Effect of Implementing a Competence-Based Curriculum on Students' Academic Performance in Mathematics: A Case of Selected Lower Secondary Public Day Schools in Rwamagana District, Rwanda

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ABSTRACT

This study is designed to determine the effect of implementing competence-based curriculum on students' academic performance in mathematics in selected lower secondary public day schools in Rwamagana District, Rwanda. This study is beneficial to Rwandan secondary schools, to the researcher himself, teachers, and other researchers providing advice on how they can develop the students' competences in mathematics subjects. Guided by constructivism and social constructivism learning theories, the study's participants were 8 head teachers and Deans of studies (5 respondents), 7 teachers of mathematics (5 respondents) and 275 students (158 respondents). These made a sample size of 168 respondents from four secondary day schools in Rwamagana district were involved in this research. The target population of this study was 290 participants. Purposive sampling by choosing the Dean of studies and Head teachers and simple random sampling was used to choose teachers and students as well as stratified random sampling. Instruments used to collect data are questionnaires and interviews. The quantitative data was analyzed by using IBM SPSS 20 while analysis of qualitative data was done using inductive thematic analysis. Results on the implementation of competence-based curriculum structure indicated that 81.7% strongly agree that discussing math concepts with classmates helps them to learn better. 86.7% agree that the school leaders support the implementation of Competence-Based Curriculum (CBC) in mathematics. 89.9% of the asked students agree that their mathematics teachers seemed well prepared to teach the CBC. The study found that the CBC program is being implemented effectively in Rwamagana District. Students are more engaged, better at problem-solving, and have a better understanding of math. The study shows that the program should continue and be improved to help students succeed in school and their careers. It was proposed that Rwanda Education Board is advised to support and train schools in implementing the CBC in mathematics. It should regularly evaluate and adjust the curriculum to improve outcomes. Teachers should participate in professional development and adopt a student-centered approach. Schools should ensure adequate resources and foster a collaborative culture. Families should encourage active student participation, maintain open communication, and provide a supportive home environment.

Keywords: Competence-Based Curriculum, Curriculum Structure, Mathematics, Public Lower Secondary Schools, Students' Academic Performance

I. INTRODUCTION

Rwanda's education system, like many in Sub-Saharan Africa, faces challenges in improving student performance in mathematics. While rote memorization may lead to temporary success on tests, it doesn't guarantee long-term retention or application skills. Competence-Based Curriculum (CBC), with its focus on competencies, aims to address this gap (Rwanda Basic Education Board [REB], 2015). However, the effectiveness of this new curriculum in improving mathematics performance in Rwandan lower secondary schools remains an under-researched area.

Rwanda introduced CBC in 2015, aiming to equip students with the skills and knowledge to succeed in a globalized world. The Rwandan CBC emphasizes critical thinking, problem-solving, and the application of mathematical knowledge in real-world contexts, aligning with the global shift in math education (Nsengimana, 2020). The Rwandan government has invested in teacher training programs for CBC implementation (Habiyaremye et al., 2023; Rwigema & Andala, 2022)

The implementation of CBC requires accessible instructional resources such as infrastructures, ICT tools, internet connectivity, Educational software, and textbooks, as well as well as trained and motivated teachers. CBC engages the students in the lessons and therefore they are subjected to finding the solutions to real-world problems (Nyaboke et al., 2021).

The shift towards CBC in Rwanda presents an opportunity to move beyond rote memorization and towards a more meaningful and relevant mathematics education. This study aims to contribute to the growing body of knowledge on the impact of CBC by focusing on the specific context of Rwandan lower public day secondary schools (Nsengimana, 2020).

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Competence-based curriculum (CBC) in Rwanda is a significant educational reform aimed at aligning the country's education system with the demands of the 21st century. This curriculum framework emphasizes the development of practical skills, critical thinking, problem-solving abilities, and the application of knowledge in real-world contexts (REB, 2015).

In Rwanda, the implementation of CBC reflects a commitment to equipping students with the competencies necessary for success in both further education and the workforce. One key aspect of the competence-based curriculum in Rwanda is its focus on learner-centered approaches. According to Rwandan education policy, the curriculum is designed to cater to the diverse needs, interests, and abilities of students, fostering a more inclusive and engaging learning environment (Nsengimana, 2020). This approach prioritizes the active involvement of students in the learning process, promoting autonomy, creativity, and self-directed learning.

Furthermore, the CBC in Rwanda emphasizes the integration of cross-cutting themes such as ICT (Information and Communication Technology), entrepreneurship, and environmental sustainability across various subject areas. This integration aims to ensure that students develop interdisciplinary skills and understand the interconnectedness of different fields of knowledge (Nsengimana, 2020).

The implementation of the competence-based curriculum in Rwanda also involves ongoing teacher training and professional development initiatives. Teachers play a crucial role in facilitating the transition to CBC by adopting innovative teaching methods, designing authentic assessment tasks, and providing meaningful feedback to students (BOARD, 2019). Moreover, the evaluation and assessment strategies under the CBC framework in Rwanda emphasize competency-based assessment methods rather than relying solely on traditional exams. This shift toward competency-based assessment allows for a more holistic evaluation of students' abilities, including their practical skills, problem-solving capabilities, and communication skills (REB, 2019).

The competence-based curriculum in Rwanda represents a comprehensive reform effort aimed at preparing students for the challenges and opportunities of the modern world. By prioritizing the development of practical skills, critical thinking, and interdisciplinary competencies, the CBC framework seeks to empower learners to thrive in an increasingly complex and dynamic global landscape.

The implementation of competence-based curriculum in mathematics education has garnered attention due to its potential to improve students' academic performance in this critical subject area. This literature review aims to explore the impact of competence-based curriculum on students' academic performance in mathematics, synthesizing findings from various studies to provide insights into the effectiveness of such educational approaches (Nsengimana, 2020).

Competency-based curriculum in mathematics emphasizes mathematical concept mastery, problem-solving skills, and the application of mathematical knowledge in real-world contexts (Suseelan et al., 2022). It emphasizes active participation, collaborative problem-solving, and authentic activities to help students improve their mathematical skills (Hershkowitz et al., 2017). Competence-based curriculum aligns with constructivist learning theories, emphasizing the importance of active learning, exploration, and discovery in mathematics education ("Constructivism in Education," 2023). By providing opportunities for students to engage in authentic mathematical tasks, competence-based approaches promote deeper understanding and application of mathematical concepts (Hatisaru, 2020).

1.1 Statement of the Problem

Rwanda's education system, like many in Africa, is striving to improve student performance in mathematics. The introduction of the CBC in 2015 aimed to address this challenge. CBC emphasizes developing critical thinking, problem-solving skills, and the ability to apply mathematical knowledge in real-world contexts. Studies suggest these are crucial for success in a globalized world (Nsengimana, 2020).

The study conducted by (Ndihokubwayo & Habiyaremye, 2018) found that students exposed to CBC were more engaged and motivated than those in regular curriculum settings. This increased motivation frequently leads to greater academic performance since students are more actively involved in the learning process. Furthermore, CBC emphasizes the development of real-world competencies and abilities that are directly relevant to students' future employment or further study. As a result, students who complete CBC are better prepared to fulfill the expectations of the workplace or higher education institutions (Nyaboke et al., 2021) . However, CBC implementation may provide obstacles that affect student achievement. Switching from a content-based to a competency-based approach requires significant changes in teaching methods and assessment practices. Teachers may need substantial training and assistance to effectively adopt CBC, and early phases of implementation may result in a temporary decrease in student performance as educators and students adjust to the new system (Nsengimana, 2020).

Furthermore, the Rwandan government has invested in teacher training programs to equip educators with the skills necessary to implement CBC effectively (Rwigema & Andala, 2022). While the theoretical benefits of CBC are promising, there is a significant gap in our understanding of its actual effect on student performance in Rwandan lower

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secondary schools, particularly in mathematics. We lack long-term data on whether CBC is effectively translating to improved understanding, application of skills, and ultimately, performance in national examinations like O Levels. If the impact of CBC on student performance in O Levels remains unknown, it could lead to several negative consequences; without evidence of effectiveness, future curriculum development may not be aligned with the needs of students and the goals of CBC, teachers may struggle to adapt their teaching methods to maximize the benefits of CBC, potentially hindering student progress, Students may not be adequately prepared for the demands of higher education or the workforce if they lack a strong foundation in mathematics.

1.2 Study Objectives

Specifically, the study intends to assess the implementation of competence-based curriculum structure on ordinary-level students' performance in Mathematics in selected lower public day secondary schools.

1.3 Research Questions

The study seeks to address the question:

To what extent does the competence-based curriculum structure contribute to ordinary-level students' performance in Mathematics selected lower public day secondary schools?

II. LITERATURE REVIEW

2.1 Theoretical Review

2.2.1 Competence Based Curriculum Assessment

According to Catacutan et al. (2023), competency-based education (CBE) is rooted in educational theories that promote active learning, student-centered approaches, and the development of practical skills. Constructivism and social constructivism emphasize the importance of learners' existing knowledge and experiences, which aligns with CBE's focus on applying knowledge in real-life situations. Outcome-based education is another theoretical framework that highlights the need for clearly defined learning goals and assessment criteria.

The implementation of Competence-based curriculum in mathematics education has sparked interest because of its potential to increase students' academic performance in this crucial subject. This literature review seeks to investigate the impact of competence-based curricula on students' academic performance in mathematics, combining findings from numerous research to provide insights into the efficacy of such educational approaches (Nsengimana, 2020).

Developing countries face a global challenge in meeting the 2030 Sustainable Development Goals (SDGs) to achieve socio-economic progress. However, many Sub-Saharan African nations struggle with this due to graduates' lack of practical skills and general abilities. To address this issue, countries like Zambia, Tanzania, South Africa, Rwanda, Nigeria, Kenya, and Ethiopia have implemented Competency-Based Education (CBE) as a potential solution (Nsengimana et al., 2020).

According to Steele et al. (2014), competency-based education programs should be evaluated based on a range of short-term and long-term outcomes. Flexible, time-sensitive accountability tests may be more effective in measuring progress than fixed, annual assessments. Schools should negotiate favorable terms and be prepared for technical difficulties. Collaboration between schools and funders should consider local infrastructure and resources. Increased student autonomy requires skillful teaching to maintain engagement. Competency-based education systems must be vigilant about equity.

Competency-based curricula prioritize essential skills for student success. Learning, teaching, and assessment should directly support these goals. The curriculum aims to equip students with practical skills and general abilities needed for the modern world. This approach emphasizes learner-centered education, aligning with the ideas of educational theorists like Charters, Bobbit, Kilpatrick, Rugg, Caswell, and Tyler. To meet learners' needs and interests, the curriculum should focus on specific learning objectives and relevant content (Nsengimana et al., 2020).

2.2 Empirical Review

Rwanda's CBC implementation has specific characteristics within the broader framework of Competence-Based Curriculum (CBC) for mathematics education. Rwanda's CBC aims to shift from rote memorization to a focus on applying mathematical knowledge and skills in real-world contexts (Nsengimana, 2020). CBC for mathematics emphasizes key competencies like problem-solving, critical thinking, communication, and applying mathematical concepts in various situations.

The study conducted by (Charles et al., 2023) on factors affecting the implementation of Competence-based curriculum in secondary schools showed that the success of implementation largely depends on the availability of resources, adequate training of teachers and effective policy implementation.

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The study conducted by Ndihokubwayo and Habiyaremye (2018) revealed that the competence-based curriculum (CBC) launched in 2015 to enhance students' skills and learning outcomes. Rwanda chose this approach due to its useful material, practicality, organization, and relevance to teachers' needs. However, national trainers claim the textbooks have issues like too much content and scarcity of materials. The Rwanda Education Board and Ministry of Education should remind designers and textbook writers of these concerns and provide guidance on creating teacher-made teaching aids to address these issues.

On the other side, The research conducted by (Kusaka, 2019) compared competencies in developed countries and those in African countries, focusing on Mozambique's primary mathematics education curriculum. It revealed that competencies were revised from basic knowledge and skills to practical skills, emphasizing the use of social, cultural, and technological tools. However, the new textbook primarily focused on basic competencies, and the nurturing of practical competencies relied heavily on teachers' abilities. There is a gap in the textbook's content, and teachers may have insufficient understanding of the practical competencies and their ability to carry out the classes.

III. METHODOLOGY

This study used a descriptive research design to collect qualitative and quantitative data. It focused on the effect of implementing Competence- based curriculum on students' academic performance in mathematics in Rwamagana lower public secondary day schools. Based on Yamane (1973), the study used a sample size of 168 respondents from the targeted four schools, including 158 students selected randomly from a population of 261, 5 mathematics teachers selected purposively from a population of 7 mathematics teachers, 5 head teachers and Deans of studies selected purposively from a population of 8 head teachers and Deans of studies. Data collection involved questionnaires and interviews to gather comprehensive information on the implementation of CBC and students' performance in mathematics. The Statistical Package for Social Sciences (SPSS) was used to help in the analysis of quantitative data. The information from interviews with head teachers and deans of studies was analysed using inductive thematic analysis.

IV. FINDINGS & DISCUSSIONS

4.1 Respondents Characteristics

The identification of participants who contributed to this study, demographic information was corrected. This includes gender, age, years of experience and educational background. The following table presents the essential data about gender and age of the students.

Table 1

Responses rate

Targeted groups	Participants	Responses	Percentage
HTs & DOSs	5	5	100.0
Maths teachers	5	5	100.0
Students	158	158	100.0
Total	**168**	**168**	**100.0**

Table 1 shows that all respondents actively participated in the gathering of information. This is indicated by 100.0% of students, mathematics teachers, deans of studies and head teachers.

Table 2

Demographic information of students

Description	Label	Frequency	Percentage
Gender of respondents	Male	72	45.6
	Female	86	54.4
Age of respondents	Under 12 years	7	4.43
	From 13 to 15 years	77	48.73
	From 16 to 17 years	41	25.95
	From 18 to 20 years	20	12.66
	Above 20 years	13	8.23

Table 2 shows that 45.6% of the students were male and 54.4% were female. It shows that the majority of students (48.73%) were aged from 13 to 15 years and the minority (4.43%) were under 12 years.

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Table 3
Demographic information of teachers

Description	Label	Frequency	Percentage
Gender of respondents	Male	4	80.0
	Female	1	20.0
Age group of respondents	From 21 to 30 years old	2	40.0
	From 31 to 40 years old	2	40.0
	From 41 to 50 years old	1	20.0
Educational level	A2	0	0.0
	A1	0	0.0
	A0	5	100.0

Table 3 shows that 80.0% of the teachers were male and 20.0% were female. Conversely, 40.0% of the teachers were aged from 21 to 30 years, 40.0% were aged from 31 to 40 years and the remaining 20.0% were aged from 41 to 50 years old. This table shows that all teachers had A0 (bachelor) as a level of education.

4.1.1 Perceptions on Competence Based Curriculum Structure Implementation

Table 4 and 5 show the perceptions of teachers and students on competence-based curriculum structure implementation.

Table 4
Perception of teachers on CBC structure implementation

Statements	Mean	Comments	Std. Dev.	Comments
The use of group discussions in the CBC classroom has facilitated improved academic performance in mathematics	4.80	Strong	0.45	Homogeneous
Problem-Based Learning Activities within the CBC Curriculum have Improved Students' Ability to Solve Real-World Problems Using Mathematics	5.00	Strong	0.00	Homogeneous
The availability of resources (textbooks, manipulatives, technology) has been a significant factor in the success of the CBC in mathematics	4.80	Strong	0.45	Homogeneous
The CBC's emphasis on accommodating different learning styles has helped students better understand mathematical concepts	4.80	Strong	0.45	Homogeneous
Compared to the previous curriculum, the CBC in mathematics has led to a noticeable improvement in students' overall academic grades	4.60	Strong	0.55	Homogeneous
Strong leadership within the school that promotes the CBC can positively influence its impact on student performance in mathematics	4.60	Strong	0.55	Homogeneous
The level of teacher training and support provided for the CBC in mathematics has positively impacted students' ability to solve real-world problems	4.80	Strong	0.45	Homogeneous
Overall total	**4.77**			

Table 4 reflects a strong agreement among the teachers on CBC structure implementation, with overall mean of 4.77. They strongly agree that the use of group discussions in the CBC classroom has facilitated improved students' academic performance in mathematics (mean of 4.80) with consistent perceptions of standard deviation 0.45. They also strongly agree that Problem-Based Learning activities within the CBC have improved students' ability to solve real-world problems using mathematics (mean of 5) without deviations. They strongly agree that the availability of resources (textbooks, manipulatives, technology) has been a significant factor in the success of the CBC in mathematics (mean of 4.80 and standard deviation of 0.45). They strongly agree that the CBC's emphasis on accommodating different learning styles has helped students better understand mathematical concepts (mean of 4.80 and standard deviation of 0.45). They strongly agree that compared to the previous curriculum, the CBC in mathematics has led to a noticeable improvement in students' overall academic grades (mean of 4.6 and standard deviation of 0.55). They strongly agree that strong leadership within the school that promotes the CBC can positively influence its impact on student performance in mathematics (mean of 4.6 and standard deviation of 0.55). Moreover, teachers strongly agree that the level of teacher training and support provided for the CBC in mathematics has positively impacted students' ability to solve real-world problems (mean of 4.80 and standard deviation of 0.45). The

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results of table 3 match with the findings of (V. Nsengimana, 2020) who revealed that CBC for mathematics emphasizes key competencies like problem-solving, critical thinking, communication, and applying mathematical concepts in various situations. Also, the results match with the findings of Charles et al. (2023) conducted a study on factors affecting the implementation of competence-based curricula in secondary schools. Their research found that implementation success largely depends on the availability of resources, adequate training of teachers and effective policy implementation. This implies that the students have sufficient mathematical knowledge and skills and are ready to apply in other subjects.

Table 5

Perception of students on CBC structure implementation

Statements	Mean	Comments	Std. Dev.	Comments
Discussing math concepts with classmates helps me learn better	4.75	Strong	0.56	Homogeneous
My school leaders seem supportive of the CBC in mathematics	4.12	Strong	0.87	Heterogeneous
My math teachers seem well-prepared to teach the CBC approach	4.41	Strong	0.67	Homogeneous
Overall total	**4.43**			

Table 5 demonstrates strong agreement of the students on the implementation of CBC structure in mathematics with overall mean of 4.43. They strongly agree that discussing mathematics concepts with their classmates help them to learn better (mean of 4.75) with consistent perceptions of standard deviation of 0.56. They also strongly agree that their school leaders support the implementation of CBC in mathematics (mean of 4.12) with a significant variation of perceptions of standard deviation of 0.87. Moreover, they strongly agree that their mathematics teachers are well prepared to teach the CBC approach (mean of 4.41) with consistent perceptions (standard deviation of 0.67). The results of table 5 align with active learning activities, cognitive constructivism, and social learning theory to inform the creation of engaging activities that allow students to actively construct knowledge through interaction and application (Shroff et al., 2021). The results of this table match with that of (Dalisay, 2024) on the effect of peer learning strategy on students' academic performance in mathematics. This study led to the conclusion that the majority of learners passed their examinations and demonstrated satisfactory performance, Peer learning was found to be an excellent technique for teaching general mathematics, motivating students, stimulating cognitive development, and improving classroom performance.

4.2 Presentation of Qualitative Results

This section discusses the information collected from the interview with head teachers and Dean of studies

The analysis of findings from the interviews with Headteachers and Deans of studies is done using the inductive thematic analysis formulated from the respondents' scripts and gave the researcher the codes of Learner-centered, collaborative learning, group discussions, problem-based learning, project-based learning, case studies, scenario-based learning, active learning.

These codes are grouped to form a theme called student-centered learning. This theme emphasizes the importance of placing students at the center of the learning process, fostering active engagement and critical thinking. The codes of Real-life examples, local materials, simulations, problem-based learning, project-based learning and case studies form a theme called Authentic and Contextualized Learning. This theme highlights the use of real-world contexts to make learning meaningful and relevant to students' lives. The codes of Sequencing, monitoring and anticipating give a theme called teacher as facilitator. This theme emphasizes the teacher's role in creating and managing a conducive learning environment. The codes of ICT integration form a theme of technology integration. This theme highlights the use of technology to enhance teaching and learning.

4.2.1 Student-Centered Learning

This theme captures the strategies and approaches that prioritize students' active engagement, collaboration, and differentiation in the learning process. Respondents emphasized peer learning and collaboration, alongside individualized support for students, reflecting a strong focus on student-centered learning. They also highlighted the importance of differentiated instruction for diverse learners. Respondents mentioned the use of group discussions, problem-based learning, and project-based learning, all of which are central to student-centered learning approaches. Additionally, there's a focus on collaboration between teachers to support student learning. Respondents discuss the use of learner-centered and scenario-based learning approaches, which allow students to learn from peers and real-life situations. This aligns with the student-centered learning theme. Moreover, Respondents refer to the use of teaching aids and group activities to support students' learning, which falls under student-centered learning.

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4.2.2 Authentic and Contextualized Learning

This theme encompasses the use of real-life examples and projects that make learning relevant and meaningful for students. Respondents stressed the importance of providing real-life context and problem-solving opportunities in mathematics, which directly ties into authentic and contextualized learning. They also mentioned how students apply mathematical knowledge in various subjects like science, economics, and entrepreneurship. They highlighted the focus on real-life problem-solving and the importance of mathematics-based innovative projects.

The application of mathematics in other subjects like sciences and ICT is also noted, indicating a strong emphasis on contextualized learning. They pointed out that students apply what they learn in mathematics to subjects like Physics, Chemistry, and Biology, underscoring the importance of contextual learning. Moreover, respondents referred to the use of local materials and simulations in mathematics, which enhance the authenticity of learning experiences. The application of mathematics in economics, finance, and computer science further underscores this theme.

4.2.3 Teacher as Facilitator

This theme reflects the role of teachers as guides in the learning process, focusing on continuous professional development and the provision of resources to support student learning. Respondents discussed the importance of continuous professional development and the provision of learning resources to support teachers in facilitating effective learning. The emphasis on teacher training aligns with the role of teachers as facilitators. They highlighted collaboration with mathematics teachers, the availability of resources, and continuous professional development. The role of teachers in guiding learning and the importance of departmental support were emphasized.

Respondents supported the teaching and learning of mathematics by providing required materials and encouraging learner-centered approaches. They also emphasized the need for continuous professional development, aligning with the theme of the teacher as a facilitator as well as the importance of teacher capacity building and the need for teachers to be equipped with the skills to effectively implement the CBC, reflecting their role as facilitators and the importance of teachers' mindset in implementing CBC effectively. The focus on supporting low-performing students also aligns with this theme.

4.2.4 Technology Integration

This theme encompasses the integration of ICT and other technological tools in the teaching and learning process. Respondents mentioned the incorporation of technology in lessons and highlighted the use of simulations, which aligns with the focus on technology integration. They refer to the importance of using technological tools in real-life problem-solving and innovative projects. The respondents also mentioned the availability of resources like Geogebra software, further emphasizing the importance of technology.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

The research was conducted in GS St Vincent de Paul Rwamagana, GS Gishari, GS Munyiginya and GS Mwulire II focusing on the effect of implementing competence-based curriculum on O-level students' academic performance in mathematics. The findings of this study provide strong evidence that the implementation of the Competence-Based Curriculum (CBC) in Rwamagana District has positively impacted ordinary-level students' performance in mathematics. The study revealed a high level of CBC implementation, with respondents reporting increased student engagement, improved problem-solving skills, and enhanced understanding of mathematical concepts.

Overall, the results of this research support the continued implementation and refinement of the CBC in Rwamagana District and highlight the potential of this curriculum approach to enhance mathematics education and prepare students for success in higher education and the workforce.

5.2 Recommendations

Rwanda Basic Education Board is recommended to provide ongoing support, resources, and training to schools to ensure effective implementation of the CBC in mathematics. Regularly evaluate the CBC and make necessary adjustments to address challenges and improve outcomes. Develop and implement policies that promote the effective implementation of the CBC, such as guidelines for teacher training, assessment, and resource allocation.

Teachers are recommended to actively participate in professional development opportunities to enhance teaching skills and knowledge of the CBC. Adopt a student-centered approach to teaching, focusing on active engagement, collaboration, and problem-solving. Utilize formative assessment to monitor student progress and provide timely feedback.

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Schools are recommended to ensure adequate resources, including textbooks, manipulatives, and technology are available to support CBC implementation. Foster a collaborative school culture that promotes teamwork, shared responsibility, and a focus on student success. Provide strong leadership and support for teachers of mathematics to implement the CBC effectively.

Families are recommended to encourage students to participate actively in their learning and support their academic endeavors. Maintain open communication with teachers to stay informed about student progress and provide support. Provide a supportive home environment that encourages learning and academic achievement in mathematics.

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