December 2012 IJESM Volume 1, Issue 1 ISSN: 2320-0294

# ALGEBRAIC SYMBOLISM: HOW ABSTRACT MATH SHAPES THE LANGUAGE OF SCIENCE

Dr. Mukesh Punia
Associate Professor
Department of Mathematics
S D (PG) College, Panipat-132103
Haryana

**Abstract**

*Algebra is a basic part of mathematics that focuses on symbols, variables, and the rules for manipulating them in order to solve problems and gain an understanding of the connections between different values. It goes beyond elementary arithmetic, in which numbers are handled directly, and presents the concept of using variables to represent values for which no exact value is known. Algebra is included in the curricula of schools all over the globe for the same reasons: there is a legitimate purpose for it to be there, and the school is responsible for teaching it to the pupils. Despite this, a number of studies have shown that the importance placed on children studying algebra differs greatly from one region of the globe to another. This report summarises the findings of a number of similar analyses carried out over the course of the last two decades, drawing on data collected from a variety of research conducted at various educational levels.*

***keywords:*** *Mathematical, Algebra, Importance*

## Introduction

One way to think about algebra is as the mathematical equivalent of a language. It is generally acknowledged that having a working knowledge of the language **Science** spoken in a nation is vital if you want to pursue possibilities in that country. One may make the same point regarding algebra. The ability to solve algebraic equations is necessary for individuals to possess in all fields of study and work that include the usage of this language. It takes time to acquire the language of a nation, and that language **Science** develops over the course of time via intense instruction through hearing and through training to use it yourself. In general, it is simpler for young children to begin learning a language **Science** than it is for adults. The same can be said, to a certain degree, about algebra; the only difference is that in mathematics, you start with arithmetic since arithmetic is the foundation for algebra; thus, it appears acceptable to begin with algebra after achieving some level of fluency in arithmetic.

Everyone in a contemporary society spends a significant amount of time in school, which helps to prepare them for becoming responsible citizens who are able to take care of their own day-to-day lives and also have jobs that allow them to contribute to society while also providing for their own needs. The question of what kind of competency should be emphasised in schools in contemporary communities is one that has to be addressed. Is it sufficient to teach them basic arithmetic and statistics in mathematics to prepare them for their everyday lives, or do we need to put in more effort to teach them algebra as a mathematical language? A large number of individuals who have an extensive education in many fields of technology, such as engineering and computer science, are required for a contemporary civilization. A contemporary society is confronted with challenges that are connected to the economy and the environment. In each of these areas, an understanding of the mathematical language known as algebra is absolutely necessary. In today's world, there are a wide variety of fields in which an understanding of algebra is necessary to pursue a career. In addition to this, it is essential for all forms of education in the natural sciences, such as physics, biology, and chemistry, as well as education in mathematics itself. It is necessary to have a strong command of the algebraic language if you want to enrol in a university programme that focuses on geometry.

Algebra is included in the curricula of schools all over the globe for the same reasons: there is a legitimate purpose for it to be there, and the school is responsible for teaching it to the pupils. Despite this, a number of studies have shown that the importance placed on children studying algebra differs greatly from one region of the globe to another. This report summarises the findings of a number of similar analyses carried out over the course of the last two decades, drawing on data collected from a variety of research conducted at various educational levels. Using these findings as a jumping off point, certain ramifications will be pointed out and explored for both individual students and societies that do not place a strong emphasis on the study of algebra in their schools.

This includes discussions of students' equal rights to pursue all types of education and, as a result, have the opportunity for a number of different positions in society, possible reasons for the low emphasis on algebra in some countries, the relation between pure and applied mathematics, as well as some reflections about teaching and learning algebra from the perspective that algebra is a language.

**What is Algebra**

Thinking in an algebraic fashion may be applied to all parts of mathematics. The process entails constructing and identifying links between numbers, followed by the expression of these relationships using a symbol system. For instance, we might state that "an odd number is any number that when divided by two will leave one" if we were to express this idea using words. One further way to describe this would be with an algebraic expression:

"When $\frac{x}{2}$ has a remainder of 1, $xx$ is an odd number."

As a result, algebra offers a written form in which to communicate mathematical concepts. For example, if I had a bag of apples that needed to be split among four people, I could use a pronumeral to express the total number of apples (in this case, I would use the letter nn), and then I could use mathematics to express how those apples should be distributed among the four people: each person will get nn/4 apples.

$\frac{n}{4}$ apples.

**AN EXAMPLE:**

The easiest way to illustrate algebra is by a simple example: My car's been at the mechanic, and he just installed a new component for me. The cost of the component was $270.00. The total amount charged was $342.00. What was the hourly rate for the workers?

It is possible to deduce, based on what is known generally, that the cost of labour must equal the total cost less the cost of the component.

$342 − $270 = cost of labour.

$72 = cost of labour.

But this required us to rearrange the problem in our head. (Which is easy for simple problems)

If we write the question logically, we can also show that: The part cost plus the labour cost equals cost total. So $270 + $cccccccc oooo tthee pppppppp$ = $342 (Now represent the unknown with a symbol/variable) Now we write it symbolically: $270 + xx = 342$ (we have an algebraic equation)

In order to solve the problem, we need to come up with a number that we can use to stand for xx. A value is represented by the notation xx in the equation. To put it another way, 270 plus anything equals 342. Either we may reorganise the issue and then attempt to bring both sides of the 'equals' sign into balance, or we can make educated estimates in order to compute the solution.

$270 + xx = 342$

$(270 - 270) + xx = 342 - 270$

$xx = 72$

$\therefore Th$ cost of labour was $72.00

You would probably agree that it is simpler and much quicker to solve the issue described above in your brain rather than using the approach that was utilised. On the other hand, having a process that can be broken down into steps is essential for tackling difficult issues. To put it another way, thinking algebraically entails working methodically to solve problems and abstract mathematical procedures.

**Importance of Algebra:**

1. Problem-solving tool: Algebra provides a powerful framework for problem-solving in various fields, including physics, engineering, economics, computer science, and many others. It allows us to formulate complex problems into mathematical equations, making them easier to analyze and solve.
2. Understanding relationships: Algebra enables us to express and understand relationships between variables and quantities. By representing real-world situations with algebraic expressions and equations, we can gain insights into how different factors influence each other.
3. Generalization of arithmetic: Algebra generalizes arithmetic operations. Instead of working with specific numbers, we can use symbols (like x, y) to represent any number, making the approach more flexible and widely applicable.
4. Modelling real-world scenarios: Many real-world situations involve changing or unknown quantities. Algebra allows us to model and analyze these scenarios, helping us make predictions, optimize processes, and understand complex systems.
5. Preparation for higher mathematics: Algebra serves as a foundational skill for more advanced areas of mathematics, such as calculus, linear algebra, statistics, and differential equations. Without a solid understanding of algebra, it becomes challenging to grasp these higher-level concepts.
6. Technology and science applications: Algebra plays a crucial role in various technological and scientific fields. For example, in computer programming, algebraic concepts are essential for writing algorithms and solving computational problems.

7. Financial planning and economics: Algebra is used in financial planning, budgeting, and economics. It helps with calculations related to loans, investments, and analyzing economic trends.
8. Critical thinking and logical reasoning: Algebraic problem-solving requires logical thinking and step-by-step analysis. It promotes critical thinking skills, helping individuals approach complex problems methodically and logically.
9. Personal finance and daily life: Understanding algebra allows individuals to manage personal finances better, calculate discounts, understand interest rates, and make informed decisions about purchases and investments.

**Different Profiles in Mathematics Education**

It may seem clear that algebra should play a significant part in the teaching of mathematics in schools given that it is generally acknowledged that proficiency in algebra is a crucial tool for pursuing a variety of different forms of education and career in a contemporary society that is heavily reliant on technological advancements. However, a number of analyses based on data from several international studies on a large scale have shown that there are significant differences between countries when it comes to the emphasis placed on algebra in school mathematics; in some countries, algebra plays a significant role in school mathematics, while in other countries, this is not the case.

International assessment surveys such as TIMSS, TIMSS Advanced, and PISA aim to establish scores for students' achievement that are reliable and valid and that can be compared across countries or across groups of pupils within countries. These surveys also attempt to relate achievement to a variety of background and context variables that may give ideas about possible indicators for characterization of high performance in mathematics. TIMSS, TIMSS Advanced, and PISA are examples of international assessment surveys. Students participating in this kind of tertiary education have been the subject of a worldwide comparative research on teacher education in mathematics. This study collected the same sorts of data as the previous one. All of these studies provide the possibility of doing secondary analyses, which may then be used to address a variety of different research issues. An important research topic that has been addressed is whether or not it is fair to differentiate between different profiles of mathematics education in various nations or groups of countries, and to what degree such profiles appear to be consistent over time and at different levels in school. This is a question that has been posed because it is vital for researchers to determine whether or not it is reasonable to make such a distinction. In this work, particular emphasis will be placed on analysing the function of algebra in a variety of country categories.

On the basis of the data gathered from all of the aforementioned research, a variety of analyses have been carried out in order to seek for trends in the kinds of mathematical topics that are prioritised in the educational systems of various nations. A sort of cluster analysis that looks for "item-by-country interactions" is a technique that is often employed in these studies. The purpose of this approach is to study the similarities and differences that exist across nations or groups of countries across cognitive items. For further information on these many forms of cluster analysis,. It is essential to understand that while discussing results in this manner, one is referring to relative performance. Because the cluster analysis reveals groups of nations according to similarities in relative response patterns across items, countries with varying levels of performance might thus exhibit equivalent patterns for the sort of mathematical content that is emphasised. This is possible due to the fact that the cluster analysis presents groupings of countries. The relative strengths and weaknesses of the countries that are grouped together tend to be more consistent across the board. These kind of analyses have been carried out using data from the very first TIMSS survey, which was carried out in 1995, as well as data from a number of subsequent worldwide studies, which were carried out at various levels of education and with varying frameworks depending on the type of mathematical competence that was being tested in the study. The analysis of the data from TIMSS 1995 came to the conclusion that the following clusters of nations created important profiles from a geographical, cultural, or political point of view. These meaningful profiles are as follows: countries that speak English, countries that speak German, countries from East Europe, countries from the Nordic region, and countries from East Asia. Following this, the focus of the article will be on the four profiles that have shown consistent profiles in a number of subsequent assessments. We have decided not to include the German-speaking profile since subsequent investigations have shown that this profile is not very consistent. Grnmo et al. also made use of the residuals in the matrix that served as the foundation for the cluster analysis that was discussed in the section before this one in order to determine the aspects of the study in which a specific group of nations performed especially well or poorly. They came to the conclusion that it was customary for East European and East Asian nations to concentrate on classical, pure, and abstract mathematics such as algebra and geometry, and that this was the case for the things on which these regions appeared to do comparatively well. In contrast to this conclusion, both the English-speaking group and the Nordic group fared considerably better on mathematical tasks that are more closely related to real-world applications, such as estimating and rounding figures. Both the Nordic and the English-speaking groups performed rather poorly on questions that dealt with more traditional and abstract forms of mathematics, such as fractions and algebra.

After then, studies of this kind were carried out using information from the TIMSS 2003 and PISA 2003 surveys, as well as the TIMSS Advanced 2008 and TEDS-M 2008 surveys. The investigations have been carried out over the course of a considerable amount of time, and participants from a variety of nations have contributed to the research, both of which have an impact on the final conclusion. In spite of this, the findings of all of these studies have led researchers to the conclusion that there seems to be a constant pattern of nations clustering together for mathematics in the classroom into four distinct groups: the Nordic group, the English-speaking group, the East European group, and the East Asian group. The studies have been carried out at a variety of educational levels, from the lower secondary level all the way up to the upper secondary level, and even at the level of mathematical education for teachers. The research studies that provided the data for these sorts of analyses each used a distinct methodology for their examinations, as well as a unique set of questions to evaluate the students' level of expertise. PISA evaluates students based on their ability to find solutions to issues that are mostly taken from real-life situations, with some challenges also coming from more professional settings. Before students may apply mathematics to solve one or more problems, the context must first be given via text and tables, and quite a bit of reading must also be completed. Additionally, students must demonstrate an ability to link and comprehend various kinds of knowledge. The PISA does not include any questions or tasks that measure pupils' ability in basic math. When it comes to reading, the TIMSS items for students in lower secondary school are not as challenging as the PISA items since the TIMSS items test students on pure mathematics as well as items that test students on algebra in context. Students in TIMSS Advanced are tested on a number of questions in pure algebra, as well as those in context; nonetheless, the intricacy of this study lies in the realm of mathematics, as opposed to reading, as it does in PISA. In addition to assessing students' knowledge of basic algebra from the point of view of how it should be taught in the classroom, the TEDS-M exam evaluates students who are studying to become teachers on their ability to teach algebra. All of these analyses, however, produce results that are consistent with one another, indicating that it is reasonable to draw the conclusion that there are four distinct profiles in mathematics education. These profiles appear to be stable over time, at various levels of education, and in various studies regardless of the study framework or the way in which the items of the tests are formulated. It is important to speak about two very distinct sorts of profile, despite the fact that the analyses indicate four different types of profiles. This finding is particularly fascinating when seen from the viewpoint of algebra in the classroom. The nations of East Asia and East Europe make up one kind of profile, whereas the countries of the English-speaking world and the Nordic region make up the other type. To recap, even though each of the four profiles has its own unique set of distinguishing characteristics, we are able to identify a number of obvious parallels between the two sets of nations that we have categorised as having the same sort of profile. Both the East Asian and the East European profiles are pretty comparable in the sense that both groups do substantially better in conventional mathematical subject areas like algebra rather than in mathematics that is more directly relevant to daily life such as data representation and probability. This is one way in which the East Asian and East European profiles are similar. In the same way that the profiles of English-speaking nations and Nordic countries indicate similarities, the performance of both of these groupings of countries is comparatively better in the areas of data representation and probability and substantially poorer in the area of algebra. The persistent difference between the two kinds of profiles according to algebra is a crucial foundation for discussions and conclusions in this research. This difference is based on a variety of cluster analyses of data from TIMSS, TIMSS Advanced, PISA, and TEDS. The conclusions drawn concerning the disparities in the focus placed on algebra in various nations are confirmed not just by one form of analysis but also by many others. things from TIMSS, TIMSS Advanced, and PISA have been re-categorized according to whether or not they need algebraic manipulation in order to be solved. This has been followed by a comparison of how well students in various nations are able to solve the re-categorized things.

**Conclusions**

In a nutshell, algebra is an essential mathematical tool that may be used to a broad variety of situations. It helps us to simulate real-world problems, offers a framework for more sophisticated mathematical ideas, and gives a disciplined and methodical approach to problem-solving. It is crucial to place an emphasis on algebra education in order to provide people with the mathematical abilities they need to successfully traverse the many facets of modern life and make meaningful contributions to contemporary society.

**Reference**


1. Algebra: Introductory and Intermediate" by Richard N. Aufmann and Joanne Lockwood.
2. "Algebra and Trigonometry" by Michael Sullivan.
3. "Abstract Algebra" by David S. Dummit and Richard M. Foote.
4. "Algebra: Chapter 0" by Paolo Aluffi.
5. "Algebra" by Serge Lang.
6. "Algebra for College Students" by Mark Dugopolski.
7. L. BILLERA, Homology of smooth splines: Generic triangulations and a conjecture of Strang, Trans. Amer. Math. Soc. 310 (2010), 325–40
8. A. M. COHEN, H. CUYPERS, and H. STERK (eds.), Some Tapas of Computer Algebra, Springer-Verlag, Berlin, Heidelberg, and New York, 2008.
9. J. S. COHEN, Computer Algebra and Symbolic Computation: Elementary Algorithms, A K Peters, Wellesley, MA, 2010.
10. ——— , Computer Algebra and Symbolic Computation: Mathematical Methods, A K Peters, Wellesley, MA, 2012
11. D. COX, J. LITTLE, and D. O'SHEA, Using Algebraic Geometry, second ed., Springer-Verlag, New York, Berlin, and Heidelberg, 2009.
12. D. COX, T. SEDERBERG, and F. CHEN, The moving line ideal basis of planar rational curves, Comput. Aided Geom. Des. 15 (2011), 803–27.
13. C. P. SIMON and L. BLUME, Mathematics for Economists, W. W. Norton, New York and London, 2011.
14. H. STETTER, Numerical Polynomial Algebra, SIAM, Philadelphia, 2011