

# **A QUALITATIVE APPROACH TO STUDY THE ROLE AND IMPORTANCE OF INQUIRY-BASED LEARNING: PROFESSIONAL LEARNING EXPERIENCE OF TEACHER-EDUCATORS AND STUDENT-TEACHERS IN INITIAL TEACHER EDUCATION PROGRAMS**

By

*Nasrin Akhter\**

*Intazzar Husain Butt\*\**

## ***Abstract***

*There is a general view that the transmission style of teaching is inadequate in helping students develop their learning in science, particularly in Initial Teacher Education (ITE) in Pakistan. Inquiry-based pedagogy in science is considered key means of improving an understanding of science and helps students cultivate their science literate thinking and develop their confidence to teach science effectively. In light of the key roles of inquiry-based pedagogy in initial science teacher education, this study explores the perceptions of teachers and students at a university in Punjab as how they understand the elements and process of inquiry-based pedagogy. The research is innovative in the context of exploring teacher-educators' and student-teachers' perceptions of inquiry-based pedagogy and also in relation to inquiry in the practicalities of their teaching at University in Punjab (Pakistan). Data has been collected using 2 focus groups with student-teachers and 20 interviews with teacher-educators. The result of this study indicates that the teachers and students mostly held positive views about inquiry-based pedagogy. Significantly, the teachers and students showed a limited understanding of the elements of inquiry-based pedagogy in ITE but they appreciated that they could facilitate the learning process using inquiry. When inquiry-based instructional strategies are integrated into a teaching science methods course, the majority of teachers developed a fair understanding of inquiry-based strategies in science. Moreover, the biggest challenges to inquiry are a non-supportive university academia, the current curriculum and assessment methods used. Finally, recommendations about the importance of teachers' and students' perceptions on inquiry-based pedagogy, arrangement of resources, preparation for teachers and students are made to the teacher-educators, University administration, and Higher Education Authority.*

**Key Words:** Teacher-educators, Student-Teachers, Inquiry-based Pedagogy, Initial Teacher Education, professional Learning Experiences

\*Assistant Professor of Education, University of Education, Lahore.

\*\*Assistant Professor of Education, University of Education, Lahore.

## Introduction

In Pakistan, as with anywhere else in the world, Initial Teacher Education (ITE) programmes are considered a privileged opportunity to develop student-teachers in science. However, a difficult phenomenon for science teacher-educators as well as science student-teachers is that the transmission style of teaching science is not enough to help student-teachers to deepen their learning of science in ITE, particularly in Pakistan. Rather, this dominant style of teaching results in rote learning to pass the examination (Ali, 2008; Akhter, 2009). The quality of teacher education, which must be considered to be a key factor in any education system, is poor in Pakistan (e.g., Khan, 2012; Mohammed, 2008). It suffers from the lack of adequate training program, less emphasis on teaching practice and non-existence of any proper support or monitoring systems for student-teachers (Mohammed, 2008; Ahmed, 2012; Khan, 2012; Memon, 2010). Inquiry includes open-ended practical activities in science, and is associated with the development of thinking skills, and positive learning outcomes. It is widely agreed that the ITE programmes which are offered at most of the public sector institutions in Pakistan are substandard in that the teachers are too rigid and autocratic, they use only transmission styles of teaching with lengthy course content, and their lessons lacking student-centred activities. The dominant pedagogy used in these programmes is characterized by chalk-and-talk, and this forces their students to memorize (Mohammed, 2008). Research suggested that many teachers avoid teaching inquiry-based science because their own experiences have not stimulated their interest in science, and what science is taught in the primary schools is taught mainly through lectures and textbooks rather than through exploration and experimentation. From the above discussion of the situation of ITE in Pakistani universities, it can be summarised that teaching is disordered and lengthy curriculum and large teaching load make teachers performance low (Khan, 2012). Also, inquiry-based learning has not, yet, become a characteristic of science practice and that “in classrooms where it does take place, confirmatory exercises and structured inquiries are by far more common than guided or open inquiries” (Windschitl, 2002:115). Therefore, there is a need to explore teachers’ and students’ perceptions using inquiry-based learning in ITE in Pakistani universities.

## Review of the Related Literature

Inquiry as a method of science instruction is considered a frequent theme in science education (NRC, 2000; Bybee, 2000). Thus, most definitions of inquiry illustrate the fundamental components of inquiry such as hands-on experiences, identify and collect appropriate evidence, present results systematically, analyse and interpret results, formulate conclusions, and evaluate the worth and importance of those conclusions where the student-teachers are central to the learning process. Moreover, Dewey’s (1938) instructional approach was also based on the belief that learning occurs through diverse experiences and reflective thinking to synthesize those experiences. Dewey (cited in Tompkins, 2001: 32) highlighted the type of learning in inquiry: *What children know and what they want to learn are not just constraints on what can be taught, they are the very foundation for learning.*

Although inquiry is considered a conflicted term, the process of inquiry generally starts with questions. Bateman (1990) suggested that questioning has a fundamental importance in inquiry. Therefore, most definitions of inquiry generally agree with formulating good questions as the core ingredients of inquiry (Lee, 2004; Kuhn, 2010). Although, broad understanding of inquiry makes it quite difficult to give a precise definition, definitions which focus on the inquiry process match the described framework of an inquiry-based culture but are missing out on certain points which are also important if a full understanding of inquiry is desired. According to Colburn (2000) and Aaronson (2007), the most confusing thing about

inquiry is its definition. In conclusion, inquiry-based learning is a contested term. Particularly in US English, the words 'inquiry' and 'enquiry' can be interchangeable, so that inquiry-based learning (IBL) is exactly the same as enquiry-based learning (EBL). The difference between the two is simply a matter of spelling (Watson, 2008). Additionally, substitute terms for inquiry or synonyms learning, discovery learning and critical thinking (Smith et al, 2007; Newman et al., 2004; Abell et al., 2001). Finally, it is hard to establish an agreed definition of inquiry after looking at various definitions of inquiry from different perspectives. However, looking at the literature, resources and research, we took inquiry-based learning as not perfectly identical with the other approaches to learning, because inquiry has distinct features and have its own core ingredients (e.g. Lee, 2004). Therefore, the definition informed to our study is as: *A way of teaching that helps students achieving understanding in science by combining scientific knowledge with reasoning and thinking skills. The role of the teacher is to act more as a facilitator of learning than as a sole instructor.*

Moreover, the literature suggests that inquiry-based learning in science complements the nature of science instruction (NRC, 2000). Therefore, inquiry-based learning is more than just a teaching tool, and interconnects with a guiding set of principles and goals (Colburn, 2000; Newman et al., 2004; Abell et al., 2001; Bybee, 2000). Thus, inquiry as a form of science instruction is advantageous in teaching the concepts and processes of science. Most research on inquiry-based pedagogy in teacher education, so far, shed light on the benefits of inquiry, and promoted the use of inquiry-based approaches in science teaching (Abell et al., 2001; Anderson, 2002; Blumenfeld, et al., 1994; Krajcik, et al., 1994; Newman et al., 2004). In looking at the advantages of inquiry-based learning, there is a very strong tendency to simply assert that inquiry is better using various arguments. Most of the literature on inquiry-based learning is assertion and some of the arguments they propose are open to considerable questions.

The inquiry approach to learning is beneficial where student-teachers are central to the learning process (Newman et al., 2004; Abell et al., 2001; Khan, 2012). Thus, the advantage of inquiry is that it cultivates the skills that help in the investigation and exploration of science (Hart, 2002; Anderson, 2000; Haefner and Zembal-Saul, 2004). Their deep learning is established when instruction builds directly on the student-teachers conceptual framework, and content is organised on the basis of broad conceptual themes common to all science disciplines. Research examining the outcomes of inquiry-based learning suggests that when students are engaged using inquiry, they describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others (e.g. Anderson, 1998; NRC, 2002; Haefner and Zembal-Saul, 2004). In conclusion, the literature asserts an immense emphasis on inquiry methods as a medium for the development of understanding that leads to students' higher achievement in science (Anderson, 2002).

Ausubel (1969) was an influential figure in meaningful learning. Ausubel (1969) suggested the advance organiser to be used. Firstly, when the material is new and the learner does not possess the appropriate relevant information to relate to it. Secondly, when the relevant information does exist in the learner's cognitive structure but that information is not developed adequately and is not likely to be recognised effectively and associated with the new information. Thus, advance organizers are used to provide support for new information. According to Ausubel (1969), the cognitive structure is hierarchically organised and logically structured, which means that the less inclusive sub-concepts and details of specific records are organised under the most inclusive concepts. However, Ausubel's great contribution was

to separate very clearly between the reception-discovery dimension of learning and the rote-meaningful dimension. In other words, if meaningful learning is the goal, than it can be achieved using discovery learning.

Moreover, inquiry places a clear focus on the process, understanding of science and self-directed learning skills, with the aim of fostering the development of interest, social competences and openness for inquiry, to prepare the student-teachers both for lifelong learning and uncertain future. Hence, inquiry-based learning is a way of assuring that student-teachers become actively involved in what they are learning, particularly in science (Kahn and O'Rourke, 2005). Previous research on science investigations, particularly in Pakistan, provides some insight into inquiry-based teaching approaches. The literature examining inquiry-based teaching in the Pakistani context suggests that inquiry supports student-teachers' performances and achieving learning outcomes (Nazir, 2006; Khan, 2012; Ullah, 2010).

The literature informs us that teaching using inquiry is more complex than a traditional lecture (Fibonacci, 2012; Ross et al., 2010). When student-teachers observe their educators, and how they are teaching, they unintentionally remember their style, and follow that teaching style when they become practicing teachers. Moreover Ross et al. (2010) suggested that the influence of teachers' own schooling has a powerful impact on their development as teachers, acting as a filter during their teacher education programs, and having an impact on what they are able to learn. Thus, inquiry-based teaching seems impractical in ITE, where ITE programs do not substantially affect developing student-teacher teaching style, and student-teachers still follow the traditional teaching style of their own teaching (Mohammed, 2006; Ahmed, 2012; Khan, 2012). Therefore, the prospective teachers start developing their own teaching styles based on how they were taught in their own school.

Another disadvantage of inquiry is limited understanding about the basic components of inquiry in science teacher education (Crockett, 2002; Anderson, 2002; Newman et al., 2004; Abell et al., 2001; Hayes, 2002). For example, teachers' limited conceptions of the nature of science, and of inquiry-based practices (Harris et al., 2005), inexperience with the range of inquiry-based approaches (Anderson, 2002), and an inadequate understanding of inquiry (Keys and Bryan, 2001). Moreover, research in Pakistani science teacher education indicates that the use of inquiry is limited to questioning about the previous knowledge in science content and structured activities led by teachers (e.g. Khan, 2012; Mohammed, 2006). Hence, the most significant challenges, and all of the risks in the implementation of inquiry-based learning, demonstrate that these challenges can prevent student-teachers from successfully engaging in meaningful investigations, and therefore, undermine learning.

Moreover, Kirschner et al. (2006) considers inquiry-based learning as one of the fashionable approaches that have gained a currency among the certain educators. The point is not that inquiry is, in itself, inadequate. Indeed, inquiry-based approaches to teaching and learning have long been promoted, as there are many positive features to inquiry-based learning. As Kirschner et al. (2006) point out that each set of advocates for unguided approaches seemed either unaware of or uninterested in the previous evidence that unguided approaches have not been shown to be more effective in terms of generating learner understanding. Indeed, inquiry is not always workable. For success, it depends on how inquiry-based approaches to learning are implemented. For example, if they are implemented with the limitations of working memory capacity in mind, they may achieve better learning

(Reid, 2013). If they generate increased cognitive loads, then learning may well be hindered (Kirschner et al., 2006). Thus, inquiry could be one of the effective approaches to learning, but it depends how inquiry is implemented.

### **Aims of the Study**

This research aims to explore the teacher-educators' and student-teachers' perceptions of inquiry-based pedagogy in their professional learning experiences in relation to Pakistani educational context. Also, the research examines the challenges faced by teacher-educators and student-teachers which arise from their existing culture and teaching situations of the university. In particular, this study focuses specifically on exploring the teacher-educators' and student-teachers' perceptions of the role and importance of inquiry-based pedagogy in science in IET programs of Pakistan.

### **Research Questions**

The following research questions were addressed:

- 1 How do the educators perceive the role and importance of inquiry-based pedagogy in science in ITE?
  - (a) How do the students perceive the role and importance of inquiry-based pedagogy in science in ITE?
- 2 How do the educators perceive the challenges that impede the practice of inquiry-based pedagogy?
  - (a) How do the students perceive the challenges that impede the practice of inquiry-based pedagogy in the classroom?

### **Research Methodology**

After considering the nature of the study, a qualitative method design was selected for its interpretive function, its flexibility, depth and detail in studying the selected issues. This study aims to explore the teacher-educators' and student-teachers' perceptions of the role and importance of inquiry and inquiry-based pedagogy in their professional learning experiences in science in ITE in Pakistan. This study has its roots in work done in a public sector university of the Punjab province Pakistan. There reason behind selecting a university is that the educators and teachers at this university, in general, contribute more towards teaching and learning knowledge than any other universities because it is a specialist university in teacher education (Khan and Saeed, 2009). Thus, this university produces a high proportion of prospective science-teachers in Punjab province. This research is an innovative study in a nature as it anticipates suggesting through teacher-educators' and student-teachers' perceptions how to overcome the obstacles in adopting inquiry-based pedagogy? and significantly contributes to the development of pedagogy in ITE.

### **Research Methods**

The 20 interviews with teacher-educators and 2 focus groups with student-teachers were conducted. The educators were selected who were teaching course of science or science education. The educators have been selected using convenient approach. The researcher personally met the director of the university department of education and sciences. The director of university campus performed the role of gatekeeper and helped in making the contact of researcher to the educators. Moreover, the focus grouped conducted with those students that have been studied science and science method course, those students were in their last semester of their program. The teachers who were interview also helped in

contacting with students. The research raised a discussion in the groups of 4-5 students. The interview's questions were constructed in the light of relevant literature on inquiry-based learning for teacher-educators' and for student-teachers' were constructed by the researcher. In order to explore these concerns and aims as deeply as possible, the interview protocol and the main questions were developed to explore the following: (1) the participants' perceptions of the role and importance of inquiry-based pedagogy in learning science; (2) their perceptions of inquiry-based pedagogy in relation to the difficulties encountered when inquiry is practised. For the interview process, the researcher ensured reliability and trustworthiness by following best practice. Therefore, the researcher prepared all interview questions before interviews were carried out and made a rehearsal with a couple of science teacher-educator. A one-to-one interview has therefore been chosen in order to maintain high reliability. The selection of interview participants was classified to the research design and its purpose. Thus, a convenient sample approach was used to select teachers in the interview and students in the focus group.

## **Results from the Data**

The following themes were emerged from the data gathered through interview and focus groups

### **1. Perceptions of the Role and Importance of Inquiry-based pedagogy**

The main goal of this study has been to capture science teacher-educators' and student-teachers' perceptions regarding their understanding of inquiry and inquiry-based science pedagogy through interviews. Although the teacher-educators' exposure to inquiry and inquiry-based pedagogical strategies differed, they shared common ideas, as demonstrated by their perceptions of inquiry-based pedagogical approaches, the practicalities of teaching using inquiry, and the factors contributing to the understanding of inquiry-based pedagogy. In the context of inquiry, teacher-educators and student-teachers reported their perceptions regarding their understanding of inquiry and inquiry-based pedagogy in relation to various inquiry-based activities in science teaching. Most of the teacher-educators indicated that they had little exposure of inquiry-based instruction or used it less as reported: *I had a little idea about inquiry-based learning* (T2). Another said: *I had done inquiry till this class, sometimes* (T3). Thus, teacher-educators reported that they had a limited use of inquiry taught in the science classes regarding their previous experience.

Besides, the student-teachers' perceptions in focus groups regarding their understanding of the importance of inquiry and inquiry-based pedagogies in learning science were examined, to see how they understood the benefits of teaching and learning science through inquiry-based pedagogy. It was found that student-teachers' reflections on the focus groups indicate that they understood how inquiry-based instructions involve student-teachers' learning. Moreover, most teacher-educators' responses indicated that they understand that student-teachers must be exposed to activities that engage them to answer scientifically-oriented questions and participate in other science-exploring activities. A few teacher-educators also agreed that learning was something that cannot be imposed on student-teachers; they must take responsibility for their own learning as reported: *Inquiry-based pedagogy in my classroom includes exploring science concepts using science materials. For example, in an experiment on magnetism, student-teachers were given materials and asked to perform directed experiments, record their observations, and report their findings* (T10).

Thus, the above response indicates that teacher-educators still provide question and guided procedure. However, student-teachers could generate an explanation supported by the evidence they collect. Also, teachers' responses indicated that student-teachers were able to do open inquiries when they understand the process of inquiry-based pedagogy. Moreover, some of the teacher-educators' responses indicate that they often question, though they could not plan an entire curriculum using inquiry-based approaches as reported: *I cannot teach the entire curriculum using inquiry. I could only engage student-teachers in questions and demonstrations* (T18). Likewise, student-teachers reported their apprehensions that they were less involved using inquiry according to their learning experiences as reported: *We are only exposed to questions; some components of inquiry such as open-ended investigations are less used because of shortage of time and resources* (G2-S4).

Accordingly, the teacher-educators' and student-teachers' responses indicated that they were exposed to questions but rarely implement inquiry-based strategies, for example, science investigation in their science class. An important point is noted that questioning is used as a fundamental element of inquiry. Consistent with this vision, one of the key competencies associated with an understanding of inquiry are the questioning strategies for engaging student-teachers in scientific inquiries (National Research Council, 2000; Lee, 2004; Kuhn, 2010). Teacher-educators and student-teachers reported their positive understanding that learners must be exposed to activities that engage them to answer science questions. The student-teachers were taught using a little inquiry, so they expressed that they did not fully understand the process of inquiry. This finding has not been examined before this study in ITE in Pakistan. Though student-teachers were less exposed to inquiry-based pedagogy in ITE, they appreciated the value of inquiry-based approaches (e.g. Anderson, 2002; Newman et al., 2004; Abell et al., 2001). Thus, inquiry is mainly used in the form of questions; answering science questions, questions about previous knowledge, developing explanations, and communicating explanations to student-teachers and to their peers. Generally, every teacher asks questions and use questions as a tool to assess students' previous knowledge. Secondly, questions are asked as the main activity to involve student-teachers in class, also use questions to warm up students to trigger their active involvement (Abell et al., 2001; Kane, 2004; Newman et al., 2004).

## **2. Inquiry-based learning and Collaborations**

The teachers and student-teachers' responses were found on the student-teacher collaboration and learning. The majority agreed that inquiry-based methods facilitate students' learning in groups. Likewise, from the interview data, the majority of teacher-educators presented similar views about the role of the inquiry based method in developing social skills in the student-teachers and enhances communication and collaboration among the student-teachers as reported: *I think inquiry-based activities enhance communication among student-teachers in group activities; this develops social skills as well as moral values in student-teachers* (T4). Likewise, student-teachers responses lead to the fact that they appreciated their female teachers like sharing and interacting with teachers so they find it an opportunity to collaborate with them in inquiry-based settings as reported: *I feel motivated when teacher involves me using inquiry-based methods. Mostly female teachers are very cooperative, encouraging and interacting.* (G2-S1)

The majority of teachers and student-teachers responded that they do inquiries in groups and promote group learning in student-teachers. The majority of teachers reported that they found that student-teachers learn best in groups and with the most pleasure. Thus, small

group discussions were one of the most highly used activities in ITE in Pakistani classes (Khan, 2012; Ahmed, 2011). There is a consensus among the teacher-educators and the student-teachers that one of the ways in which student-teachers' learning is promoted with social interaction. In the present situation regarding teaching in ITE in Pakistan, where the equipped laboratory and facilities are not available to use inquiry-based approaches, collaboration in the forums of group discussion and group project is found to be very helpful.

### 3. Teacher-educators' role using Inquiry-based Pedagogy

The teacher-educators agreed that they liked the idea of being a facilitator of learning by allowing the student-teachers to learn in groups. In addition, they appreciated that inquiry-based strategies help them to develop as a friendly and interactive educators with student-teachers; also their role as facilitator of learning develops a confidence and a sense of ease in their student-teachers as reported: *Using inquiry-based activities, I facilitate student-teachers' learning in class. My student-teachers feel easy in communicating with me; that developed their confidence* (T3). Also, they admired their role in an inquiry-based classroom is quite different from that of a teacher in a conventional classroom. It is an important issue to note that teachers are misunderstood in doing inquiry-based activities because they are assumed not doing a worthwhile job. Their apprehensions were particularly in an environment where most of the other lecturers are not consistent in using inquiry. Nonetheless, the majority of student-teachers reflected their personal dissatisfaction in the way the teacher treated them. The majority of the student-teachers reported that they were disappointed and their self-esteem was lessened when they were discouraged by teachers as reported: *Teachers get annoyed by questions; do not respond nicely and discourage asking them* (G2-S2).

Thus, student-teachers comments to teachers' teaching style were the least positive. Student-teachers reported that inquiry-based teaching styles involve them actively though teachers were conventional in their teaching style and did not pay much attention to student-teachers' needs. Thus, there is an inconsistency in what teacher-educators claim and what student-teachers say. Student-teachers are more likely to report what happen in the classroom. Though, student-teachers responded that they had fewer opportunities using inquiry-based activities by their teachers, therefore, they did not feel prepared on their experiences; that make them realise the importance of inquiry-based pedagogy in learning science. In addition, the teachers also often expressed the view that they should provide suitable instruction and guidance for student-teachers before asking student-teachers to engage in any inquiry and that they had reservations about accepting the principle "*inquiry is about seeking the right answer*" as applied to student-teachers. Consequently, they prepare model answers (i.e. teacher-made notes). Thus, this study found that the role of teacher to interact with student-teachers takes the form of questions in ITE in Pakistan. Although, the teacher-educators used the terminologies of group work, discussion, open questions, so on, they did not discuss the substance of all the mentioned terms. It can be noted that they did not know or think about how these approaches would contribute to students' learning.

One of the major reasons for some teachers to resist the principle of "*teacher as facilitator of learning*" lies in the conventional practice and culture of the University. In addition, teachers were inclined to adopt a traditional teacher-centred approach in teaching. Some teachers may worry that once they have to stand aside and allow student-teachers to take ownership of their learning, the traditional pattern of teachers dominating the lessons may disappear. This may create discipline problems and the classroom may get out of



control. In fact, those teachers who tended to resist the ‘facilitator role’ did encounter the difficulties they worried about. In ITE in Pakistan, the role confusion of the teachers might have set off their perceptions that inquiry-based learning should be limited to a certain extent so that they would not change their current teaching practice. Also, reflections during the process of learning in teaching in ITE progresses, realities of the social world’s changes and various new images of teachers emerge. Diversification of teachers’ as well as student-teachers’ roles present teachers as innovators, leaders, social reformers, and catalysts for educational change, etc. (Ali, 2007; Ahmed, 2012, Khan and Saeed, 2009), and this perhaps encourages teachers in any society to combine their role as educators and active agents for social and educational change.

It is noted that a little attention has been given to this subject area before this study into ITE in Pakistan; most teachers usually stuck with their authoritarian approaches and were, therefore, less friendly with student-teachers. The majority of student-teachers reported a concern that most teachers wanted strict discipline in class in ITE in Pakistani universities. Usually a friendly relationship does not seem to have been developed between teacher and student-teachers. As a matter of fact, student-teachers were not provided with enough time to do inquiry-based methods; therefore teachers have to involve them in small group discussions. The teachers work according to the university expectation, which uncovers the problems of teachers’ adaptations of behaviour with respect to the authority or culture. It could be seen as an unintentional imposition on the teachers who have had opposite experiences of working that might resist the change in understanding a new pedagogy but appeared in the changing their behaviours.

#### **4. Perceptions on Inquiry-based pedagogy in developing Learning**

Most teacher-educators and student-teachers were strongly positive that inquiry-based activities were important in exposing student-teachers’ learning in the sense that weaknesses in understanding were more apparent. Specifically, student-teachers were engaged by questions, learned to give priority to evidence which they used to develop explanation of the science phenomenon they were observing, and were required to report their findings in terms of what they had learned as reported: *I think student-teachers learn when they are given an insight to look at things themselves. They learn best when they get something to examine, observe it and think. I believe that inquiry-based pedagogy include the entire element that make student-teachers observer, thinker and examiner of science phenomena. Thus, inquiry-based pedagogies help in learning science* (T4). Correspondingly, student-teachers’ responses on the focus groups were examined for their reflections on how they learn science. The majority of student-teachers in focus groups discussed similar views to teacher-educators about inquiry-based methods help in developing learning as reported: *I learn best when the concept is clear to me, I explore through various sources until I find the solution. When I get stuck at a question I struggle to seek answer. I understand concept in inquiry-based sessions and learn it with an interest* (G1-S4).

Although some teacher-educators responded that student-teachers were initially frustrated with learning science through inquiry, and did not feel prepared to handle independently science projects assigned to them though they were able to pass through the challenge. While reflecting on their experiences, they realized the importance of inquiry-based pedagogy for learning and teaching science. Teacher-educators’ reflections indicated that this transition in thought was facilitated through the positive outcome in their inquiry-based activities, from peer discussions necessitated by lack of teacher-educators’ interaction

and through their reflection on the benefits of inquiry-based learning as: *I think student-teachers initially realised inquiry as a challenging method but they started understanding inquiry-based strategies gradually... Inquiry-based strategies engage student-teachers in learning science, they have fun, share with others and develop confidence and their interest to learn increased* (T11).

Likewise, most student-teachers reported that inquiry-based activities help student-teachers in improving their learning as reported: *I think when we deeply understand the concepts using inquiry-based activities. I learn best science through observation and practical experiments in science that makes me active. We learn science most effectively by doing using inquiry-based activities quite* (G2-S2). The teacher-educators' reflections indicated that their understanding of the value of the inquiry-based pedagogy was indicated by the connections made to the use of inquiry-based approaches to investigate what inquiry-based learning is about. Teacher-educators' and student-teachers' understanding of inquiry and inquiry-based pedagogy in science is consistent with the findings in the prior literature indicating that inquiry teaching must not be considered independently of inquiry-based pedagogy and inquiry learning, as they are all interrelated (AAAS, 1994; Abell et al., 2001; Anderson, 2002; Blumenfeld, et al., 1994; Krajcik, et al., 1994; National Science Teacher Association (NSTA), 1998; Newman et al., 2004).

Teachers and student-teachers alike reflected that student-teachers like to learn using inquiry-based teaching. On the whole, this is consistent with the prior studies (e.g. Anderson et al., 2004; Abell et al., 2001; Anderson, 2002; Blumenfeld, et al., 1994; Krajcik, et al., 1994; National Science Teacher Association, 1998; Newman et al., 2004). This study has found that inquiry-based approaches help student-teachers developing deep learners. Moreover, the teachers and student-teachers also reported that inquiry develops learning through social interaction, the sharing of ideas with peers and inspires interest in student-teachers to do science. Particularly in ITE in Pakistani universities, the student-teachers could be encouraged to understand science phenomena in their real-life situations.

## **5. Perceptions on Contribution of the Teaching Method Course in developing Inquiry-based Pedagogy**

Teacher-educators and student-teachers showed interest in learning from the Science Teaching method course. The majority of teacher-educators and student-teachers reported that teaching of science courses or science teaching methods courses have an important role in developing their understanding of inquiry-based pedagogy. The majority of teacher-educators reported that their teaching experiences were strong enough to develop them into effective teachers of science but they learned more about inquiry when they taught teaching science method course as reported: *Teaching science method courses helped me to know and teach a range of teaching approaches* (T2). The majority of student-teachers reported that the contribution of science methods course provided good exposure in understanding the process of inquiry-based pedagogy as reported: *I think this teaching method course has been helpful to let us know about a range of teaching methods of science generally and how to teach science effectively by involving student-teachers, collaborations and developing their thinking to explore science* (G1-S4). Thus, student-teachers' reflections indicated that they were exposed to different instructional strategies that helped them understand inquiry through science teaching method course such as: the use of inquiry-based activities to develop their abilities to conduct inquiries and the use of science questions to activate further investigations.

## **6. Challenges with the Insufficient Time**

The majority of teacher-educators and student-teachers reported the shortage of time as a serious barrier; also a big challenge when inquiry-based methods are practised as reported: *I think the biggest problem for me is a lack of time. As having short of time, I felt nervous to manage a lesson when student-teachers were not prepared to use inquiry in class. But gradually student-teachers started responding to how inquiry-base teaching works out. We better need to spend plenty of time with our student-teachers (T2)*. Student-teachers likewise reflected their worries about the increased time it would take to develop inquiry-based lessons as reported: *I believe that teachers require more time to prepare their sessions and it seems impossible with too lengthy curriculum (G1-S3)*.

Consequently, teachers' over-loaded work makes them busier and time seems too short. Thus, teacher-educators' and student-teachers' views are concurrent that they struggle hard to manage their lesson in time. Time is a problem because teachers convey the entire lesson to student-teachers in the given time and not make student-teachers' independent learner and do not assign student-teachers task to read them. This study has also found that tight and short teaching and preparation time also increases the pressure on teachers and student-teachers in adopting inquiry-based approaches (e.g. Bovill et al., 2010; Mohammed, 2006; Khan, 2012; Hussain, 2010; Nazir, 2006; Ullah, 2010). Student-teacher and teacher-educators also voiced their apprehensions about inquiry-based teaching given the current set-up through the science courses in ITE curriculum, which might not afford them adequate class time to prepare inquiry-based lessons. This apprehension is consistent with similar findings in the literature for implementing inquiry (Hayes, 2002; Weiss et al., 2002). Additionally, the majority of teachers reported that they have excessive amounts of work to teach. They have to teach the whole content in curriculum before the exam starts and they cannot therefore pay attention individually to each student-teacher. Therefore, a large teaching and administrative load influence their performance because of time pressure. These findings are consistent with past studies (Anderson, 2002; Volkman et al., 2005).

## **7. Lack of University Support in working with Inquiry based approaches**

Lack of university support is another serious challenge reported by the majority of teacher-educators. They presented their apprehension about the lack of university support that hinders if they intend to use inquiry-based methods as reported. The majority of teacher-educators reported that lack of support from university seems a big hurdle in their teaching, as reported: *The biggest hurdle is lack of support from university. The university did not set an environment to support teachers to decide on how they plan to teach (T7)*. Similarly, student-teachers expressed anxiety about using inquiry form of instructional strategies in their teaching practice during their school placements because they feared lack of support from the university to implement inquiry-based instruction as reported: *University does not help in adopting inquiry-based activities. If the science teachers use inquiry-based approaches that is their own choice or decision. Inquiry-based approaches are not encouraged by university (G2-S3)*. Thus, teachers and student-teachers agreed that lack of university support in implementing inquiry has resulted into lack of teachers' readiness and motivation to use inquiry. Moreover, an outcome of this study is that even though some teacher-educators felt insecure about their pedagogical knowledge and realized that traditional university environments might not allow them to use inquiry-based science activities (Anderson et al., 2005; Khan, 2012; Weiss et al., 2002). As one of the discoveries that had not been explored in the existing literature, it is evident that the administrative structure of the university affected the implementation of inquiry-based learning. Different administrative structures

allow different degrees of freedom for teachers' actions. The University has a traditional and bureaucratic administration in place, and decisions are made with a top to bottom approach; therefore, teachers and student-teachers are not involved in any way. Therefore, a focus is on teachers' relationships with the authorities rather than on the quality of teaching and learning for student-teachers (Khan and Saeed, 2009; Ahmed, 2012; Memmon, 2010; Halai, 2008).

## **8. The role of Curriculum to Support Inquiry**

Teacher-educators' and student-teachers' reflection provided on that the current curriculum does not support inquiry-based methods to be used. One of the key take-away messages is that teacher-educators' intentions was to rely less heavily on text but more heavily on student-centred learning. The majority of teacher-educators were of the opinion that current science courses are very textual and lengthy. Indeed, science is presented as a knowledge-based subject to them as articulated as: *The science curriculum is text-based and too lengthy. Curriculum does not support inquiry-based pedagogy* (T19). Thus, teacher-educators' responses indicated that inquiry-based pedagogy was a better approach in bringing about student-teachers' understanding of science concepts than memorize concepts as this form of instruction helps student-teachers build on what they already know and thus sustains their knowledge. Thus, the key reasons given by the teacher-educators for using inquiry-based pedagogy were that it would help them get away from dependency on the text and student-teachers understand the key ideas of science deeply using inquiry. Likewise, the majority of student-teachers reported that they were used to memorise text rather than involved in inquiry-based curricula reported as: *Student-teachers appreciate that teachers-prepared notes help them to pass exams. Therefore, using inquiry, student-teachers do not benefit* (G1-S3). Thus, most educators feel that is an easier job to do lectures rather than using inquiry-based lesson. The science curriculum in ITE consists of a heavy use of factual information and lengthy content (Plevyak, 2007; Ross et al., 2010; Ali, 2008).

Another concern shown by the teachers and student-teachers is that science courses cannot be revised to develop them in an inquiry-based way, because inquiry might generate unstructured curricula and make teachers and student-teachers nervous being unprepared. Therefore, teacher-educators need to develop their key skills related to working and thinking using inquiry-based methods and to be less concerned with the content coverage. The teachers also reported a number of obstacles to change that ranged from a lack of expertise in collaborations with other staff to the problems inherent in joint planning in transforming existing curriculum (Kraijcik et al., 1998; Ali, 2008; Memon, 2007). Thus, the curriculum could, perhaps, be redesigned to include structured and open inquiry-based activities, raise inquiry-based pedagogies.

## **9. Examination and Inquiry-based Learning**

The majority of teacher-educators' and student-teachers' responses indicated their apprehension about the examination which emphasis not on learning but how student-teachers are good in recalling. Teachers think that learning is not assessed through exams as reported below: *Our entire assessment is summative and students are not assessed for their learning* (T3). Likewise, one of the key reasons given by the student-teachers to avoid inquiry-based pedagogy was that exam and curriculum would not help them get away from dependency on memorising text as reported: *Curriculum offers a lot of information to recall and memorise* (G2-S1). Thus, teachers and students do not come across any connection between inquiry-based pedagogy and current assessment methods used in ITE. Also, the

student-teachers are assessed to a lesser degree on their classroom activities, projects, assignments and inquiry-based approaches, consistent with (Ahmed, 2012, Mohammed, 2008, Khan and Saeed, 2009). Consequently, teachers do not have an opportunity to evaluate student-teachers' skills and abilities using inquiry-based approaches (Khan, 2012). Thus, assessment system revolves around grades instead of gaining in-depth knowledge and learning in science (Shirazi, 2004; Khan, 2011). The teachers and student-teachers also expressed that changes to the pattern of assessment can bring useful changes to the curriculum. Thus, if assessment offers rewards for some classroom activities, useful changes could be made to both the curriculum and to teaching approaches. If the assessment system cannot be altered, this hinders the implementation of inquiry-based pedagogy methods in ITE.

## **Conclusions and Implications**

As has been stated, this study did not aim to defend directly inquiry-based pedagogy in the contemporary situation of teaching at a public sector university in Punjab but it has provided interesting insights, through teacher-educators' and student-teachers' perceptions. Thus, according to what we have learned from the research framework, research findings, and discussion, inquiry-based pedagogy is necessarily seen a useful approach to teaching and learning in ITE. The majority of teacher-educators' and student-teachers' perceptions indicate that they have insufficient understanding of inquiry. Their use of inquiry-based activities is limited up to the questioning to their students about their previous knowledge. Although, it is important to note that they appreciate developing their teaching and being able to learn more about inquiry-based pedagogy. Teacher-educators and student-teachers have been facing cultural and situational difficulties; for example, lack of resources, lack of university support, and examination at the University which may limit the implementation of inquiry-based pedagogy. Therefore, this point, about teachers seeking development in ITE, can be used encouraging those teachers to apply inquiry-based pedagogy in ITE, particularly, by turning examination into inquiry-based assessment. In addition, the teacher-educators' and student-teachers' perceptions of inquiry-based pedagogy raise some key issues, in the context of practical implementation as suggested:

- Inquiry-based learning will not be easy to implement without university policies and curricula that support an inquiry-based pedagogy avoiding the need to teach student-teachers how to prepare for examinations.
- There is a pressing need to re-think assessment policies and assessment methods so that there are clear rewards for the outcomes from inquiry-based learning.
- It is clear that the conceptualisation of inquiry-based learning by teacher-educators is very inadequate. If inquiry-based learning is to take root in university life, there has to be some agreement on what constitutes such learning. The idea that inquiry-based learning is characterised as a process drive by enquiry *may* offer a key.
- This raises the question of the training of teachers. In turn, that raises the issue of who trains the teachers. Indeed, there is clear evidence that quality training does not necessarily generate changes in practice; no matter how committed the teachers are to implement such changes (El-Sawaf, 2007).

Moreover, the teacher-educators and student-teachers at the University need to consider:

- There is clearly a need to develop a shared understanding of what constitutes inquiry-based learning. This has to involve senior managers in the university, it has to involve heads of departments, and it has to involve practising teachers.

- The whole area of assessment needs re-considered. Currently, the rewards come from the correct recall of memorised information. New forms of assessment need to be introduced and this will require skilful training.

In spite of all the barriers to inquiry-based pedagogy, inquiry-based methods open up the development of pedagogy and help in filling the gap between pedagogy and practice in ITE in Pakistan, Particularly and in the world, generally. Therefore, inquiry-based pedagogy could be a good start to improve student-teachers' learning as well as teacher-educators' professional teaching practices in ITE.

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**The Interview and focus group protocols could be provided on demand.**