

Teaching Mathematics at High School: A Comparison of Public and Private School Teachers' Practices

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Abstract *This paper compares the mathematics teaching practices of private and public high school teachers in Punjab. Two hundred public and 180 private school teachers were selected by using random sampling technique from district Sahiwal. The quantitative data was collected by using a Likert type 58 questionnaire items. The questionnaire consisted of six parts: mathematic teaching practices, mathematic effective students' instruction, mathematic resources availability, use of mathematic resources, use of instructional techniques and evaluation techniques used by the teachers. The study indicated that private school teacher teach in cooperative environment, individual concentration, small group discussion and encourage students in mathematic classrooms as compared to public school teachers. They write equations to represent concept and then engage students in problem solving and practice computational skill as compared to public school teachers. Public school teachers highly believe that text book is primary instructional tool for teaching. They practice difficult problem by drill in their classes. Although Public school teachers are well trained, qualified and experienced yet they emphasize rote learning which is a big hurdle in conceptual understanding. Provision of material resources in public schools is high. Mathematic curriculum document, manipulative, measuring devices, and spreadsheets, worksheet calculators, teacher guide and computers as teaching resources are available in public schools. Whereas, helping books and calculators' availability is better in private schools.*

Key Words:

Teaching Practices,
Mathematic Classrooms,
Secondary Education

Introduction

The article 25-A, of the constitution of Pakistan requires that free and compulsory education from 5-16 years of age must be organized by the Provinces. Subsequent to 18th amendment, the Government of Punjab enacted *the Punjab Free and*

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Compulsory Education Act 2014 to provide make necessary provisions for free and compulsory education from age of 5 to 16 years. A closer look at the curriculum documents which have been implemented since the creation of Pakistan in 1947 reveal that mathematics has remained as a compulsory subject from grades I to X. The central place given to the subject of mathematics up to high school level shows that state has deemed the study of this subject necessary for national development. In today's competitive world, education is vital for the future for any nation.

Every nation needs a STEM workforce in order to continuously provide innovation the 21st century demands. Since mathematics plays a strong role in the economic and technological advancement of any nation, therefore, it is not only beneficial but also essential to study how mathematics is being taught at secondary level in opinion of public and private teachers. It is further important to look into how effective students' instruction is organized, what mathematics resources are available to the teacher and how those resources are used, and what different instruction and evaluation techniques are used by the secondary school teachers. Since in Pakistan there is a huge private sector presence in the system of education, therefore it becomes crucial to make a comparison of mathematics teaching practices in both the public and privately managed schools.

Simpson, Payne, Munro and Hughes (1999) concluded from his qualitative study that mathematics teaching practices among other aspects that influence students' knowledge acquisition. Attwood (2001) identified various factors that result into low mathematics achievement and included learning environment and culture amongst other variables. Henson and Eller (1999) reported that mathematics students of the schools achieve higher where classroom practices are discussed by the principals and teachers alongside some other variables.

Artzt and Thomas (1992) suggested a significant increase in achievement level when the students learnt in small co-operative groups as compared to individual work. Similar suggestion was made by Stevenson and Stigler (1992) when they compared Asian and United States mathematics classrooms. The teaching methods and strategies used by math teachers also influence students' learning (Robitaille & Garden, 1989). Wenglinsky (2001) employed multilevel structural equation modeling to study mathematics teachers' classroom practices related to instruction, type of content taught, and assessment and found that

Classroom practices indeed have a marked effect on student achievement and that, in concert with the other aspects of teaching under study, this effect is at least as strong as that of student background. This finding documents the fact that schools indeed matter, due to the overwhelming influence of the classroom practices of their teachers.

Arends, Winnaar and Mesimege (2017) studied mathematics teachers' classroom practices in African schools and found that the discourse, feedback, continuous assessment, collaboration, and solving problems and metacognitive strategies, are associated with student achievement.

Stipek, et.al. (2001) mentioned that teachers' beliefs are strongly associated with their practices. They further reported a strong association between self-confidence of students and teachers as math learner and math teacher respectively. Wenglinsky (2002) studies how teachers' classroom practices are linked to students' academic performance. He concluded that effect of classroom practices is as much as the students themselves as far as their achievement is concerned.

Some of the research conducted in Pakistan have investigated into the classroom practices and its influence on students' achievement. Awan (2012) and Liaqat (2009) found that private schools were preparing better mathematics lesson plans at secondary level as compared to public schools. Iqbal (2006) explored that private schools used a variety of teaching techniques and has access to and used variety of teaching aids as compared to their counterparts. Similarly Asikhia (2010) and Etuk et al (2013) concluded that teacher teaching style, knowledge of the subject, and teacher interaction with the students influence their mathematics achievement.

The above review of the literature has shown that teachers' classroom practices influence the students' outcomes. In Pakistan a large student population is accommodated in the private schools. It, therefore becomes imperative to compare the classroom practices of the public and private school teachers in the Pakistani context.

Theoretical Considerations

Owens (1995, p.158) alludes that "No discipline can claim uniform agreement on the theoretical framework for teaching and learning". Since the way humans learn is very complex therefore there are various theories of learning (Romberg, 1988) and each of these theories are applicable to a certain extent in mathematics classroom (Maree, 1997).

Leonard (2002:38), stated that in behaviorism "learners are placed in a controlled environment in order to be directed to a specific set of behavioral changes based on a set of predetermined, instructor-based objectives". The principles of behaviorism are applicable to teaching of mathematics at secondary level when teacher use drill and practice technique while teaching the concept such as solving linear equations, factorizations and other low level skills and concepts. However, the underlying principles of behaviorism are not helpful solving complex problems, proofs and establishing various mathematical relationships.

Since drill and practice and reinforcement cannot result into invention of a new idea (Romberg, 1988), therefore, a theory that requires active construction of knowledge was needed. Gestalt theorizes that learning involves active construction: learners experience the world in meaningful patterns and then construct meanings from those patterns. According to this theory learning is defined as change in the thought process while solving a problem.

The constructivist theories have dominant influence on mathematics classrooms for decades now. The Piaget's theory is built around three core components: equilibrium, assimilation and accommodation (Anastasia, 2018). In the process of assimilation child's new knowledge interconnects with his existing insights whereas the process of accommodation reconstruct the internal insights. According to Piaget mathematics learning happens when the learner construct their interactions within their physical, social and cultural environment.

In order to develop an understanding of two of the main principles of Vygotsky's work: MKO and ZPD needs to be understood. The MKO refers to someone who has higher ability level than the learner for a specific situation. The MKO needs not to be a human being. There are various electronic support systems that can be used for the learning process. The teachers in real classroom situations must understand when a learner needs him as an MKO and when he can proceed without him. Vygotsky (1978) sees the ZPD as the area where the child is allowed to develop skills he will then use on his own for developing higher mental functions.

In recent years, the influence of constructivist theories on mathematics education has decreased (English, 2007). Lesh and Doerr (2003) presented powerful arguments in the edited volume, *Beyond constructivism: Models and modeling perspectives on mathematics problem solving, learning, and teaching*, for moving away from constructivist ideologies. Goldin (2002) has also underlined the shortcomings of constructivist theories.

In summary, mathematics teaching and learning has and will remain influenced by each of the above mentioned theories.

Purpose of the Study

Since mathematics plays a strong role in the economic and technological progress of any nation, therefore, it is not only beneficial but also essential to study how mathematics is being taught at secondary level in opinion of public and private teachers. It is further important to look into how effective students' instruction is organized, what mathematics resources are available to the teacher and how those resources are used, and what different instruction and evaluation techniques are used by the secondary school teachers. Since, in Pakistan, there is a huge private sector presence in the system of education, therefore it becomes crucial to make a comparison of mathematics teaching practices in both the public and privately managed schools.

Methodology

This quantitative study compared the secondary school teachers' classroom practices by school ownership. The data were collected by administering Likert

type questionnaire that was developed by the researchers and validated through expert opinion. It was also pilot tested for reliability and Cronbach alpha for the final version was 0.84. The researchers themselves administered the questionnaire. The final questionnaire was comprised of 58 items and it had six sections namely 1) mathematic teaching practices, 2) mathematic effective students' instruction, 3) mathematic resources availability, 4) use of mathematic resources, 5) use of instructional techniques and 6) evaluation techniques

The sample was 380 teachers (public = 200; private = 180) who were randomly selected from the district Sahiwal. The data has been analyzed for each item separately using *t*-test in order to make comparison between public and private school teachers. The suitability of using *t*-test for likert scales type items has been confirmed by Norman (2010) using actual examples and simulated data. Similarly, de Winter and Dodou (2010; p.1) concluded that “for five-point Likert items, the *t*-test and MWW generally have similar power, and researchers do not have to worry about finding a difference whilst there is none in the population”.

Findings

Data was collected through the questionnaire developed by the researcher after the consultation on Likert type scale. Data was collected from the teachers teaching mathematic subject in secondary school at public and private sector. Independent sample *t*-test was used to see the significance of difference of the use of teaching practices at public and private sector.

Table 1 shows that there is a significant difference in the opinion of public and private school teachers regarding the teaching practices they use in their mathematics classroom.

Significantly higher number of private schools teachers agreed mathematics is best taught *with students of equal capabilities, by connecting mathematics with other disciplines, by asking questions to students to gauge their understanding and using textbook as a primary instructional tool.*

On the other hand significantly higher number of public school teachers agreed that mathematics is best taught when *built on prior student understanding of the concept, through students' conceptual understanding, by engaging students in hands-on/project-based learning and in cooperative learning groups.*

However, no statistical difference was found regarding the opinion of teachers about *mathematics is best taught by developing students' interest in mathematics*

Table 1. Comparison of Mathematics Teaching Practices of Public and Private School Teachers

Mathematics is Best Taught	Mean (Public)	Mean (Private)	SD (Public)	SD (Private)	<i>t</i>	<i>P</i>
with students of equal capabilities	2.50	2.75	0.89	0.72	2.99	0.003
by connecting mathematics with other disciplines	2.00	2.40	0.73	0.94	4.66	<0.001
by asking questions to students to gauge their understanding	1.80	2.20	0.89	0.95	4.24	<0.001
using textbook as a primary instructional tool	1.90	2.65	0.72	0.88	9.13	<0.001
when built on prior student understanding of the concept	2.40	1.95	0.68	0.76	6.09	<0.001
through students' conceptual understanding	2.10	1.90	0.91	0.91	2.14	0.033
by engaging students in hands-on/project-based learning	2.30	2.10	0.92	0.72	2.34	0.020
in cooperative learning groups	2.00	1.75	0.92	0.85	2.74	0.006
by developing students' interest in mathematics	2.10	2.00	0.79	0.97	1.11	0.269

Table 2 presents the data analysis regarding *utilization of effective students' instruction*. It is evident that a significantly higher number of private schools teachers agreed that the effective students' instruction practices used by them while teaching include *explain the reasoning behind an idea, introduce content through formal presentations and bind students to practice difficult problems regularly by drill*

Table 2. Comparison of mathematics Teaching Practices Regarding Utilization of Students' Instruction Techniques

Description	Mean (Public)	Mean (Private)	SD (Public)	SD (Private)	<i>t</i>	<i>P</i>
Explain the reasoning behind an idea	2.10	2.40	0.91	0.75	3.48	<0.001
Introduce content through formal presentations	1.95	2.15	0.76	0.93	2.30	0.022
Bind students to practice difficult problems regularly by drill	2.05	2.30	1.05	0.98	2.39	0.017
Write equations and functions to represent relationships.	1.95	1.55	0.76	0.60	5.65	<0.001
Practice your computational skills.	2.30	1.85	0.80	0.93	5.07	<0.001
Engage students in problem solving style of learning than lecture	2.55	2.00	0.89	0.86	6.11	<.001
Pose open-ended questions	1.95	2.00	0.76	0.79	0.63	0.530
Represent and analyze relationships using graphs, charts or tables.	2.00	2.05	0.56	0.69	0.78	0.436
Engage the whole class in discussions	1.90	1.80	0.79	0.70	1.30	0.194
Explain reasoning for solving problems differently where needed	2.00	1.90	0.73	0.72	1.34	0.180
Example of daily routine life for learning	2.30	2.15	0.92	0.88	1.62	0.106

Table 2 further shows that a significantly higher number of public school teachers agreed that the effective students' instruction techniques used by them while teaching mathematics include *write equations and functions to represent relationship*, *practice your computational skills* and *engage students in problem solving style of learning than lecture*. The table 2 further reveals there is difference

in the opinion of public and private school teachers regarding use of the effective students instruction techniques such as *pose open-ended questions, represent and analyze relationships using graphs, charts or tables., engage the whole class in discussions, explain reasoning for solving problems differently where needed and example of daily routine life for learning*

Table 3 presents the data regarding availability of mathematics resources to schools by their ownership. It is evident that the resources such as *computer software, mathematics manipulative, mathematics curriculum and worksheets* significantly more available to the private school mathematics teachers as compared to the public school teachers. The only mathematics resource that more available to the public school teachers is *teacher’s guides*. No difference was found regarding the availability of the mathematics resources to the public and private school teachers including *calculators, computers, measuring devices and helping textbooks*.

Table 3. Comparison of mathematics resources availability

Resources	Mean (Public)	Mean (Private)	SD (Public)	SD (Private)	<i>t</i>	<i>p</i>
Computer Software	2.10	2.50	1.29	1.40	2.90	0.004
Manipulative	2.05	2.55	0.83	1.10	5.03	<0.001
Curriculum documents	1.95	2.30	0.76	0.92	4.06	<0.001
Worksheets	2.25	2.45	0.91	1.05	1.99	0.047
Teacher’s guide	2.35	2.00	0.67	0.79	2.00	0.046
Calculators	2.35	2.20	0.93	0.83	1.10	0.272
Computers	2.15	2.25	0.81	0.91	1.13	0.258
Measuring devices	2.10	2.20	0.72	0.83	1.26	0.210
Helping Textbooks	2.25	2.40	0.79	0.99	1.64	0.102

Table 4 compares the use of mathematics resources by public and private school teachers. It is evident that a significantly more number of public school teachers, than private school teachers, claim to use *computer software* in mathematics classroom. Whereas, significantly more private school teachers claim to use *math manipulatives, curriculum documents, teacher guides and worksheets in mathematics classroom*. No difference in the use of *calculators, computers, measuring devices and helping books* by the public and private school teachers was found.

Table 4. Comparison of Mathematics Resources' Use in Teaching Practices

Resources Being Used	Mean (Public)	Mean (Private)	SD (Public)	SD (Private)	<i>t</i>	<i>P</i>
Computer Software	2.65	2.35	1.09	1.57	2.18	0.030
Math manipulative	2.35	2.90	0.81	2.45	3.00	0.003
Curriculum documents	1.95	2.20	0.76	1.15	2.52	0.012
Teacher's guide	2.05	2.30	0.51	0.92	3.32	0.001
Worksheets	1.75	2.15	0.64	0.99	4.72	<0.001
Calculators	2.15	2.25	1.09	0.79	1.01	0.311
Computers	2.30	2.50	0.80	1.24	1.89	0.060
Measuring devices	2.30	2.45	0.80	1.00	1.62	0.106
Helping textbooks	2.10	1.90	1.17	0.79	1.93	0.054

Table 5 compares the instructional techniques/methods used by public and private school mathematics teachers. It is revealed that significantly more public school teachers claim using *discussion method*, *lecture method*, *individual concentration* and *teaching in small groups* as compared to private teachers. On the other hand significantly more private teachers claim using *project method*, *demonstration method*, *group work* and *visit to mathematics museum* in their mathematics classroom. No statistical difference in the use of *problem solving technique* and *drill method* was found among teachers from the both type of schools though the *drill method* seems to be most commonly used by the teachers.

Table 5. Comparison of Mathematics Instructional Techniques/Methods Used by Public and Private School Teachers

Description	Mean (Public)	Mean (Private)	SD (Public)	SD (Private)	<i>t</i>	<i>P</i>
Discussion method	2.20	1.60	1.01	0.82	6.32	<0.001
Lecture method	2.60	2.25	0.82	0.64	4.60	<0.001
Individual concentration	2.50	2.00	0.83	0.86	4.04	<0.001
Teaching in small groups	2.30	2.05	0.80	0.89	2.88	0.004
Project method	1.65	2.70	0.93	0.92	11.05	<0.001
Demonstration method	1.55	2.00	1.00	0.97	6.42	<0.001
Group work	2.05	2.85	1.00	0.93	8.05	<0.001
Visit to mathematics museum	1.70	2.75	0.86	1.48	8.56	<0.001
Problem solving technique	2.25	2.00	0.91	0.46	1.33	0.185
Drill method	2.75	2.90	2.34	1.07	0.79	0.431

Table 6 presents teachers classroom practices regarding assessment techniques used by the public and private school teachers. It is evident that public school teachers use *question/answer during class* significantly more than private school teachers. However, the private school teachers use *novel home works, projects, worksheets, tests based on detailed calculations and examinations on criteria set by school* significantly more than public school teachers. No significant differences in the use of *assignments, pre-assessments and observations* have been found between public and private school teachers.

Table 6. Comparison of Mathematics Assessment Techniques Used by Public and Private School Teachers

Description	Mean (Public)	Mean (Private)	SD (Public)	SD (Private)	<i>t</i>	<i>p</i>
Question/Answer during class	2.15	1.55	0.88	0.69	-7.34	<0.001
Novel home works	1.90	3.65	0.79	6.74	12.83	<0.001
Projects	2.15	2.70	1.04	1.30	4.57	<0.001
Worksheets	2.15	2.75	1.04	0.85	6.12	<0.001
Tests based on detailed calculations	1.90	2.00	0.72	0.92	3.56	<0.001
Examinations on criteria set by school	1.60	2.05	0.75	0.94	5.18	<0.001
Objective type tests	2.20	2.10	0.70	0.97	-1.16	0.247
Assignments	2.30	2.15	1.13	0.99	-1.37	0.172
Pre-assessments	2.80	2.70	1.58	0.86	-0.75	0.451
Observations	2.05	2.10	0.69	0.79	0.66	0.511

Discussion

This study was aimed at to compare mathematics classroom practices of public and private secondary school teachers. The classroom practices were split into six components i.e. mathematic teaching practices, mathematic effective students' instruction, mathematic resources availability, use of mathematic resources, use of instructional techniques and evaluation techniques used by the teachers.

The findings of this study suggest that in view of private school teachers mathematics is best taught *with students of equal capabilities, by connecting mathematics with other disciplines, by asking questions to students to gauge their understanding and using textbook as a primary instructional tool*. Whereas, significantly higher number of public school teachers agreed mathematics is best taught when *built on prior student understanding of the concept, through students' conceptual understanding, by engaging students in hands-on/project-based learning and in cooperative learning groups*. The finding regarding working in cooperative groups for effective math learning is in accordance with Johnson and

Johnson (1975) and Davidson (1990). Similarly the teaching through conceptual understanding has also been advocated by Shellard and Moyer (2002). However, no statistical difference was found regarding the opinion of teachers about *mathematics is best taught by developing students' interest in mathematics*. The mathematics teaching practices of the public and private school teachers are in alignment with the some of the practices listed by Sabeen and Bavaria (2005). Khabbazsbashi, Khalifa, Robinson, Ellis and Misfud (2017) also elaborated that text book is a customary method in teacher centered technique.

Private school teachers give more emphasis on computational skill as compared to public school teachers. Public school teachers explain reasoning, pose open ended question and practice difficult problem by drill in the comparison with private school teachers. Provision of material teaching resources in public schools is high regarding computer software, mathematic curriculum document, manipulative, measuring devices, and spreadsheets as compared to private schools (Iqbal, 2012) In spite of extensive classes at optional level in government funded schools, they indicated great outcomes when contrasted with the private schools. It might be because of the better services in government funded schools as material goods, research facilities and prepared educating staff. I-lead instructors in state funded schools are very well qualified, experienced and have command on their subjects.

The NCTM has built up a position explanation which gives a system to the utilization of innovation in math educating furthermore, learning. The NCTM announcement supports innovation as a basic instrument for powerful mathematic learning. Utilizing innovation suitably can expand both the extent of substance and scope of issue circumstances accessible to students. NCTM suggests that students and teachers approach an assortment of instructional innovation apparatuses, teachers be given proper expert advancement, the utilization of instructional innovation be incorporated over all educational program and courses, and that instructors make educated choices about the utilization of innovation in mathematics course (NCTM, 2003). This study shows that mathematic curriculum document, manipulative, measuring devices, and spreadsheets, worksheet calculators, teacher guide and computers as teaching resources are used highly at public schools. On the other hand, helping books and computers software is more use in private schools classrooms.

The highly used instructional techniques at public schools are demonstration, project, drill and group work method whereas problem solving, lecture, individual concentration, small group and discussion methods are largely used at private classrooms. Problem solving technique is recommended in our national curriculum for enhancing students learning. However visit to mathematic museum and computer lab is the practice in public schools. Similarly, problem solving has been advocated as effective mathematics teaching practice by researchers in the past (Checkly, 1997)

Assessment is the input system for enhancing classroom learning. By enhancing teachers' assessment techniques and abilities, we can enhance classroom learning. This is a motivated errand, yet this is the method for enhancing students' performance. This study explored that set criteria detail exams, worksheets, projects, observations and novel homework are the practices being used by public secondary school teachers for students' evaluation. On the other hand, pre-assessments, assignments, objective type test and question answer sessions are practices commonly used for evaluation by the private secondary school teachers. Romberg (2000) and Computing Technology for Math Excellence (2006) have also talked about assessment of thinking skills and diagnostic, formative and summative assessments do various purposes.

Conclusion

The purpose for the study was to identify the teaching practices of public and private schools for the advancement of composing abilities in mathematic classrooms. It has been our common observation that the public school teacher used teacher centered teaching techniques. Previous researches shows that cooperative learning, engage students in different projects and problem solving techniques are effective best practices for teaching mathematic. This study conclude that private school teacher adopt Problem solving techniques, cooperative environment, individual concentration, small group discussion and encourage students in mathematic classrooms as compared to public school teachers. Public school teachers highly believe that text book is primary instructional tool for teaching mathematic. They practice difficult mathematic problem by drill in their classes. Provision of material resources in public schools is high. Mathematic curriculum document, manipulative, measuring devices, and spreadsheets, worksheet calculators, teacher guide and computers as teaching resources are available in public schools. Private schools are moderately costly so larger part of the general population hurry to the public schools and it is the reason for large classes in the estimate which influenced the teaching of the teachers. In spite of extensive classes at optional level in public schools, they indicated greater outcomes when contrasted with the private schools. It might be because of the better services in public schools such as material goods, laboratories and prepared educating staff .public school teachers are very well qualified, experienced and have command on their subjects.

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