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MOMOZOKU, Umaru Salihu, JOB, Samuel Jiyah, AWOYALE, Olusegun & AUDU, Abdulmalik Onubedo
Department of Mathematics, Federal University of Education, Kontagora-Niger State.
emozoku@yahoo.com

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Abstract
Language is a fundamental prerequisite to all human activities and communication. The subject of mathematics is a language which is central to the development of science, engineering and technology. This study highlights the importance and types of mathematics languages used in computer science and technology, and how it enhances computer education and creates prospects for computer developers and users worldwide. The study discusses how mathematics as a language can be used in various forms in coding, developing computer programming languages and interpreting computer programming languages. It also listed some importance of mathematics in computer science and programming, and a few computer programming languages. Few areas in computer science and programming where specific branches of mathematics are utilised were discussed. The study concluded that Mathematics is one of the disciplines needed by those who want to pursue a career in computer science and programming as it is used in various ways from software development, system design, assessment and test results or quality metrics, selection of architectures or algorithms and so on. It is suggested that those intending to major in any computer science courses should take mathematics courses relevant to their computer course of interest. Specialist teachers in mathematics and computer science should be employed to give learners the basic knowledge they need to excel in computer science and programming courses.

Introduction

Language is used for communication and manipulation of objects. Language is a powerful instrument that controls those who understand its expressions and terminologies (Kontagora, 2020; Boulet, 2007). It is a fundamental prerequisite to all human activities and communication. A language is an essential tool for knowledge acquisition, dissemination of information and application (Shuukwanyama et al, 2022). Boulet (2007) and Dabell (2022) asserted that central to

the development of science, engineering and technology is strong understanding of mathematics and its language.

Language is at the heart of mathematical activity. Mathematics is learned through communication (Boulet, 2007). Communication is a key factor in the building of understanding. Language is used by teachers to describe mathematical processes, to read and interpret notation, and to define mathematical terms (Boulet, 2007; Shuukwanyama, Long, Nkosi, & Maseko, 2022, Sherwood, 2022). Ajayi and Lawani (2015) asserted that language occupies a very important position in the curriculum of any school system and is a vital tool for communication between and among different people or computers through signs, the use of special codes, shapes, and so on.

Mathematics is a subject whose utility cuts across all human endeavours. It is acclaimed that for any nation to develop scientifically and technologically, the government and the citizens of that nation must embrace mathematics education. Mathematics education is the teaching and learning of mathematics. In the process of imparting and acquiring mathematical knowledge and skills, both the teachers and learners must understand and use proper mathematical language.

Mathematical language is a system used in the field of mathematics to communicate mathematical ideas, concepts, and theories among people. It is distinct and unique from the usual language most people are used to and is used to communicate abstract, logical ideas (Ryan, 2022). Mathematical language consists of different symbols: a small set of mathematical operators with precise meaning, variables, and numbers that exist in a continuous space. Furthermore, mathematical language follows rules that are much stricter and more rigorous than natural language (Scarlatos & Lan, 2023).

Mathematical language is the means through which learners can communicate meaning and ensure it is presented in a structured way. Whether written in the form of prints or media or spoken or signs or braille, learners are expected to present their thinking and reasoning through the use of mathematics vocabulary and reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language. Mathematical language differs significantly because it extends to include the use of graphs, charts, mathematical symbols, diagrams and numbers. It is evident that mathematics, as a language, has a rather unique phraseology and vocabulary (Dabell, 2022; Morgan, 2023).

According to Helmenstine (2020), mathematics is a language because students learning mathematics require "a robust vocabulary knowledge base; flexibility; fluency and proficiency with numbers, symbols, words, and diagrams; and comprehension skills. Dabell (2022) stated that mathematics is a universal language because it is the same all over the world. They maintained that a phrase or formula has the same meaning, regardless of another language that accompanies it. Mathematics grammar and syntax, like vocabulary, are international. No matter what country one is from or what language one speaks, the structure of the mathematical language is the same.

Mathematics language is a language of symbols, concepts, definitions, and theorems that does not develop naturally like a child’s natural language but needs to be taught (Haaidov & Ilany, 2017,

Dabell, 2022, Segerby, 2023). It consists of different types of sounds and symbols that are utilized to give objects or significance. These symbols denote meaning which relies on the true explanation of these symbols. Mathematics language is unique and complex. Mathematics language has its creativity and productivity and universal, having its own peculiarities and distinctive features (Dabell, 2022). Mathematics and its branches including various topics are considered as a language because it disseminates information on what to be done by engaging its users on actions to be taken through proper communication and engagement. This mathematics language consists of concepts, vocabulary, or register which is special to mathematics and its branches (Dabell, 2022; Shuukwanyama et al, 2022).

Mathematical language is used to teach computer science courses. According to Geeks for Geeks (n.d) mathematics is a fundamental intellectual tool in computing and the foundation on which computer science is built and also a subset of Mathematics. Computer science examines the principles and use of computers in processing information, designing hardware and software, and using applications. Possessing a strong foundational knowledge of mathematics is vital to gaining an understanding of how computers work. Using mathematics language when teaching computer science courses encourages positive communication. Mathematics is abstract and teaches problem-solving skills, logical thinking, how to structure and analyse arguments, how to evaluate work and utilize algorithms all of which are critical skills for a computer scientist (Byju's, 2023, Yardley, 2023; Sass Way, 2021; Gillespie, n.d). Mathematical skills are necessary for developing new computer science theories and applications (Codes, n.d). The University of Chicago (n.d) stated that Mathematics provides an essential foundation for virtually every area of computer science, and its applications are correspondingly vast.

The importance of mathematics in accessing computer science

Mathematical skills: are necessary for developing new computer science theories and applications. Many computer science breakthroughs have been made possible by advances in mathematics for it teaches problem-solving skills, logical thinking, and how to structure and analyze arguments which are critical skills for a computer scientist. Problem-solving skills: Studying mathematics can also help develop problem-solving skills, which can be applied to various fields in computer science. Mathematics provides analytical skills: Mathematics provides lots of analytical skills to students that can be used in identifying and fixing bugs in computer science. Mathematics trains you to evaluate work: Mistakes happen, and with programming, they are inevitable. It is important to possess the ability to identify the error and fix it. One ability to analyse the equation, identify the issue, and ultimately rectify it improves as one practice and solves more and more questions in computer science. Mathematics teaches one how to utilize algorithms: Algorithms are finite set of commands sent to the computer to carry out specific functions or run a program. An algorithm is a commonly used term in the field of computer science and technology in general. It provides a basis under which any program or application can be created and implemented in computer science. Mathematics is abstract: Most concepts in mathematics are taught through abstract language. Computers only understand programming languages and these languages are abstract. All these skills are vital when it comes to programming and computer science.

Computer science

Computer Science is the study of computers and focuses on the development and testing of software and software systems. It involves working with mathematical models in data analysis and security, computational theory, hardware and software design, algorithms, information, and automation; and the way humans interact with technology (www.mtu.edu). Other areas of computer science include the study of algorithms and data structures, computer and network design, modelling data and information processing, artificial intelligence (AI), data science, computer graphics and computational geography, cloud computing, cryptography and cyber security, human-computer interaction (HCI), machine learning, video game development, programming language theory, database management, coding, information technology, robotics (engineering, computer science and technology), security, software engineering, computer architecture, computer systems and networking and so on (www.mastersportal.com and www.uopeople.edu).

Specific mathematics techniques required for computer science

Many computer science breakthroughs have been made possible by advances in mathematics, and specific mathematics techniques required for certain types of computer science are listed below (Rao, 2018; Codes, n.d; Yardley, 2023; Sedlacek, 2016; iponwire, 2023; The University of Chicago, n.d; Byju's, 2023):- Binary mathematics is also important in programming, as it is used to represent numbers in a computer. Binary and Other Numbering Systems like Hexadecimal. Converting a number from decimal to binary and from decimal to hexadecimal systems is a common task in programming. Mathematics is used in programming to do basic arithmetic operations like adding, subtracting, multiplying, and dividing. These operations are used in almost every program and are necessary for manipulating data and doing calculations. Numbers, in their most basic form, are what bring entertainment, communication, and information to our homes and fingertips. Logic is the language used for most formal specification languages and is fundamental for understanding much of the literature in verification and programming language foundations and design. Computers make calculations by modifying bits (zeros and ones). In accordance with the laws of Boolean algebra, which form the basis of all digital circuits. Programming languages rely directly on logical operators such as and, not, and or. Software developers using high-level languages will often work to optimize their code by minimizing the number of low-level operations and may even operate directly on bits. Coding relies heavily on mathematical notation and symbols. Programs can be described precisely with mathematics, and the tools of propositional logic can be used to reason about their correctness.

This skill is critical to the design and analysis of algorithms, a core area of computer science. Iterative programming and functional programming are two major paradigms which rely upon the principle of mathematical induction to verify their loops (for and while) and recursive function calls, respectively. Graphs are powerful data structures which are used to model relationships and answer questions about said data. They are also extensively used in computer science to represent file systems, for version control, and in functional programming, deep learning, databases, and many more applications. The algorithm is designed for compressing a different type of file (text,

images, video, etc). Counting helps analyse the complexity of algorithms. Basic Analysis is useful to know regarding the theoretical complexity of algorithms. Linear Algebra is interesting for optimization algorithms. Discrete mathematics is mainly used in graph theory and stochastic, Artificial Intelligence and Machine Learning require a thorough knowledge of Mathematical concepts like Linear algebra, Multivariable Calculus, Probability Theory, etc. Creating a blog requires a focus on audience preferences, topic popularity, article ratings, and so on various branches of mathematics are required for all of these. Machine Learning cannot be done without a solid grasp of linear algebra, statistics, and optimization (which requires multivariable calculus). Algebra and calculus are two examples of advanced mathematics that are often used in programming to solve hard mathematics problems and make advanced apps while Relational Algebra is used in Databases. Number Theory has multiple applications in block-chain, cryptography, Cryptanalysis and computer security. Number theory also has memory-related uses in computer architecture and operating systems. Modular arithmetic is the mathematical basis for hash functions, which are extremely useful tools with many applications.

Checksums, based on hashing, can verify that files transferred over the internet do not contain errors. Recurrences are also a common way of defining algorithms and data structures. They form the backbone for many models of computation. They are also fundamental for software verification. Counting techniques are used to develop quantitative intuition. Compression algorithm is designed for compressing a different type of file (text, images, video, etc). Matrix Transformation is used in 2D and 3D modelling and differential equations may be used in software used to simulate physical phenomena or traffic patterns. Statistics and probability are commonly used in programming, particularly for prediction, assessing risk, data analysis, forecasting future events/trends and visualization. Conditional probability has many applications in machine learning. Set Theory is important for SQL programming

Computer Programming Language.

Computer programming (often called *programming*): is the process of writing or creating and using instructions, known as codes, written in a programming language to facilitate specific actions in a computer, application or software program, and instruct them on how to perform. Wikipedia (n.d) states that programming involves tasks such as analysis, generating algorithms, profiling algorithms' accuracy and resource consumption, and the implementation of algorithms. A programming language is like a set of instructions that humans can use to tell computers what to do and how to do it. It is a special type of computer language that both people and computers can understand (Whitenton, Gadsden & Chuatico, 2023).

Sedlacek (2016) and Pehlivan (2019) see computer programming languages as abstract and problem-solving tools that play a critical role in the development of both computer systems and computer programs which are the most important components of these systems. They added that the syntax of the programming languages must represent specific processes, commands, and visuals through punctuation, symbols, and single words. Pehlivan (2019) added that a programming language can make it possible to write programs that can easily be integrated into one or several computer systems with different architectures.

Coding languages enable computers to understand human-oriented instructions for various commands and computations. Writing code allows humans to translate information into a language a computerized machine can process. Coding languages are essential for building websites, developing mobile apps, and running cloud-computing services (Whitenton et al, 2023).

Dubhal (2021) stated that coding is all about dealing with numbers and building logic around them. Coding requires a complete set of basic topics from simple equalities to complex mathematical representations that are required while coding and also helps in working with the algorithms which enhance their skills in the art of reading, comprehending, formulating thoughts, and communicating with abstract language. The list includes binary mathematics, linear algebra, calculus, discrete mathematics, and statistics (www.geeksforgeeks.org and Effortless Math, 2021). Pehlivan (2019) stated that the efficiency of the development processes of source code depends on design principles adopted by language developers, such as readability, writability, reliability, portability, and extensibility. These principles increase the effectiveness and common usage of programming languages.

Pehlivan (2019) and **Hemmendinger (n.d) stated that computer programming languages** are many for expressing a set of detailed instructions for a digital *computer* as each language has its programming practice or style. Such instructions can be executed directly when they are in the computer manufacturer-specific numerical form known as *machine language*, after a simple substitution process when expressed in a corresponding *assembly language*, or after translation from some "higher-level" language. All programming languages fall into one of three broad categories which are low-level, high-level and specialized languages, further categorized as per their features and use (educaba, 2023; Wikipedia, n. d; Cangiano, 2023; Whitenton et al, 2023). Programming languages serve different specific purposes and are classified accordingly.

**High-level programming languages*: high-level languages are the furthest away from the actual code that translates commands on a computer system. Examples include C++, Java, &Python.

**Low-level programming languages*: low-level languages contain basic instructions for a computer to understand. It involves little to no abstraction from the core coding process. Examples are assembly and machine languages.

A *machine language* consists of the numeric codes for the operations that a particular computer can execute directly. The codes are strings of 0s and 1s, or *binary* digits ("bits"), which are frequently converted both from and to hexadecimal (base 16) for human viewing and modification. Machine language instructions typically use some bits to represent operations, such as addition, and some to represent operands, or perhaps the location of the next instruction. Machine language is difficult to read and write since it does not resemble conventional mathematical notation or human language, and its codes vary from computer to computer.

Assembly language is one level above machine language and is designed to be easily translated into machine language. Blocks of data are referred to by name instead of by their *machine* addresses. Assembly language requires detailed knowledge of internal *computer architecture*. It is useful when such details are important, as in *programming* a computer to interact with *peripheral devices* (printers, scanners, storage devices, and so on).

There are many computer programming languages few are widely used and some of those in use are listed below:

Procedural language: A procedural language is a third-generation language easily created with simple procedures. Examples are C, FORTRAN, PASCAL, BASIC, COBOL

Functional language: Functional language is a type of high-level language that revolves around mathematical functions as their fundamental concept. Functional languages give functions equal status by assigning them to variables, using them as arguments in other functions, & retiring them as value from functions. Examples Haskell, Lisp, Erlang, F, Clojure.

Scripting language: these are high-level languages that are user-friendly and easy to learn for automating repetitive tasks and creating dynamic web pages. Examples are JavaScript, Python, Perl, Bash

Query languages are computer languages that retrieve and manipulate data from databases. It allows users to issue commands or statements to edit or retrieve data based on specific criteria. Query languages find applicants in various fields including business, intelligence, data analysis, and web development. Examples are SQL, SPAROL,

Domain-specific language: a programming task by provides a language tailor to the needs of a particular application. Multiple applicants utilize domain-specific language (DSLs), including scientific computing, financial modelling & game department. Examples are MATLAB, R, Mathematica

Complied language: these are languages typically processed by compilers through theoretically any language can be compiled or interpreted. Examples are Action Script, ALGOL, Basic, C, C++, C#, Clojure, COBOL, Haskell, Java, Pascal, Python, Rustand Scale.

Education oriented programming languages are languages developed primarily for teaching & learning programming. Examples include logo, Pascal, Scheme, and BASIC.

Extension programming languages are languages embedded into another program and used to harness its features in exclusive scripts. Examples are CAL, Perl, JavaScript, Python, SQL, Pike

Hardware description languages (HDL): is a specialized computer language used to describe the structure, design, and operation of electric circuits, & most commonly, digital logic circuits. The two most widely used and well-supported HDL varieties used in industries are Verilog and VHDL. Hardware description languages include confluence, ELLA, impulse C, Lava, system C, and system Verilog.

Imperative language: maybe multi-paradigm and appear in other classifications. Examples are Ada, ALGOL (58, 60), BASIC, C, C++, CH, COBOL, D, FORTRAN, Go, Java, MATLAB, PASCAL

Logic-based languages are a set of attributes that a solution must have, rather than a set of steps to obtain a solution. They include Curry, prolog, RDOP, Oz, Datalog,

Numerical Analysis: focuses on languages exclusively used for technical computing. Examples are C, Python, Fortran, Analytical, GNU Octave, Julia, MATLAB

*Algorithmic Languages***:** Algorithmic languages are designed to express mathematical or symbolic computations. They can express algebraic operations in a notation similar to mathematics and allow the use of subprograms that package commonly used operations for reuse. They were the first high-level languages. For example, Fortran

Business-oriented language: Common Business Oriented Language (COBOL) has been heavily used by businesses since its inception. COBOL uses an English-like notation novel when introduced. Business computations organize and manipulate large quantities of data, and COBOL introduced the *record data structure* for such tasks. A record clusters *heterogeneous* data such as a name, an ID number, an age, and an address—into a single unit. This contrasts with scientific languages, in which *homogeneous* arrays of numbers are common. Records are an important example of "chunking" data into a single object, and they appear in nearly all modern languages.

*Object-Oriented Language***:** Object-Oriented programming language: object-oriented languages have become the predominant approach in developing new software. The dept process in these languages revolves around creating & interacting with objects, which consists of pieces of code (modules) & data structures. Examples are Java, Python, C++, Ruby Swift,

*Symbolic Mathematics Language***:** For example, ***MATLAB/*** *GNU Octave*

Conclusion and Forward

Language is a means of human communication, either spoken or written, consisting of the use of words in a structured way and acts as the fabric used in constructing networks of ideas and meaningful relationships between one concept and another. It plays a significant role in transmitting knowledge to learners. Communicating mathematically requires mathematical understanding; a robust vocabulary knowledge base; flexibility; fluency and proficiency with numbers, symbols, words, and diagrams; and comprehension skills of which the language of mathematics is central to teaching, learning and communicating meaning. Language is at the heart of mathematical activity. Mathematics is learned through communication. Communication is a key factor in the building of understanding. Language is used by teachers to describe mathematical processes, to read and interpret notation, and to define mathematical terms. Mathematics helps one develop the abilities needed in the computing industry, and, more significantly, it teaches one how to think mathematically to solve problems. Mathematics is one of the disciplines needed by those who want to pursue a career in computer science as it is used in various ways from software development, system design, assessment and test results or quality metrics, selection of architectures or algorithms, and similar activities that require quantitative evaluation of data and comparison of options and so on. Programming languages a branch of computer science uses mathematics language for coding. Some of the fields of mathematics in use range from basic arithmetic to more complex mathematical ideas like algebra, calculus, and statistics, analysis. There is no chance of building a strong career in computer science courses without basic mathematical knowledge. Therefore, the following are forwarded to be observed by those concerned:

Learners who want to major in any computer courses should take mathematics courses relevant to their computer science course of interest. Specialist teachers in mathematics and computer science should be employed to give learners the basic knowledge they need to excel in computer science courses. Teachers should build in mathematical language acquisition and precision reading as a principle that enables learners to think more precisely and to communicate more clearly.

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