire assignment is divided into phases and every progress of students is monitored at each phase. The first phase is generally about getting to know students plan of approaching the assignment. In the subsequent phases they report their progress. This phased-out manner works like formative assessment. The students work on their trajectory of learning and en-route get guided by their friends. They incorporate the feedback to revise and resubmit the assignments.

Reflective Journal of the Teacher Educator

I also maintain a reflective journal. Every week I make a note of what I did in my class. These reflections help me plan the forthcoming classes. Each class is built on the strengths and learnings of the previous classes. I can, thus, say that every class is built on the learnings of earlier classes. The pedagogy evolves to adapt to the need of topic/content under discussion. For illustration, discussions in geometry classes will be very different from those that happen in the classes where we discuss philosophy of mathematics. Most times, the content-based teaching is usually done in a reflective mode, and for topics which are new to the students, such as philosophy of mathematics, it is fair to go in a lecture mode.

Conclusion

Teaching B.Ed. students involves dealing with adults who think differently and maturely. The challenge at this stage is of re-introducing the familiar concepts in an interesting way. If the act of re-familiarisation is not handled sensitively, it would make B.Ed classes dull and boring. It is about awakening one's thoughts in a reflective mode.

In most of our Pedagogy classes the students are bound to find elements of re-thinking, re-looking, re-knowing and re-conceptualising. The students are led to think critically to facilitate their own learning in a meaningful way. They reflect on their earlier ideas and build newer perceptions based on their past experiences. With B.Ed students, one of the effective teaching practices is to create routes that invite reflections on their past learnings and understandings.

References

- Chick, H.; Beswick, K. (2013). Educating Boris: An examination of the Pedagogical Content Knowledge of Mathematics Teacher Educators. In V. Steinle, L. Ball & C. Bardini (Eds.), Mathematics education: Yesterday, today and tomorrow. Proceedings of the 36th annual conference of the Mathematics Education Research of Australia. Melbourne, VIC : MERGA.
- Gandhi, H. (2016). What mathematics matters to teachers? Voices of Teachers and Teacher educators, V(1), 26-31. NCERT: New Delhi.