# CHAPTER - I

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## 1.1.0 INTRODUCTION

In the modern scientific and technical world, education plays a vital role. In education, the advancement of a country shows its pace of development. The development of a country lies in its optimum use of human resources. Education is the greatest source of regeneration and revitalization. In today's competitive world, people have to struggle in every field to achieve something. The struggle for success starts from school age to be an achiever. There are many factors that contribute to academic achievement. These factors include intelligence, study habits, home environment, interests, and school factors. Academic achievement is one of the most important goals of education. Good academic records predict the future of the child. In the age of competition at every step in life, academic records speak for an individual.

In the 21st century, mathematics has become the backbone for prosperity in each and every field of life. Mathematics is well known as the father of all sciences. It is impossible to think about any scientific study without mathematics. Mathematics is the knowledge of 3Rs i.e. reading, writing and arithmetic. Each student in his day-to-day life has to achieve certain vital goals and objectives. Mathematics works as a base-camp to achieve these objectives. Every stage of education has its own importance. Secondary education lays the basic foundation for all types of higher education. Successful achievement in mathematics at Secondary stage, especially 8th grade is prerequisite for better academic achievement in higher stage. Mathematics achievement is an essential part of the academic achievement in the modern era. It is the key to success in many professions. Mathematics is a critical subject in school education, and proficiency in it plays a key role in students' academic success and future opportunities. However, research suggests that students from marginalized communities, particularly Scheduled Caste (SC) students, often face educational disadvantages. These can result in lower academic achievement, particularly in subjects like mathematics, where conceptual understanding and problem-solving are crucial.

Contemporary educational landscapes reveal persistent disparities in mathematics achievement across both global and national contexts. The Programme for International Student Assessment (PISA) 2022 results demonstrate concerning gaps, with students from marginalized

communities underperforming by significant margins. In the Indian context, the National Achievement Survey (NAS) 2021 data specifically documents how Scheduled Caste students in Odisha face substantial academic disadvantages, scoring 15-20 points below their peers in Class VIII mathematics assessments. These disparities reflect systemic challenges including unequal access to quality instruction, socioeconomic barriers, and inadequate learning resources. The Annual Status of Education Report (ASER) 2022 further corroborates these findings, revealing that only 27% of rural Odisha's Class VIII students could solve basic division problems, with SC students disproportionately affected by textbook shortages and lack of teaching aids.

The study draws upon three foundational theoretical perspectives to examine mathematics achievement disparities. Vygotsky's sociocultural theory (1978) provides crucial insights into how social interaction and cultural tools mediate learning processes, particularly relevant for understanding SC students who may lack home-based academic support. Bandura's self-efficacy theory (1994) helps explain how students' belief systems about their mathematical capabilities significantly influence their academic performance, suggesting that interventions targeting mindset development could yield meaningful improvements. Bruner's constructivist theory (1960) complements these perspectives by emphasizing the active construction of knowledge through appropriate scaffolding, especially critical during the middle school transition to abstract mathematical concepts.

The middle school years (Grades 6-8) represent a pivotal transition period in mathematics education, marking the shift from concrete arithmetic operations to abstract algebraic and geometric reasoning. This developmental stage, aligned with Piaget's formal operational stage (1972), serves as a critical foundation for future STEM participation and career pathways. The National Education Policy 2020 specifically identifies this stage as requiring targeted intervention, particularly for marginalized groups. Current data indicates that approximately 60% of SC students fail to achieve grade-level mathematics proficiency by Class VIII, creating persistent barriers to educational and economic mobility. This underscores the urgent need for research examining both the challenges and potential solutions for improving mathematics outcomes among SC students during this crucial educational juncture.

The transition to abstract mathematics in Class VIII is fraught with cognitive and pedagogical hurdles. Piaget’s (1972) theory highlights that students at this stage begin

developing hypothetico-deductive reasoning, yet many struggle with algebraic variables or geometric proofs due to inadequate foundational skills. Kapur's (2018) study of Indian middle-schoolers reveals that 45% of students cannot translate word problems into equations, a skill essential for higher mathematics. For SC students, these challenges are exacerbated by systemic inequities. The NCERT (2019) curriculum emphasizes activity-based learning, but ASER (2022) reports that 70% of rural Odisha schools rely on rote memorization, leaving SC students—who often lack home support—disproportionately disadvantaged. This mismatch between policy and practice perpetuates cycles of underachievement.

The intersection of caste and educational access profoundly impacts SC students' mathematical achievement. Vygotsky's (1978) sociocultural theory posits that learning is mediated by cultural tools and social interaction, yet SC students frequently face exclusion from peer study groups or coaching centers due to caste-based stigma (ASER, 2022). Bandura's (1994) self-efficacy theory further explains how low teacher expectations and societal stereotypes diminish SC students' confidence in mathematics. For instance, a 2021 study in Odisha found that SC students were 30% less likely to be encouraged to participate in math competitions compared to their upper-caste peers (Journal of Social Inclusion Studies, 2021). These invisible barriers, compounded by economic hardship—55% of SC households in Khurdha lack textbooks (NAS, 2021)—create a hostile learning ecosystem.

The NEP 2020's emphasis on "equitable and inclusive education" remains unrealized in Odisha's ground realities. While the policy advocates for competency-based learning and teacher training in constructivist methods, implementation gaps persist. NAS (2021) data shows only 40% of Odisha's middle-school math teachers received training in student-centered pedagogies. Furthermore, the NEP's mandate to bridge digital divides clashes with infrastructural deficits: ASER (2022) notes that 80% of Khurdha's SC-majority schools lack computers or internet access, depriving students of digital learning tools like GeoGebra or interactive math apps. This dissonance between policy goals and on-the-ground execution necessitates localized research to identify scalable solutions.

Gender intersects with caste to further marginalize SC girls in mathematics. NAS (2021) reports that SC girls in Odisha score 12 points lower than SC boys, attributed to societal norms discouraging girls from STEM fields. A 2022 study in Khurdha revealed that 60% of SC girls were pulled out of school during puberty for domestic labor, disrupting their math education

(Odisha Education Department, 2022). Yet, evidence also shows that when girls receive mentorship and resources, they outperform boys—a finding from Kerala's "Maths Brigade" initiative (UNICEF, 2021). This paradox highlights the need for gender-sensitive interventions alongside caste-focused strategies.

Khurdha's SC students epitomize the consequences of systemic neglect. Despite Odisha's Targeted Intervention Program for SC students, only 20% of allocated funds reached rural schools in Khurdha (Comptroller and Auditor General Report, 2023). Classroom observations reveal stark disparities: SC students are often seated separately and receive less teacher attention (ASER, 2022). The district's teacher-student ratio of 1:42 (vs. the national ideal of 1:30) exacerbates these inequities (UDISE+, 2022). Without hyperbole, this constitutes an educational emergency demanding empirical investigation.

This study focuses on assessing the mathematics achievement of 8th-grade SC students in Khurdha district. The aim is to understand their performance, identify the challenges they face, and provide data that can inform strategies for improving their achievement in mathematics.

### 1.2.0 CONCEPTUAL BACKGROUND OF THE STUDY

Mathematics is more than just numbers and formulas; it is a way of thinking, reasoning, and understanding the world. Proficiency in mathematics builds foundational skills essential for higher education and lifelong learning. Academic achievement in mathematics is not just an educational concern but also a social equity issue, especially when disparities exist between different social groups.

#### 1.2.1 Teaching of Mathematics at Middle Stage

The teaching of mathematics at the middle school stage (Grades 6-8) represents a critical juncture in educational development where students transition from concrete arithmetic operations to more abstract mathematical thinking involving algebra, geometry, and data analysis. This phase, aligned with Piaget's formal operational stage of cognitive development, demands significant pedagogical expertise as students begin to develop hypothetico-deductive reasoning skills that form the foundation for advanced STEM learning and problem-solving capabilities in real-world contexts. The National Education Policy (NEP) 2020 specifically emphasizes this stage as requiring targeted instructional strategies, particularly for marginalized students who often struggle with this transition due to a combination of cognitive, pedagogical, and systemic challenges. Research indicates that approximately 60% of Scheduled Caste (SC) students in Odisha fail to achieve grade-level mathematics proficiency by Class VIII (NAS,

2021), highlighting the urgent need to examine and reform current teaching methodologies. Effective mathematics instruction at this level must incorporate constructivist approaches that enable students to actively build mathematical knowledge through exploration and problem-solving, as advocated by Bruner's (1960) theory of learning, which emphasizes the importance of discovery and inquiry-based methods. However, ground realities in many Odisha schools, particularly those serving SC populations, reveal a stark contrast between these recommended practices and actual classroom instruction, with ASER (2022) reporting that 70% of rural classrooms continue to rely on rote memorization and teacher-centered lectures that fail to engage students in meaningful mathematical thinking or address individual learning needs.

The challenges in teaching middle school mathematics are multifaceted, encompassing cognitive developmental factors, pedagogical limitations, and systemic resource constraints. From a cognitive perspective, the shift from concrete to abstract thinking poses significant difficulties for many students, particularly when instruction fails to provide adequate scaffolding through visual representations, real-world applications, or hands-on activities that bridge these conceptual gaps. Vygotsky's (1978) sociocultural theory emphasizes the critical role of social interaction and cultural tools in mediating this learning process, yet SC students in Khurdha district often lack access to both - with 55% of households unable to provide academic support (NAS, 2021) and schools frequently lacking basic teaching aids beyond chalkboards (ASER, 2022). The pedagogical challenges are further compounded by severe teacher preparedness gaps, with NAS (2021) reporting that only 40% of Odisha's middle-school mathematics teachers have received training in constructivist methods, leading to over-reliance on textbook-centric instruction that fails to accommodate diverse learning styles or address common misconceptions. This situation is exacerbated by systemic issues including overcrowded classrooms (with student-teacher ratios as high as 1:42 in Khurdha, per UDISE+ 2022), inadequate infrastructure (80% of schools lacking computer access), and the pervasive issue of mathematics anxiety that affects 30-40% of students at this stage (Kapur, 2018), creating a perfect storm of barriers to effective mathematics learning.

Despite these challenges, promising interventions demonstrate the potential for improvement when research-based strategies are implemented with fidelity. The NCERT (2019) curriculum advocates for activity-based learning approaches that have shown measurable success, such as Shaikh's (2015) study where hands-on geometry activities improved student retention rates by 25%, while pilot programs in Khurdha utilizing math kits saw 15% gains in problem-solving abilities among SC students. These examples underscore the importance of professional development that equips teachers with skills in differentiated

instruction, proper use of manipulatives, and techniques for building mathematical discourse in classrooms. The integration of technology, though currently limited by infrastructure gaps, offers another avenue for enhancing conceptual understanding through visualization tools and interactive software. Ultimately, transforming middle school mathematics education requires a systemic approach that addresses both instructional quality and resource equity, aligning with NEP 2020's vision while adapting to Odisha's specific context. This involves not just revising pedagogical methods but also confronting deeper issues of caste-based educational disparities, teacher motivation, and community engagement to create an ecosystem where all students, regardless of background, can develop the mathematical proficiency needed for academic and life success. The imperative for such reform is both urgent and clear, as the consequences of middle school mathematics struggles extend far beyond the classroom, influencing future educational pathways, career opportunities, and socioeconomic mobility for marginalized students in Khurdha and similar contexts across India.

Key Teaching Strategies:

1. Constructivist Approach: Bruner's (1960) theory of constructivism emphasizes active learning, where students build knowledge through exploration. Kapur's (2018) review of middle-school mathematics highlights how inquiry-based methods improve conceptual understanding. For instance, students who engaged with geometric concepts through hands-on activities (Shaikh, 2015) showed 25% higher retention rates compared to rote learners. The NCERT (2019) curriculum similarly advocates for "activity-based learning" to foster problem-solving skills. Teachers need to focus on allowing students to construct their own understanding by exploring mathematical concepts, engaging in group activities, and applying knowledge in real-world contexts.
2. Emphasis on Problem-Solving: Mathematics at this level should promote problem-solving skills by presenting students with challenges that require the application of multiple mathematical concepts.
3. Scaffolded Instruction: Teachers should provide support as students encounter new, difficult topics, gradually withdrawing this support as students become more independent.
4. Integration of Technology: Utilizing digital tools, such as educational software and graphing calculators, can help students visualize abstract mathematical ideas and encourage interactive learning. The integration of technology, such as graphing calculators (NCERT, 2020), has shown promise in visualizing abstract concepts. However, disparities in resource access limit implementation, particularly in rural Odisha (ASER, 2022).