Exploring Students’ Learning Difficulties in Secondary school Mathematics Classroom and Teachers’ Effort to Help Students Overcome These Difficulties

N. YERRAIAH, School.Asst. (Mathematics)  
Z.P.High School, KALLUR, Chittoor Dist. (A.P)-517113  
E-mail: nyerraiah@gmail.com  
Cell: 090002 99639  
094408 98809

1. Abstract

This article sets out to describe and explain how five high school teachers in Pulicherla Mandal, identified as improvement-oriented teachers, in their day-to-day teaching, try to use pedagogical remedies to help their students overcome the difficulties that hinder in-depth learning in secondary mathematics classrooms. Providing reflective accounts from teacher’s experiences and presenting illustrative examples from their classrooms, the study provides a broad picture of the context in which students learn mathematics. The study recognizes the factors that constrain students from gaining in-depth understanding into subject matter knowledge; it highlights the possibilities of fostering in-depth learning by establishing the primacy of the teacher in bridging the gap between students’ perceptive faculty of mind and subject matter knowledge. It recognizes the influences the teacher’s actions, pedagogical moves and decisions exert on students’ in-depth learning of concepts. The study also underscores the vital importance of students’ prior knowledge of basic mathematical concepts in in-depth learning of new concepts. Implication of the results of the study underscores the need for synergy of efforts on the part of teacher, school, and other key stakeholders, and curriculum in creating and promoting an environment conducive to students’ in-depth learning in mathematics.

2. Background of the Study

Mathematics, as one of the core curriculum subjects, is taught in all types of schools in Andhra Pradesh from 1st class to 10th class. In the mathematics curriculum prescribed for middle and secondary classes a wide spectrum of concepts are to be learnt and mastered by the students. Generally, learning mathematics is not fun for a majority of students studying in public and private schools in Andhra Pradesh but a nightmare. Mathematics curriculum contains specialized knowledge which needs certain attitudes, frame of mind. Unfortunately, in many government and private schools in Andhra Pradesh teachers usually fail to instill and
nurture these critical abilities in students. The result is that even after passing Class 10 majority of students fails to make any connection with the subject. Teachers try to transmit the knowledge to students that is prescribed in textbook, asses’ students’ learning through getting them to define or apply rules in a prescribed way “Mathematics learning consists mainly of memorization of rules for solution of textbook problems. Students memorize rules…without understanding why they are doing any of it”.

A wide range of factors are responsible for poor quality of mathematics education in main stream government schools in Andhra Pradesh. Notably, the factor such as teachers’ poor subject knowledge, teachers lacking in pedagogical competence and teachers’ and students’ perceptions about mathematical knowledge hinder students from developing mathematical understanding.

Yet another important factor which affects students’ learning and virtually the level of achievement in is mathematics curriculum. The Mathematics curricula’s standards at all levels primary, middle and secondary are either incompatible with the mental level of students or school Mathematics curriculum has not been thoroughly contextualized to reflect students’ interest, aspiration, and above all, their real life experience. Understandably, when students do not relate well to the curriculum they fall short of efforts to excel in the subject.

To improve teaching and learning processes in Mathematics classrooms requires a better understanding of the real nature of the common difficulties that hinder conceptual learning, particularly at secondary level, as well as the pedagogical remedies by the teachers, to help students overcome these difficulties. The concern primarily arises from a desire to see students learn more than memorization and recalling factual information provided in the textbook, that is what is happening in many mathematics classrooms in Andhra Pradesh, where students are treated as ‘parrots’ rather than ‘active learners’ or ‘creative thinkers’. Despite its high academic value in-depth student learning in mathematics is not usually the focal point of all the classroom activities and interactions in most government and private schools in Andhra Pradesh. There is an obvious paucity of the contextualized understanding of the challenges our students and teachers faced everyday in Mathematics classroom and the possibilities of improving mathematical learning that exist in our schools.
3. Literature Review

The new National Curriculum of mathematics is based on three broad categories of activities that define the critical abilities of scientifically literate students in Andhra Pradesh. These are: knowing and using mathematical knowledge (learning science); constructing new science knowledge (doing mathematics); and reflecting on mathematical knowledge (thinking mathematically). These broad performance indicators are connected with standards and benchmarks which describe what knowledge and skills students should acquire in the subject. These standards emphasize “high order thing”, “deep knowledge”, “substantive knowledge”, and “connection to the world beyond the classroom”.

The study attempted to determine whether mathematics achievement varies systematically across students and schools; to what extent the mathematics curriculum frameworks are implemented in schools account for differences in mathematics achievement. Findings of the study indicated that students were able to pass low-rigor items requiring simple mathematical skills. Moreover, items favoring female students in content domain belonged to knowledge of concepts to recall basic facts, terminologies, numbers, and geometric properties. Items favoring male students in either domain belonged to the problem solving level.

3.1. Defining and describing in-depth student learning

In the context of mathematics, ‘in-depth learning’ and ‘rote learning’ have variously been defined and explained. For example, in-depth learning manifest itself in mathematical thinking which is characterized in terms of how students make of sense of mathematics, the strategies they apply to solve problem, the conceptual representation they create, the argument they make and the conceptual understanding they demonstrate. The types of learning: “relational” and “instrumental”; the ideas explained in the context of instrumental and relational learning are relevant to the practice of teaching mathematics Relational learning is explains both as what to do and why (knowing with reason), where as instrumental learning is described as “rules without reasons”.

3.2. In-depth learning: A valuable educational goal

It is clear from the above discussion that ‘in-depth learning’ is used as an antonym of ‘rote memorization’ of content knowledge for the sake of reproduction when required. In the
literature numerous advantages have been associated with the goal of in-depth learning of subject matter knowledge. First, in-depth learning can satisfy a number of personal needs of the learner. One of the important needs is the desire to achieve a certain level of satisfaction, which arises from the curiosity to know reasons, facts, justification and causes behind events or principles. In-depth learning in mathematics facilitates further learning; it enables critical abilities such as reasoning and analytical skills, and helps develop learners’ creative faculty of mind.

3.3. **In-depth learning avoidance: A common phenomenon**

Notwithstanding the above explained good reasons to treat in-depth student learning a valuable educational goal, unfortunately it is and has not been a central concern in every classroom in the world in general and in Andhra Pradesh in particular. According APSCERT, “…teaching for understanding is not such an easy enterprise in many educational settings. Nor is it always welcome”.

3.4. **Factors that facilitate or hinder students’ in-depth learning**

In-depth learning is often difficult because it entails deep cognitive engagement with the subject matter. This is why students do not voluntarily or spontaneously engage in cognitive activity that fosters in-depth learning. Students bring with them a variety of conceptions, abilities, skills, knowledge, interest, attitudes, beliefs, perceptions, aspirations, expectations, habits, and preferences, which may not be in harmony with the demands of deep engagement with subject matter.

4. **Research Methodology**

An exploratory qualitative case study method was used to investigate the topic in hand. It allowed an in-depth investigation of the teachers’ perception of in-depth students learning in mathematics, the context and nature of common difficulties students faced everyday in the mathematics classroom and the instantaneous pedagogical remedies the teachers used to help students overcome these difficulties.
5. Research Questions

The following questions guided data collection in the study:

1. What do the teachers know about the notion of ‘in-depth student learning’ in mathematics?
2. What common conceptual difficulties do students face in their mathematics classroom?
3. Why do students face these conceptual difficulties?
4. What pedagogical remedies and tactics do the teachers use to help students overcome these difficulties?

6. The context and participants of the study

The respondents in this study were five secondary school mathematics teachers (6 male, 1 female), all belonged to government secondary schools in Pulicherla Mandal, characterized by their relatively good reputation for imparting quality mathematics education at secondary level. The seven participants drawn from these schools were selected as a representative of those surveyed in purposive sampling process and all displayed a high level of commitment towards teaching their subject.

7. Data analysis

In line with the research questions, two major categories were used to process the data: (1) Teachers’ views about conceptual learning of subject matter and the issues underlying it, with particular focused on mathematical concepts prescribed in the curriculum at secondary level, and (2) the ways in which the teachers recognize the conceptual difficulties facing students in in-depth learning of these concepts, how they go about helping students overcome those difficulties.

8. Findings

Analysis of the data collected through in-depth interviews of teachers and observation of routine lessons, particularly the anecdotal evidences and critical incidences recorded during classroom observations shed light on the common difficulties facing students in mathematics classroom, the possible causes underlying these difficulties and teachers’ effort to help students overcome these difficulties.
8.1. The teachers’ perspectives about in-depth student learning in mathematics

The teachers bring quite an elaborate understanding to what does it mean to learn in-depth in mathematics. To elaborate on their concept of in-depth learning they compare traditional and modern ways of teaching and argue about how transition from conventional mode of instruction to a more student-oriented mode of pedagogy could be adopted in mathematics classroom.

One of the participants, for example, reflects: “To move away from traditional way of teaching requires us to bring about little but substantive and sustained changes in our routine work. We can make our teaching activity-based or discovery-oriented by adopting a more student-focused teaching practice”. To elaborate on this, he says that the “seeds of mathematical thinking” can be sown in early years (primary classes) in students’ minds. At early years when children begin to form concepts teachers need to present mathematical concepts by making them as much practical as possible through the use of activities and concrete materials. Student can only master the process of learning mathematics through concrete experience which can ultimately lead to development of students’ mental capacity to meaningfully engage in logical reasoning and thinking at the level of abstraction. Concrete experiences not only can help students relate mathematics to everyday life, but also can enhance their motivation and encourages them to actively participate in the lesson. The teacher goes on to elaborate:

Similarly, drawing on his classroom experiences, another research participant talks of the ways through which students could be helped out in overcoming the difficulties they confront while trying to grasp mathematical concepts. In his view, simplification of mathematical problems needs to be tackled in a creative way with students. “Understanding of each concept [in mathematics] involves a few opportunities [either to understand or misunderstand]. If you capture these opportunities you are able to master the process leading to deeper understanding of the concept”, the teacher explains. What the teacher has learnt from his experiences is that in case students miss any of critical moment or opportunity to grasp concepts they are in trouble; the opportunities then turn into obstacles in the way of understanding subject matter knowledge.
Yet another participant, reflecting on one of her recent mathematics lessons, reports: “I taught a mathematics lesson about the algebraic formulae \((a+b)^2\) using blocks. In the first day quite a few students did not follow what I presented; because, for most of the students getting introduced to the concept through a practical activity was an ever first experience, as these students came from different feeding schools. However, later they understood it very well since we used real material to construct the formula. “Acting as a guide and facilitator, I prepare my students to overcome the problems they are faced with while trying to simplify mathematical problems”, the teacher explains (Excerpt from teacher interview).

The above reflective accounts embedded in the teachers’ classroom experiences provide insights into their beliefs about and the ways of managing pedagogy geared towards in-depth learning in mathematics. A careful analysis of these accounts reveals important insights, ideas and experiences which are relevant to and helpful in understanding teaching for concepts with deeper learning.

8.2. **Students’ conceptual difficulty and teachers’ pedagogical remedies and tactics**

There appears to be a huge gap between what is intended in the NCF and what actually happens in the classroom where students learn Mathematics. Realization of such curricular goals as development of higher order thinking, knowing and using mathematical knowledge and constructing new mathematical knowledge (Government of Andhra Pradesh,) remains a utopian dream in the schools. The following Table 1 provides an illustrated picture of the situations that work as barriers to students’ in-depth learning, how teachers try to help students overcome these barriers.
Table 1
Examples from participants’ classrooms illustrating the context and nature of the common difficulties that hinder students’ in-depth learning in mathematics.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Concept</th>
<th>Conceptual difficulty hindering in-depth learning</th>
<th>Teacher’s action to help students overcome the conceptual difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Simplifying Algebraic equations</td>
<td>Teachers: To simplify the equations e.g., ( x^2 = 16 ), why we should take square root on both sides of the equation?</td>
<td>By using the analogy of pairs of balance the teacher explained the reasons behind taking square root on both sides of the equation in order to simplify it.</td>
</tr>
<tr>
<td>II</td>
<td>Application of algebraic formula</td>
<td>Teacher: Asked students to simply the expression: ( \sqrt{-x} = \sqrt{3} )</td>
<td>Involving students the teachers simplified first step (multiplying and dividing the expression by ( \sqrt{a^2-1} - \sqrt{a^2+1} ) and ( \sqrt{a^2-1} + \sqrt{a^2+1} ) respectively and pushed students by giving clue and recalling rules.</td>
</tr>
<tr>
<td>III</td>
<td>Why (-x = -3) Takes the form of ( x = 3 )</td>
<td>Teacher: Why the minus sign on both sides of the equation disappeared? Students: Remained silent, after a while, one student responded: “It is a rule, Sir”.</td>
<td>The teacher explained (verbally) as why minus signs on right-hand side and left-hand side of the equation get cancelled.</td>
</tr>
<tr>
<td>IV</td>
<td>Real, Rational and Irrational Numbers</td>
<td>Teacher: How many numbers are there between 0 and 1? Students: Answered in chorus: “No number, Sir” (teacher’s question was a bit ambiguous).</td>
<td>The teacher explained that there were uncountable numbers belonging to the Set of Real Numbers and Irrational Numbers, Imaginary Numbers, Fractional Numbers between 0 and 1.</td>
</tr>
</tbody>
</table>
9. Discussion

By and large, the teachers display awareness about the demerits of rote learning and how it compares with in-depth learning. Retrospectively, the teachers find value in deeper understanding of mathematical concepts. They are cognizant of some of the ways through which conceptual learning can be fostered at secondary level. The emphasis, however, is on quality intervention at primary level into creating mental connection and ‘sowing the seed of mathematical thinking’ and nurturing it through provision of stimulating environment. The insights reflected from the teachers’ description of their practices are helpful in knowing more about the ways and the means through which in-depth learning of mathematical concepts at secondary level could be made easier for students. Teacher should focus on critical steps which if are misunderstood by students can be major hurdle to carrying out simplification. Teacher can maximize his/her gains in term of students understanding of the concept provided he/she knows the ways to emphasize and reinforce these steps.

Reflecting on and analyzing through the above examples we can understand the gravity of the difficulties students face in the classroom. It appears that in the context of each situation presented above the crux of the matter lied in the poor background knowledge students brought to the learning situation. It is evident from the above examples that students of Grade 9 and 10 (age level 12-14) failed to demonstrate rudimentary understanding of very basic but important mathematical concepts contributing to learning of the concepts at higher level. Fundamentally, the challenges seem to arise from students’ poor subject knowledge background, which apparently is the consequence of the poor teaching, inadequate academic support and guidance, insufficient individual attention they received from their environment (subject teacher, school, parents and peers). The teachers were of the view that for their poor content knowledge background students might not be blamed, since a substantial majority of students received their primary and middle level education from other public and private school, which did not offer good learning environment. Secondly, the students of their school were taught by different teachers in the primary and middle grades who themselves did not have a command over subject matter knowledge in mathematics.

10. Conclusion and Implications

The anecdotal evidences discussed above exemplify the typical challenges or the kind of conceptual difficulties students usually face in secondary mathematics classrooms in
Andhra Pradesh. Not a single factor can be held responsible for students’ lacking the cognitive abilities or motivation required to engage in-depth learning; underlying these difficulties there are multiple reasons. However, some of the main reasons that notably contribute to students’ lacking the capacity to engage in in-depth learning include their not being conversant with the ways of learning concepts other than memorization because they might not have been exposed to such experiences before (in the previous grades). Their attitude about knowledge and their approaches towards learning mathematical concepts seem to have been shaped by their previous classroom experiences.

Thus, the teachers’ reflections together with the data generated by classroom observations allude to students’ limited understanding of fundamental concepts as being the primary factor contributing to students’ inability to gain command over subject matter knowledge at secondary level. This situation was further compounded by students’ hesitation to ask questions when got stuck. Therefore, it is prudent to recognize that the problems that apparently constrain student in-depth understanding of subject matter knowledge in mathematics at secondary level is embedded mainly in the poor prior knowledge background students bring with them. Lacking adequate prior knowledge of concepts is a chronic deficiency, which may not be addressed through easy ways or quick fixes. Both teacher and students need to work hard during the critical stages of students learning primary concepts.

In sum, in-depth student learning is a worthwhile educational goal. At the same time it is more complex than is being perceived—a tip of iceberg much of it is not visible—and makes teaching harder because of the high demands it places on time, resources, energy, expertise, commitment, and creative mental efforts on the part of both the teacher and the learners. Dealing with the problems on incidental or contingency basis or in a ‘crisis management fashion’ does not help to overcome the challenges to promoting in-depth student learning in mathematics. Well-thought-through pedagogical decisions and instructional strategies need to aim at constructing conceptual structures and facilitating the process of evolution of mathematical thinking. Teaching for in-depth learning of subject-matter in mathematics therefore needs to be dealt with through careful planning (of content, strategies, time and resources), creative actions and diligent and wholehearted efforts on the part of both the teacher and students.
The above conclusions seem to have important implications for understanding of the realities that exist in secondary mathematics classrooms in Andhra Pradesh. Specifically, the implications of the results of this study can be seen and explained in the context of schools, teachers, other education stakeholders, policy and curriculum, which are briefly explained below.

**For schools**

Students’ learning of subject matter with deeper understanding may not take place in the classroom in an isolated fashion. In-depth learning, as explained in this paper, is closely connected with various conditions inside and outside the classroom. Therefore, reforming practices in mathematics classroom calls for synchronization and integration of efforts on the part of school. Synergy can be built around the efforts such as providing opportunities for teachers to enhance their content knowledge, deepen and widen their knowledge of innovative pedagogies and ongoing assessment techniques. This would require schools to recognize the vital importance of long-term planning, preparation and well structured and well-thought through strategies instead of depending on incidental measures to deal with the difficulties arising from teachers’ inability to promote in-depth student learning in such important curriculum subjects as mathematics. A majority of secondary schools in Andhra Pradesh are composite enrolling students from Nursery to Grade 10. These schools need to pay particular attention to how students learn mathematics in early years. When students move to upper grades with adequate knowledge base and enhanced cognitive skills they can easily master concepts at secondary level. In addition to this, schools need to consider giving a greater degree of freedom for teachers to take certain decisions with regards to syllabus coverage and preparing students for internal and external test/exams.

**For teachers**

As far as teacher’s role in promoting student in-depth learning is concerned, first of all, it is highly relevant to consider as what teachers need to know and be able to do in order to promote deeper understanding of the subject-matter knowledge in mathematics. This inevitably places demand on teachers’ knowledge of subject matter, pedagogical content knowledge, knowledge of the learner, knowledge of the
curriculum, knowledge of test and evaluation, better understanding of new classroom management strategies, knowledge of resource management, and readiness to accept and ability to cope with the diversified challenges associated with in-depth student learning. The high demands of conceptual learning require mathematics teachers to letting go of transmission-oriented practices; they need to carefully prepare lesson plans, student worksheets, blackboard work, home assignments, and assessment tasks, in order to be able to think about and convey the subject matter in different ways.

**For teacher education**

Teacher education whether it is pre-or in-service training is considered to be a means to preparation of teacher for the profession. This calls for the need for quality teachers learning and continued professional development. The new or innovative teaching techniques or instructional approaches mathematics teachers in Andhra Pradesh need to adopt are to be informed by the knowledge generated by the educational researcher in Andhra Pradesh and outside it.

**For curriculum**

Curriculum plays an important role in how students learn and develop in school. The realities of practice, however, suggest that for Mathematics teachers fostering in-depth learning in line with and in the true spirit of the aims and objectives of the National Curriculum is a task easier said than done. It is therefore important to suggest that the goal of in-depth student learning be integrated with the principles that guide school education (focused on secondary level) in general and teacher education (focus on high school teachers) in particular. The goal of fostering learning of subject-matter knowledge with deeper understanding in such core curriculum subjects as mathematics needs to be the first and foremost guiding principles of the school curriculum. If it is not so then the trend or the tradition in which “coverage of syllabus” is considered as synonymous with learning concept would continue to prevail. The syllabus coverage has become almost an ‘enemy’ of the teachers who want to teach for understanding rather than examination.

11. References
