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## Inquiry-Based Teaching in Mathematics Classroom in a Lower Secondary School of Karachi, Pakistan

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### Abstract

There is greater demand on schools to provide autonomy to the learners in the learning process. Diverse strategies are suggested by academicians to achieve the desired autonomy. One such strategy is inquiry-based teaching which provides students with enhanced autonomy in the learning process. This study explores how inquiry-based teaching could be introduced in mathematics classroom in a lower secondary school of Pakistan through an action research process? Analytic memos, sample of students work, reflections from critical friend, observations, field notes and interviews were the main tools of data generation during the study. The results of the study report that inquiry-based teaching in mathematics classroom in lower secondary school of Pakistan could be initiated through change in physical setting of the classroom, changing role of students and teachers in the learning process, focusing autonomy rather than efficiency of the students in the learning and modifying the current examination system.

**Keywords:** Inquiry-based Teaching, Mathematics Classroom, Developing Context

### Introduction

The provision of autonomy is advocated by academicians from decades at the expense of traditional view of control of the learners in the learning process. Autonomy develops skills as well as deeper understanding of the learners as compared to the dominant “chalk and talk method” which limits opportunities of intellectual development and deeper understanding. Various student-centered teaching strategies are suggested by educationists for making students more autonomous in the learning process. Among those strategies inquiry-based teaching is considered to be one the most important ones due to its historical evolution and its effectiveness in promoting autonomy in the learning process.

Although inquiry based teaching is defined in many ways, in this study inquiry-based teaching is understood as an approach of instruction in which learners are put into situations where they engage in learning process more autonomously (Borasi, 1992; Cater, 2004 & Jaworski, 1996). These situations are created through activities in which students are provided opportunities of

bringing out their prior knowledge, confrontation to their own way of thinking, organization of those knowledge and experiences, restructuring of their old beliefs and knowledge, and application of new idea to new situations (Chin, Lin, Chang & Tuan, 2007). Literature reveals that inquiry-based teaching in Mathematics has a long history which can be traced back to problem solving movement of Polya in 1945 (Jaworski, 2007). It received greater attention both in curriculum design and methods of instruction especially in USA after the launch of Sputnik<sup>1</sup> by the Soviet Union in late 1950's (Frelindich, 1998). Moreover, one of the most important factor which fuels the evolution process is fundamentally rooted in a popular debate in mathematics education on the key issue that how mathematics learners can be supported by teachers in construction of mathematical knowledge and understanding? (Chin, Lin, Chang & Tuan, 2007). This popular debate and the Sputnik mission triggered policy makers, curriculum designers and teachers across the globe to revisit and restructure their educational practices in line with inquiry-based teaching.

The inception of inquiry-based teaching promoted a discourse not only in the developed world but also in different developing countries including Pakistan that fundamentally negates the traditional "chalk and talk" method of teaching in schools. For example, commenting on the educational system in developing countries especially with reference to Pakistan, Mohammed & Jones (2008) say that,

"The educational system of many developing countries are frequently criticized for being authoritarian, transmissive, syllabus-driven and text-book oriented...to improve the situation, many reformers propose a paradigm of education that recognizes and respects the knowledge and experience that children bring to the classroom that encourages individual construction of knowledge and seeks to create the space and facilities for children's capabilities to develop fruitful. This paradigm promotes autonomy, imagination, innovation, spontaneity, enquiry and flexibility in general, child 'child centeredness. (p.39)".

Much has been said favoring student-centered teaching strategies like inquiry-based teaching in Pakistan. However, there are rare examples of introduction of these strategies in real classroom situations. This study practically explores the opportunities and challenges of introducing inquiry-based teaching in a lower secondary mathematics classroom in urban Pakistan through an action research.

### **Methodology**

The purpose of the research was to study the process of implementation of inquiry teaching strategies in a lower secondary Mathematics classroom in Karachi, Pakistan. The research method was action research because during the research the teacher researcher played dual role of a teacher and primary participant by introducing inquiry-based teaching strategies through a systematic process of planning, action, observation and reflection. The research model used

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<sup>1</sup> Various robotic spacecraft missions launched by former Soviet Union in 1957

during the study was Kemmis, McTaggart & Retallick (2004) model of action research. Total duration of the research was four months and comprised of five cycles. The secondary participants include all the students and mathematics teacher of class seven and the head teacher of the school. Data were generated through analytic memos, reflective diary, and reflection from critical friend, observations, sample of students work, interviews and field notes. The data collected through different tools were coded, themes were generated and detailed analysis on each these themes were done.

## **Results**

The results of the study are presented under the following four major themes: change in physical setting, changed role of teacher and students, autonomy vs. efficiency and examination system.

### **Change in Physical Setting**

The seating arrangement in the researched class was such that the students were sitting in vertical columns with two of them sharing a desk and facing the blackboard. This seating arrangement did not provide them opportunities to interact with maximum number of colleagues, limiting the social, physical and intellectual space for the students in the learning process. In order to promote maximum interaction with each other, the strategies of group work and discussions were introduced and the seating arrangements were changed. In the changed seating arrangement, five students worked in groups sharing a common table. This arrangement provided the students with opportunities of sharing ideas with each other critique each other's understanding of mathematical topics and participate in collaborative work. In one of the groups, while learning the focused mathematical concept, students were engaged in rich mathematical discussion. The first student said, "it means cylinders are made of two bases and one curved part". At this, the second student said, "what do you mean by curved?" Responding to the question a third student explained the concept of curved surface and base of the cylinder in a comprehensive way by using a paper". Such type of discussion, cooperation and deep inquiry were not witnessed in the classroom arrangement in which two students were sitting together facing the blackboard.

Hence, inquiry-based teaching can be actively implemented by changing the classroom environment that is, by arranging the students into small groups. Classroom environment where students have little opportunity to share their ideas with their colleagues, due to lack of proper physical arrangements, are debilitating to deep learning. Thus, active participation and autonomy in learning, the fundamental principles of inquiry-based teaching, cannot be effectively facilitated without creating an interactive learning environment within classroom. Hence, changing seating arrangements from traditional way of seating in vertical columns to small groups is one of the important changes required for initiating inquiry-based teaching.

### **Changed Role of Students and Teacher**

Before the introduction of inquiry-based teaching, students and teacher had certain defined roles which they follow on daily bases in each mathematics lesson. For example, teacher asks questions, students respond to the questions, students make mistakes and teacher corrects them

on the spot; teacher solves the exercise on the black board and student copy them. However, inquiry-based teaching provided the students opportunities to share their understanding with each other and take responsibility of their own learning. As in inquiry-based situation, students discussed the topic under consideration with each other, teacher monitored their activities. Moreover, students correct their mistakes by themselves with minimum guidance from the teacher's side and discussed topics relating their daily experiences as well as critiqued one another's understanding. Hence, inquiry-based shifted the role of teacher as a source of knowledge to as facilitator of learning, made the students more responsible and autonomous in the learning process.

### **Autonomy vs. Efficiency**

According to Piaget and Dewey (as cited in Carter, 2004), the central propose of education is autonomy. They define autonomy as the ability to create rules for themselves to deal with situations not following the external controls as external controls are an impediment to cognitive development (Carter, 2004). Here, the external control may be a teacher or any fixed framework given to the students to follow during the learning process. During the study, autonomy was provided to the students in the learning process. For example, the students were autonomous in making groups of their own and to manage the time, resources and group formation by themselves. These actions created a series of challenges like; students were unable to complete the activities in the stipulated time. For example, during the inquiry lessons the students had not enough time to practice the word problems. Every student was bringing their prior mathematical ideas, sometimes with unfocused discussion not related to the topic under discussion. Giving them total autonomy in the learning process diverted the students from the original topic. As a result, they were unable to manage time and complete the task. Although, autonomy provides the student an opportunity to freely express their ideas creating mathematical discussion, enhances cooperation and deeper understanding of the mathematical topic under consideration, it creates challenges like issue of time management and completion of tasks which is considered to be one of the top most priorities of the teachers in Pakistani educational system (Dean, 2009). Hence, the students are trained to be efficient rather than autonomous by the teachers.

### **Examination System**

Although the study was of small scale conducted in one school, it explored a significant relationship between inquiry-based teaching and examination system in developing context like Pakistan. This study reports that examination system guides students learning styles, their learning priorities and teachers' choice of instructional practices. Inquiry-based teaching being more flexible and student-centered teaching strategy provided the teacher, students and the school administration the opportunity to think about their practices. For example, during one of the inquiry-based lesson, students were engaged in a group work, discussion, use of materials and were not focusing the questions given in the textbook. Therefore, they were continuously asking about whether these questions were going to be included in the examination or not. Moreover, the mathematics teacher of the class was asking the teacher researcher to focus the exercises given in the textbook. Similar findings are also well were explored in Pakistani mathematics classrooms by other researchers. According to Halai (2007), the system in Pakistani

schools is product-oriented and confined to books, so the introduction of innovation in the classroom is a challenging process. It is clear that the teacher wanted to give more importance to exercises. Similarly, the students' behavior reflected their attitudes as they were repeatedly asking about the exercises in the textbooks. In such type of summative examination system where students opted to focus the exercises in the prescribed books to prepare themselves for the examination, introduction of inquiry created anxiety among the students and the teacher. Hence, the summative examination system is one of the major hindering factors in the way of inquiry-based teaching in the school as it creates anxiety among the students, limiting learning only to books and teachers. Thus, examination system in Pakistani schools is a source of students' anxiety, as it hinders students' learning process and resists innovation in class (Rodrigues, 2007).

The above discussion shows that exam-oriented system is promoted by many interlinking factors like the larger school system, and the teachers which ultimately affect the learning of the students, diverting them more towards the examination. The introduction of a more process-oriented approach of teaching like inquiry where the learning of the students is the focus could be challenging for a single teacher, as it is introduced and promoted by the top management. Hence, effective implementation of inquiry teaching strategies requires the facilitating role of policy makers, whole school system, cooperative organizations, and curriculum designers.

### **Conclusions**

Introduction of inquiry-based teaching in mathematics classroom provided the students an opportunity of physical, social and intellectual space in the learning process. This situation was contrary to the phenomenon in developing context like Pakistan where students are treated as passive recipients of knowledge. This study explored that inquiry-based teaching is a process neglected not only by teacher and students within the classroom, it is critically influenced by the external classroom factors like syllabus, time and the examination system. Although the study was an action research conducted in a single school, it explored many important aspects related to the introduction of inquiry-based teaching within and outside the classroom. These aspects include the concept of autonomy in inquiry, use of textbook, examination, course completion and time management. These emerging themes can be used as a framework for future studies by taking large samples using the quantitative approach to explore their relation with inquiry-based teaching in a comprehensive way. Moreover, literature reveals three levels of inquiry. These levels include structured inquiry, guided inquiry and open inquiry (Blair, 2008). This study explored that open inquiry demands more autonomy of the students in the learning process. Therefore, it is too early to introduce it due to the traditional pedagogical practices of the school which are structured around examination, syllabus and course completion. Before introducing the concept of inquiry based teaching in this context, first the other variables should be made favorable and facilitative.



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