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INTEGRATING VOCABULARY INSTRUCTION INTO MATH CLASSROOM

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ABSTRACT. **Background:** The emphasis on vocabulary instruction in math classes has gained momentum in recent years. Mathematics vocabulary instruction enables students to comprehend and understand mathematical concepts. Most of the study and research findings on integrating or incorporating vocabulary instruction in math classes focus on high school and middle school students. As Math is the foundation for science and engineering, training on math concepts begins at school and extends to the college level.

Methods: The study draws on a simple percentage method to understand students' proficiency in math vocabulary, their difficulties in comprehending the word problems and integrating vocabulary instruction into Math classes. An online questionnaire survey was distributed among first-year undergraduate engineering students in Chennai to identify students' exposure to math vocabulary and their views on integrating vocabulary instruction into the math classroom. The primary data collected through an online survey is analyzed using R studio.

Results and Discussion: As the students come from different backgrounds, the level of understanding the math vocabulary, new or unfamiliar words from real-life experience, adds complexity in the teaching-learning process. Given the system of education with a prescribed time (classes) for completion of the syllabus, both the students and teachers may find it challenging to focus on math vocabulary instruction. The research paper highlights the importance of learning math vocabulary for first-year engineering students and integrating vocabulary instruction into the math classroom.

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Key words and phrases. Engineering, Instruction, Language, Math Vocabulary, Students.

1. Introduction

Vocabulary includes words, phrases and conveys a particular meaning. Vocabulary is always linked to language learning or language acquisition. The concept of a word is always defined by its form, meaning and use. Math vocabulary consists of keywords and terms with specific and general meanings. Academic vocabulary poses a challenge, specifically to English as a Second or foreign language students, as English is the medium of instruction in most of the engineering colleges and universities. Though Mathematics necessitates reading and comprehension to solve word problems, Math vocabulary instruction is not included in the mainstream education in India. A proper balance between the integration of vocabulary instruction and math learning among learners lead to the fulfillment of course objectives and achievement of expected course outcome. Students need to understand content-area texts to acquire math knowledge, solve word problems and learn new math concepts.The language of math where students find it too hard to learn, challenging to comprehend math terms and concepts, are words that do not share the same meaning, completely unfamiliar words, new words and academic vocabulary. Thus, integrating vocabulary into math classes helps students in math vocabulary acquisition, which leads to a better understanding of words in a mathematical context and mathematical concepts, whether new or old.

2. Preliminaries

Math vocabulary instruction is necessary for engineering students as it enables the student to demonstrate their factual, conceptual and procedural knowledge. Green [5] analyzed that students find it difficult to communicate mathematically due to a lack of Math vocabulary. Schell [12] strongly believed that effectiveness in math learning originates from the innovation in skills and concepts. Anderson-Inman and Horney [1] suggested that finding a comprehensive protocol will assist students in upending the difficulties in mathematical learning. Rubenstein and Thompson [11] broadly classified these difficulties under eleven categories. According to Kotsopoulos [7], students consider the language of mathematics as a foreign language and few educationalist view it as a second language. Chad Larson's (2007) research project provides a solution and

emphasis on 'how math vocabulary plays a fundamental role in middle class mathematics'. Hence Bay-Williams & Livers [2] proposed that teaching Math vocabulary in everyday classroom instruction enhances the students to solve math word problems and excel in mathematical concepts. Capraro et.al [4] projected that Math vocabulary is intrinsically confined to students' theoretical understanding of mathematics. Pamela J. Dunston and Andrew M. Tyminski [10] researched the Frayer Model and Feature analysis to reveal the positive effects of integrating Math vocabulary into classroom teaching. Paul J. Riccomini et.al (2015) describes five precise methods for facilitating students to learn and remember essential mathematical vocabulary. Shannon Elisa King's [6] research summarizes the twelve most excellent practices for integrating math vocabulary for K5 elementary students. Bed Raj Acharya [3] designed a qualitative study to explore the difficulties faced by public school students in mathematics learning in their learning framework. Orosco & Abdulrahim [9] recommended that comprehension theories and concepts used in literacy can be acknowledged to the perspective of word problems. Vanessa Valley's [13] study exhibited that regular execution of math word problems in the classroom significantly improved the use and understanding of English math vocabulary. Marjorie Sarah Kabuye Batiibwei [8] observed that learning math through activities supports students to excel in mathematics. Researchers strongly believed that the development and accomplishment of math skills in students lie in establishing a proper understanding of math vocabulary in classrooms. Most of the study and research findings on integrating or incorporating vocabulary instruction in math classes focus on high school and middle school students. As Math is the foundation for science and engineering, incorporating vocabulary into math classrooms encourages students in better learning of content area texts.

3. Main Results

The study draws on a simple percentage method to understand students' proficiency in math vocabulary, their difficulties in comprehending the word problems and integrating vocabulary instruction into Math classes. An online questionnaire survey was distributed among first-year undergraduate engineering students in Chennai to identify students' exposure to math vocabulary and their views on integrating vocabulary instruction into the math classroom. A total of

265 First-year Engineering students participated in the survey and answered the questions. The questionnaire survey consists of 11 questions with ten questions as close-ended and the last question "Suggest ways and measures to improve vocabulary so that solving Math word problems become easier." as an open-ended question. This question aims to understand the students' point of view and their role as stakeholders in curriculum implementation and development.

3.1. **Data Analysis.**

(i) Age Classification

Table 1 - Age classification with Percentage Analysis

Age	**17**	**18**	**19**	**20**	**22**	**Total**
No. of Response	21	154	75	14	1	265
Percentage Analysis	7.93	58.11	28.30	5.28	0.38	100

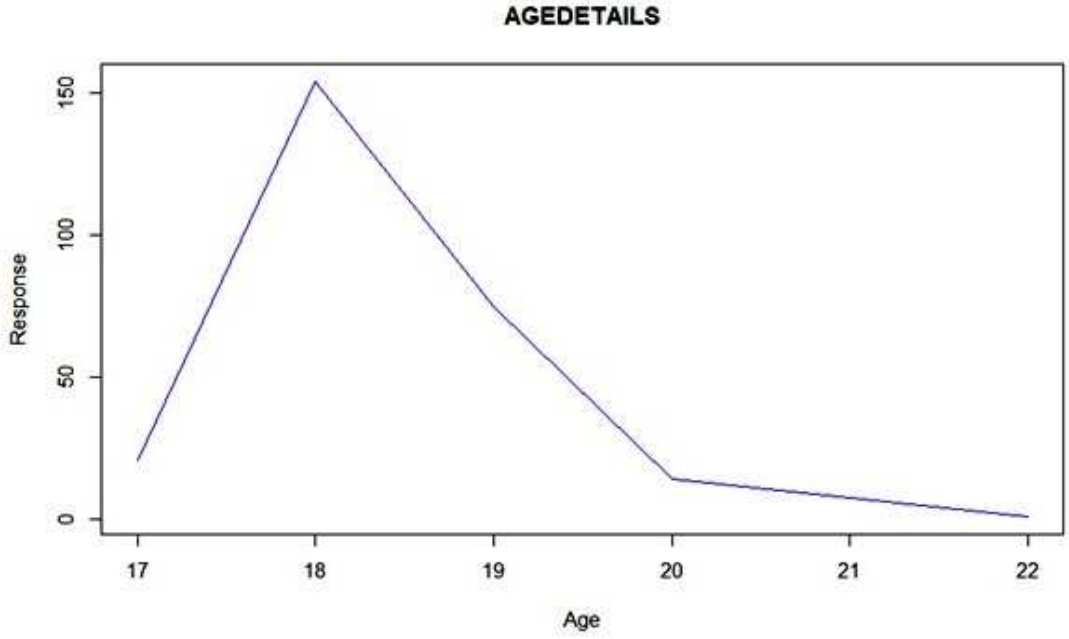

Fig .1 Graph of Participants Age Details

The age group of the respondents ranged from 17-22 years.

(ii) Participants Analysis

A total number of 265 respondents participated in the online survey. The majority of the students who answered the questions were male (83.8 percent). The percentage of female students who contributed to the study was 16.2.

Table 2 - Participants Details with Percentage

Gender	**Male**	**Female**	**Total**
No. of Response	222	43	265
Percentage Analysis	83.8	16.2	100

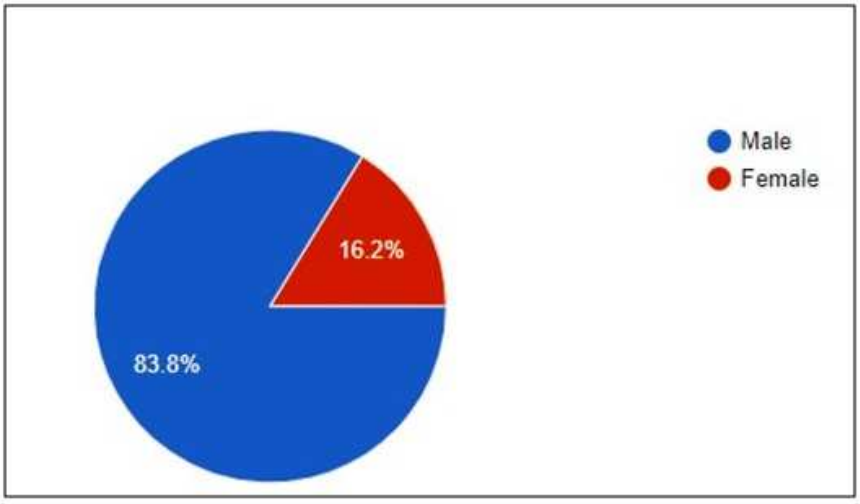

Fig .2 Percentage of Male and Female participated in the survey

(iii) Board of Education

The participants were first-year engineering undergraduate students from Chennai, India.

Table 3 - Board of Education with Percentage Analysis

Board of Education	**CBSE**	**State Board**	**ICSE**	**ISE**	**International Baccalaureate**	**Others**	**Total**
No. of Response	151	89	10	10	1	2	263
Percentage Analysis	57.41	33.84	3.80	3.80	0.38	0.76	100.00

(iv) The Medium of Instruction (School)

Though the English language is the primary medium of instruction for 98.11 percent of students, English is not their mother tongue, a vast majority of students communicate in their mother tongue or native languages. The response to the medium of instruction may lead to the assumption that the students can comprehend better in the English Language. Insufficient language competence

is a significant issue faced by learners for whom English is not a primary language.The majority of the students agree that vocabulary is essential to solve math word problems and help students to excel in content area text.

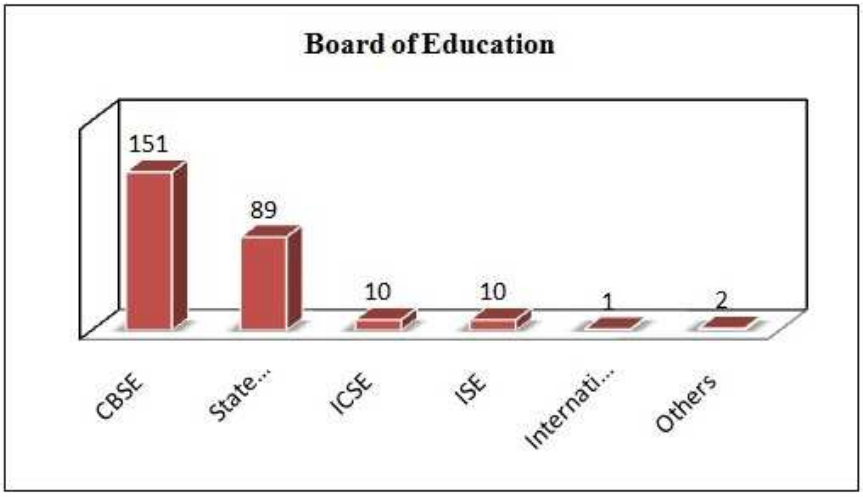

Fig.3 Board of Examination

Table 4 - Medium of Instruction with Percentage Analysis

Medium of Instruction	**English**	**Tamil**	**Telugu**	**Hindi**	**Marathi**	**Bengali**	**Total**
No. of Response	260	0	1	1	2	1	265
Percentage Analysis	98.11	0	0.38	0.38	0.75	0.38	100.00

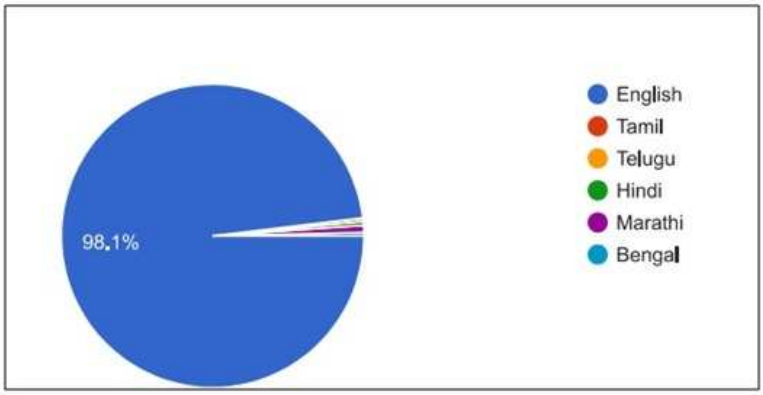

Fig .4 Medium of Instruction

(v) Student's Feedback on Math Vocabulary

Table 5 - Math Vocabulary Questionnaire Analysis

Q.No	Questionnaire	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1.	Vocabulary acquisition and learning begin at the early primary level.	96	138	26	1	2	263
	Percentage Analysis	36.5	52.5	9.9	0.4	0.8	100
2.	Mathematics is the foundation for all engineering subjects.	129	108	22	2	4	265
	Percentage Analysis	48.68	40.75	8.30	0.75	1.51	100
3.	Vocabulary is essential in solving math word problems.	73	144	39	8	1	265
	Percentage Analysis	27.55	54.34	14.72	3.02	0.38	100
4.	Integrating vocabulary into math classrooms should be included in mainstream Indian education.	38	140	73	12	0	263
	Percentage Analysis	14.45	53.23	27.76	4.56	0.00	100

Q.No	Questionnaire	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
5.	Do you think integrating vocabulary instruction in math classes help engineering students?	44	148	61	10	0	263
	Percentage Analysis	16.73	56.27	23.19	3.80	0.00	100
6.	Do you think learning vocabulary helps engineering students to excel in content area text? (Math & Science)	77	139	38	6	2	262
	Percentage Analysis	29.39	53.05	14.50	2.29	0.76	100
7.	Given the time frame for each class, integrating vocabulary learning in math classes is a burden for both teachers and students.	32	90	96	38	3	259
	Percentage Analysis	12.36	34.75	37.07	14.67	1.16	100

4. Results and Discussion

The primary data collected through an online survey is analyzed using R studio. The command matrix in R is used to create the matrix with rows and columns. Command print is used to view the data in matrix form. The summary command is utilized for analyzing the data.

Output:

Command: print(QUES)

	$[,1]$	$[,2]$	$[,3]$	$[,4]$	$[,5]$
$Q1$	96	138	26	1	2
$Q2$	129	108	22	2	4
$Q3$	73	144	39	8	1
$Q4$	38	140	73	12	0
$Q5$	44	148	61	10	0
$Q6$	77	139	38	6	2
$Q7$	32	90	96	38	3

Command: summary(QUES)

$V1$	$V2$	$V3$	$V4$	$V5$
$Min.$: 32.00	$Min.$: 90.0	$Min.$: 22.00	$Min.$: 1	$Min.$: 0.000
$1stQu.$: 41.00	$1stQu.$: 123.0	$1stQu.$: 32.00	$1stQu.$: 4	$1stQu.$: 0.500
$Mean$: 69.86	$Mean$: 129.6	$Mean$: 50.71	$Mean$: 11	$Mean$: 1.714
$3rdQu.$: 86.50	$3rdQu.$: 142.0	$3rdQu.$: 67.00	$3rdQu.$: 11	$3rdQu.$: 2.500
$Max.$: 129.00	$Max.$: 148.0	$Max.$: 96.00	$Max.$: 38	$Max.$: 4.000

Inference:

The survey analysis reveals that students face difficulty in understanding new vocabulary from real-life examples that appear in Math problems. As the students come from different backgrounds, the level of understanding the math vocabulary, new or unfamiliar words from real-life experience adds complexity in the teaching-learning process. Some of the ways and measures to improve math vocabulary are

- Emphasis on vocabulary while teaching math concepts.
- Out of class reading and learning help students to improve their math vocabulary.
- Math vocabulary corpus.

- Regular practice of math word problems and
- Cultivate lifetime reading habits among students.

5. Conclusion

Words that do not share the same meaning, completely unfamiliar words, new words and academic vocabulary are identified as primary focus areas in the teaching and learning process of math language. Teachers should provide opportunities for students to learn unfamiliar terms and words, break the word guessing habit, as the majority of students do the guesswork instead learn the word or its meaning. It is observed that the students and teachers may find it challenging to focus on math vocabulary instruction with limited time (classes) for completion of the syllabus. The instructional time spent on teaching math vocabulary never goes waste, as students develop a clear understanding of the math concepts and actively involve in the meaning-making process of learning math language. Thus the research paper highlights the importance of learning math vocabulary for undergraduate engineering students and integrating vocabulary instruction into the math classroom.

References

[1] L. Anderson-Inman, M. Horney: *Transforming text for at-risk readers. In D.Reinking, L. D. Labbo, M. C. McKenna, and R. D. Kieffer (Eds.), Handbook of literacy and technology: Transformations in a post-typographic world*, Mahwah, NJ: Erlbaum., (1998), 15–43.

[2] J. M. Bay-Williams, S. Livers: *Supporting math vocabulary acquisition*, Teaching Children Mathematics, **16** (2009), 238–245.

[3] B. R. Acharya: *Factors Affecting Difficulties in Learning Mathematics by Mathematics Learners*, International Journal of Elementary Education, **6**(2) (2017), 8–15. Doi: 10.11648/j.ijeedu.20170602.11.

[4] M. Capraro, M. Robert, , W. H. Rupley: *Semantics and Syntax: A Theoretical Model for How Students May Build Mathematical Misunderstandings*, Journal of Mathematics Education, **3**(2) (2010), 58–66.

[5] G. W. Green: *Helping your child to learn math*, Carol Publishing Group: New Jersey, 1995.

[6] S. E. King: *Twelve Best Practices for Mathematics Vocabulary Instruction for K-5 Elementary Students*, School of Education Student Capstone Theses and Dissertations, 4109, 2016.

[7] D. KOTSOPOULOS: *Mathematics Discourse: It's Like Hearing a Foreign Language*, Mathematics.Teacher, **101**(4) (2007), 301–305.

[8] M. S. K. BATIIBWE: *Developing Mathematical Thinking Through The Activity Based Heuristic Approach: A Case Of Making Connections Between Patterns, Sequences And Graphs*, European Journal of Education Studies, **6**(12) (2020), 284–310.

[9] M. J. OROSCO, N. A. ABDULRAHIM: *Examining Comprehension Strategy Instruction with English Learners' Problem Solving: Study Findings and Educator Preparation Implications*, Teacher Education and Special Education, **41**(3) (2018), 215–228.

[10] P. J. DUNSTON, A. M. TYMINSKI: *What's the big deal Vocabulary?. MatheMatics teaching in the Middle school,* **19**(1) (2013), 38–45.

[11] R. RUBENSTEIN, D. THOMPSON: *Understanding and supporting children's mathematical vocabulary development*, Teaching Children Mathematics, **9** (2002), 107–112.

[12] V. J. SCHELL: *Learning Partners: Reading and Mathematics. Reading Teacher*, **35** (1982), 544–548.

[13] V. VALLEY: *The Impact of Math Vocabulary on Conceptual Understanding for ELLs*, An Online Journal for Teacher Research, **21**(2) (2019), https://doi.org/10.4148/2470-6353.1278.

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