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Thematic Structuring of the General Mathematics Curriculum at the Secondary Level Utilizing Grounded Theory

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ABSTRACT

The objectives of the current study were to examine the shortcomings of the existing secondary-level General Mathematics curriculum, identify contemporary trends in the subject, and suggest a thematic division for the sector-wise organization of the curriculum. Grounded Theory was used as the research design for this study. The study used Creswell's systematic approach, utilizing structured data analysis processes like open coding, axial coding, and selective coding, and creating a sectorial division. According to Creswell, this investigation was divided into three stages. At the first stage, prominent teachers of General Mathematics participated in semi-structured interviews using an interview protocol as a research instrument. At the second stage, the potential causes of the curriculum's shortcomings were determined. At the third stage, contemporary trends in mathematics were discovered through the use of document analysis to examine the mathematics curricula of developed nations. Ultimately, the data gathered during the three processes described above was used to create a thematic division. Purposive sampling was used to gather data from a sample of 22 teachers. Conclusion of stage I showed that curriculum of General Mathematics has imperfectness that prevent it from meeting the cognitive and creative requirements. Conclusion of stage II explained the causes of these deficiencies. Conclusion of stage III confirmed that in order to prepare students for the modern world, contemporary tendencies should be inferred. Consequently, a supposed outline of curriculum of Mathematics was designed.

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1. Introduction

Students' learning and academic performance are greatly influenced by the curriculum. It consists of the curriculum, instructional strategies, assessments, and learning objectives developed to meet the educational needs of the pupils. Students' varied needs and skills are taken into consideration in a well-designed curriculum. It enables learning experiences to be differentiated and tailored to suit various learning styles, interests, and speeds. Curriculum creation supports inclusive education and fosters student success by attending to individual needs. Practitioners with enough and pertinent teaching and learning expertise must be included in curriculum development. Curriculum development at the grassroots level is only possible after that (Haider, 2016). Curriculum development involves continuous assessment, evaluation, and feedback, based on evidence-based research and practices. It ensures the curriculum remains effective, responsive, and in line with societal and student requirements. Regular examination and modification of the curriculum are necessary for it to remain relevant, effective, and significant for students. This allows for continuous improvement, adjustment to changing requirements, and the application of innovative teaching methods. A comprehensive and well-rounded curriculum prepares students for success in the 21st century. As a potent force for social

and economic transformation as well as for the advancement of a country, mathematics and other sciences have achieved an important position. In order to improve the welfare of society, it focuses on recognizing problems, determining their causes, and finding remedies (Arif, 2011).

Pakistan, a developing nation, is striving to maintain a respectable position in the international community. To address issues such as food, shelter, fuel, energy, health, security, declining economy, natural resource exploitation, and increasing agricultural and industrial production, Pakistan needs a strong foundation in science, mathematics, and technology. The creation and analysis of curricula is a delicate topic in education, especially in an ideological society like Pakistan that strives for technological advancement. Mathematics is now required in every country's educational system, but many students are afraid of it due to curriculum, textbook, and teaching methods. Teachers and curriculum designers are responsible for most duties, but there has been little attention paid to the development of mathematics curricula in the past (Arif, 2011). At every level of education, learning mathematics is essential. From the first grade to the university level, it is taught. Pakistan's mathematics curriculum is developed at the national level (Government of Pakistan, 2006). Pakistani students typically dislike mathematics because it is harsh, dry, and challenging. Furthermore, secondary mathematics has drawn more attention because it establishes the foundation for students' future achievement. Conceptual knowledge, which requires both analytical and logical mental processes, is a component of mathematical education. Students' efforts are crucial to their comprehension of mathematics (Ellis, 2011).

1.1. Challenges in Pakistan's Mathematics Curriculum

The mathematics curriculum in Pakistan faces several weaknesses that hinder effective teaching and learning. The Pakistani mathematics education system faces challenges in developing critical thinking and problem-solving skills due to a curriculum that prioritizes rote learning over conceptual understanding. Insufficient access to technology, inadequate teacher training, and a disconnect between mathematics and real-world applications further hinder effective teaching. Traditional assessment practices, which focus on memorization, fail to provide constructive feedback for improvement. Comprehensive reforms in curriculum design, teacher training, resource allocation, and assessment methods are needed to create a more effective, inclusive, and relevant education system (Khan, Farooqi, & Mehmood, 2018). Within the framework of thematic instruction, learning is structured around overarching topics. Numerous disciplines are combined into one through the use of thematic education. People learn best when they can connect what they are learning to the real world and when they are learning inside a coherent "whole" concept, according to the theory underpinning thematic training (Funderstanding, 2011).

1.2. Statement of Problem

Mathematics is essential in everyday life and various industries, fostering logical thinking and problem-solving. It serves as the language of science and engineering, aiding in the analysis of complex systems in physics, engineering, and computer science. Additionally, it enhances financial literacy and decision-making, influencing tasks such as budgeting and interpreting data. A strong mathematical foundation is crucial for high-paying careers, including finance, data analysis, and engineering. A well-structured curriculum is necessary for effective mathematics education. It encompasses all knowledge and skills provided by an institution (Bharvad, 2010). (Wheeler, 1967) defined curriculum as planned learning experiences under school guidance. However, the general mathematics curriculum at the secondary level may not fully prepare students for specialized careers. While covering core topics like algebra and calculus, it may lack the depth required for fields such as Economics or Statistics. A thorough evaluation of the curriculum is essential to address its gaps and align it with modern mathematical trends.

1.3. Significance of Study

Mathematics is considered the foundation of all sciences, playing a vital role in students' cognitive and logical development. In Pakistan, it is emphasized in national education policies and taught at all levels to enhance problem-solving skills (Rind & Mughal, 2020). Curriculum changes occur when discrepancies arise between intended learning outcomes and actual implementation. Various socio-political factors influence changes in Pakistan’s mathematics curriculum. To meet educational goals, the curriculum should be regularly updated, and student engagement should be encouraged. The 2006 National Curriculum of Mathematics is based on

social efficacy philosophy, which promotes performance-based learning and skill development (Harb & Taha Thomure, 2020).

1.4. Research Questions

1. How can the GM curriculum at SL be improved?
2. What are the reasons for its inadequacy?
3. How can the curriculum adapt to contemporary trends?
4. How can the curriculum be arranged thematically?

1.5. Objective of the Study

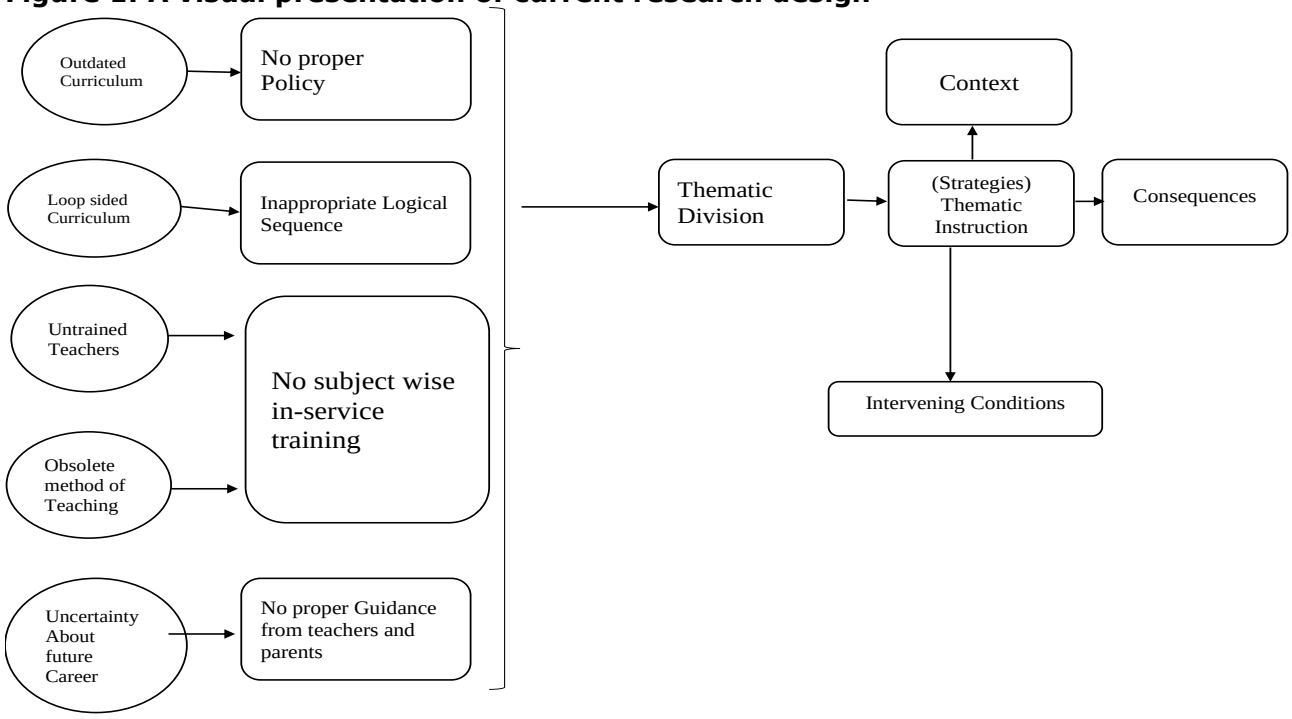
The objectives of the present study are given below:

1. To investigate the shortcomings of the existing secondary general mathematics curriculum
2. To learn about current developments in general mathematics.
3. To provide a theme division for the secondary level sectorial division of general mathematics.

2. Conceptual Framework of Research

This study employs a methodical grounded theory approach that includes data analysis procedures such as axial coding, selective coding, open coding, and logic paradigm General Mathematics development. Using a problem statement as the foundation, it focuses on in-depth analysis of phenomena or social processes. By comparing events and concepts to identify similarities and contrasts, researchers can refine codes and categories and gain a deeper grasp of the subject through iterative and ongoing data gathering procedures (Creswell, 2014).

Figure 1: A visual presentation of current research design



3. Review Of Related Literature

The review focused on the current issue, highlighting the challenges students face due to a lack of awareness about mathematics-related subjects. Additionally, the review discussed research on strategic planning, mathematics curricula, and grounded theory.

3.1. Curriculum

A curriculum is made up of the subjects that those in charge of educating future generations want to emphasize. The curriculum's goal is to serve as a road map with distinct objectives and goals. These are planned in accordance with a framework or body of research that represents a profession (Kelly, 2009). These contents may vary based on changes in society. As a result, every country must continuously assess its circumstances from a variety of perspectives and update its curriculum to incorporate topics relevant to modern culture. However, it is difficult

to adapt the curriculum to their society due to a number of variables (Kusaka, Nhêze, & Baba, 2021).

3.2. Curriculum Development

Curriculum development, a term commonly used in education, was traditionally believed to be the responsibility of administrators, researchers, or theorists, with teachers being seen as neutral transmitters of the curricular message and materials being developed by experts (Enns-Connolly, 1990; Gough, 1977).

3.3. Thematic Division

Thematic division is the systematic organization of concepts, information, or content based on common themes or topics. It is used in various fields such as writing, research, presentations, and data management. The process involves classifying content into distinct themes or topics based on their underlying subject matter, content, or characteristics, also known as thematic General Mathematics orientation or thematic categorization (Braun & Clarke, 2006).

3.4. Modern Trends Linked to Mathematics

By placing mathematics in real-world contexts and giving students a range of ways to build and interact with their mathematical knowledge, digital technologies in mathematics education allow students to regain control over how they interpret what they have learned. Modern technology, through modeling, visualization, manipulation, and the introduction of increasingly complicated scenarios, can improve collaboration and emphasize the practical uses of mathematics in addition to its computing capacity (Drijvers, 2013).

3.5. Grounded Theory

Data analysis must be done after qualitative data has been collected in order to develop categories (a theory) to explain an intriguing phenomena. Since the theory is based on the collected evidence, it is impossible for it to deviate from reality (Opie, 2004). Grounded theory is one kind of qualitative research design. Grounded theory was established and advocated by Strauss and Glaser in the 1960s (Birks & Mills, 2022).

4. Research Methodology

This section explained the study's design, instrument validity, population, sample, data collection process, and analysis. It provided a comprehensive overview of the research and sought to address the study's objectives effectively.

4.1. Design of the study

The research was qualitative in nature. Grounded theory was used in this study, which was conducted in three stages. Open coding, axial coding and selective coding were carried out. Grounded theory refers to qualitative research when a researcher develops a general description of a process and then discusses it with associates who have a great deal of expertise with it.

4.2. Population

Target populations consists of male and female teachers of Mathematics appointed in government secondary schools of Sargodha. Interviewing teachers in every secondary school in Punjab was not feasible. Time and expense were the primary concerns for this aim. Therefore, this study was restricted to Sargodha government secondary school teachers.

4.3. Sample

The study employed purposeful sampling, selecting 25 teachers from various Secondary schools in Sargodha District for interviews, and conducted interviews with these teachers, who teach General Mathematics.

4.4. Research Instrument

The semi-structured interview is the instrument used to establish rapport and enable a comprehensive exchange of information between the participant and the researcher. Consequently, a semi-structured interviewing technique was used. An interview protocol was developed in order to get the data.

4.5. Validity of Research Instrument

Researchers verified the tools' validity, and the interview protocol's questions were reviewed by three credible subject-matter experts who teach secondary school mathematics, confirming each one's content validity, ensuring the study's goals were met.

5. Data Analysis and Interpretation

Grounded theory was utilized to analyze and propose improvements for the general mathematics curriculum at the secondary level. The study identified weaknesses in the existing curriculum and provided recommendations for its thematic reorganization to align with modern educational standards.

5.1. Stage I: Identifying Themes from Current Curriculum Shortcomings

The researcher conducted semi-structured interviews with prominent Mathematics teachers to identify weaknesses in the secondary level General Mathematics curriculum. These weaknesses were discovered through interviews.

5.1.1. Outdated Curriculum

The quality of instruction has a major impact on how effective a curriculum is.The curriculum has remained unchanged for years, failing to meet modern educational and societal requirements.

Table 1: Outdated Curriculum of General Mathematics

Coding	Themes
Unaltered syllabus	Outdated curriculum
No improvement	
Unrevised curriculum	
Out-of-date content	

5.1.2. Lopsided Curriculum

The current structure lacks coherence and balance, leading to uneven development of mathematical skills because of an imbalanced or skewed curriculum towards certain areas of study, neglecting others.

Table 2: Lopsided Curriculum

Codes	Theme
Disunited curriculum	Lopsided curriculum
Disparity between topics	
Inequality	
Gaps between topics and exercise questions	

5.1.3. Irrational Sequence

An illogical and irrational curriculum can reduce the effectiveness of the curriculum.

Table 3: Irrational sequence

Codes	Theme
Unbalanced syllabus	Irrational Sequence
Unreasonable categorization	
Links between content	
Variances	

5.1.4. Untrained or Unqualified Teachers

According to the study's data, when mathematics is taught by incompetent or inexperienced teachers, the curriculum loses its usefulness.

Table 4: Untrained or Unqualified Teachers

Codes	Themes
Lack of trainings	Unqualified teachers
Shortage of Math’s teachers	Untrained teachers
Unskilled	
incompatible	

5.1.5. Obsolete Methods of Teaching

The data of the study revealed that instructional approaches that are considered outdated or less effective in promoting meaningful learning experiences reduce student's learning outcomes.

Table 5: Obsolete Methods of Teaching

Codes	Theme
Less effected teaching	Obsolete methods of teaching
Ignoring modern technologies	
Ineffective learning process	
No creative tasks	
Rote learning	

5.1.6. Two Curricula

The dual nature of curricula (science vs. general mathematics) creates gaps in learning, limiting students' choices and future readiness.

Table 6: Two Curricula

Codes	Theme
Merged curriculum	Two curricula
Single curriculum for SL	
Less concepts in GM	
Career options	

5.2. Stage II: Reasons and Their Possible Resolutions

At this stage, the shortcomings of the GM curriculum at SL have been analyzed, along with their underlying causes. Possible solutions to address these weaknesses have also been identified.

Table 7: Reasons of weaknesses and how to overwhelmed

Weaknesses	Encounter weaknesses
➢ The syllabus of General Mathematics taught at secondary level is quite old. No change will be made in it for a long time.	➢ The curriculum should be revised. Changes should be made according to modern requirements. Questions and examples should be made according to the present time.
➢ There is no symmetry in the syllabus. Some topics are given in detail; some topics are completely ignored. In the syllabus of 9th class, there is a lot of financial mathematics, while in 10th class, algebra is given in a lot of detail. This makes students lose their interest	➢ Curriculum should not be skewed. The curriculum of two years should be arranged so that the students can maintain their interest.
➢ There is no logical sequence in the General Mathematics syllabus. There is no connection between the math syllabus of class 9 and class 10. Units which are studied in class 9, completely different from the units, studied in class 10.	➢ The syllabus of General Mathematics should be arranged in such a way that the units which are included in the syllabus of class 9, their further and advance detail should be included in the syllabus of class 10.
➢ Due to the non-availability of relevant mathematics teachers, the teachers who are not educated in mathematics are assigned to teach mathematics. These teachers cannot develop the basic concept of students. Thus, students lose interest in this subject.	➢ Teachers who are qualified in mathematics should be appointed to teach mathematics. Govt should recruit qualified teachers. And meet the shortage of teachers in schools.
➢ Many mathematics teachers today still teach according to the old methods. They do not innovate in their teaching methods.	➢ Subject-wise refresher courses should be conducted for teachers. Annual training of teachers should be organized. So that teachers can learn new methods and techniques.
➢ There are two different mathematics curricula for secondary education. The science group has one syllabus, and the humanities group has another.	➢ The mathematics curricula for the science and humanities groups should be identical. Together, these two curricula should be created into a new syllabus that will benefit both science and humanities students equally.

5.3. Stage III: Modern Trends in Mathematics Curriculum

At this stage, the researcher used document analysis as a tool to compare secondary mathematics education in Pakistan with mathematics education in the modern world. In order to examine current trends in mathematics, the researcher examined secondary school curricula in several nations and discovered that:

The mathematics curriculum in developed countries is characterized by the integration of technology, problem-solving, and interdisciplinary connections between subjects like science and economics. This approach enhances students' understanding of abstract concepts and fosters analytical thinking and creativity. In contrast, Pakistan's curriculum often relies on traditional methods, limiting students' ability to apply mathematics in practical or innovative ways. Developed countries prioritize mathematical modeling and continuous assessment, providing students with practical skills for real-world problems. Pakistan's curriculum lacks these areas, relying on summative exams that primarily test memorization. Upper Secondary and Lower Secondary secondary education lasts four years in the majority of developed nations, including Turkey, Canada, Australia, Japan, and others. In certain nations, math is required for four years. In several nations, science and mathematics are elective subjects at the upper secondary level, whereas mathematics is required at the lower secondary level. By adopting global best practices, Pakistan can enhance its mathematics curriculum and equip students with the skills and knowledge needed for a modern, technology-driven world.

5.4. Stage IV: Suggested Thematic Division

A thematic division based on a four-year program, similar to international standards, is recommended to address deficiencies and provide comprehensive coverage of mathematics concepts. Purposed thematic division would be:

1. Real Numbers and Operations
2. Financial Arithmetic
3. Algebra
4. Measurement
5. Geometry
6. Introduction to Trigonometry
7. Data Management

6. Discussion

The curriculum of General Mathematics should be structured based on topics and themes to ensure a more systematic and effective learning experience. Organizing the content thematically allows students to build a strong foundation by gradually progressing from basic to advanced concepts. It helps in establishing clear connections between related topics, making learning more meaningful and engaging. Additionally, a well-organized curriculum enhances comprehension, reduces confusion, and allows educators to tailor teaching strategies according to specific themes. This structured approach also facilitates assessment, enabling teachers to evaluate students' understanding more effectively. Dividing the curriculum into topics and themes promotes a logical learning sequence, ensuring that students grasp mathematical concepts with greater clarity and confidence.

7. Conclusion

As this was a qualitative study, findings are not given. The conclusion of study is that this study highlighted several critical shortcomings in the current curriculum. Outdated content fails to reflect advancements in the field, leaving students disconnected from modern applications of mathematics. The lopsided emphasis on certain topics creates gaps in knowledge, while irrational sequencing hinders students' ability to connect concepts cohesively. Furthermore, untrained teachers and obsolete teaching methods exacerbate these issues, leading to ineffective instruction. The existence of two separate curricula for science and humanities students creates disparities, restricting opportunities for humanities students in mathematics-intensive fields. Addressing these weaknesses requires updates to content, better teacher training, and a unified curriculum that ensures equitable access to quality education. The study suggested a four-year secondary education program for Pakistan's mathematics education, highlighting the need for a comprehensive overhaul of the existing curriculum. The research emphasized the importance of thematic instruction, which integrates mathematical concepts into real-world contexts, enhancing student engagement and fostering critical thinking. The curriculum should adopt modern trends

like technology integration and personalized learning, preparing students for the 21st-century global economy. Collaborative efforts among policymakers, educators, and stakeholders are crucial for effective implementation.

7.1. Recommendation

These research areas aim to provide evidence-based insights to improve mathematics education in Pakistan.

- Investigate the long-term effects of updated curricula and teacher training on student learning outcomes.
- Evaluate the effectiveness of thematic teaching compared to traditional methods in enhancing student understanding and engagement.
- Study the benefits of a four-year secondary program on student academic and career outcomes.
- Research the feasibility and effectiveness of implementing proposed thematic areas within the curriculum.
- Investigate factors that influence successful curriculum implementation, such as teacher attitudes and school resources.
- Study how to ensure equitable access to quality mathematics education for all students.
- Research the most effective ways to integrate technology into the mathematics curriculum.

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