

THE TEACHING OF 'MODULAR ARITHMETIC' IN SENIOR SECONDARY
MATHEMATICS CURRICULUM FOR CONTRIBUTION TO SUSTAINABLE
MILLENNIUM DEVELOPMENT GOALS

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ABSTRACT: *This paper observes that Modular Arithmetic is listed in the Senior Secondary Education Curriculum for Mathematics (2007) without content description that would guide teachers as it is the case with other topics in the curriculum. It could not be ascertained whether the omission of this valuable topic to daily activities of man in society was deliberate or otherwise. This paper sorts the opinion of in-service mathematics teachers as to what the content of 'Modular Arithmetic' should be. Data were gathered using a researcher made instrument titled Content of Modular Arithmetic Questionnaire (COMAQ). Eight probable sub topics of modular arithmetic were listed on the instrument. The sample size was 30. The analysis of COMAQ was carried out using simple frequency count and percentage. Results showed that four out of the eight listed sub topics on the questionnaire were unanimously accepted as a good description of modular arithmetic. The paper consequently recommended that the four sub topics be included in the SSECM to complement achievement of Sustainable Millennium Development Goals (SMDGs).*

KEYWORDS: Modular Arithmetic, Senior Secondary Mathematics, Curriculum, Millennium Development Goals

INTRODUCTION

The developing world has continued to face challenges of poverty, unemployment and terrorism despite the Millennium Development Goals (MDG's). It may be recalled that the eight MDG's range from reducing extreme poverty rates to halting the spread of HIV/AIDS and providing universal primary education, by the target date of 2015 (Eight millennium development goals, n. d.). Poverty, hunger and terrorism have continued unabated in several African countries even after the 2015 target. For example, thousands of university graduates who had completed the mandatory National Youth Service Corps (NYSC) in past years in Nigeria (KOPA, Photo Albums of Graduating Youth Corps Members Nationwide) have remained jobless and roaming about the streets without employment for good living. This could raise an army of unemployed educated hungry youths rather than reduce extreme poverty, or stop deceases and stop terrorism in the nation. Although the MDGs have achieved significant progress over the past 15 years but persistent gaps in official development assistance and insufficient access to markets, affordable medicines and new technologies have highlighted the need for a rejuvenation of the global partnership for development (Kin-Moon, 2005). This to an observer could explain why the Sustainable Millennium Development Goals (SMDG's) have been inaugurated. The 17 SMDG's is the shared

vision of humanity and a social contract between the world's leaders and the people (Ki-Moon, 2016). In the words of the UN secretary general during the world environment day on 5th June, 2016, he said “give young people decent jobs and they will create a better future”. Unfortunately, the jobs are not yet there for the youth in many developing countries. Nigeria in particular is still battling with ‘Bokoharam’ –a terrorist organization which is operating in the country. The terror group had claimed responsibility for several bombing of humans, public buildings, and outright kidnap of hundreds of school children in North East of Nigeria.

The Sustainable Millennium Development Goals (SMDGs) movement could be complemented with sustainable school curricula. The achievement of SMDGs may become a herculean task in view of the gaps that are currently observed in the curricula for science and mathematics in schools. Science and mathematics in schools should be taught by teachers for values. Values education is a necessity for job and wealth creation among youths. The curriculum revision at primary and secondary school levels that took place in 2007 was a direct reaction to the targets of the MDG's that terminated in 2015. Currently, gaps exist in school curricula just like gaps exist in the MDGs. The mathematics curricular for schools which is a service subject to other academic disciplines in schools should also be sustainable if the goals of the SMDG's would be attained. Mathematics educators are expected to intensify research into existing gaps in the subject curricula with the sole aim of bridging such gaps.

The present paper is researching into gaps in the Senior Secondary Education Curriculum for Mathematics (SSECM) which was last revised in 2007. One such gap is ‘modular arithmetic’ –a topic of invaluable importance to students and society. The topic was haphazardly addressed in the curriculum. It should be emphasized that the teaching of desirable topics in the mathematics curricula is a good service to other subject disciplines in schools, and by implication a takeoff board into good health, sustainable job and wealth creation.

However, the exclusion of the content of modular arithmetic from the curriculum for mathematics at senior secondary level is the focus of the present study. The topic was listed in the curriculum without the corresponding content description. The gap came to the fore during a teaching practice session of undergraduates. A student teacher was confused during a lesson on modular arithmetic, and the substantive mathematics teacher (i.e. the mentor teacher) could not come to the rescue. The teachers defended themselves by putting the blame squarely on the mathematics curriculum which they claimed to be incomplete. This situation of inadequate teaching of modular arithmetic is not too different in other schools in the locality. It was indeed a general problem for teachers in whose hand the implementation of school curriculum is entrusted.

Modular arithmetic is a system of arithmetic for integers where numbers wrap around upon reaching a certain value called the modulus. The modern approach to modular arithmetic was developed by Carl Friedrich Gauss in his book ‘Disquisitiones Arithmeticae’, published in 1801 (Modular Arithmetic, n. d.).

The values of modular arithmetic to students and society are many and these include:

- Time keeping as in module 12 arithmetic
- The algorithm that determines a market day in the community as in modulo 5 arithmetic
- The algorithm that determines the day of the week for a given date as in module 7
- The modular operation as implemented in programming languages and calculators
- In computer algebra, modular arithmetic is commonly used to limit the size of integer coefficients in intermediate calculations and data (Neale, 2005).

The content of modular arithmetic is wide. These include:

- Division of numbers with remainders
- Integer modulo n , where n is a number- particularly, when $n=5, 7, 9, \text{ or } 12$.
- Congruence relation
- Properties of modulo arithmetic
- Congruent classes
- Residue systems
- Reduced residue system modulo n
- Modular exponentiation, and
- Application (Neale, 2005; Buckley, n. d.).

Some of these topics however may not be within the scope of Senior Secondary Education Curriculum for Mathematics (SSECM). At the same time, some of the subtopics should necessarily be taught in schools for the inherent values to society and also, to serve as foundation for algebra at the tertiary level.

Purpose of the Paper:

The general purpose of this paper is to determine probable topic description for modular arithmetic in the Senior Secondary Education Curriculum for Mathematics (SSECM). Specifically, the paper presents eight sub topics of modular arithmetic to serving teachers for their opinion about the items (i.e. sub topics) that could make a good content description for modular arithmetic.

Research Question:

In view of the observed gaps in the SSECM (2007), in which modular arithmetic was listed but with no corresponding content description; it becomes necessary to determine a list of probable sub topics that will adequately describe the content of modular arithmetic. What Mathematics sub topics therefore should form the components of modular arithmetic for students in the Senior Secondary Education Curriculum for Mathematics?

Method:

The study adopted a questionnaire survey. The instrument used for data collection was named Content of Modular Arithmetic Questionnaire (COMAC). It contained a list of eight sub topics that were found in literature as relevant to modular arithmetic. The study used a purposive sampling technique, in which 30 in- service teachers responded to COMAC. The teachers were on in- service training at the Faculty of Education to read mathematics education for PGDE

certificate, M. Sc (Ed) or Ph. D degrees. They all had at least three years of mathematics teaching experience at the secondary school level. The respondents were required to indicate whether the sub items listed are: very relevant, relevant, or not relevant to modular arithmetic for Senior Secondary Education Curriculum for Mathematics.

RESULTS

Table 1: Summary of Opinion of In-Service Teachers on the Relevance of Sub Topics of Modular Arithmetic to Senior Secondary School Mathematics Curriculum

S/N	Topics	Very Relevant	Relevant	Not Relevant	Remarks
1	Division of numbers with remainder	30 (100%)	0 (0)	0 (0)	*
2	Integer modulo n	30 (100%)	0 (0)	0 (0)	*
3	Congruence relation	30 (100%)	0 (0)	0 (0)	*
4	Properties of modulo Arithmetic	30 (100%)	0 (0)	0 (0)	*
5	Congruence classes	0 (0%)	0 (0)	30 (100%)	**
6	Residue systems	0 (0%)	0 (0)	30 (100%)	**
7	Reduced residue system modulo n	0 (0%)	0 (0)	30 (100%)	**
8	Modular exponentiation	0 (0%)	0 (0)	30 (100%)	**

*Topics should be taught at Senior Secondary School level

** Topics should be delayed till Tertiary level

The entire 30 respondents (i.e. 100% of the respondents) ticked that the first four sub topics of modulo arithmetic as shown on Table 1, are very relevant to the Senior Secondary Education Curriculum for Mathematics. These sub topics are: division of numbers with remainder, integer modulo n, congruence relation and, properties of modulo arithmetic. Furthermore, the correspondents ticked the remaining four sub topics on the table as not relevant to the SSECM. These topics are: congruence classes, residue systems, reduced residue system modulo n and, modular exponentiation.

DISCUSSION

The four sub topics which the respondents ticked as very relevant to the Senior Secondary Education Curriculum for Mathematics can be taken without hesitation as suitable to make the content of modular arithmetic. The sub topics are of wide application among students, men and women in society, in their day to day activities such as keeping the time or appointments; in checking market days and more (private discussion with students and teachers). Unfortunately, most text books that are in use as class texts for mathematics in secondary schools do not have

modular arithmetic on their table of content let alone show the procedure to teach it. Furthermore, the other four sub topics which respondents ticked as 'not relevant' to SSECM are indeed invaluable to tertiary mathematics. This corroborates Neale, 2000; that the topics are of wide application in modular operations such as programming languages and useful in computer algebra.

CONCLUSION

The omission of content description for modular arithmetic is a gap which should not have existed in the first place, consideration the usefulness of the topic to daily activities of man in society. The Sustainable Millennium Development Goals (SMDGs) initiative is consequently a highly welcomed development. If the already observed gaps in the MDGs must be bridged then the gaps in school curricular would have to be filled. The case of modular arithmetic is just one of several gaps in Senior Secondary Education Curriculum for Mathematics (SSECM) which has to be addressed as prerequisite for achieving SMDGs.

RECOMMENDATIONS

The description of modular arithmetic as established by this study includes: division of numbers with remainder, integer modulo n , congruence relation, and properties of modular arithmetic. This content description is recommended to mathematics teachers for teaching in schools.

SUGGESTION FOR FURTHER RESEARCH

In view of the facts that modulo arithmetic is a new topic in the Senior Secondary Education Curriculum for Mathematics and also, existing students' textbooks on book shelves did not contain the topic let alone show its procedures, research into best practice of teaching modulo arithmetic to students should be intensified. The identified procedure of teaching the topic should be documented for teachers and students.

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