

# MATHEMATICS EDUCATION IN SECURITY: THE ROLE OF MATHEMATICS TEACHER

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## Abstract

Mathematics plays an important role in safeguarding national security. However, developing countries including Nigeria seems not be harnessing its maximal benefits. Practical applications of Mathematics in the area of security are numerous and used by the developed nations to tackle security problems. This paper sees the important role a teacher may play in the course of teaching mathematics to bring relevant instance of mathematics usage in enhancing security with a view to make learning of mathematics more interesting to Students who in turn could develop interest and pick a career in mathematics especially in the areas of its application for national security. The paper highlighted some areas of security which depend on mathematics and pointed how teachers could leverage on that to bring out the relevance of mathematics to their students. The Paper Recommends among others that; Mathematics teachers need to always connect their teaching with real life examples to enable students see the meaning of what they are learning, there is also the need for a deliberate effort by the country to invest vigorously in mathematics education.

**Keywords:** Mathematics, Security, Mathematics Teacher

## Introduction

Mathematics has vast applications in virtually all areas of human endeavours. Its application ranges from the usage as medium through which physical sciences are expressed and developed to practical applications in social sciences such as economics and business management. Another area which mathematics has contributed and continued to contribute immensely is National security. Mathematics plays an important role in safeguarding national security, countries such as America, India, China and Russia have recognized the importance of mathematics, used it earlier and now become the champion in nuclear weaponry and energy. It is a common knowledge that the Second World War was brought to end following the invention of the first ever Electronic Numerical Integrator and Calculator (ENIAC) - which was the first

known computer by America Military and Mathematicians from Harvard University in 1945. However, security is not just limited to the absence of war or ability of a nation to protect itself using weaponry but it includes security of valuable things such as data, ideas, money or anything that needs protection from attack physically or otherwise.

According to Bhat and Anees (2020) during COVID-19 pandemic, mathematics provides its models and tools to help world understand, monitor, and control the spread of the virus. Furthermore, it is also used to create weather forecasts and prepare for natural disasters and also warns us of climate change and helps us to anticipate and mitigate its consequences. All these are security issues of utmost importance to humanity and which mathematics plays an important role. Security has borrowed many tools from mathematics and in some sense, many

theories in security can be seen as the natural progressions of mathematics (Pawlak, 2017). He pointed specifically, the following areas of mathematics and their usage;

- Group theory, Finite Field theory, Number Theory, Algebraic geometry: cryptography
- Lattice Theory: access control, cryptography, secure information flow
- Probability theory, Statistics: risk management, intrusion detection, privacy protection
- Game theory: Security model
- Logic: security policies, verification and analysis of security protocols

This is enough evidence to appreciate the importance of mathematics in National security. However, this role is not fully appreciated especially in developing countries such as Nigeria (Yahuza, 2021). Though, Bage and Salami (2019), have explored the role revitalized mathematics in Nigerian secondary schools could play on national security.

Similarly. Amao and Bakare (2021) discussed the role mathematics could play in National security, among other areas. Also, earlier in 2017, in a seminar organized by Department of Mathematics Covenant University, Mr. Sam Etham, a Director in the Ministry of Defense, Nigeria Airforce Computer unit spoke on the role of Mathematics in national security and urged Nigerian mathematicians to assist in solving the country's security problem (Covenant University, 2017). Though these presentations are appropriate, however, they are general in nature; they did not talk on the specific areas of mathematics that could be applied in national security in some details or specific applications of mathematics in national security. In his effort to further develop upon the previous presenters Yahuza (2021), highlighted the applications of some branches of mathematics in national security, citing examples. For instance, he identified Abstract Algebra, Probability and Statistics, Geometry and Mathematical Modelling.

However, viewing at the above

discussions, none specifically talked about the role of mathematics teacher in enhancing the teaching of mathematics in relation to security.

No wonder, despite numerous practical applications of mathematics, it is common to find students complaining that they do not see any application of the mathematics in life. This could be the reason why they develop negative attitudes towards it and hence perform poorly. Mohamed and Waheed, (2011); Mata, Monteiro and Peixoto, (2012); Ngussa and Mbuti, (2017) pointed, that among the students' factors, attitude is regarded by many researchers as a key contributor to higher or lower performance in mathematics. It is therefore important for mathematics teachers to bring out practical examples that are relevant to real life in order to make students appreciate the mathematics learned. This could make them work hard to learn it in the interest of national security. Teachers of mathematics can play a vital role in bringing out how mathematics relates to security in their teaching.

This paper highlights some of the roles a teacher may play in order to make students realize the importance of mathematics in curtailing security and hence be able to appreciate the mathematics they are learning. The mathematics required in enhancing security in most of the cases is not the rigorous mathematics we sometime think, however, in some situations higher mathematics is needed. Mathematics teachers need to realize this and always highlight in the process of teaching how a particular piece of math could be applied to check security problem.

The following are some of the areas where mathematics is used in security and what teachers should do to during their teaching practices.

### **Mathematics in Cybersecurity**

Nowadays all data and information pertaining individual or a country are stored in computer or internet. In most of the cases unauthorized users tend to steal vital

information which is security threat to an individual or a country. In order to secure the data some levels of encryption are made using mathematics skills.

Cryptography is the scientific discipline that underlies all of cybersecurity, information security, and network security (Rob, 2018). It uses math to encode communications and protect computer systems from unwanted intruders, while making sure that authorized users have the access they need. The math used in cryptography can be very simple or highly advanced. More advanced cryptography is usually the domain of high-level engineers, who design and refine the complex algorithms that keep systems safe. In this context a teacher may bring this as an example when teaching algebra course, for instance binary math powers everything a computer does, from creating and routing IP addresses to running a security client's operating system. It is a mathematical language that uses only the values "0" and "1" in combination. Computer networks "speak" in binary, so cybersecurity professionals need to understand how it works.

### **Permutation in Code Generation**

Telecommunication companies and many other companies rely on mathematics to generate random numbers that represent money equivalent amount i.e. credit card and electric unit. Mathematical idea of permutation is usually used to generate large string of different numbers within few minutes. The system ensures security of the codes generated and it makes it hard for somebody to replicate them. Also on combination lock, a Permutation of numbers are used for security; in this only one correct arrangement will be set to unlock the lock.

### **Mathematical Modelling in the Military**

The military use mathematics in planning attack and also in defense. Mathematical modelling is central to many applications of mathematics to real life situations. The application to national security is no exception. Nowadays pattern of

how things occur can be studied and then modeling processes are employed to forecast many possibilities which were not possible before. In such a way the military have a prior knowledge of what is expected and then plan to avert any bad possibility. For instance, America stopped nuclear testing in 1992; but through sophisticated modeling using computers they are capable to ascertaining their capabilities in nuclear without carrying any nuclear test (Desousa, 2013).

### **Probability and Statistics usage**

Probability and statistics play various roles in national security. For instance, during second world war Japan had developed PURPLE cipher system of communications which the Allies forces had never seen and did not have the idea on how to operate it. However, they were able to make significant findings about it using statistics and probability. Using advanced math and mathematical analysis the Allies force were able to reconstruct the machine, and this contributed to bringing an end to the war (Minihan, 1998). Statistical analysis plays critical role in national security in other ways. For instance, in developed countries thousands of CCTV cameras are mounted across the cities to monitor situations in order to ensure the security of their citizens; as such enormous amount of data is recorded every second which require much effort to analyze. Through the usage of big data and computerized statistical analysis, useful information could be obtained from massive dump of data. British Broadcasting Corporation (2015) as cited in Yahuza (2021), reported that Statistical analysis enabled Police to make sense from mass data and identify four attackers by examining 2,500 items of CCTV footage and other forensic evidence in the London underground railway system bomb on 7th July 2005 within a reasonable short time. Mathematics teacher may use fascinating examples such as above to show his students how useful is the mathematics they are learning especially in helping security.

### Mathematics in food security

It is always pertinent for every country to know its food security, that is to find out whether there is sufficient food for its citizens or not. Knowing the food insecurity of a country is the first step to address the problem of food security of that country. One way of using math to fight food insecurity is the design of a food insecurity survey tool that will enable the collection, analysis, and communication of the data regarding food insecurity in a community or a nation (Clement, 2020). The accuracy of food insecurity data will in turn help stakeholders; government, NGOs individuals etc to take proactive and effective measures in addressing the issue. In a way the students now should be able to see how mathematics could be used to address the problem of food insecurity. Several similar examples by the teacher will definitely make the students to realize the importance of mathematics in their life.

### Signals Intelligence

Signals intelligence (SIGINT) is intelligence-gathering by interception of signals, whether communications between people or from electronic signals not directly used in communication (Wikipedia, 2022). SIGINT is most often used by military or intelligence agency professionals, who have to deal with messages and data of one or more parties that are gathered using any type of electronic, communications, or foreign instrumentation signals intelligence, irrespective of how the information was conveyed. This is a new technique which is very important in all types of signal transmission and it is based on transmission of a series of numbers. Signal intelligence analysis is an exciting new method which applies principles of mathematics and physics in solving difficult civil and security problems (Charles-Ogan, 2014). Some applications of signal intelligence are powerful statistical tool which can be used for a wide range of applications namely:

- Signal processing
- Data compression

- Fingerprint (which is more surprising), for detecting the properties of quick variation of values
- In internet traffic description for designing the services size
- Industrial supervision of gear-wheel
- Computer graphics and multi-fractal analysis
- Wave propagation o Image processing
- Pattern recognition
- Detection of aircraft and submarines.

### The Role of Mathematics Teacher

Teachers should support students in developing their ability to solve problems, reason mathematically, and connect the mathematics they are learning to the real world around them for meaningful development. Mathematics teacher may play an important role in making learning take place, become interesting and meaningful. Larson (2016) pointed "A math teacher is someone who inspires their students to look beyond the pages of the textbook to become problem solvers and critical thinkers, p.1." The above application of mathematics could be made meaningful and clear to students by mathematics teachers through real life examples connecting the mathematics they learn to real-life situation. One of the main objectives of mathematics education is to enable students to apply mathematics to real life situations (Wijaya, van den Heuvel-Panhuizen and Doorman, 2015).

For instance, in teaching Binary numbers mathematics teacher should explain to the students how and where this knowledge could be applied; starting with simple examples on coding games students could see how binary numbers they learn can be used in enhancing security. More examples on data security through coding should be given to students, this will make them realize the importance of that aspect of mathematics which in turn could make them develop career leading towards that line and in the end improve the security of the nation's data. Another area where teachers of mathematics may leverage on, when teaching is the topic - permutation and combination in algebra, to



show the students the relevance of the mathematics they learn in class. A game on combination lock could thrill students to develop interest in learning mathematics or showing the students how to generate social security number (SSN) may give the students some idea of why mathematics important could lead to having more mathematicians and the more mathematician a country has the more its potentiality in developing security wise a good example is India and Pakistan each has potential in nuclear for both weapon and peace (generating electricity). Mathematical modeling is another interesting area where a Mathematics teacher may use several examples of situations of mathematical modelling in the teaching and learning process to show the importance of mathematics in enhancing security. There are many examples of modelling available a teacher of mathematics could use, for instance Rogachev and Antamoshkina (2019) pointed that the solution to the problem of ensuring food security is possible using economic and mathematical modeling based on fuzzy production cognitive maps. This is a cognitive map within which the relations between the elements (such as concepts, events, project resources) of a “mental landscape” can be used to compute the “strength of impact” of these elements. These and many more are examples of how a mathematics teacher may use various real life examples to teacher mathematics in such a way students could see its application especially in tackling different aspect of security.

Connecting mathematics with real life establishes the basis of certain learning theories and approaches in the field of mathematics education (Altay, Erhan & Bati, 2020). In Realistic Mathematics Education (RME) developed by Freudenthal, mathematics education is described as the real life itself, and the reality here is the mathematics related to real life contexts and problem situations in students' minds. This approach suggests that teachers introduce a new mathematical concept through the use of a relevant and meaningful problem situation

that students experience in their lives. The basic principle is to enable students to make a connection between the mathematical concepts and their own life experiences. In other words, the most fundamental feature of RME is that mathematical concept should be developed with by means of the problems encountered in in real life contexts. Research suggests that meaningful real-life contexts provide opportunities for students to explore mathematical ideas (Boaler, 1993; Kent, 2000).

### Conclusion

One of the demands made on school mathematics is that it should be socially, environmentally, culturally and academically relevant. Varied meanings are attached to relevance although the most popular meaning is that learners should be able to use the mathematics that they learn in real-life situations. Mathematics teachers should therefore rise up and play a prominent role in solving the security problems in country by encouraging the students through real life examples. This will make the students develop interest in learning and studying mathematics which could lead to having more trained mathematicians who would apply mathematics in tackling various security problems.

### Recommendations:

The following recommendations are made;

1. Mathematics teachers need to always connect their teaching with real life examples to enable students see the meaning of what they are learning.
2. There is need for a deliberate effort by the country to invest vigorously in mathematics education.
3. There is need for harnessing urgently and utilizing all available resources including mathematics and Mathematicians to address the security problems in Nigeria.
4. Mathematicians and mathematics educators should be employed by our security apparatus to help them in their effort to tackle security challenges.

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