# Notes from a Tutoring Project: Bridging the Language Gap in Mathematics for Hindi Medium Learners During the Secondary-Tertiary Transition

Kumar Gandharv Mishra & Shantha Bhushan

# Abstract

In this paper, we present an analysis of a pilot programme that addressed the complexity of transition from school to university mathematics. We undertook this project during the Covid lockdown 2020 and supported seven highly disadvantaged students whose mother tongue was Bengali but had studied in a Hindi medium school till tenth grade and were aspiring to join the undergraduate mathematics programme taught in English. The key challenges were language, mathematical content, socio-economic issues, online instruction, and uncertainty caused by the pandemic in 2020. So, the project was undertaken to bridge this language gap as well as enhance their mathematical skills for qualifying university level entrances. Three of these students joined the mathematics programme of the Azim Premji University that is committed to supporting diversity.

**Keywords:** Hindi medium learners, language transition, mathematical learning

### Introduction

How difficult is it for Hindi medium school students to learn mathematics in English? What are the challenges involved in this transition, and what methods can be applied to ease this transition? The paper tries to answer such questions and shares our experience of teaching mathematics to seven Hindi-speaking students. These seven students were also native Bengali speakers. Their study had been affected due

to the Covid-19 pandemic, and the school from where they had passed high school took an initiative to tutor such students online. They were enrolled in grade XII in different institutes after they completed their schooling (up to grade X) in Hindi medium at a school under the Azim Premji Foundation. Since the purpose of tutoring was to prepare them for university entrance examinations, we focussed on building their mathematical reasoning, elementary mathematics and some portion of grade XI-XII mathematics. However, language was an issue, as students had studied mathematics in Hindi medium till grade X. The transition from secondary school into university mathematics-also referred to as secondary-tertiary transition (STT)-is a sensitive moment for many students (Gregorio et al., 2019). Gueudet (2008, as cited in Gregorio et al., 2019) counts social changes as one of the aspects during the secondary-tertiary transition. In India, when students come across this transition, they also come across a change in medium of instruction from regional language or Hindi to English while studying university level mathematics, and face several challenges (Mishra & Sharma, 2017). Generally, the medium of instruction, especially in sciences, shifts to the English medium at university and college level in India. Thus, one of the aims of the tutoring project was also to make these students familiar with mathematics in English medium, so that they do not face any problem during the entrance examinations, as well as when they move to university level.

During initial discussions, students expressed their problems with English language such as their inability to understand mathematical terminology in English, and the inability to comprehend longer sentences given in English. It was important to build their confidence with the English language along with mathematics. Thus, we chose elementary but fundamental topics for the simple reason that when students have familiarity with mathematics, they can concentrate on the language part. This also gave the tutor and mentor the time to understand the students in an environment of online and distance learning. We started working on their mathematical vocabulary with elementary topics like fractions, decimals, percentage, and ratio-proportion. Working with such topics provided us a good chance to explore mathematical vocabulary. Other topics included Coordinate Geometry, Geometry, Surface Area and Volume, General Reasoning, Matrix, Functions, Linear Programming and Probability. These were covered at the backend of the project. General Reasoning comprised topics like Number List, Direction, Relation, Coding-Decoding, Pictorial Reasoning and Arrangement. The tutoring project revolved around bridging language transition with elementary mathematics. During the tutoring project, the first author was in the role of tutor, and the second author was in the role of mentor. The students were also taught English in a separate session by other tutors which was independent of our session. Below we present the details and learnings from this programme.

# Bridging the Language Gap

Knowing that language is a crucial factor in determining learning, we began with an informal online interaction with students. First, we provided them with a comprehension passage in English comprising mathematical vocabulary and asked them to encircle the mathematical words in it. They encircled most of the mathematical words but later we came to know that they had used the internet to do so. The first couple of interactions with children also helped us identify some other issues. For example, for statements such as "5 is subtracted from 2" and "X is subtracted from Y", students were unable to understand whether it should be 2-5 or 5-2; X-Y or Y-X. They struggled to make meaning out of sentences like "two-fifths of a cake", "one-third of the fruits". They were also unaware of the terminology in English, for example, Like Fractions, Improper Fractions, Unlike Fractions, etc. Here, we highlight one of the important observations from a word problem on fractions:

"A train starts full of passengers. At the first station, it drops one-third of these and takes in 96 more. Now, the total number of passengers in the train is 176. With how many passengers did the train start?"

These students could not understand what 'one-third of these' in English means i.e., 'one-third of passengers', and they used 1/3 for these expressions instead of x/3, where 'x' is the initial number of passengers.

5. Ab.	∝ - 1' =	80	- and a start
	300-1	= 80	
	8x-1 8x 3x x	= 240 = 240 41 = 291 = $\frac{291}{2} + \frac{96}{2}$	
	α	= 529	
	×	· 269.5 Ja	-

Figure 1. A Student's Solution to a Word Problem Based on Fractions

This problem was discussed in the subsequent session and students got to know how to interpret *one-third of something*. Such minute but significant incidents provided us insight into how language transition from one medium (Hindi) to another medium (English) can affect students' learning and their approach to problem-solving in mathematics. Students were provided with a terminology sheet on words and sentences related to fractions which was developed by us. The sheet included the translation of some English sentences into Hindi. For example: "I coloured two-third portion of the paper (Maine kagaz ka do-tihai hissa rang diya - मैंने कागज़ का दो तिहाई हिस्सा रंग दिया), 5 is multiplied by 7 (5 ko 7 se guna kiya gaya- पाँच को सात से गुना किया गया). It helped them figure out the translation. Our first session had started with a test on Fractions for students. The question paper was in English medium. When we provided the students with a Hindi version of the same test paper, students did well as compared to the test in English medium. After a few more tests, we could identify some patterns such as problems in identifying mathematical terms and, problems in meaning and use of prepositions in sentences (say mathematical prepositions). After Fractions, we moved to Decimals and Percentages and other topics. We discussed the Hindi meaning of phrases such as 'two-fifth of ten', '25 per cent of 100', '5 per cent more than

ISSN: 2277-307X

22' when students struggled to make meaning out of such sentences. Regular discussion of such sentences helped them understand the respective meanings. We observed that students started considering 'of' as a substitute for multiplication symbols. To make learning engaging and make students comfortable as well as aware with mathematical terminology, the classroom exercises involved questions mainly based on 'Crossword Puzzle', 'Fill in the Blanks' and 'Match the following'. Apart from these, we regularly also used activities based on 'Jumbled Words', 'Write/Say in words', 'Hindi Translation', 'Make mathematical words from a letter', 'Make mathematical sentences from words', and Comprehension as a classroom activity to strengthen their familiarity with mathematics terminology in English. The students enjoyed quizzes based on forming a mathematical word in English or identifying a mathematical word in English from a crossword puzzle. The first 15-20 minutes of sessions started with these kinds of activities daily. While teaching online, we used screen sharing with help of Ms-paint as a whiteboard and a tablet pen to work on. These activities were part of both synchronous and asynchronous sessions. Here, we provide a sample of our intervention methods embedding mathematical concepts with English grammar.

### 1. Fill in the Blanks:

i. When 2 is subtracted ..... (from/of/with/to) 5, the result is 3.

ii. Two-fifth ..... (from/of/with/to) 25 is 10.

iii. 5 multiplied...... (from/of/with/to/by) 7/5 equals 7.

iv. One-fourth...... (and/by/with/to) three-fourth makes one.

2. Use a Preposition (to, from, by, at, of, in) to Fill in the Blanks:

i. If you subtract 6 ..... 10, you get 4.

ii. If you divide 25 ..... 5, you get 5.

iii. If you add 50 ..... 50, you get 100.

iv. If you multiply 15 ..... 4, you get 60.

v. In the fraction a/b, the number ..... the top (a) is called the numerator and the number ..... the bottom (b) is the denominator.

vi. If F = a/b, then b/a is the inverse or reciprocal ..... F.

vii. If a: b::c:d, then a,b,c and d are ..... proportion.

viii. The ratio..... two quantities is 4:3.

# 3. Fill in the Blanks with Suitable Words:

How to find the centroid of a triangle?

To find the centroid ...... a triangle, we need to understand what a centroid is. A centroid is a point obtained by ...... of the three medians of a triangle. Suppose we have a triangle ABC. In this triangle, vertex A is ...... to side BC; vertex B is opposite to side AC and ...... is opposite to AB. We find the mid-point of each side AB, ..... and draw a straight line from each of the corresponding vertices. The straight lines intersect at a common point G inside the triangle. G is the ...... of the triangle and it divides the medians into ratio 2:3.

# 4. Match the Words on the Left with What is Given on the Right:

a. 18 – 8 = 10
b. triangle
c. semicircle
d. 8
e. 33.33
f. 8 + 5 = 13
g. circle
h. one half of $1/2$
i. 30
j. 1/2

### 5. Make Meaningful Sentences from These Words:

- a. Centroid/of/medians/the/point/intersection/is/of
- b. Surface area/cuboid/the/of/sum/is/of/six faces/area/of
- c. Ratio/circumference/circle/diameter/of/constant/is/circle/to/of
- d.Numerator/Improper/is/greater/fraction/denominator/than/in/an

# 6. Write (Say) in Sentences:

- a. 5 72
- b. 6 x 1/12
- c. Pollution  $\alpha 1/Tree$

d. 67.23, 56700.900, 67.045

e. A:B :: 4:5

7. Represent these Sentences as Mathematical Expressions (using symbols, numbers, notations, etc.):

- a. Two multiplied by one-half
- b. Three fourth of a hundred
- c. A point is located 5 units and 4 units from x-axis and y-axis respectively.
- d. 5 paise (in rupees)
- e. Pressure is inversely proportional to volume

### 8. Crossword Puzzle

Identify mathematical words from this crossword:

А	Т	Y	D	0	U	В	L	Е	Η	J	В	J	L
J	Е	Р	Ι	Κ	Y	J	Q	Ν	D	Y	Е	Т	F
Н	F	R	Α	С	Т	Ι	0	Ν	С	Н	Q	R	G
U	Р	0	Н	0	D	Κ	Т	М	0	В	U	D	D
Ν	0	Р	Ν	М	Т	0	W	R	R	V	Ι	S	Y
Ι	L	0	W	Р	Р	Р	Е	Р	D	W	V	D	Η
Т	D	R	R	А	Т	Ι	0	S	Е	0	А	Ι	V
Y	В	Т	Т	R	J	S	D	А	R	Р	L	V	Ζ
G	Y	Ι	Y	Е	Q	U	Α	L	Р	Q	Е	Ι	Е
Н	Т	0	U	S	Η	R	J	Е	Κ	S	Ν	D	Т
D	Е	N	0	М	Ι	Ν	Α	Т	0	R	Т	Е	D
R	U	Т	Н	А	L	F	S	W	Е	С	V	В	Ι
Т	N	Q	U	А	Ν	Т	Ι	Т	Y	Т	Е	R	0
R	Т	Y	U	С	В	D	J	L	Е	0	Р	W	W
Е	A	W	S	В	R	S	C	Ν	Q	W	S	G	D

### 9. Make a Meaningful Sentence from these Pairs of Words:

- a. (Corresponding angles, Parallel lines)
- b. (Transversal, Angles)
- c. (Equal angles, Triangle)
- d. (Isosceles triangle, Perpendicular)
- e. (Square, Triangle)

- f. (Vertex, Angles)
- g. (Polygon, Vertex)
- h. (Line, Line segment)
- i. (Point, Coordinates)
- j. (Parallel, Perpendicular)

#### 10. Comprehension Test

We developed passages based on mathematical concepts and asked the students to write and explain their answers to the questions based on the passage. We also used introductory paragraphs of a chapter from NCERT textbook as the passage and developed some questions for the students to answer. Such exercises helped in developing the confidence of students with mathematical sentences in English.

**Figure 2.** A Sample of Comprehension-Based Test Modified from NCERT Grade X Mathematics Textbook

#### Passage

You must have observed that in nature, many things follow a certain pattern, such as the petals of a sunflower, the holes of a honeycomb, the grains on a maize cob, the spirals on a pineapple and on a pine cone etc. We now look for some patterns which occur in our day-today life. Some such examples are:

(i) Reena applied for a job and got selected. She has been offered a job with a starting monthly salary of Rs 8000, with an annual increment of Rs 500 in her salary. Her salary (in Rupees) for the 1st, 2nd, 3rd, years will be, respectively 8000, 8500, 9000, ....

(ii) The lengths of the rungs of a ladder decrease uniformly by 2 cm from bottom to top. The bottom rung is 45 cm in length. The lengths (in cm) of the 1st, 2nd, 3rd, ..., 8th rung from the bottom to the top are, respectively 45, 43, 41, 39, 37, 35, 33, 31

(iii) In a savings scheme, the amount becomes 5/4 times of itself after every 3 years. The maturity amount (in Rupees) of an investment of Rs 8000 after 3, 6, 9 and 12 years will be, respectively: 10000, 12500, 15625, 19531.25

(iv) The number of unit squares in squares with side 1, 2, 3, units are, respectively  $1^2, 2^2$  ,  $3^2, \ldots$ 



(v) Shakila puts Rs 100 into her daughter's money box when she was one year old and increased the amount by Rs 50 every year. The amounts of money (in Rupees) in the box on the 1st, 2nd, 3rd, 4th, birthday were 100, 150, 200, 250... respectively.

In the examples above, we observe some patterns. In some, we find that the succeeding terms are obtained by adding a fixed number, in other by multiplying with a fixed number; in another we find that they are squares of consecutive numbers, and so on.

(Source: NCERT Math Textbook, Class 10, Chapter - Arithmetic Progression)

On the basis of reading the above paragraph, answer the following questions:

- a. What do you understand by succeeding and preceeding terms? Provide some examples.
- b. How can you find out the succeeding terms in a list of numbers?
- c. Write some examples of patterns which you observe in nature.
- d. What will be Reena's salary in 6th year? Explain your answer.
- e. How many unit squares can fit into a square of 7 units? Explain your answer.
  f. Make your pattern of (a) numbers and (b) some geometrical figures.

# **Discussion and Conclusion**

Mathematics educators working with students whose native language is not English need to be more cognisant of what is known about the complex process of learning a second language (Cuevas, 1984). Several researchers have emphasised the role of language in learning mathematics (e.g., Barwell n.d.; Barton & Barton, 2003; Bose & Choudhary, 2010; Moschkovich, 2007). In India, a study by Mishra and Sharma (2017) has also highlighted the challenges faced by Hindi medium learners in studying mathematics due to change in medium of instruction from regional language or Hindi to English at tertiary level. Mathematics is not "language free" and the specialised vocabulary, syntax and discourse of the subject present challenges for L2 learners (Barton & Barton, 2003). Thus, there is great value in teaching and learning of mathematical vocabulary for non-English medium students, especially when the medium of teaching and learning mathematics changes to English medium. According to Rubenstein and Thomson (2002, as cited in Riccomini et al., 2015), there are at least 11 categories of difficulties associated with learning the language of mathematics: a) meanings are context dependent; (b) mathematical meanings are more precise; (c) terms specific to mathematical contexts; (d) multiple meanings etc. Our interventions were similar with Marzano's (2004, as cited in Riccomini et al., 2015) six steps for effective vocabulary instruction. Riccomini et al. (2015) also proposed activities for teaching mathematical vocabulary involving game-like activities, which we incorporated in our interventions like crossword puzzles.

We believe that the discussed intervention methods can be a good exemplar for bridging the language transition in mathematics. The tutoring project brought out some positive results as currently three of the seven students are studying at Azim Premji University. The project is already undergoing an extension on a large scale. Since this was a pilot project which was complex, we did not attempt to study the behaviour change by doing pre- and post-assessment analysis. Also

given the complexity of online learning and difficulty in obtaining internet connection and mobile/laptop, we decided to monitor the progress of students individually. Students used to send their answer sheets through email and the sheets were evaluated qualitatively to give feedback the next day. The intention of this project was to provide support; therefore, we chose to give each student individual feedback focussed on their growth and, thus, prevent a competitive situation. We made detailed notes for weekly discussions that helped monitor the progress and identify the issues that needed work. Although we were not able to quantify the impact of this project, we could see a clear growth in each of the students.

# Acknowledgements

We are thankful to Dr Vijaya Sheshadri, a language expert who helped us develop intervention methods for enriching the English expertise of learners in the context of mathematics. We thank Manaswi who was also a tutor for a couple of sessions during the initial days of the project. We also thank the principal Lokesh Thakur, and teachers of Azim Premji School, Udham Singh Nagar who made all the logistics possible, and facilitated the students during the project. We are also grateful to Kinnari Pandya, Nitya Vasudevan, Uttara Sengupta and Sonali Barua for their continuous effort behind the project. The project was funded by the Azim Premji Foundation, India.

### References

- Barton, B., & Barton, P.N. (2003). Investigating the relationship between English language and mathematical learning. In M.A. Mariotti (Ed.), CERME 3: Third conference of the European Society for Research in Mathematics Education. Italy.
- Barwell, R. (n.d.). *The role of language in mathematics*. Retrieved from National Association for Language Development in Curriculum: https://www.naldic.org.uk/Resources/NALDIC/docs/resources/documents/The%20 Role%200f%20language%20in%20mathematics.pdf
- Bose, A., & Choudhury, M. (2010). Language negotiation in a multilingual mathematics classroom: An analysis. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia (pp. 93-100). MERGA.
- Cuevas, G.J. (1984). Mathematics learning in English as a second language.

ISSN: 2277-307X

Journal for Research in Mathematics Education, 15(2), 134-144.

Gregorio, F., Martino, P.D., & Lannone, P. (2019). The secondary-tertiary transition in mathematics: Successful students in crisis. *EMS*, *113*(9), 45-47.

- Mishra, K.G., & Sharma, J. (2017). An empirical study into difficulties faced by 'Hindi Medium Board Students' in India at undergraduate mathematics and its social implications. In A. Chronaki (Ed.), 9th International Conference of Mathematics Education and Society-MES9, 2 (pp. 699-708). University of Thessaly.
- Moschkovich, J. (2007). Using two languages when learning mathematics. *Educational Studies in Mathematics*, 64(2), 121-144.
- Riccomini, P.J., Smith, G.W., Hughes, E.M., & Fries, K.M. (2015). The language of mathematics: The importance of teaching and learning mathematical vocabulary. *Reading & Writing Quarterly*, *31*(3), 235-252.

*Kumar Gandharv Mishra* is pursuing a PhD in Education at the Central University of South Bihar.

mishrakumargandharv@gmail.com

*Shantha Bhushan* is a faculty member at Azim Premji University, Bengaluru. shantha.bhushan@apu.edu.in