

## Unraveling Epistemological Beliefs of Chemistry Teachers at Secondary Level

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### Abstract

*This paper investigated epistemological beliefs held by chemistry teachers at secondary level in Khyber Pakhtunkhwa. Sample of the study were 400 chemistry teachers from target population out of three districts of zone 2 in Khyber Pakhtunkhwa. Convenient sampling technique was used in school selection while teachers were randomly selected. Data were collected through researcher-developed questionnaire followed by semi structured interview and were analyzed through statistical tools i.e. mean, standard deviation, ANOVA, t test, correlation and qualitative data through qualitative data analysis techniques. Epistemological beliefs questionnaire was used to measure teachers' beliefs. Finding of the study revealed that teachers hold a range of beliefs i.e. naïve and sophisticated beliefs and those beliefs in return influences teachers how to teach. It was recommended that teachers, teacher educators, curriculum developer and ministry of education endeavor to diagnose and unravel chemistry teacher's beliefs, and if alterations of beliefs are desired, encourage mediation to reshape those beliefs through proper mentoring.*

### Introduction

Justified true belief is called knowledge. Epistemology is study of nature, sources and justification of human knowledge (Gholami, 2010). Teachers are the change agent; their level of belief can change student's beliefs. Teacher's epistemological belief is the crucial parameters in improving teaching learning process. Teacher's belief is the significant factors that stimulate change process in learners as well as the inculcation of teaching strategies to be used in classroom. Chemistry teachers need to adopt beliefs harmonious with content knowledge in order to make students, problem solving, conceptual and capable of doing individual assignments, asking questions and mutual student-student and teacher discussion. Teachers have massive responsibility to prepare scientifically literate students so that they can get firm grasp of the new knowledge and maintain firm lifelong retention (Doyle, 2012).

### *Statement of the Problem*

The purpose of the study is to investigate teacher's beliefs towards chemistry teaching at secondary level in Khyber Pakhtunkhwa. Teachers have to make their teaching practices on some theory and be

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able to explain what works inside classroom. Epistemological beliefs are crucial parameters in making decision of teacher's instructional practices, student motivation and Meta cognition. Therefore, it is necessary to identify and explore teachers' beliefs at secondary level.

*Objectives of the study*

To investigate epistemological beliefs held by chemistry teachers  
To find core elements of chemistry related beliefs related to instructional practices fostering students' engagement

To investigate how epistemological beliefs, differ across gender

To investigate how epistemological beliefs, differ across sectors

*Research Questions*

What sorts of epistemological beliefs are held by chemistry teachers?

What core elements of chemistry related beliefs are related to instructional practices fostering students' engagement?

How epistemological beliefs differ across gender?

How epistemological beliefs differ across sectors?

*Significance of the Study*

Contemporary sophisticated belief will encourage teachers to deviate from naïve into more sophisticated beliefs creating student-centered learning environments inside classroom. The study will help to attract the attention of teacher educators in order to transform the naïve beliefs into more sophisticated beliefs. This study will explore how teachers' sets of beliefs about knowledge will guide teachers to address the type of instructional practice that are used in learning environment. A major benefit from this study will be an understanding of teacher knowledge that may be useful to improve teacher education and to make educational innovations more successful.

**Review of Literature**

Hofer (2000) furnished theoretical model depicting epistemic beliefs which are classified into two classes i.e. beliefs regarding the nature of knowledge and Beliefs about the nature of knowing. Every school has their own learning environment where teachers have their own way of carrying out teaching learning process. Every teacher has theoretical knowledge and sharing of knowledge needs specific teaching approaches, every concept bears different nature of knowledge that

enforce teacher to adopt and apply teaching method harmonious with student's creativity, problem solving and Meta cognitive skills (Ausubel, 2012). There are two forms of epistemological beliefs hold by teacher's i.e. naive and sophisticated beliefs. Teacher centered teaching is supported by naive beliefs, student centered teaching is stimulated by sophisticated beliefs. Teachers needs to possess those beliefs and teaching approaches that stimulate and inculcate critical, analytical, reasoning and Meta cognitive skills and improve learner's enquiry and problem-solving traits (Huling, 2014). Teachers with sophisticated beliefs stimulate students Meta cognition, critical and analytical thinking. Sophisticated teachers will foster higher order learning as compared to teachers of naive beliefs (Zohar, 2011). Teacher beliefs are subject to changing of how they teach different activities for student's engagement, which directly affect the students' learning (Lim C, 2010). Teachers' belief determines their teaching paradigm, their liking and disliking for a certain way of teaching in terms of methods and classroom environment. As a result, it's the epistemology that bridges the gap between theory and practice (Juntunen, 2014).

### **Methodology**

The study is both quantitative and qualitative in nature for which a mix method research design was used. The study was conducted in Khyber Pakhtunkhwa. Populations of the study constituted both public and private male, female high schools of Zone 2. All chemistry teachers of (9<sup>th</sup>& 10<sup>th</sup>) were included in the population of the study. Among zone 2 a sample of 400 chemistry teachers were selected with 5% confidence level. The selection of schools was convenience sampling while teachers were randomly selected.

#### *Data collection instrument and analysis*

A self-administered questionnaire was developed for collection of data from chemistry teachers followed by semi structured interview. The questionnaire was divided into four major domains. 1. Knowledge simplicity 2. Knowledge certainty 3. Learning quickness 4 Sources of learning. The reliability was measured through Cronbach's alpha test for which alpha coefficient value 0.9 was obtained. Data collecting instruments were developed under the close guidance and supervision of research experts to ensure content validity. The collected data were analyzed by using (SPSS, version 16.0). For analysis of data mean, standard deviation, t test and correlation were used and tables were

prepared for illustration. The data were interpreted and discussed accordingly.

*Analysis: Table 1 Gender wise Comparison of Teachers Beliefs*

Domain	Gender	Mean total	Standard Deviation	t- test	df	Sig
Chemistry Teachers beliefs	Male	78.31	7.194	1.132	448	0.000
	Female	77.56	6.772	1.132	448	0.000

Table 1 depicts the gender comparison regarding teacher's level of beliefs. The overall mean value of male teachers (public and private) is 78.31 higher than female teachers (public and private) 77.56 about all the components of teacher's beliefs i.e. Knowledge simplicity, Knowledge certainty, Innate ability of knowledge, Learning quickness and Source of knowledge. Similarly, standard deviation value of male teachers 7.194 is higher than female teachers 6.772.

*Table 2 Sub categories in Gender wise Comparison of Teachers Beliefs*

Domain	Gender	Mean	Standard Deviation	t	df	Sig
Knowledge simplicity	Male	16.36	2.837	5.927	448	0.000
	Female	14.75	2.931	5.927	448	0.000
Knowledge certainty	Male	14.17	3.000	-5.167	448	0.000
	Female	15.60	2.796	-5.167	448	0.000
Innate ability	Male	15.73	2.959	-2.021	448	0.000
	Female	16.30	2.955	-2.021	448	0.000
Learning Quickness	Male	13.23	3.257	-1.816	448	0.000
	Female	15.75	2.717	-1.816	448	0.000
Source of knowledge (authority)	Male	16.82	3.507	5.071	448	0.000
	Female	14.17	3.330	5.071	448	0.000

Table 2 shows that mean value of male teachers is 16.36 higher than female teachers 14.75 regarding sub category of knowledge simplicity. However, standard deviation is higher 2.931 for female than male 2.837. Similarly, t value shows that this difference is significant. Mean value of female teachers is 15.60 higher than male teachers 14.17 concerning the sub category of knowledge certainty. Similarly, standard deviation is higher for male 3.00 than female 2.796. Similarly, t value shows that this difference is significant. Mean value for the sub category

regarding innate ability of knowledge of female teachers is 16.30 higher than male teachers 15.73. Similarly, standard deviation is 2.959 higher for male than female 2.955. However, t value shows that this difference is significant. Table 2 also shows that mean value of female teachers is 15.75 higher than male teachers 13.23 with respect to learning quickness. Similarly, standard deviation is 3.257 higher for male than female 2.717. Similarly, t value shows that this difference is significant. Mean value of male teachers is 16.82 higher than female teachers 14.17 concerning source of knowledge acquisition. Similarly, standard deviation is 3.507 higher for male than female 3.330. However, t value shows that this difference is significant.

*Table 3 Sector wise Comparison of Teachers Beliefs*

Domain	Sector	Mean Total	Standard Deviation	t	df	Sig
Chemistry Teachers beliefs	Public	79.75	6.657	7.111	448	0.000
	Private	75.18	6.651	7.111	448	0.000

Table 3 portrays the Sector wise comparison regarding teacher's level of beliefs. The overall mean value of public-school teachers is 79.75 higher than private school teachers 75.18 about all the components of teacher's beliefs i.e. Knowledge simplicity, Knowledge certainty, Innate ability of knowledge, Learning quickness and Source of knowledge. Similarly, standard deviation value of public-school teachers is 6.657 higher than private school teachers 6.651. Likewise, t value shows that this difference is significant.

*Table 4 Sub categories in Sector wise Comparison of Teachers Beliefs*

Domain	Sector	Mean	Standard Deviation	t	df	Sig
Knowledge simplicity	Public	15.84	3.060	1.745	448	0.000
	Private	13.34	2.850	1.745	448	0.000
Knowledge certainty	Public	15.07	3.023	2.416	448	0.000
	Private	14.38	2.904	2.416	448	0.000
Innate ability	Public	16.58	2.870	5.535	448	0.000
	Private	14.04	2.879	5.535	448	0.000
Learning Quickness	Public	15.88	2.810	3.730	448	0.000
	Private	14.80	3.264	3.730	448	0.000

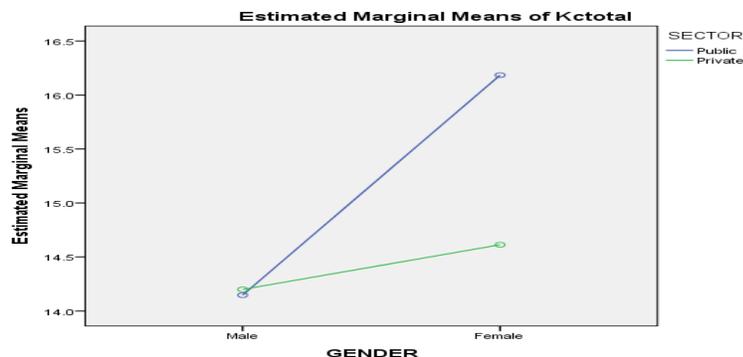
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Source of knowledge	Public	16.38	3.179	2.238	448	0.000
	Private	14.62	3.969	2.238	448	0.000

Table 4 demonstrates that mean value of public-school teachers is 15.84 higher than private school teachers 13.34 regarding sub category of knowledge simplicity. Similarly, standard deviation is 3.060 higher for public school teachers than private teachers 2.850. Likewise, t value shows that this difference is significant. According to table 4 mean values of public-school teachers are 15.07 higher than private school teachers 14.38 concerning the sub category of knowledge certainty. In the same way standard deviation is 3.023 higher for public school teachers than private teachers 2.904. Similarly, t value shows that this difference is significant. Mean value for the sub category regarding innate ability of knowledge of public-school teachers is 16.58 higher than private school teachers 14.04. However standard deviation is 2.879 higher for private school teachers than public sector 2.870. “t” value shows that this difference is significant. Table 4 also shows that mean value public school teachers is 15.88 higher than private school teachers 14.80 with respect to learning quickness. However standard deviation is 3.264 higher for private school teachers 2.810. Similarly, t value shows that this difference is significant. Mean value of public-school teachers is 16.38 higher than private school teachers 14.62 concerning source of knowledge acquisition. However standard deviation is 3.969 higher for private school teachers 3.179. However, t value shows that this difference is significant.

*Interaction Effect for Sector and Gender wise comparison*

In order to determine the interaction effect between gender and school sector, five domains of epistemological beliefs were placed in the multivariate analysis. Analysis results show that there is significant interaction effect between gender and sector in the domain of knowledge certainty and learning quickness. The possible interaction between gender and school sector was investigated with the help of interaction



graph. In gender wise comparison of knowledge certainty “female gender” both public and private teachers has more sophisticated high level beliefs of means value more than 14.5 regarding the domain of knowledge certainty than “male gender” public and private teachers with means value of less than 14.5.

*Table 5 Interviews Summary of sector and gender wise Schools’ Teachers*

Teachers	teachers’ beliefs and change in students learning	Beliefs about knowledge simplicity	Beliefs on textbook knowledge or integrated knowledge	Beliefs about Knowledge certainty	Do you believe teachers can be challenged?	Core element fostering student’s engagement
1	positive intentions increase student’s retention	Experience and practice make ease in chemistry	Text book has only words and images. Without integration	Only change is constant and the rest of all things are certain.	Teacher is human and can be challenged	Teacher’s knowledge, beliefs, emotional attachment
2	Create Student’s interest in learning	AV aids and technology create interest	personal knowledge too is very helpful	Knowledge increases with time and experience	teacher can be challenged	Academic and professional training, students counseling
3	Teacher’s words and action bring change	teaching as job is easy, teaching as profession is complex	integrate knowledge to real life	knowledge improve with level and age as well	Good teacher creates challenges	Teachers subject command, availability of resources

4	Motivate student learning	Teacher beliefs encourage students	Amalgam knowledge	knowledge changes with time, experience	teachers have strong and weak aspect	Lesson planning, classroom environment
5	Teachers belief can change students learning behavior	Chemistry teaching is ghost language	Books can't satisfy students learning	Expert and scientist can challenge theories or concepts	it's rare for students to challenge teachers	students and teachers' interest, classrooms size, resources,

### Discussion

Teachers' responses about epistemological beliefs were divided in five sub-categories and presented in table 1-4. The mean score (total) of teacher's beliefs in gender wise for male chemistry teachers were 78.31 reveals high level and sophisticated beliefs than female chemistry teachers with a mean score (total) of 77.56. Results of analysis shows that both male and female chemistry teachers possess varied beliefs regarding, five sub categories of epistemological beliefs. Mean score 16.36 for knowledge simplicity depicts that male chemistry teacher strive hard to teach as compare to female with mean score 14.75 tackle chemistry teaching as simple and easy. The trend become reversed in the domain of knowledge certainty where female chemistry teachers mean score value 15.60 exhibit uncertain and ever-changing attitude towards chemistry knowledge as compare to male teachers with mean score 14.17 display with a fixed and unchanging beliefs regarding chemistry subject knowledge. In the sub category of innate ability female teachers with a mean score 16.30 manifests the sophisticated beliefs that learning takes place with a constant effort as compare to more naïve beliefs of male teachers as shown by mean value of 15.73. Similarly, in the sub category of learning quickness female chemistry teachers with a mean score 15.75 affirm that knowledge construction is a slow and gradual process unlike male teachers with a mean score 13.23 of has the beliefs that knowledge acquisition occurs in quick and speedy fashion. Again, the scenario

reversed in the sub category of authority of knowledge where male teachers with a high mean score 16.82 believe that knowledge acquisition occurs through reasoning, critical, analytical and Meta cognitive thinking while female with a mean score of 14.17.

### *Conclusions*

On the basis of findings following conclusions were drawn.

- ✓ Maximum respondents agreed that male chemistry teachers have high level and sophisticated beliefs fostering critical, analytical, reasoning and Meta cognitive skills
- ✓ It was concluded from the study about knowledge simplicity, male chemistry teachers strive hard to teach chemistry and students were struggling in understanding chemistry.
- ✓ It was concluded from the study that female chemistry teachers exhibit uncertain and ever-changing beliefs in chemistry knowledge than male counterpart.
- ✓ Majority of female teachers opined that students learning is a slow and gradual process of building knowledge
- ✓ Most of the male teachers possessed sophisticated beliefs regarding authority of knowledge acquisition that knowledge acquisition takes place through reasoning, Meta cognition, challenging the teacher.
- ✓ It was deduced from discussion the study that public chemistry teachers possess experienced beliefs regarding five domains of epistemological beliefs than private teachers.
- ✓ Majority of public-school teachers opined regarding “depend on textbook knowledge or integration of own knowledge” that Text book has only words and images. Without integration of teacher’s knowledge, you can’t even teach a word.

### *Recommendations*

On the basis of conclusions, following recommendations are presented:

It’s recommended that both public and private chemistry teachers may concentrate on domains of epistemological beliefs to inculcate critical, analytical, Meta cognitive and problem-solving skills in students. Teacher-students and student-student interactions should be established through mutual friendly discussion, individual and group assignment in order to foster students Meta cognition and better achievement in chemistry.

Private chemistry teachers hold naïve beliefs so demand the attention of authorities for the provision of refresher courses.

In gender wise comparison female chemistry teachers outperformed their counterparts in male school. Continues professional development and a better monitoring be exercised to improve the standard of teaching.

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