HOW INQUIRY-BASED LEARNING IS PERCEIVED IN INITIAL TEACHER EDUCATION?

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ABSTRACT. *The transmission style of teaching is inadequate in helping students develop their learning in science in Initial Teacher Education (ITE) in Pakistan. In light of the key roles of inquiry-based pedagogy (IBP) in ITE, this study explores the perceptions as how they understand the elements of IBP. The data has been collected using questionnaires from 50 teachers and 580 student-teachers and, 2 focus groups with student-teachers and 20 interviews with the teachers. The results show that the teachers and students, mostly held positive views. The biggest challenges of inquiry are a non-supportive university academia, the current curriculum and assessment methods. Finally, recommendations concerning the importance of inquiry-based pedagogy in science in ITE, the arrangement of resources, teacher-educators' professional development, and preparation for student-teachers are presented to the attention of teacher-educators, the University administration, and Higher Education Authorities.*

Key Words*:* Inquiry-based Pedagogy, Initial Teacher Education, Professional Development

INTRODUCTION

It is widely agreed that the ITE programs which are offered at most of the public sector institutions in Pakistan are substandard in that the teachers are too rigid, only transmission styles of teaching with lengthy content, and their lessons lack of student-centered activities. The dominant pedagogy used in these programmes is characterized by chalk-and-talk, and this forces their students to memorize [1].

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 initial teacher education in Pakistani universities, it can be summarized that teaching is often overwhelmed by a lengthy curriculum and large teaching load [2]. Also, inquiry 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* [3] .

The evidence suggests that it can be assumed that the inquiry form of teaching and learning science is probably not practiced in most of the elementary schools today in Pakistan. The system has encouraged a transmission style of teaching science and this result in rote learning to pass the examination [4,5]. The quality of teacher education, which must be considered to be a key factor in any education system, is poor in Pakistan [2,6]. It suffers from the lack of adequate training programmes or professional development program, the weak emphasis on teaching practice and non-existence of any proper support or monitoring systems for student-teachers. In the absence of any accredited body to certify teachers, the mere acquisition of a degree in initial teacher education is considered to be sufficient to apply for the teaching profession in the public sector [6,7,2,8].

Inquiry-based pedagogy opens the possibility of enriching learning in the sciences and may assist in encouraging a move towards conceptual understanding rather than examination-driven rote-recall.

Inquiry-based Learning

The literature relating to inquiry-based learning is confused in many ways. Firstly, there is no agreed operational description of what is meant by the term. Secondly, the ways to make it work are not clearly laid out. Thirdly, the evidence is that it does work, and brings enhancement to learning. A fourth area of confusion relates to the way science as a research discipline operates; confused with the way science is best taught.

What is Inquiry-based Learning?

The meaning of inquiry in science teacher education varies as much as the methods of inquiry themselves [9,10,11] notes how different promoters focus on different characteristics of inquiry while many [12,13] observe that the most confusing thing about inquiry is its definition.

One description states: *Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations... using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results* [14]. Bateman [15] has addressed the role of questioning because of its fundamental importance in inquiry. The process of inquiry generally starts with questions. Therefore, most definitions of inquiry generally agree with formulating good questions as the core ingredient of inquiry (Lee, 2004) [16]. Nonetheless, inquiry-based learning is much more than questioning. Aaronson [13] considers inquiry as a teaching strategy to teach skills. Aaronson [13] goes on to see inquiry as a teaching strategy to motivate learners.

Kahn and O'Rourke [17] probably capture the essential essence of inquiry-based learning when they use the description of learning that is *driven by a process of enquiry* which actively involves students in discussion, questioning, and investigation. The description used here in relation to teaching the science as part of a programme of initial teacher education in Pakistan fits into this in part: a way of teaching that helps students achieve 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 an instructor.

Making Inquiry-based Learning work

Inquiry provides opportunities for student-teachers to find solutions to problems by asking and refining questions, designing and conducting investigations, gathering and analysing information, making interpretations, and drawing

conclusions [17,18]. Thus, 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 [17].

The key to all this is setting up the questions for the learners to explore or develop a mechanism that allows them to generate questions. The next stage is the development of a learning situation where the questions can be explored meaningfully, probably in small groups. A critical feature is making the right resources available so that students can engage with evidence and materials.

Does Inquiry-based Learning work?

There are two levels of this question: can learning be organized in such a way that a genuine inquiry occurs? More importantly, does inquiry-based learning lead to *better* learning? The latter has to be defined more precisely for '*better learning*' can be seen in many ways. Perhaps a useful way is to see '*better learning'* in terms of better understanding.

In looking at the advantages of inquiry-based learning, there is a very strong tendency simply to assert that inquiry is better using various arguments [10,19,2,20,21,22]. Some have reported positive outcomes including identifying assumptions, using critical and logical thinking, considering alternative explanations and developing deep learning [14]. Anderson [21] speaks of the development of personal meaning and understanding that leads to student higher achievement in science, but this begs the question about how '*higher achievement*' is being seen. Several others [23,2,24] have found that inquiry-based learning gives better outcomes in Pakistan yet, the way the outcomes are measured raises interesting issues.

In their review of research findings, the conclusions of Kirschner *et al.* [25] are worth pondering when they talk of the '*failure of inquiry-based learning*'. This links back to the brilliant insights of Ausubel [26] many decades ago. Ausubel [26] was an influential figure in meaningful learning and a summary of some of his findings is shown in figure 1, with the possible location of inquiry-based learning is shown on it.

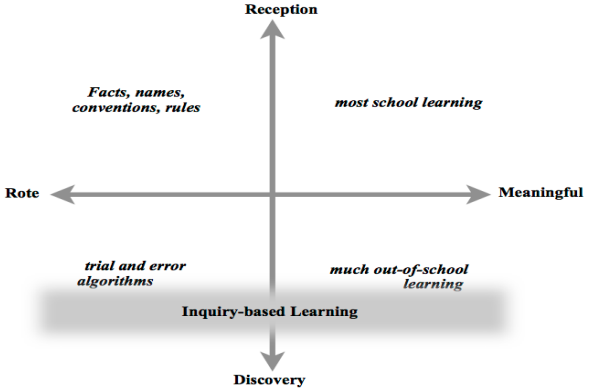

Figure 1: Inquiry and Ausubel Meaningful Learning

The key point that Ausbel made was that the strategy of teaching was TOTALLY unrelated to the extent of meaningfulness of the learning. Kirschner *at al.* [25] show why: the key factor in meaningful learning (understanding) lies in the limiting capacity of working memory and NOT on the teaching strategy adopted. Despite the related assertions about the value of inquiry-based learning, the approach appears not to work when student-teachers need to introduce complex and abstract ideas in science through the experience of developing understanding, their own thinking and reasoning having many benefits for student-teachers which are not obtained in other ways [27,28]. Moreover, inquiry-based learning may contradict a curriculum which emphasizes content, textbooks that see science as a body of knowledge. Here, inquiry-based learning may prove less effective than other approaches.

Asking new teachers to use inquiry-based methods may also contradict with their own learning experiences which strongly reflect the way any teacher teaches. Indeed, Ross et al. [28] 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 to do [29,7,2].

If prospective teachers do not fully grasp the nature of inquiry-based learning, being asked to implement inquiry-based learning may simply be impossible [30,21,10,9,31]. Too often inquiry-based learning is seen in terms of teachers asking questions - a totally inadequate conception - and this is a common pattern in Pakistan [2,32]. Moreover, teachers and student-teachers became frustrated by their limited preparation when using inquiry, including management, lack of time, limited available materials, lack of support, emphasis only on content, and difficulty in teaching. Thus, teachers may also fear the risk that student-teachers will not be receptive to a change in the learning and teaching style.

Sometimes, the idea of constructivism is to invoke to justify inquiry-based learning. It needs to be recognized that seeking to construct meaning is a natural process and there is nothing a teacher can do to encourage learners to construct their understandings or not construct their understandings. Sometimes, teachers can challenge wrong meanings (wrong in the sense of being inconsistent with accepted scientific understandings). Sometimes, teachers can discourage rote memorization, but unless the examination system rewards more than correct recall, even this will be of limited value.

The point is that constructivism is an excellent description of what goes on naturally. However, constructivism has little predictive value and cannot directly lead to better teaching, simply because what happens overtly in the classroom has no direct bearing on a process which takes place naturally inside the head of each learner. This was the remarkable insight that Ausubel [26] revealed. The review of Kirchner *et al.* [33] offers useful insights on this while Reid [34,35] has developed the theme further.

Kirschner *et al.* [33] make the point that it is not that inquiry-based learning that is, in itself, inadequate. It depends on how inquiry-based approaches to learning are implemented. For example, if it is implemented with the limitations of working memory capacity in mind, it may achieve better learning. If it generates increased cognitive loads, then learning may well be hindered [33]. Thus, inquiry could be one of the effective approaches to learning, but it depends how inquiry is implemented.

Research and Teaching

NRC [14] suggests "*inquiry as questions generated from student teachers' experiences is the central strategy for teaching science*". However, this tends to confuse the nature of scientific inquiry with the process of teaching the sciences. The teaching of the sciences need not follow the way the sciences work as research disciplines. The teaching of the sciences DOES need to work consistently with the way the human brain works.

The methods of scientific inquiry must never be confused with the teaching and learning approaches to be adopted in the teaching and the sciences, this confusion often being seen [14,36,12,19,10,21].

Aims of the Study and Research Questions

This study seeks to focus on the perceptions of teacher-educators and student-teachers relating to inquiry-based pedagogy in a Pakistani educational context. The nature, role and importance of inquiry-based learning were explored along with a consideration of the challenges faced by teachers and student-teachers in seeking to implement the approach. Two broad areas are, therefore, addressed:

(a) The perceptions of teacher-educators and student-teachers relating to inquiry-based learning in professional practice in initial teacher education

(b) The challenges that teacher-educators and student-teachers face in any move to implement inquiry-based learning

THE METHODOLOGY ADOPTED

The initial teacher education programme in a large public sector university in the Punjab province of Pakistan was the focus. The university is relatively new, has large numbers of students from a wide range of backgrounds and offers a useful setting to explore perceptions as well as the potential difficulties in implemented an inquiry-based learning approach.

Three broad methods were employed:

A written self-report survey	N (teachers) = 50, N (students	4 point Likert format	Pre-tested with 30 teachers and 50 students to check for clarity
Interviews with teaching staff	N = 20	30 minutes each	Both interviews and focus groups were semi-structured, allowing considerable freedom to respondents
Focus groups with students	2 groups	1 hour each	

The mixed method approach aimed to provide the richest insights possible while the different approaches allowed for comparisons and corroboration [37]. Reid [35] observes that test-retest reliability is important in conducting surveys in educational research while the conditions for constructing and conducting a reliable survey as outlined in by Reid [34] were followed.

Findings

Teacher-educator Characteristics

50 teachers completed the questionnaire and for clarity, the data are presented as percentages.

Table 1 Background Information of Teacher-educators

Characteristic (N = 50)		
Gender	Male	30
	Female	70
Age Group (years)	24-30	36
	30-40	32
	40-50	20
	above 50	12
Qualification	MSc	38
	Med	20
	Current student for PhD	20
	PhD in science	22
Experience (years)	Less than 1	20
	1-5	50
	6-10	14
	More than 10	16
Courses taught	Science	56
	Science and teaching methods	44

With a new university, established in 2002, the teaching staff tends to be younger with less experience. Inevitably, with the teaching profession as one of the most popular and socially acceptable professions for women in Pakistan, the proportion of women is high. 56% of teachers taught science courses and 44% taught both science courses and teaching methods of science courses. Only with MSc in Science or in Education teach science method courses. Also, 52% of teachers had received training for hands-on (inquiry based) science activities. 64% responded that no training had been offered to them. Thus, the majority of teachers have had no training during their professional time at the University.

Student-teacher Characteristics

580 students completed the questionnaire and for clarity, the data are presented as percentages.

Table 2: Background Information on Student-teacher

Gender	Male	26
	Female	74
School type	Private	29
	Public	71
Language of instruction	English	41
	Urdu	59
Year of study	1st year	16
	2nd Year	40
	3rd Year	44
Courses being studied	Science	25
	Science and teaching methods	75

The table illustrates the dominance of women in education while the university, being a public sector university with lower fees, attracts large numbers from public sector schools, often Urdu-medium. Student teachers were asked about their experiences and the way their teachers have taught them:

Table 3 The Ways Teachers work in ITE

	Views	SA	A	D	SD
	Number of student-teachers = 580	**%**	**%**	**%**	**%**
	My teachers …..				
A	Act as a facilitator in the science classroom	38	48	11	3
B	Present the science content as material to be memorized	23	56	16	5
C	Encourage me whether I solve science problem correctly or not	38	44	14	4
D	Welcome my scientifically oriented questions	35	50	10	5
E	Motivate me to seek the answers to open-ended science problems	40	42	14	4
F	Involve me in too much written work in science	25	38	32	5
G	Involve me through hands-on science activities in scientific investigations	26	48	20	6
H	Set tests and examinations that allow me to show all I can recall	34	48	12	6
I	Teach the science mainly through lecturing	41	39	13	7

The overall view is quite positive although it is evident that the emphasis is on transmission of knowledge and the reward of what has been memorized.

Teachers reported their views on inquiry-based pedagogy and the practicalities of teaching:

Table 4 Views on Inquiry-based Pedagogy in Science in ITE

	Views	SA	A	D	SD
	Number of teachers = 50	**%**	**%**	**%**	**%**
A	I believe that an inquiry-based pedagogy in science does not result in much learning	20	20	46	14
B	I like the idea of being a facilitator of learning by allowing the student-teachers to learn in groups	24	66	10	0
C	I feel that an inquiry-based pedagogy in science is a more effective style of teaching science rather than lecturing	22	62	16	0
D	I think inquiry-based pedagogy in science will benefit student-teachers who are only seeking right answers	26	56	18	0
E	I think that an inquiry-based pedagogy in science should be used in ITE	48	50	2	0
F	Teachers should be taught how to use inquiry approaches in science	44	54	2	0
H	Skills in handling open-ended problems are critical for my student-teachers	26	44	20	0
I	I think that an inquiry-based pedagogy in science will encourage critical thinking	42	54	4	0

In interpreting table 4, it has to be recognized that the teachers may hold diverse views of the nature of inquiry-based learning and their experiences in employing this approach may be limited. There is overall agreement that this approach offers a good way forward, and that it is highly relevant in science-based course related to ITE. However, there are marked signs of hesitation over its effectiveness in achieving learning. However, evidence of learning is almost certainly defined by the nature of current examinations which reward recall. The possibility of wider skills being developed (like critical thinking) is recognized but, sadly, not yet rewarded in examinations. Students were now asked how they saw inquiry-based learning but, again, it has to be recognized that their experiences may be limited. Nonetheless, they are positive:

Table 5 Inquiry-based Pedagogy helps in Learning

	Number of Student-teachers =580	SA	A	D	SD
	Views	**%**	**%**	**%**	**%**
A	Enables me to learn how to identify and ask appropriate questions	39	54	6	1
B	Enables me to only seek right solutions to science problems	23	55	21	1
C	Allows me to explore science concepts on my own	34	47	17	2
D	Enhances my curiosity to involve me in open-ended science investigations	31	50	15	4
E	Enables me to use appropriate equipment/material to analyze and interpret data	32	48	16	4
F	Enables me to take ownership of my learning during scientific investigations	26	54	17	3
G	Encourages a thought-out solution when I do practical work in science investigation	38	47	12	3
H	Develops my critical thinking to evaluate the evidence in scientific investigations	42	45	10	3

One key feature in the data in table 5 is the high proportion '*agreeing'* with smaller proportion '*strongly agreeing'*. This may reflect lack of experience but they are expressing an aspiration. They *want* to have opportunities to think, question, challenge, explore, interpret and evaluate. In fact, it probably expresses an implicit rejection of the recall-driven nature of much of their current learning.

Table 6 shows a comparison of teachers' and student-teachers' views on inquiry-based pedagogy and learning outcomes in ITE:

Table 6 Teacher-educators' and Student-teachers' Views of Inquiry and Learning

	Views	SA	A	D	SD	SA	A	D	SD
	Number of teachers = 50 Number of Student-teachers = 580	%	%	%	%	%	%	%	%
		Teachers Responses				Student-teachers Responses			
a	I should like to develop a more inquiry-based style of teaching	32	56	12	0	47	45	6	2
b	I should like to see the library and the internet used more in science teaching	50	40	8	2	44	42	12	2
c	My student-teacher are not mature enough to learn using an inquiry-based approach	6	42	46	6	-	-	-	-
d	Examinations mostly test the ability to recall information	30	62	6	2	35	50	12	3
e	Inquiry-based learning will need much more time	38	46	14	2	35	47	15	2
f	National Examinations must change to assess skills of understanding and of thinking	32	56	10	2	34	48	14	4
g	I should like to develop experimental work which illustrates how science operates	32	56	10	2	38	45	14	3
h	It is not possible to test student-teachers for their abilities in inquiry-based skills	16	36	38	10	18	43	32	7
i	I could not have access to enough resources to teach using an inquiry-based method	16	38	36	10	23	47	25	5
j	Inquiry-based approaches will work well only with the most able student-teachers	12	54	30	4	29	36	25	10

The majority of teachers and student-teachers' perceptions tend to held positive views. Almost all of the teacher-educators' and student-teachers' responses indicated that they both appreciated inquiry-based pedagogies compared to sole lecture method. Moreover, the teacher-educators' and the student-teachers' views on the key barriers of the inquiry-based approach in science were sought out as:

Table 7 The key Barriers in Seeking to Develop an Inquiry-based Approach

	Views	Teacher-educators' responses				Student-teachers responses			
	Teachers = 50 Student-teachers = 580	*Cannot be Overcome*	*Serious Barrier*	*A Minor Problem*	*Easily Solved*	*Cannot be Overcome*	*Serious Barrier*	*A Minor Problem*	*Easily Solved*
		%	%	%	%	%	%	%	%
a	There is insufficient time	8	62	24	6	25	50	18	7
b	Will not provide good examination results	12	34	36	18	10	49	28	13
c	Leaves the curriculum unstructured	8	44	36	12	18	40	33	9
d	Makes classroom management very difficult	6	32	26	36	18	36	27	22
e	There is not enough equipment to teach this way	12	58	20	10	22	47	22	7
f	Universities would not support it	8	44	26	8	16	47	26	11
g	The method is not consistent with the way other subjects are taught	16	34	28	22	16	40	32	12
h	The learners will be left confused	14	24	36	26	17	38	30	15
i	I have not been taught using an inquiry-based approach very much	6	28	38	28	17	38	28	17

Table 7 presents nine possible barriers were offered to teachers and student-teachers. Indeed, looking at all nine potential barriers, on average, nearly two thirds of the teachers and student-teachers regarded them as serious barriers or as a minor problem. The most serious perceived barriers were related to time demands and the necessary equipment to support inquiry-based pedagogy.

Both groups are of the view that inquiry-based approaches lead to poor examination results although research evidence does not really support this - it depends on how the inquiry-based approach is implemented (Kirschner et al, 2006). This almost certainly reflects lack of experience. Similarly, they think inquiry generates unstructured curricula but this does not follow at all (a look at the International Baccalaureate reveals what can easily be done). However, consistency of methods across subject areas is important and a lack of consistency will generate confusion. Also, lack of the prior

exposure to inquiry-based approaches is a serious barrier in adopting inquiry-based approaches.

It is possible to look at any differences in the responses of men and women using chi-square as a contingency test. However, the sample size for men is somewhat small making any significant differences difficult to detect. Thus, the differences between both of the groups were non-significant.

Findings from the interview and focus groups

Several broad areas were explored and respondents were allowed considerable freedom to expand and comment as they wished. A summary of the findings is now offered under these headings.

Perceptions of the Role and Importance of Inquiry-based pedagogy

It has to be recognised that the experiences of inquiry-based learning will vary widely but they aim was to explore the common features that were shared. The questionnaires haves indicated the dominance of the lecture approach and this was confirmed. For example, one teacher noted that, '*I had a little idea about inquiry-based learning'* (T2) while another said,. '*I had done inquiry till this class, sometimes'* (T3).

There was a general appreciation that inquiry-based learning involved engaging in seeking to answer scientifically-oriented questions and participate in other science-exploring activities. Thus, one teacher stated, '*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). In this, the teachers still provide questions and guided procedures. However, student-teachers could generate an explanation supported by the evidence they collect.

The description is somewhat inadequate when compared to the more widely accepted idea that inquiry-based learning describes learning that is *driven by a process of enquiry* which actively involves students in discussion, questioning, and investigation (Kahn and O'Rourke, 2005). This may involve starting with a question and the learner then has to find the data evidence and methods appropriate in moving towards an answer.

Most of the respondents saw inquiry-based learning in terms of questioning but were not confident that the whole course could be approached this way. For example one teacher noted, '*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).

Overall, while it was common for there to be questioning, they rarely implemented inquiry-based strategies. Thus, class discussions and assignments were focused on the use of science questions for initiating thinking from teacher-educators. The clear picture emerges that the student groups only had a limited conception of what was meant by inquiry-based learning in the context of their initial teacher education courses. Nonetheless, they could see the potential benefits (similar to the findings in Anderson (2002), Abell (2001), Newman *et al*., (2004). Thus, inquiry was conceptualized 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. Even in a lecture-driven course questioning may occur (Newman et al., 2004). However, this can be very far from genuine inquiry-based learning.

Inquiry and Collaborations

While it is possible to use an inquiry-based learning approach at an individual level, one of the great benefits is when the approach is used with students working in groups collaboratively. The teachers were overall enthusiastic about benefits from this: '*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). Another said: *I think student-teachers learn best in groups when they discuss in group. The group discussion is the best idea with them* (T10). The student-teachers were also very positive. For example, one student noted, '*I feel motivated when teacher involves me using inquiry-based methods. Mostly female teachers are very cooperative, encouraging and interacting* (G2-S1).

The use of social settings, encouraging student-teachers to learn in groups, was widely applauded. Thus, the majority of teachers reported that they found that student-teachers learn best in groups and with the most pleasure (Ahmed, 2011; Khan, 2012). Most student-teachers responded that they enjoy their learning in groups and enjoy interactions with peers and teachers. It has to be appreciated that group-work in laboratory situations is not so easy, due to resource limitations, but the ideas of group discussion and group projects was found to be very helpful (Halai, 2010). Thus, collaborations using inquiry-based approaches develop an atmosphere of confidence and ease for student-teachers.

Inquiry and Critical Thinking

An overwhelming majority of the teachers from the interview data responded that inquiry develops scientific thinking to review the science process and to analyse science experiment data critically. For example, one teacher stated, '*Using inquiry-based activities, student-teachers reflect on what they understand in science experiments; also they think how and why things are happening in science'* (T19) while one other teacher-educator saw, '*the use of inquiry as a rich experience in developing critical thinking in student-teachers as reported: Inquiry-based pedagogy provides rich experiences to student-teachers' thinking'* (T12).

Ideas like thinking skills, critical thinking, higher-order thinking skills, analytic abilities arose spontaneously in the teacher discussions along with the the idea of developing reflective thinkers. While there's not certainty about exactly how the teachers or student-teachers understood these ideas, there was a common thread throughout. Inquiry-based learning had the potential of moving learning away from reception, memorisation and recall towards something much richer. Typical comments were:

'I believe that inquiry brings a way to go into a depth in investigating' (G1-S4). *'Inquiry develops thinking critically in science processes; indeed we learn to think critically, and rationally. This enables us to solve problems'* (G1-S4).

However, there are practical limitations: One teacher noted, '*Unfortunately, we do not have much practical work to do in our lectures/sessions. Rather have to restrict our student-teachers to a limited use of unguided inquiries. Therefore student-teachers got a little chance to develop critical thinking'* (T18). One student-teachers stated, '*Most lecture session do not let us do our own constructed activities so we got no or less chances to be reflective or develop a critical thinking* (G2-S4). Thus, both teachers and student-teachers reported their apprehension regarding a restricted environment in the teaching session where they have little or no opportunity to develop thinking skills.

The Role of teachers in using Inquiry-based Pedagogy

With inquiry-based learning, the focus of learning moves from the teacher as the source of information to the teacher have sets up the questions and problems and encourages the students to work together to find the resources and ways forward. This is not an easy step to take in Pakistan culture where the role of the teacher is so often perceived in terms of dispensing information.

Nonetheless, the response was very positive about the change of role. For example, '*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). The student-teachers were clearly not satisfied with the traditional teacher role. One observed that, '*Teachers get annoyed by questions; do not respond nicely and discourage asking them* (G2-S2). Student-teachers also 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 appears to be an inconsistency in what teachers claim and what student-teachers say.

Student-teachers are more likely to report what happen in the classroom. The figure 2 below depicts the teacher-educators' and student-teachers' perceptions on the role of teacher using inquiry. It appears from the teachers and student-teachers' responses that the teachers' various roles using in inquiry in facilitating learning, managing class and reacting to the challenges when inquiry is practised.

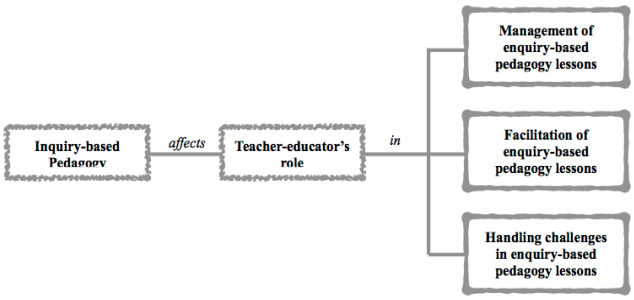

Figure 2 Teacher-educators' Role using Inquiry

While the student teachers were very aware that their teachers were encouraging them to use inquiry-based teaching styles, they felt they did not have good neither examples to neither follow nor they were well-prepared in employing this approach in their future teaching. They had been encouraged to prepare model answers (i.e. teacher-made notes). Although, their teachers used the terminologies of group work, discussion, open questions, so on, they did not discuss the substance of all the mentioned terms.

There clearly was a marked m between the experiences of the student teachers and the encouragement to move towards inquiry-based learning. While the teachers faced the mismatch in their perceptions of they role as teachers (delivering information) and their role in inquiry-based learning, the students faced the mismatch between their aspirations and their lack of good role models to follow.

Perceptions on Inquiry-based pedagogy in developing Learning

Inquiry-based learning was seen to have considerable value in allowing weaknesses in understanding to be become more apparent and to allow concepts to develop more clearly. For example, on teacher noted that, '*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). The majority of student-teachers in the focus groups held similar views. For example, one student observed, '*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).

However, the teachers saw inquiry-based learning as an integral part of all inquiry-orientated learning. Teachers and student-teachers alike reflected that student-teachers like to learn using inquiry-based teaching. This is consistent with many prior studies [21,38,21,10].

Perceptions on Contribution of the Science Method Course in developing Inquiry-based Pedagogy

Both teachers and student-teachers saw their methods courses as relating well to the science courses in revealing a range of teaching strategies. For example, on teacher noted that, '*Teaching science method courses helped me to know a range of teaching approaches* (T2) while one student stated, '*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, the student-teachers' reflections indicated that they were exposed to different instructional strategies that helped them understand inquiry such as the use of inquiry-based activities to develop their abilities to conduct inquiries. The majority of teachers and student-teachers indicated that at the time when they went through their science content course they did not recognize the teaching strategies as inquiry-based strategies.

Perceptions of the Challenges with Insufficient Time

The majority of teachers 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 pre 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). '*I believe that teachers require more time to prepare their sessions and it seems impossible with too lengthy curriculum'* (G1-S3).

Any over-crowded curriculum places teachers under pressure and there is a natural fear to move away from the traditional lecture dominated approach [32,2,23,24]. Student-teachers foresaw that this would be a problem when they were teaching themselves. This apprehension is consistent with similar findings in the literature for implementing inquiry.

Lack of University Support in adopting Inquiry

The majority of teachers reported that lack of support from the university seems a big hurdle in their teaching. Thus: '*The biggest hurdle is the lack of support from the university. The university did not set an environment to support teachers to decide on how they plan to teach'* (T7). Similarly, some student-teachers expressed anxiety about using inquiry forms 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: '*University does not help in adopting inquiry-based activities. If the science teachers use inquiry-based approaches that is their own choice or decision'* (G2-S3).

Faced with all the uncertainties that are inevitable when starting teaching, student teachers expressed nervousness that they could manage their time to implement inquiry-based instruction in any case [10,2]. Indeed, a university has a focus on teachers' relationships with the authorities rather than on the quality of teaching and learning for student-teachers [29,40,41].

Science Curriculum Support to Inquiry

If inquiry-based learning is to be adopted, then the curriculum design and the assessment must be developed constantly with this. In Pakistan, learning is heavily dependent on written text, the provisions of information, the correct recall of what is given. The concept of student-centered learning is rarely observed. Thus, one teacher noted that, '*The science curriculum is text-based and too lengthy. Curriculum does not support inquiry-based pedagogy* (T19).

The teacher-educators saw inquiry-based pedagogy as a better approach in bringing about student-teachers' understanding of science concepts. Similarly, they also saw that inquiry-based pedagogy would help them get away from dependency on the text. Likewise, the majority of student-teachers reported that they were used to memorise text rather than involved in inquiry-based curricula: '*Student-teachers appreciate that teachers-prepared notes help them to pass exams. Therefore, using inquiry, student-teachers do not benefit'* (G1-S3).

This exemplifies the overall principle that inquiry-based learning is very difficult (maybe even impossible) to implement given unsuitable curricula and assessment that consistently gives the rewards for the maximum recall, largely ignoring understanding, critical thought or evaluation of ideas. The difficulties in re-constructing curricula and re-thinking assessment totally cannot be underestimated [4,40]. However, the textbook could perhaps be redesigned to include structured and open inquiry-based activities, thus raise inquiry-based pedagogies.

Examination and Inquiry-based Assessment

Assessment issues, of course relate tightly to curriculum aims. The problems with assessment were seen clearly: **'***Our entire assessment is summative using exam and student-teachers are not assessed for their learning'* (T3). The *curriculum offers a lot of information to recall and memorize. Examinations test memory and do not assess learning* (G2-S1).

Assessment has been suffering from an overload of examinations that focus simply on the memorization of facts and learning by rote [4]. This causes fear in student-teachers who feel uncomfortable about what is expected. In the current situation in initial teacher education in Pakistan, examinations are a huge part of assessing student-teachers, with little emphasis on classroom activities, projects, assignments and inquiry-based approaches [7,29]. Consequently, teachers do not have an opportunity to evaluate student-teachers' skills and abilities using inquiry-based approaches [2].

In simple terms, the goal of learning is examination passing. The goal of initial teacher education in Pakistan is to develop teachers who are crammed full of information. Until these issues are resolved, inquiry-based approaches seem peripheral in initial teacher education in Pakistan.

Conclusions

This study did not seek to evaluate inquiry-based learning as a teaching and learning strategy. It aimed to explore how inquiry-based learning was perceived in initial teacher education in Pakistan and what problems would arise if it were introduced.

It is clear that understandings of what is meant by inquiry-based learning with both teachers and student-teachers are rather inadequate. Inquiry-based learning is much more than using questions and the student-teachers were much more perceptive than their teachers in this regard. In an educational culture which has focused on the efficient transmissions of information and an examination system that rewarded maximum recall, it has to be acknowledged that the introduction of inquiry-based learning will need a massive paradigm shift. The start must happen with revisions of curricula, clear statements of support from university authorities but, most importantly of all, the complete overhaul of the assessment system so that the outcomes from inquiry-based learning are rewarded. The potential gains may be enormous; the obstacles in making these gains are very large.

In addition, teacher-educators' and student-teachers' perceptions of inquiry-based pedagogy raise some key issues, in the context of practical implementation:

- 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 conceptualization of inquiry-based learning by teachers 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 characterized as a process driven 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 [42].

According to the findings of this research, I would recommend and encourage Pakistani teachers and student-teachers 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. Perhaps, a member of staff needs to be seconded out for a short time, to master the literature on the subject and develop a policy document. Moreover, the whole area of assessment needs re-considered. Thus, inquiry-based pedagogy could be a good start to develop pedagogy and improve student-teachers' learning as well as teachers' professional teaching practices in ITE.

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