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CHALLENGES IN APPLYING RESEARCH INFORMED STRATEGIES IN MATHEMATICS PEDAGOGY AT SECONDARY LEVEL: A CASE STUDY

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ABSTRACT

"All students can learn mathematics and all students need to learn mathematics" was the part of the vision statement to provide the excellent mathematical education,as stated in the position paper of national focus group of NCERT on "Teaching of Mathematics".This case study examines the problems and challenges in applying research inform strategies in mathematics pedagogy at secondary levelso as to fulfill this vision.The study was carried out at Bai P.M Patel Girls School,Surat.The teachers teaching mathematics were given questionnaire and their classroom teaching was also observed with reference to the research informed strategies in mathematics pedagogy and the data were analyzed.The study reveals that the mathematics pedagogy at secondary level is not up-to-the mark and is lacking far behind than what it is expected to be as described in National Curriculum Framework(NCF)2005.It is suggested to make suitable policy at national level for immediate improvement in mathematics pedagogy.

Key Words:-Research Informed Strategies, Mathematics Pedagogy, Secondary Level, Case Study.

1. INTRODUCTION

Mathematics is the most international of all curriculum subjects, andmathematical understanding influences decision making in all areas oflife—private, social, and civil. Mathematics education is a key to increasingthe post-school and citizenship opportunities of young people, but today, as in the past, many students struggle with mathematics and becomedisaffected as they continually encounter obstacles to engagement. It isimperative, therefore, that we understand what effective mathematicsteaching looks like—and what teachers can do to break this pattern.

At secondary level, the student learns mathematics as an academic discipline and begins to perceive the structure of mathematics. Mathematical terminology is highly stylized, self conscious and rigorous. In the elementary stage, if students have learnt many shapes and know how to associate quantities and formula with them, here they start reasoning about these shapes using the defined quantities and formulas. Algebra is developed at some length and

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students need to learn to geometrically visualize what they accomplish algebraically. A substantial part of the secondary mathematics curriculum is devoted to consolidation and hence the student needs to integrate the many techniques of mathematics learnt into a problem solving ability.

School mathematics takes place in a situation where: (1) Children learn to enjoymathematics, (2) Children learn important mathematics, (3) Mathematics is a part of children's lifeexperience which they talk about, (4) Children pose and solve meaningful problems, (5) Childrenuse abstractions to perceive relationships and structure, (6) Children understand the basic structureof mathematics and (7) Teachers expect to engage every child in class.

This needs sound mathematics pedagogy. The mathematics pedagogy must:

- be grounded in the general premise that all students have the right to access education and the specific premise that all have the right toaccess mathematical culture;
- acknowledge that all students, irrespective of age, can develop positivemathematical identities and become powerful mathematical learners;
- be based on interpersonal respect and sensitivity and be responsive tothe multiplicity of cultural heritages, thinking processes, and realitiestypically found in our classrooms;
- be focused on optimizing a range of desirable academic outcomes thatinclude conceptual understanding, procedural fluency, strategiccompetence, and adaptive reasoning;
- be committed to enhancing a range of social outcomes within themathematics classroom that will contribute to the holisticdevelopment of students for productive citizenship.

The mathematics education in our schools is beset with problems, like; (a) A sense of fear and failure regarding mathematics amonga majority of children, (b) A curriculum that disappoints both a talented minority as well as thenon-participating majority at the same time, (c) Crude methods of assessment that encourageperception of mathematics as mechanical computation, and (d) Lack of teacher preparation andsupport in the teaching of mathematics. Systemic problems further aggravate the situation, in thesense that structures of social discrimination get reflected in mathematics education as well.

The analysis of these problems need to shift focus from mathematical content to mathematical learningenvironments, where a whole range of processes take precedence: formal problem solving, useof heuristics, estimation and approximation, optimization, use of patterns, visualisation,representation,reasoning and proof, making connections, mathematical communication. For this purpose, it is necessary to find and to implement new strategies in mathematics pedagogy which are recommended by relative research findings. Present case study is one such attempt to identify the challenges in applying research informed strategies in mathematics pedagogy at

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secondary level. The study examines the present practices of mathematics pedagogy at secondary level with reference to such strategies in terms of different aspects.

2. REVIEW OF RELATED LITERATURE

Some of the major researches conducted earlier related to the present study have been highlighted below:

Bush[1](2005)in his paper "Improving Research on Mathematics Learning and Teaching in Rural Contexts" described ethnomatematics in mathematics education and place-based pedagogy in rural education and,in turn discussed how research in place-based pedagogy can benefit from research methodologies in mathematics.

KRAMARSKI[2] (2009) studied "Developing a pedagogical problem solving view for mathematics teachers with two reflection programmes".Findings indicated that systematic reflection support was effective for developing mathematics PCK and strengthening metacognitive knowledge of mathematics teachers, more than reflection discourse. No differences were found between the groups in developing beliefs about teaching mathematics in using problem solving view.

Ning[3] (2009) in his research paper "Concerning the New Mathematics Curriculum: The Pedagogical Content Knowledge of High School Mathematics Teachers" described a 2-year longitudinal study into the pedagogical content knowledge of 176 high school mathematics teachers from 83 schools in Jiangsu province of China and investigated that(1)the teachers were not well prepared for the new curriculum as they lacked sufficient understanding of the principles, standards and objectives of the new curriculum;(2)the teachers needed to expand their repertoire of their teaching strategies and their knowledge of the newly added contents in the syllabus; and(3)there was agap between the teachers' pedagogical content knowledge and their teaching practice.

Ebanks[4] (2010) studied "The Influence of Learner-centeredPedagogy on the achievement of students in Title-1 Elementary schools" and found that(1)the participant's association with learner-centered pedagogy were ineffective in the effort to raise student achievement,(2)inappropriate matching of learner-centered pedagogy to student interest might be among the causes of this ineffectiveness.

Hodara[5] (2011) in his paper "Reforming Mathematics Classroom Pedagogy: Evidence-based findings and recommendations for the Developmental Math Classroom" examined related studies by classifying them into six sets:student collaboration,meta-cognition,problem representation,application,understanding student thinking and computer-based learning and concluded that structured forms of student collaboration and instructional approaches that focus on problem representation may improve math learning and understanding.

Kaksatayeva[6] (2012) in her paper "Current Status and Prospects of Training Future Teachers of Mathematics for Specializes Teaching in Kazakhstan" described innovative techniques to teach Mathematics,namely,differentiated learning technique, module learning, information technology in teaching, masterylearning, collectivelearning, technology-integratedlessons, project-based learning ,communicative and cognitive learning and others.

Khan[7] (2012) studied "Preparation of Effective Teachers of Mathematics for Effective Teaching of Mathematics " examined the impact of job category(Primary, middle and secondary) and gender on the total score of teachers' score of teachers' satisfaction about content of the mathematics course in teacher training programmes and concluded that all teachers were satisfied.

Parashar and Singh[8] (2012) conducted study on "Transactional Strategies of Secondary School Science: in Purview of National Curriculum Framework(India)-2005"in which he collected data under four aspects,namely,school facilities, classroomfacilities, classroom transaction and students response for the classroom transaction. The major findings of the study were:- (1)No school had the science park(2)ICT facilities are not available in most schools.(3)Interaction procedure was not followed systematically.(4)Opportunity to perform experiments individually were insufficient.

Das[9] (2015) in his paper "Pedagogical Knowledge in Mathematics: A Challenge of Mathematics Teachers in Secondary Schools" examined teachers' limitations in expanding their expertise in facilitating mathematical problem solving through effective pedagogy and found them with(1)poor content (2)no formal lesson plan; and(3)deficiency of pedagogical knowledge of mathematics in general and particularly in geometry.

Sharma [10] (2015) presented his paper on "Activity-based teaching-learning strategy in mathematics" in which he discussed about the activity based teaching-learning strategies for effective learning of mathematics.

Sue and Andrew[11] (2015) in their research paper "Teachers' perspectives on successful strategies for teaching Computing in school" identified a range of pedagogical strategies used by teachers in practice, categorized them into the five areas,namely,contextualised learning, computational thinking skill development,code manipulation, working collaboratively and learning away from the computer; and further suggested that focusing on the use of these strategies could help teachers to feel more confident in the Computing classroom.

Aksu and Kul [12] (2016) in their study "Exploring Mathematics Teachers' Pedagogical content knowledge in the Context of Knowledge of Students" investigated student knowledge determined to be part of pedagogical content knowledge (PCK) by Shulman (1986) and accepted by a variety of researchers as a component of PCK.The study identified all teachers of sample to be deficient in terms of knowing how to correct the errors and misconceptions experienced. The results had significantimplications for developing teaching practices and professional development of teachers.

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From the perusal of the above studies, it is evident that there is no research that studied the challenges in applying research informed strategies in mathematics pedagogy at secondary level. Hence it was thought worthwhile to undertake the present study.

3. OPERATIONAL DEFINITIONS OF THE TERMS USED

Four important terms have been used in this study which needs to be defined operationally.

- **Research Informed Strategies:** Research informed strategies in this study means the strategies formulated, revealed, recommended and suggested by the research studies on pedagogies in the subject of mathematics.
- **Mathematics Pedagogy:** The term mathematics pedagogy used in this study is meant to signify all contributions to the mathematical education of students in mathematics classrooms. It includes not only the multi-faceted work of the teacher but also the contributions to classroom learning of curriculum designers, educational materials developers and educational researchers.
- **Secondary Level:** Secondary level means the students studying; and the teachers teaching in standards: IX and X.
- **Case Study:** The term Case study means that this study is focused only on one school, namely, Bai P.M Patel Girls' School located in Surat city of Gujarat state of India.

4. DELIMITATION OF THE STUDY

(1) This is a case study limited only to one school,Bai P.M Patel Girls' School,Surat which is a Gujarati medium ,government aided, religious minority school only for girls student affiliated to Gujarat Secondary and Higher Secondary Education Board.

(2)The study is delimited to the pedagogy of only one subject, namely, mathematics.

(3)The study is delimited only upto secondary level that is upto standard: IX and X.

5. OBJECTIVES

The objectives of the study are as under:

(1)Tostudy the strategies of mathematics pedagogy of the teachers at secondary level.

(2)To assess the strategies of mathematics pedagogy of the teachers at secondary level with reference to the strategies of effective mathematics pedagogy revealed in related research studies at secondary level.

(3)To identify the challenges in implementing the strategies of effective mathematics pedagogy revealed in related research studies at secondary level.

6. RESEARCH METHODS

6.1METHODOLOGY USED

A descriptive survey method has been used to conduct this study.

6.2 POPULATION

This is the case study confined to Bai P.M Patel Girls' School located in Surat cityof Gujarat state,India,which is the population for this study.It is a Gujaratimedium, government-aided religious minority school only for girls, affiliated to Gujarat secondary and Higher secondary Education Board and managed by Surat Parsi Panchayat Board,Surat.

6.3 SAMPLE

The following units of the population have been selected which constitute sample of the study:

Sr.No.	Sampling Units/Subjects	Sample Size(in number)	Sampling Technique
1.	Teachers	03	All the teachers teaching Mathematics in Standard; IX and X are selected purposively.
2..	Classroom Observation	36 periods	2 periods of each teacher in each division of Std: IX and X are observed purposively.

6.4TOOLS USED FOR DATA COLLECTION

- Classroom Observation Schedule
- Questionnaire for teachers

The above tools are self made, prepared by the investigator. Before making it final it was tried out with a small group of subjects. The language and other technical errors have been minimized by trying out (initial administration) the tools.

6.5 DATA COLLECTION

The data were collected during 4th to 25thSeptember, 2017.The teachers as were asked to fill up the questionnaire. The researcher personally sat in the classroom as an observer to collect data related to classroom.

6.6STASTICAL TECHNIQUES USED FOR DATA ANALYSIS

As per the objectives of the study, the data have been organized demographically. Both quantitative and qualitative modes of analysis have been used to characterize the data. Simple descriptive statistics like the Frequencies, Percentage, and Average Scores have been used for analyzing the data as per the requirements. The data have been presented in tabular, figural, and with proper description. On the basis of the analysis of the data, results of the study have been reported.

7.DATA ANALYSIS AND INTERPRETATION

The data have been organized and analyzed in two different aspects of the study. Each aspect focuses the objective(s) stated above.

TABLE: 1 Data related to classroom observation

Sr. No.	Aspect	% of responses		Average
		Std:IX	Std:X	
1.	An ethic of care	66	56	61
2.	Arranging for learning	42	51	46.5
3.	Building on students' thinking	21	19	20
4.	Worthwhile mathematical tasks	19	20	20.5
5.	Making connections	31	42	36.5
6.	Assessment for learning	42	24	33
7.	Mathematical communication	48	51	49.5
8.	Mathematical language	51	49	50
9.	Tools and representation	19	15	17
10.	Teacher knowledge	61	58	59.5

The data tabulated aboveare also represented by chart in figure-1 below:

Figure: 1 Result of Classroom Observations

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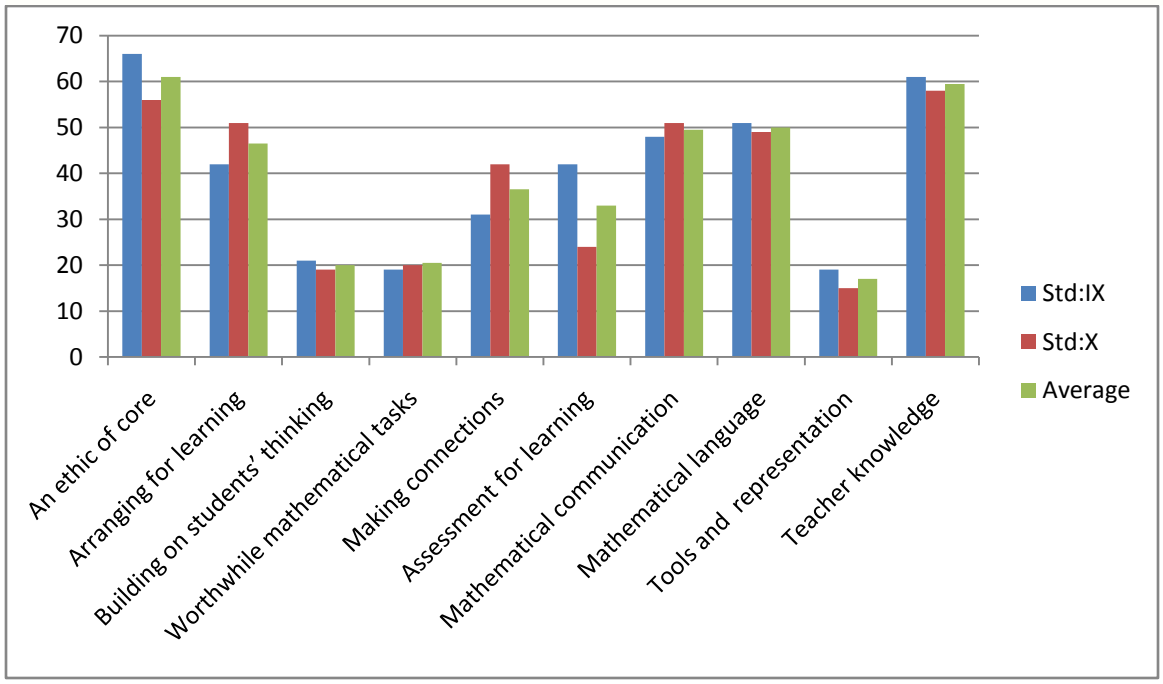

Also, the data collected from the questionnaire for the teachers are tabulated in table-2 and is also represented by a chart in figure-2.

Table: 2 The data from the questionnaire

Sr.No.	Question related aspect	Average % of responses of teachers
1.	Preparation of lesson	66.67
2.	Knowledge of using technology(ICT)	33.33
3.	Preparation to deal with individual differences	33.33
4.	Formation of conceptual understanding in students	33.33
5.	Increasing procedural fluency in students	33.33
6.	Strategic competence of student	33.33
7.	Adaptive reasoning development	00
8.	Productive disposition	66.67
9.	Articulating goals	00
10.	Fostering engagements	66.67
11.	Strategy of assessment of students	66.67

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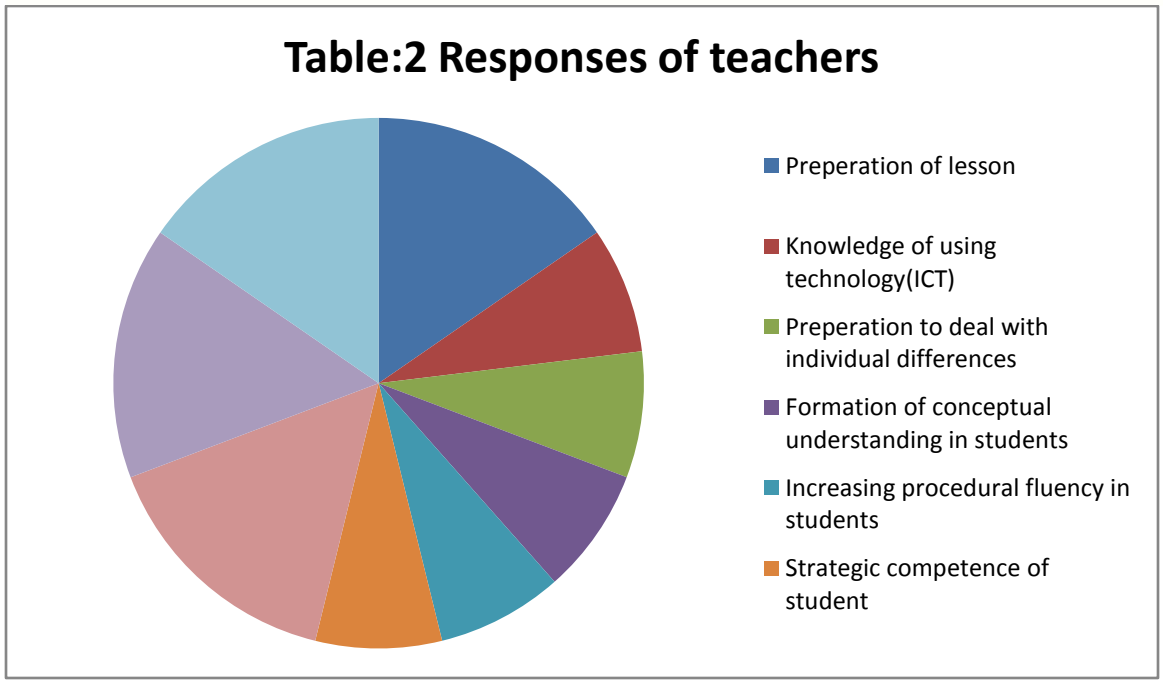

8. FINDINGS

The findings of the study as revealed from the analysis of the data are as follows:

A. Findings from classroom observation

1. An ethic of care: The 61% observations of this aspect reveal that teachers care the classroom community, that is students, and try to develop students' mathematical identities and proficiencies.

2. Arranging for learning: The 46.5% observations of this aspect reveal that teachers provide students with opportunities to work both independently and collaboratively.

3. Building on students' thinking: Only 20% observations of this aspect reveals that teachers lack of teaching mathematics that enable students to build on their existing proficiencies, interests and experiences.

4.Wortwhile mathematical tasks: Only 20.5% observations of this aspect reveals that teachers lack of understanding that the tasks and examples they select influence how students come to view,develop,use and make sense of mathematics.

5.Making connections:36.5% observations of this aspect reveals that teachers lack in supporting students in creating connections between different ways of solving problems, between mathematical representation and topic, and between mathematics and everyday experiences.

6. Assessment for learning: 33% observations of this aspect reveal that teachers lack of using a range of assessment practices to make students to view, develop, use and make sense of mathematicalthinking visible and to support students' learning.

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7. Mathematical communication: 49.5% observations of this aspect reveal that teachers are less able to facilitate classroom dialogue that is focused on mathematical augmentation.

8. Mathematical language: 50% observations of this aspect reveal that teachers in half of the cases cannot shape mathematical language by modeling appropriate terms and communicating their meaning in ways that students understand.

9. Tools and representation: Only 17% observations of this aspect reveal that teachers do not use tools and representations to provide support for students' thinking.

10: Teacher knowledge: 59.5% observations of this aspect reveals that teachers develop and use sound knowledge as a basis for initiating learning and responding to the mathematical needs of all their students.

B.Findings from the questionnaire

1.Preparation of lesson, Productive disposition, Fostering engagements and strategies of assessment of students; these five aspects were each responded equally,66.67% by the teachers which reveals that teachers are relatively better aware of these five aspects of mathematics pedagogy.

2. **Knowledge of using technology(ICT), Preparation to deal with individual differences, Formation of conceptual understanding in students, Increasing procedural fluency in students and Strategic competence of student;** these five aspects were each responded equally,33.33% by the teachers which reveals that teachers are relatively less aware of these five aspects of mathematics pedagogy.

3. Adaptive reasoning development and Articulatinggoals; these two aspects were each responded, 00% by the teachers which reveals that teachers have zero knowledge of these two aspects of mathematics pedagogy.

9. CONCLUSION AND SUGGESTIONS

The findings of this case study provide sufficient evidences to conclude that the mathematics pedagogy at secondary level is not up-to-the mark and is lacking far behind than what it is expected to be as described in National Curriculum Framework (NCF) 2005.Thepreparedness, awareness and academic fitness of the teachers towards the mathematics pedagogy is very less in many of the aspectsand almost zero in few inevitable aspects. For example, enabling the students to build on their existing proficiencies, interests and experiences; the lack/absence of understanding to select tasks and examples that influence how students come to view,develop,use and make sense ofmathematics; not using tools and representations to provide support for students' thinking;negligible knowledge of using technology(ICT), least preparation to deal with individual differences; being less able/unable to teach so as to form the conceptual understanding in students, Increasing procedural fluency and Strategic competence of student, developing adaptive reasoning and articulatinggoals; these all aspects needs urgent attention of the Government and policy makers so as to prepare creative minded mathematically strong youth for the nation in the present era of cut-throat competition.

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It is suggested that to cope up with these challenges, more training programs for in-service teachers should be organized.Also, the strength of students per class should be minimized as a part of the national education policy so as to deal with the individual differences. The school must be given permission (NOC) to recruit lackingstaff; provisions for the math's lab in each school as well as participation of each student in math's talent tests should be made mandatory.

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