



THE AGA KHAN UNIVERSITY

eCommons@AKU

---

Book Chapters

---

August 2003

# Learning to teach science using a new strategy: A case study of a primary science teacher

Nelofer Halai

*Aga Khan University, Institute for Educational Development, Karachi*

Follow this and additional works at: [http://ecommons.aku.edu/book\\_chapters](http://ecommons.aku.edu/book_chapters)

 Part of the [Elementary Education and Teaching Commons](#), and the [Science and Mathematics Education Commons](#)

---

## Recommended Citation

Halai, N. (2003). Learning to teach science using a new strategy: A case study of a primary science teacher. *Impact: Making a difference*, 147-160.

**Available at:** [http://ecommons.aku.edu/book\\_chapters/54](http://ecommons.aku.edu/book_chapters/54)

# LEARNING TO TEACH SCIENCE USING A NEW STRATEGY: A CASE STUDY OF A PRIMARY SCIENCE TEACHER

*Nelofer Halai*  
*AKU-IED, Karachi, Pakistan*

## **Abstract**

Constructivism has emerged as the dominant learning model in science educational reform. Despite this, there is a paucity of research studies on instructional strategies that might help the construction of knowledge that is in consonance with the established body of science. The use of activities based on discrepant events in teaching science at the primary level is seen as one way of encouraging this construction. Hence, Science Teachers enrolled in science methods courses / programmes at AKU-IED are exposed to this instructional strategy.

The four-member team of science teacher educators, teaching on an eight-week in-service programme, chose to look at the experience of the participating science teachers critically as they were exposed to the use of this strategy for the first time. The purpose was to understand how the participants learn the strategy and use it in the primary classroom. Four independent case studies were generated -- this paper presents the case that I studied.

I worked with one female science teacher from a private school in Karachi. The teacher was observed, while this strategy was taught, as she planned the lesson using this strategy and while she delivered the lesson to class five students. She was also interviewed in-depth after the practice teaching. Data shows that the teacher succeeded in delivering the lesson as planned, however, she faced some unique challenges in planning and teaching. Despite, having strong content knowledge and confidence in her teaching ability, she faced difficulty in selecting the discrepant event suitable to the content of the lesson.

Analysis reveals that the discrepant event requires a special kind of “practical pedagogical knowledge” that requires both content knowledge and experience with hands-on activities. Observation also showed that, despite support, the teacher had difficulty in explaining the discrepancy in the event to the pupils. The pupils too, lacking a wider experience of life, had difficulty in seeing the discrepancy in the activity. Implications for teachers and

teacher educators are discussed, as follows:

---

Constructivism, as a learning model, has found a great deal of acceptance in Science education (Baker, 1997; Collette & Chiapetta, 1989). There is a growing recognition that educators need a wider repertoire of strategies applicable to a constructivist classroom (Bonsetter, 1998; Gunstone, et al. 1999). One promising approach is through the use of so-called 'dissonant' or 'discrepant events' (Kavogli, 1992). Discrepancy refers to a dissonant situation where the outcome is contrary to what the learner expects. This results in arousal of conflict with a consequent need for the learner to assimilate the unknown or incongruous material into his or her cognitive structure. Perplexity and contradiction play an important role in stimulating the learner's curiosity. This concept of discrepancy can be traced to the early work of Festinger and his Theory of Cognitive Dissonance in which he stated that the creation of dissonance is psychologically very uncomfortable and motivates individuals to actively reduce the level of dissonance and thereby return to a state of greater equilibrium or consonance. Current research in the area of conceptual change maintains that students' dissatisfaction with their existing conceptions constitutes a fundamental condition in bringing about meaningful cognitive change (Posner, et al. 1982). A change is necessary to change students' alternate frameworks and to help them to construct knowledge that is in line with the current scientific thinking.

Mustafa (1998) shares her experience of working with this strategy with middle school students in her school in Karachi, "I found discrepant events very useful and motivating strategy however, it was time consuming and difficult to implement. I had difficulty in developing events suited to the learning needs of the students." Despite the difficulty, Shakoor (1998), found discrepant events to be a viable strategy in the Science classroom in Pakistan. Shrigley (1987) finds that discrepant events fascinate children and could and should be used to teach inquiry-based science to children. Hence, this strategy is included in the repertoire of strategies introduced to teachers enrolled in the Certificate in Education (Science) offered at the Institute for Educational Development (AKU-IED). As a teacher educator and a teacher-researcher I am interested in professional development of teachers and the experiences that they undergo when exposed to a teaching strategy for the first time.

The Certificate in Education is an eight-week in-service program offered in five curriculum areas (Science, Mathematics, English, Social Studies and Primary Education), offered to teachers from AKU-IED Cooperating Schools. It might be worth mentioning here that

AKU-IED was established in July 1993 as an integral part of the Aga Khan University, with the purpose of serving the region<sup>1</sup>. The Institute's programmatic activities include a two-year Master of Education and in-service Certificate Programmes. The Certificate in Education (Science) has been offered almost every year to primary and secondary science teachers from all parts of Pakistan and the countries that AKU-IED serves<sup>1</sup>. This programme is taught by AKU-IED faculty along with graduates of the MEd programme.

This study was initiated to look critically at the experience of primary science teachers participating in the Certificate in Education Programme offered by AKU-IED. The research question under study was:

What is the experience of primary science teachers when exposed to a new teaching strategy (discrepant event in this case) and the process that they follow in using the strategy in the classroom for the first time?

The four-member teaching team<sup>2</sup> undertook to develop four independent case studies under the leadership of the author. However, this paper presents one case that I studied and developed.

## **Methodology**

The research participants were drawn from the twenty-two teachers taking part in the Certificate Programme (Science). These teachers could be categorized into four groups: teachers from the government schools, private schools, AKESP system in Pakistan and teachers from schools outside Pakistan<sup>1</sup>. One teacher representing each sector was selected to participate in the study. As mentioned above each member of the four-member teaching team took responsibility of developing a case. The criteria used to select the teachers were:

1. The teacher must have a science background, i.e., must have at least a BSc / Inter in Science or equivalent educational qualifications;
2. The teacher should be teaching science at the primary level;
3. The teacher should have at least three years experience of teaching;

---

1 This includes Afghanistan, Bangladesh, India, Kenya, Kyrgyzstan, Pakistan, Tajikistan, Tanzania, Syria and Uganda.

2 I acknowledge the contribution of the Ms. Shahida Javed, Mr. Idrees Ahmed and Mr. Saeed Nasim who with me constituted the teaching team as well as the research team.

4. Should be doing well in the in-service programme.

The teachers participating in the study were treated no differently from other participants of the programme except that they sat for a 30-45 minute interview conducted after practice teaching.

The data collection was spread over a four-day period in which the primary teachers were exposed to the teaching of discrepant event for the first time. The schedule that was followed for teaching and research was as follows:

**DAY 1:** The four-member team taught a hands-on six-hour session on discrepant events. Besides their teaching responsibilities the research team<sup>3</sup> also observed their designated teacher as part of the research study.

**DAY 2:** The teachers prepared for and developed a lesson plan to teach a science lesson at the primary level using discrepant events as a teaching strategy. They also presented the prepared discrepant event to their peers to obtain feedback. The research team observed and took field notes about the participating teachers' preparation and planning for teaching.

**DAY 3:** The teachers taught the prepared lesson in a real classroom, while being observed by a member of the teaching team. They were then given feedback after the lesson. The research team maintained comprehensive field notes on the class observations.

**DAY 4:** The research team interviewed the participating teachers for 30-45 minutes.

The teaching format outlined above was generally followed by the teaching team throughout the programme. Farhana has summed it up in her interview<sup>4</sup> as such:

You have a special way to move ahead, that I have been observing from the first day. Whenever we learn something new, first of all you people demonstrate it as a teaching strategy, which we have not studied before. We observe; then keeping our experience in mind, we plan something

---

<sup>3</sup> Please note that the four-member teaching team and the research team was the same, however they had different roles and functions to perform during the teaching/research period.

<sup>4</sup> All quotes from the teacher's interview have been edited to enable the reader to better understand the meaning. In addition, at places Urdu words that she used in her conversation have been translated into English by the author. Journal entries are used verbatim.

ourselves. After that we present it to our peers which helps to build confidence. And finally, we implement the plan in a classroom.

Support and help was provided to the teachers throughout the planning and developing stage of their lesson plans. The whole lesson was observed by at least one member of the teaching team. Data for the study was collected in the form of field notes and reflective journal entries maintained by both the research team and the teacher. The teacher was also interviewed for a duration of 30-45 minutes, which was recorded on audiotape and transcribed.

Data analysis involved reading and coding the field notes along with reflective journal entries of the teacher and the researcher as well as the transcribed interviews. Comments, remarks and emerging categories were noted in the margin. Patterns and trends in these materials helped to identify relationships between variables and themes, whereas the isolation of patterns and processes and collapsing them in large categories enabled the findings to emerge (Strauss & Corbin, 1998).

### **Teaching and learning a new teaching strategy**

Farhana Batool<sup>5</sup> is a bright and articulate science teacher working in a private school in Karachi, which I shall refer to as the Central Model School (CMS). She had recently shifted to Karachi from Islamabad and had begun to teach at CMS. It was a reflection of the confidence the school had in her ability to benefit from the in-service programme that she was sponsored to attend after teaching in the school for only four months. During the eight week in-service, she participated enthusiastically, asking questions and raising issues both during class and through her reflective journal. She had the ability to grasp new ideas relatively quickly and was a very conscientious teacher.

Farhana was not aware of discrepant events as a strategy for teaching science, and was curious as to its nature. Teachers were paired into groups of four when the actual subject was introduced in the programme. Farhana took a “lead” role, reading the instructions, translating them in Urdu for the members of the group who were not very conversant in English, and then following the instructions along with them.

Her first reaction to the use of discrepant events by the teaching team in the programme was expressed in the following dialogue from the interview transcript:

---

<sup>5</sup> A pseudonym has been used to protect the teacher’s identity.

Farhana Batool (FB): On the first day when the activity started, one had the feeling that discrepant events were something else. That these activities would not be the same as those activities that we do daily. In the beginning we had a discussion, then one activity was done in front of us, we did an activity by ourselves also. Till that time it appeared that discrepant event activities were something else.

Nelofer Halai (NH): What does it mean when you say “something else”?

FB: It seemed to me that discrepant events were not normal activities.

NH: OK

FB: They are something special. They are something different where we would have to consult different books. In the beginning, it appeared that it was going to be a difficult task. When we started lesson planning, thought more, picked up and read more books, then it became clear that a discrepancy is present in almost all activities. The majority have them though we don't think in that way. It has more to do with the way we think. Which direction are we going in? The most helpful were the suggestions we got to improve the discrepant event from our peers and tutors. For me, the most ideal time is that time.

NH: Your peers?

FB: When we were doing the presentations for other teachers, when we talk, the confusion automatically comes forward and we become more clear ourselves about the activity and where we should improve. That really helps us a lot. And we automatically become more confident. If things have worked here, then definitely they will work in the class.

The content atmospheric pressure and related concepts were to be taught using this strategy. A part of the morning's work included working on a pre-selected discrepant event based on some aspect of atmospheric pressure. Each group was to then present to the rest of the class both the activity as well as the science underpinning the activity.

Farhana's group was given an activity where they were supposed to put a lighted matchstick in a jam jar and put a hand on the jar in such a way as to make it airtight.

When the jar was released it was expected to remain sticking to the hand. Farhana tried it several times but could not do it. Then Farid, another teacher in her group, tried it and it worked very well. The jar remained stuck to his hand for quite some time leaving a dark red ring mark. He also said that he felt suction on his hand. However, all subsequent attempts to obtain the required suction failed and the jar did not “stick” to the hand. Farid and then Farhana both tried it together with a third teacher from the group, but it did not work. The jam jar refused to stay put and would not adhere to their hands as it had during the group work. However, they made the best of the situation and explained the activity to the rest of the teachers.

As a teacher-educator and teacher-researcher, these two things are a source of interest for me - the fact that the selected activity was very temperamental, sometimes it worked and sometimes it did not; and secondly, a very cursory attempt was made to explain the science behind the event. Perhaps in this case it was because the activity did not work so the teachers could not explain the science related to the discrepant event. In the same way other groups were expected to demonstrate their discrepant event activity to the rest of the class and teach the scientific concept underlying it. However, I saw that only one group took pains at trying to get at the underlying scientific concept.

At the end of the morning sessions, I was not sure how many teachers had understood the concept of atmospheric pressure from the demonstrations. In retrospect, I think we, the teaching team, should have encouraged and actively facilitated more discussion of the underlying science principles when we demonstrated discrepant events ourselves. Later we saw that the teachers too focused on making the activity work and less attention was paid to understanding or explaining the science underpinning the event. For instance, in the above example, the focus was on making the jar stick rather than on understanding and explaining to the peers the reason behind it and relating it to atmospheric pressure.

### **Learning to use a new teaching strategy**

On the second day, the teachers were given time to look up resources in the library to prepare their lesson plan using a discrepant event. I was immediately surrounded by a group of students who wanted more specific help. I mentioned the name of Liem’s (1987, 1991) book, *Invitation to Science Inquiry*, and the teachers were off chasing it. I saw Farhana and one of her colleagues in front of the photocopier in the afternoon. They were getting some activities copied. I asked them how they had located the activity. They told me that they looked for an activity that they could do easily and one for which the materials were easily accessible. They then looked in the textbook to see the absence

or presence of that topic and came up with an objective for the lesson.

In essence, the sequence was exactly the same as the one that we as the teaching team had followed in planning this session. Interestingly, it is also the exact opposite to what we profess to teach, i.e. make the objectives first and then develop the lesson. The teaching team had decided to address some biological content in the week in which a discrepant event was to be introduced.

However, very few discrepant events were found suitable for teaching Biology and even fewer resources were available to help develop discrepant events in Biology. Hence, it was decided to teach atmospheric pressure, as there was a lot of material available in this area. Does it mean that in some strategies like the discrepant event it is easier to first locate the activities and resources and then select the topic area? Is there any harm in following this practice?

### ***Farhana's discrepant event***

Farhana selected the activity for teaching based on a number of factors. She explained the selection process in this way:

To plan the lesson I had to find the activity with the topic in mind. For that I had to go to the library and read trying to find different activities, reading them thoroughly and then thinking about them. Some of the activities that I read were very general which the children would already know. I dropped such activities. Some activities that I selected, on closer inspection, were not relevant. That is, I would not be able to draw a relation between the activity and the topic to be taught. Then there were some good activities but to explain them would require a high level of understanding in science and hence would be inappropriate for class four. I was also looking for those activities that needed material, which I could get myself. Neither did I want to borrow material from AKU-IED nor did I want to purchase them. So I had to keep the availability of material in mind too. Maybe the material I wanted to use were available at AKU-IED but not in my school so I wanted to develop an activity that I could easily support and recreate anywhere.

She had first selected another activity that she tried to prepare at home. However, despite repeated attempts she could not get the desired results. Hence, she prepared another

activity using discrepant events for the microteaching session. This activity worked well and Farhana used it to teach a science lesson to class four in the CMS for one period lasting one hour. This was the day that a political party had called a strike in Karachi and hence there were only thirty students in the class instead of the over forty to be expected. The topic was “hot air rises”. The discrepant event she used in her teaching was as follows:

Take three bottles from which the bottom has been cut away.

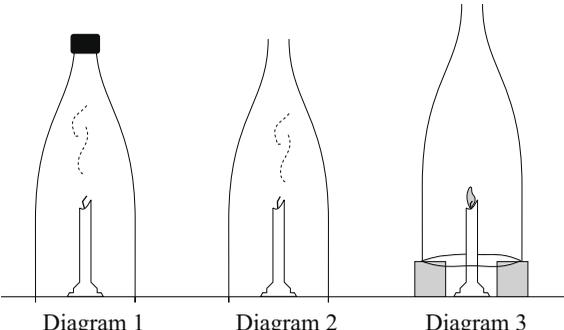


Diagram 1      Diagram 2      Diagram 3

First light a candle and cover it with the plastic bottle as shown in Diagram 1. Make sure that the top of the bottle is tightly closed with the cap. The candle will soon extinguish.

Light another candle and cover it with a bottle, as shown in Diagram 2, make sure that the cap is removed. Even now the candle will extinguish very soon, which comes as a surprise!

Light the third candle and cover it with the third bottle, as shown in Diagram 3. Make sure that the bottle is raised higher by placing it on small wooden pegs. The candle will continue to burn for a long time.

Her management of the class and the materials was excellent, though she faced some difficulty initially when all her students could not see the demonstration. The best part of the lesson was the manner in which she used the Predict Observe Explain (Gunstone, 1991) sequence of questioning to enhance student engagement and suspense. In her journal, she records that she could do better by devising a lesson where the students, in small groups, work on a discrepant event themselves. Her lesson also succeeded in achieving the goal of demonstrating to students that hot air rises, however, very little class time was devoted to why hot air rises.

### **My understanding of the process**

On analysis, I think that Farhana went through at least three stages:

1. The Appreciation stage, which I call the Wow and Vow stage!
2. The Application stage, which I call the Muddling Through stage.
3. The Analysis stage, which I call the Second Thoughts stage.

The Wow and Vow stage is the initial euphoria where Farhana was delighted with the presentation made by the teaching team; she called it almost magical. She was fascinated by the activities presented, the manner in which it was presented to create inequilibrium in her mind and the way it was resolved by teaching the content. She also resolved to teach in a similar manner.

This stage of Muddling Through comes into play where a teacher like Farhana is given time to develop her own lesson plan using this strategy. There is almost a sense of panic and she, with her colleagues, is seen in the library and at the photocopier making copies of potentially suitable activities. Further support was sought by discussing the discrepant event with the teaching team. Farhana, was particularly keen to see that there was a good match between the discrepant event selected and her teaching goals.

During this stage, teachers like Farhana who have good English language skills, offer strong peer support. I often saw her surrounded by other teachers asking help in trying to understand some activity sheet that they had brought from the library. A number of teachers, both from the government and private sectors, had difficulty in comprehending either the directions for doing the activity or the science underlying the activity. Often times it was a little bit of both.

Slowly, most teachers settle down and start working on their selected discrepant event. During this stage, Farhana made two decisions that helped her to succeed: she decided on a topic and did not change it even if the activity that she had selected did not work; and she chose to select another activity covering the same topic rather than change the topic and activity. This is where a number of her colleagues had difficulty. As soon as an activity did not work, they panicked and chose another activity that they thought would work unmindful of the topic area. That meant that not only did they have to work on a new activity, they had to read up and understand a new topic area.

The most difficult part was yet to come, to actually try the discrepant event and make it work “the way it is supposed to work”. Farhana, like many others had to change the discrepant events because she could not achieve the desired results. The Muddling Through stage, I believe, continued right through the teaching practice stage. I observed that the teachers were at different levels of comfort with working with this strategy.

There were some teachers who could barely understand the concept of discrepancy and had difficulty in seeing the discrepancy in most of the activities given in resource books. And there were teachers like Farhana who had written in their reflective journals that she wanted to not only demonstrate discrepant events but wanted to let students do these activities individually. Farhana was among the teachers who used discrepant events with relative success.

The last stage was where Farhana had second thoughts about her ability to engage and use this strategy in her own classroom. She writes in her journal:

There is a question in my mind. Here at AKU-IED we have time, books and guidance of our facilitators to help us to plan and deliver an effective lesson. Is it really going to work when we go back to our own places? There we have a lot to do and in one day we have to take three or four lessons. I think we are really going to have a tough time. Although we did all the work individually today, we faced a tough time in preparing our lesson. A lot of practice will be required to overcome this problem.

During the interview when Farhana was asked the most essential and critical elements for using discrepancy in the primary classroom, she said:

Content knowledge is the most essential aspect. Without having content knowledge, no matter which method we use, we definitely cannot ask questions with confidence. This is my own experience. If I have to ask questions, so that children are encouraged to ask more questions, then I will hesitate to go on a track where I am not sure of my own content knowledge. But when we are confident, we want the child to think more and ask more questions. Content knowledge is the basic requisite of good teaching.

I agree with Farhana that science content knowledge is the most important prerequisite to be able to teach effectively using this strategy. Very often primary teachers in Pakistan themselves have very little preparation in the science. Hence, they do not have exposure to either the science content or science activities that they can: (a) see a discrepant event and recognize a discrepancy; (b) explain the discrepancy based on science content knowledge. These two conditions help to make this strategy particularly challenging for primary science teachers.

## Implications for teaching

The first stage of Wow and Vow is very important for motivation of the teachers, but it is the second stage of Muddling Through that defined success for Farhana. She needed the time and space to work on her activity and materials. However, support and pressure both are required at this stage -- if no support is provided at this stage, the teacher will soon become frustrated trying to do a task for which she is not well prepared.

However, if there was no pressure, it is possible that Farhana might have not been able to prepare another activity to replace the first one in such a short span of time. The pressure was provided in two ways: (a) by requiring the teachers to prepare a lesson to teach in a real classroom and (b) by expecting teachers to demonstrate a part of the lesson in front of their colleagues. Farhana felt that the latter aspect of the whole teaching sequence was most helpful in clarifying ideas, removing confusions and improving the lesson plan. There was a pressure to present something reasonable to one's peers in the given time.

The biggest challenge for teacher educators is to devise means where the teacher can undergo two or three cycles of the Muddling Through stage. Each iteration will help them to get closer to the stage, which Bonsetter (1998) calls Phase III. He states that teachers go through three phases as they try to implement reform in education:

**Phase I:** The pre-reform stage where the teacher is “doing what they have been doing”.

**Phase II:** The teacher is exposed to a new way of doing something via a one-day workshop. S/he tries it out, it does not work and s/he concludes, “this stuff is just another short term educational trend”. And they revert back to Phase I.

**Phase III:** The teachers do not stay long enough with the reform to reach Phase III where teachers reflect on what they are doing and how they might integrate these new ideas into their pre-workshop repertoire of teaching tools.

To keep the teachers engaged with a new strategy until they become comfortable using it is the challenge that is facing teacher educators at AKU-IED too. One of the reasons that the Certificate in Education has transformed into a more field-based format is to extend and lengthen Phase II and support the Muddling Through process so that the teachers reach Phase III.

## References

- Baker, D. B. (1997). *Constructing Science in the Middle and Secondary School Classrooms*, London: Allyn and Bacon, 1997.
- Bonstetter, R. J. (1998). Inquiry: Learning From the Past with an Eye on the Future. *Electronic Journal of Science Education* 3 (1), 1-5.
- Collette, A. T., & Chiappetta, E. L. (1989). *Science Instruction in the Middle and Secondary Schools*. Columbus: Merrill.
- Gunstone, R. F. (1991). Reconstructing Theory from Practical Experience. In B. Woolnough (Ed.), *Practical Science: The Role and Reality of Practical Work in School Science* (pp. 67-77). Milton Keynes: Open University Press.
- Gunstone, R. F., Loughran, J., Berry, A., & Mulhall, P. (1999). *Inquiry in Science Classes - Do We Know "How, When and Why"?* Paper presented at the Annual Meeting of AERA in Montreal, Canada.
- Kavogli, Z. (1992). Discrepant Events: An Alternative Teaching Process. *Science Education International*, Vol. 3 (3), 10-13.
- Liem, T. L. (1991). *Invitations to Science Inquiry*. Chino Hills: Science Inquiry Enterprise.
- Liem, T. L. (1987). *Invitations to Science Inquiry* (2nd Ed.). Chino Hills: Science Inquiry Enterprises.
- Mustafa, S. (1998). *Discrepancy: An Innovative Strategy for Promoting Students' Learning in Science*. Unpublished master's dissertation, Aga Khan University Institute for Educational Development, Karachi, Pakistan.
- Posner, G. J., Strike, K. A., Hewson, P.W., & Gertzog, W.A. (1982). Accommodation of a Scientific Conception: Toward a Theory of Conceptual Change. *Science Education*, 66 (2), 211-227.
- Shakoor, M. (1998). *Discrepant Event as an Alternative Science Teaching Strategy in Lower Secondary Classroom*. Unpublished master's dissertation, Aga Khan University Institute for Educational Development, Karachi, Pakistan.

Shrigley, R. L. (1987). Discrepant Events: Why They Fascinate Students. *Science and Children*, 24-25.

Strauss, A., & Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks, CA: Sage Publications.