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Challenges and learning opportunities involved in the professional development of mathematics teachers within the government sector

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CHALLENGES AND LEARNING OPPORTUNITIES INVOLVED IN THE PROFESSIONAL DEVELOPMENT OF MATHEMATICS TEACHERS WITHIN THE GOVERNMENT SECTOR

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Abstract

As Professional Development Teachers (PDTs), we have been working in the government sector for the last several years to improve the profile of Mathematics teachers within the sector. Our experience of the Professional Development of teachers suggests that working in the government sector is not an easy task. However, neither is it an impossible one.

The government's system faces varied challenges in tackling the professional development needs of teachers. The most important one is the capacity of the professional staff to undertake this mammoth job. Secondly, there is a strong need to change the perceptions of policymakers to consider the professional development in the continuum rather than one singular event. This requires a strong support structure to conduct the Professional Development activities in an ongoing manner.

Through our paper, we would like to outline our experiences to present how we have become engaged in the processes of developing Mathematics teachers within the government sector and what are the challenges that we are facing in continuing our efforts to take these efforts further. It is also very important to mention that the Mathematics Association of Pakistan (MAP) has remained very responsive to our ongoing professional needs to carry forward our responsibilities within the government sector.

Introduction

This paper discusses our work within the government sector to improve the performance of Mathematics teachers in government schools. As already mentioned, our experience of the professional development of teachers suggests that working in the government

sector is not an easy task though not an entirely but impossible one either. This paper also discusses various challenges and issues we have faced in tackling the professional development needs of Mathematics teachers within the government sectors.

Through our paper, we will outline experiences of our engagement with the Professional Development of Mathematics Teachers in the government sector. It will identify the specific areas where Mathematics teachers needed support to improve their teaching performance. It will also include what we have achieved in terms of bringing changes in their existing beliefs and attitudes towards teaching and learning Mathematics. Moreover, we will discuss to what extent the teachers have appreciated and implemented the new ideas and skills related to teaching and learning Mathematics. In this paper, we will share what we have learned in our engagement with the Professional Development of Mathematics teachers. This paper comprises of six sections; namely, process, findings, and challenges and issues, lessons learnt, recommendations and conclusions drawn.

It is universally acknowledged that the role of teachers is pivotal to the quality of education in a country. It is essential that teachers maintain a high level of character, competence and display an ability to communicate and instill self-discipline, self-control and resourcefulness in their activities. But the existing situation of the schools in the government sector showed that teachers in these schools were not maintaining the standard of education in government schools. They were relying on traditional methods of teaching, neither enriching nor updating their content knowledge to keep pace with the changing system of education. The students received an inadequate education, and were not encouraged to give importance to relating practical and theoretical knowledge.

The officials of the provincial and city government conceptualized Professional Development Programmes for the teachers in order to expose them to new teaching methods, that would help them to re-examine and revamp their existing methods of teaching and bring about changes not only in their own beliefs and attitudes, but also in their teaching styles. To address these issues, the government sector has offered several programmes for teachers' development, such as Sindh Primary Education Development Programme (SPEDP), Girls Primary Education Development Programme (GPEDP), Middle School Project (MSP), and the City District Government Programme. The focus of these programmes has been to encourage the development of elementary and secondary teachers in the following subjects: Mathematics; Science; Social Studies; Languages (Urdu, English, Sindhi); Skill Development; and, Early Childhood Education.

The objectives of these programmes has been to:

- provide adequate professional training so as to make teaching / learning effective;
- keep the teachers abreast of new developments in curriculum, subjects and pedagogy;
- develop the skills and attitudes necessary to meet emerging national development goals and programmes;
- make teachers aware of the problems of the community;
- develop the necessary skills and attitudes enabling teachers to be effective change agents.

To achieve these objectives the officials organized a series of training programmes for teachers in these subject areas. We were asked to plan and conduct training programmes for the Mathematics teachers. In our planning, we had focused on the following skills, strategies and activities:

- Questioning skills
- Reflective Practice
- Cooperative Learning
- Problem Solving
- Do, Talk, Record
- Role Play
- Development of Mathematics Resources by using low / no cost materials
- Assessment and Evaluation

These skills and strategies enabled them to revise their existing beliefs and to start thinking about bringing about changes in their teaching methods. These training programmes were valuable opportunities for the teachers to enhance their understanding of teaching and learning Mathematics. The Mathematics Association of Pakistan offered two workshops, lasting for the duration of a week each, for government teachers. We were also assigned the responsibility to plan and conduct these workshops. The purpose of these workshops was to encourage government teachers to critically examine their existing practices and come up with ways to teach Mathematics more effectively. At the end of the workshops, the teachers were involved in designing action plans to implement these newly taught ideas in their classes.

The aim of these programmes was to assist government teachers in their Professional Development and make their teaching methods more effective. However, there were no follow-up activities included in these programmes to see the impact of strategies and

activities that had been introduced in these programmes. Therefore we decided to visit the schools and observe the classes of the teachers who had participated in the workshops, in order to see the effectiveness of the innovative teaching methods that they had planned to introduce in their classrooms.

Findings

This section will include findings from the observation and discussions carried out during the follow-up study on the impact of the new teaching methods on the teaching and learning of Mathematics in the classrooms.

Impact on teaching practice and students' learning

It appeared from our observations and discussions with the teachers that they have developed an understanding of the following areas:

1. Understanding of Mathematics Content Knowledge

2. Development of teachers' understanding of teaching mathematics

3. Reflective Practice

4. Designing and implementing Mathematics Resources

Understanding of mathematics content knowledge

Prior to the start of training programmes, we tested the teachers to see their level of understanding about Mathematics content and teaching methodologies. This test showed that they had certain misconceptions and lack of understanding in Mathematics content.

We tried to design activities related to Mathematics content in order to overcome these misconceptions but there was still a need to provide the teachers sufficient guidance for the enhancement of their content knowledge. Observing their classes and discussing their problems related to their understanding of Mathematics content with them during school visits addressed this confusion.

An apt example of this is of one of the teachers who had been facing problems introducing sets to his class due to his own misconceptions about "sets". He explained that he had been facing problems in introducing sets through the use of concrete materials. When

asked why he was confused, he responded:

> I had planned to use concrete materials like stones, matchsticks, toothpicks, bottle caps, tamarinds and date seeds to introduce sets, but I could not understand how these materials represented a set. I had tried to arrange the material according to their physical properties. In this way, I thought there were different sets of stones, match sticks, toothpicks, bottle caps, tamarinds and date seeds, but I was confused in counting the number of elements in each sets.
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> For example, in a set of matchstick there were twelve matchsticks, so my understanding was that the number of elements is twelve. When I consulted the textbook definition of a set, it emphasized that a 'Set is the collection of well defined distinct objects'. Therefore I was confused."

After this discussion, I suggested that he do some reading on the topic of sets and I provided him with appropriate reading material. We also arranged a meeting in which I would work with him on the task of introducing "sets".

Similarly, the teachers also enhanced their content knowledge while engaged in designing activities. In a discussion about enhancing content knowledge one of the teachers responded:

> Previously I always placed emphasis on the textbook problems. However after attending the workshop, I have started thinking about activities beyond the textbook. This helped me to overcome misconceptions about mathematical concepts. For example, I used to show ratios in the form of fractions e.g. 2:3 = 2/3. I did this because it was presented this way in the textbook.
>
> However, when I consulted a reference book to find activities related to ratios, I did some reading on the concept of ratios and realized that ratios could not always be written in the form of fractions.

The two examples above demonstrate that the teachers started thinking to deviate from the textbook-oriented activities and are trying to be more creative in their teaching approach. This has enabled them to overcome misconceptions as well as enhance their understanding of Mathematics knowledge.

Teaching mathematics: development of teachers' understanding

The strategies and activities that the teachers learnt during the workshops helped them to bring changes in their teaching methods. During observation and discussion it was found that they were trying to bring changes in teaching mathematics. Their main focal points of change are:

- Introducing group work, pair work
- Encouraging students to interact with their colleagues and with their teachers, creating a friendly environment.
- Designing activities beyond the textbook
- Encouraging students to ask questions
- Appreciating students' work

It was very encouraging for me to see the positive changes when I visited a school to observe a Mathematics class. Although the class size was large, the teacher handled the class effectively. He had divided the students in groups and each group was assigned a task. He took rounds and encouraging group members to share their ideas with the other group members. The students responded positively and were actively involved in the tasks. They helped each other to understand the task and willingly shared materials.

When I asked a group of students regarding their feelings about the changes that had been implemented in their classroom, they responded:

S1: Previously I never talked in class because I was shy, but working in a group provided an opportunity to share my ideas with the other group members, enhancing my confidence.
S2: It was very interesting to sit in a group and share our experiences with the other group members.
S3: We learnt from each other.

These examples show that the teacher effectively involved students in the task through group work. In a discussion about the impact of group activities on students learning, the teacher says that the students learn a lot from each other. They share their experiences freely while working in groups.

It was encouraging for me to see that the teachers were trying to invent their own problems to develop their students' understanding about the Mathematical concepts. For example,

a teacher was teaching a lesson on percentages. Instead of starting the exercise from the textbook, he divided the class into groups and posed a problem to them. He asked them to write down the Mathematics test marks of the class. Then he asked them to discuss the following in their respective groups:

- What were the total marks?
- The relation between marks obtained and the total marks.
- What would be the marks obtained if the total marks were 100?

The students in groups started working on the questions whilethe teacher moved around the class to listen what was being discussed. After the task was completed, he asked the groups to nominate one group member to present the group findings on the board. Different solutions came up where some groups solved the task by using the unitary method, and others solved it by using ratios and proportions. The teacher asked the groups to explain the process. It appeared from the example that the teacher, instead of explaining directly the rule of finding percentage allowed them to work out the problem by using any method. After getting the explanations from the students, the teacher explained how to calculate the percentage. This teacher had realized that allowing students to use the method of their choice helped them to develop a more solid understanding of Mathematical concepts.

Reflective practice

One of the main aims of the training programmes was for participants to reflect on their practice and to recognize their own strengths and weakness. An analysis of one's thinking is challenging one's own established ideas, encouraging change. Recognizing this, the PDTs supported participants by encouraging them to reflect and analyze through the use of a variety of strategies. Activities to promote and sustain reflection included:

- Maintaining a reflective journal
- Critical discussion of sessions
- Evaluation and analyses of lessons
- Reviewing the students' learning

A reflective journal is one of the tools to improve one's teaching practice. During different programmes, we decided to introduce this strategy of reflective practice to improve and understand their teaching. Through this practice teachers can grow both personally a well as professionally. Teachers must reflect on their own practice because it helps them

to better understand what it means to be a teacher. Schon emphasizes the importance of "thinking about one's teaching." and another author defines this process of reflection as "an important human activity in which people recapture their experiences, think about them and evaluate them." Teachers should be provided with opportunities to critically analyze daily practices on an ongoing basis and explore alternatives for improvement.

The method we had adopted to introduce this aspect required participants to be given the question "What did you learn today" at the end of each day. During the next morning session, two or three participants shared their reflection in front of the class. Only the facilitators were allowed to comment while the teacher shared their reflections. The purpose of this activity was to give the teachers feedback and appreciation on their reflections and offer them suggestions to improve their writing. The facilitators gave input on reflective practice for four to five days. After the facilitator's input, the participants were also allowed to give their comments and suggestions on their colleagues' reflections.

Through this activity we observed that teachers took a keen interest in their writing and realized that this exercise was pivotal for them in their teaching practice. During the discussion on reflective practice, we were told that the teachers continued to write in their reflective journals even after the training programme was completed. (See some examples of government teachers' reflection)

Designing and implementing mathematics resources

Science exhibitions are very common in schools, but nobody thinks of Mathematics exhibitions as a strategy to encourage achievement in Mathematics. However in the workshops, teachers realized the value of Mathematics exhibitions to enhance students' conceptual understanding of the subject.

This was our experience in designing and displaying Mathematics resources by the subject teachers while conducting several training programmes / workshops in the government sector. Teachers took a keen interest in making these resources and not only designed Mathematics resources, but also used these resources in their teaching practice (Microteaching). While designing Mathematics resources in groups, they also provided group reflections, where they discussed their experiences of working in groups and the challenges they faced. While they were engaged in designing Mathematic resources, they were asked to consider various questions such as:

- How will the resources be utilized in the classroom?

- What Mathematics will be taught using the resource?
- What were some issues / concerns that came up while working in your group?
- Was there any tension among some group members? Why or Why not
- How would you describe your learning, in term of Mathematics, group collaboration and others' teaching contexts?

During the process of designing Mathematics resources, the teachers interacted with each other and discussed different concepts of the subject, realizing how different areas such as Arithmetic, Algebra and Geometry are interconnected and how the resources could be utilized in effective teaching. During the display of Mathematics resources, different group members were asked what the purpose of designing Mathematics resources was. Here are some of their responses:

> Through these resources we can make learning interesting and we can motivate the learners.
>
> Abstract ideas and concepts could be clarified easily. Sometimes we teach these ideas directly by introducing formulae and it becomes difficult for students to understand. I really enjoyed this experience.
>
> Through these resources, textbook problems can be related with practical life and we can invite students to share their own practical knowledge. We can confirm and verify rules and principles of Mathematics. For example abstract concepts such as variables, constants, co-efficients, expressions and others can be strengthened, through pattern seeking. One of the rules, $(a + b)^2 = a^2 + 2ab + b^2$ could be verified by drawing lengths and breadths of square and rectangle.

Challenges faced by PDTs

- Heavy workload due to series of workshops
  Due to continuous involvement in different government sector projects, we had a heavy workload to complete, along all with all the tasks related to each project.
- Lack of interaction between PDTs and government officials
- Interruption of government officials during the activities of workshops
- Lack of resources
- Dealing with teachers with less content knowledge
- Documentation of work

- Absence of participants
  One of the challenges we faced during the programmes was that most of the time participants were absent due to their own work at home or somewhere else, which affects their learning, it showed that they did not give importance to their learning.
- Perception of policymakers to consider the Professional Development as an event
- Lack of physical facilities

Challenges faced by teachers

- Large classes
  During the observation and discussion with the teachers, they mentioned that they were worried about the large class size because they were unable to control the class. Noise level was very high during the delivery of the lesson.
- Heavy furniture
- Lack of resources
- Completion of syllabus
- Time duration of the period
- Non-availability of resource room
- Lack of interaction among subject teachers and head teachers
- Lack of coordination between school heads and DOEs

Lessons learnt

In this section we discuss what we learnt during our period of engagement with these professional development activities for teachers. We also want to suggest ways to overcome obstacles for us during the process of the workshops.

As PDTs, we feel that an engagement with such programmes offered by the government sector enhanced our understanding about the nature of activities required that would best meet the Professional Development needs of the participants. It was our first commitment with the government sector as PDTs and we were unfamiliar with the behavior and attitudes of government officials. However with the passage of time, we learnt how to deal with these officials. It is the tendency of these officials to want to work according to their own agenda. Keeping in mind this situation, we did not insist on our ideas followed their instructions. To overcome this problem, we discussed our ideas related to Teachers Development with them and convinced them to give us a free hand in the selection of content for the workshops. It was very encouraging for us that these officials

started thinking about incorporating our ideas of Teacher Development. This example showed that while we could not achieve our goals at once, we had to wait for the appropriate time to convince other people of the validity of our ideas and our positive outlook.

Another important fact we realized during this process was of attitudes of teachers from the government sector. We had previously thought that these teachers were rigid and working with them, challenging their existing attitudes and teaching methods. We were surprised when that they kept an open mind and started to revise their attitudes and beliefs from a very early stage in the workshops. They were ready to accept new ideas and realized that there is a need to bring a change in their existing teaching practices. They were curious and motivated towards change. This showed that it is unfair to pass a judgment about these teachers without first working with them.

As it has been mentioned in the paper, many participants have faced problems in Mathematics content which was incorporated in the activities. We think that it would be better if we conduct a needs analysis before selecting the Mathematics content.

The participants of these training programmes were from government schools, where the medium of instruction is Urdu. The handouts and other material that we prepared was in English language, which in our opinion was unfair. Realizing this, we planned to provide Urdu translations as wellthough it created financial problems. It would have been better had we prepared handouts and other material in Urdu from the beginning. This would have been cheaper and more practical. As teacher-educators, we have to think about the background from where the participants come from.

Participants initially felt that the new teaching methods were time consuming and that there was not enough time to complete their lessons through activity-based teaching. Realizing this, we decided to demonstrate, the efficient use of Mathematics resources through practice lessons. This helped them realize that it would be possible if there was appropriate time management implemented. As teacher-educators, we have to provide practical examples to support what we are saying. Planning and implementing summer workshops with the team of facilitators from the MAP platform was really a wonderful experience for us, where we learnt how to negotiate and interact with people.

Recommendations

As Professional Development Teachers, we want to share the following suggestions,

which may help policymakers and other officials in launching new Professional Development Programmes:

- The Professional Development Programmes need to be ongoing.
- There should be follow-up activities, to see the impact of the strategies.
- Enough time should be allocated for need analysis and planning.
- The responsibility of preparing a programme handbook and writing reports should be given to tutors instead of other writers.
- Appropriate physical facilities should be provided to participants and facilitators.

Conclusion

From the above examples, it seems that teachers' implementation of newly established ideas have brought changes into their teaching practice. Although these changes may not be major ones, the outcome of these changes is apparent in terms of students' learning. The teachers are putting in their maximum efforts to shift their classrooms from being teacher-centered ones to being child-centered however they are still facing challenges in trying to convince stakeholders of the meaningful learning outcomes.

It is encouraging to see that the teachers are analyzing their practices critically, which in turn, provides an opportunity for students to develop their conceptual understanding. As far as the impact of these changes on students' learning is concerned, it seems that students are now actively participating in learning activities. The use of concrete material in different activities creates active involvement of students. In fact students are now enjoying Mathematics. We may say that changes in the teachers' teaching practice and attitudes enables them to create a classroom environment where students actively participate. This results in the improvement of the quality of education. Our findings showed that these small changes make a big difference.