# ENGLISH FOR MATH: AN EXPLORATORY NEEDS ANALYSIS OF MATHEMATICS EDUCATION STUDENTS

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**ABSTRACT**

The present exploratory study investigates the English learning needs of Mathematics Education students from the perspective of English for STEM. Although English proficiency is increasingly necessary in mathematics, English teaching for these students is usually general. A descriptive quantitative design was used, and a 28-item needs analysis questionnaire was administered to ten Mathematics Education students at an Islamic university in Makassar. The data were analysed with frequencies, percentages and mean scores to identify the students' perceived necessities, lacks and wants. Because of the small sample, the findings are exploratory and limited to this group. Seven of the ten students agreed that they felt motivated to improve their English, yet only three felt confident using English in class and only one could readily understand lecturers' explanations or videos in English. Seven students chose speaking as the most important skill, and six chose it as the most difficult. Eight students agreed that they needed to improve their grammar and vocabulary, and five agreed that they needed to master the technical terms of mathematics. Neutral responses dominated: half or more of the students chose the neutral option on 16 of the 26 Likert items, so most needs were expressed tentatively. These preliminary results suggest that ESP classes for Mathematics Education students could adopt a speaking-centred, content-based approach that integrates technical mathematics vocabulary with oral communication, and they call for a larger study that combines student questionnaires with interviews, proficiency measures and lecturers' views.

**Keywords:** English for Specific Purposes; English for STEM; Mathematics Education; Needs Analysis

## A. INTRODUCTION

In today's Science, Technology, Engineering and Mathematics (STEM) education, English is not only a universal language of communication but also an essential channel for accessing scientific literature, writing research papers and keeping up with international knowledge. In Mathematics Education, students are required to study English language materials, write research reports and explain complex mathematical ideas. These skills are necessary for academic achievement as well as for preparation for the global job market.

Although English plays a key role in a variety of academic contexts, teaching at university level is often general and overlooks the specific language needs of the disciplines. Consequently, students encounter difficulties when they attempt to learn technical terms, write academic papers and engage in scientific discussion. An English for Specific Purposes

(ESP) approach is therefore necessary in this context, and a thorough needs analysis can help ensure that language teaching supports students in their studies and future work.

Needs analysis is a fundamental step in the development of language curricula, particularly in ESP. Richards (2001) describes needs analysis as the process of determining learners' priorities in order to design the most appropriate programme. Brown (1995) similarly argues that systematically gathering information is essential so that the curriculum actually meets the requirements of a specific group of learners. Early models, such as Munby's (1978) communicative needs processor, focused on describing the target situation in detail.

In the context of ESP, needs analysis is not only concerned with linguistic proficiency. Hutchinson and Waters (1987) distinguish two major types of needs: target needs, which refer to what learners have to achieve, and learning needs, which concern what learners require in order to reach their target. Target needs are commonly analysed as necessities, lacks and wants. Dudley-Evans and St John (1998) extended this idea, arguing that the analysis should cover the present situation and the target situation and take institutional constraints into account. Basturkmen (2010) further highlights the difference between objective needs, which are based on facts, and subjective needs, which come from students' perceptions or desires. When needs analysis is treated as a continuous process (Hyland, 2006), educators can develop syllabuses that are more sensitive to the professional context, field of study and student culture.

Earlier empirical research has emphasised the role of needs analysis across a wide range of disciplines. Studies in marketing (Hulwa et al., 2025), business management (Wulandari, 2023), psychology (Ananta et al., 2025), nursing and health sciences (Mohamed et al., 2024; Riza & Ratmanida, 2023), art and design (Mao & Zhou, 2024), fashion and visual communication design (Munir et al., 2025; Saputro & Savitri, 2025) and mechanical engineering (Sbastian & Yuniarto, 2025) have shown that students become more motivated when teaching materials are aligned with their career goals. In STEM fields, however, studies frequently find that students' needs remain unmet while general English instruction continues (Nurhasanah & Kurniawan, 2023). Learning mathematics also involves the challenge of the mathematical register, in which abstract logic and proof must be expressed precisely in language (Halliday, 1978; Pimm, 1987; Schleppegrell, 2007).

Needs analyses that focus on Mathematics Education students, however, were scarce in the literature reviewed for this study. The studies cited above concern fields in which English serves mainly professional communication, and the STEM studies concern engineering and

vocational programmes. Prospective mathematics teachers differ from these groups because they need English for two purposes: to read mathematical texts written in a specialised register and to explain mathematical ideas orally to learners. Little is therefore known about how these students perceive their necessities, lacks and wants, or whether their priorities follow the written orientation of their discipline or the oral demands of teaching.

Many ESP studies identify speaking as the major communicative need (Ananta et al., 2025; Riza & Ratmanida, 2023), but the needs of Mathematics Education students may differ, because their discipline relies heavily on written forms and logical symbols. The present exploratory study therefore investigates the English language needs of Mathematics Education students from the perspective of English for STEM. By identifying their necessities, lacks and wants, the study aims to provide a basis for ESP curricula that are aligned academically and professionally with the field of mathematics. The study addressed the following research questions:

RQ1. What are the target needs (necessities) of Mathematics Education students in learning English?

RQ2. What are the students' current competences and language lacks?

RQ3. What are the students' wants, learning preferences and field-related needs?

## B. LITERATURE REVIEW

### *Needs Analysis in English for Specific Purposes*

ESP is an approach to language teaching in which decisions about content and method are based on the learner's reason for learning (Hutchinson & Waters, 1987). Rather than restate the models outlined in the Introduction, this section considers what they imply for Mathematics Education students. In Hutchinson and Waters' (1987) terms, the necessities of these students arise from two target situations: studying mathematics, which requires reading textbooks and articles and writing reports, and teaching mathematics, which requires explaining concepts orally. Their lacks are the distance between their present English and the demands of both situations, and their wants may favour one situation over the other. Dudley-Evans and St John's (1998) present situation analysis is relevant because, where mathematics is taught mainly in Indonesian, students meet English chiefly in general courses, and their present situation may differ sharply from the target situation. Basturkmen's (2010) distinction between objective and subjective needs is equally important for this study: a student

questionnaire captures subjective, perceived needs, which must later be compared with objective information from lecturers, curricula and proficiency measures.

### *English for STEM and Mathematics*

In STEM disciplines, English is used to read textbooks and research articles, write reports and present findings. Needs analyses in engineering and other technical fields have shown that students value both receptive skills for reading technical texts and productive skills for professional communication (Nurhasanah & Kurniawan, 2023; Sbastian & Yuniarto, 2025). Mathematics poses additional challenges. Mathematical texts combine natural language with symbols and formulas in a specialised mathematical register (Halliday, 1978; Pimm, 1987). Schleppegrell (2007) shows that this register packs meaning into dense noun phrases, gives everyday words technical meanings and relies on precise logical connectors, so explaining a concept or a proof in English requires more than general vocabulary. Prospective mathematics teachers also need English to explain concepts orally to others. These features suggest that English courses for Mathematics Education students should combine technical vocabulary with the language needed to explain mathematical ideas, and that a needs analysis for this group should ask about both written and oral demands.

## C. METHOD

### *Research Design and Participants*

This exploratory study adopted a descriptive quantitative design to investigate the English learning needs of Mathematics Education students from the perspective of English for STEM. It aimed to identify three facets of needs, namely necessities, lacks and wants, as a starting point for the design of relevant ESP instruction. The participants were ten undergraduate students in the Mathematics Education programme at an Islamic university in Makassar, selected through purposive sampling. The inclusion criterion was that students had used English for academic purposes in their study of mathematics. The sample is too small for generalisation: each respondent represents ten percentage points. The study is therefore framed as an exploratory pilot needs analysis whose purpose is to identify tentative patterns in one setting and to inform the design of a larger study, not to estimate the needs of Mathematics Education students in general.

### *Instrument and Data Analysis*

The instrument was a structured needs analysis questionnaire in two parts (see Appendix). The first part collected demographic information. The second part contained 28 items

organised around Hutchinson and Waters' (1987) categories of necessities, lacks and wants. Twenty-six items used a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5), and two items (items 5 and 14) asked students to choose the single most important skill and the single most difficult skill. The items were adapted from earlier ESP needs analyses (name the sources) or developed by the researchers, the language in which they were presented to students, and how they were reviewed, e.g., by an ESP lecturer, before use. The questionnaire was administered through Google Forms.; participation was voluntary and anonymous. Internal consistency (e.g., Cronbach's alpha) was not calculated because a sample of ten does not yield a stable reliability estimate; this is acknowledged as a limitation. The data were analysed descriptively. For each Likert item, the frequency and percentage of each response option and the mean score were calculated. Because each percentage represents only a few students, frequencies are reported alongside percentages, and an item was interpreted as showing a clear tendency only when at least half of the students agreed or disagreed. Items on which most students chose the neutral option were interpreted as showing uncertainty rather than need.

## D. FINDINGS AND DISCUSSION

### *Findings*

The questionnaire items were grouped into four categories: target needs and learning motivation, current competence and language lacks, skill priority and perceived difficulty, and learning preferences and professional requirements.

*Target needs and learning motivation*

Table 1 presents students' perceptions of the importance of English for their academic and professional careers.

**Table 1.** Target needs and learning motivation

| No. | Statement | SD | D | N | A | SA | Mean |
|---|---|---|---|---|---|---|---|
| 1 | I need English to understand academic texts in mathematics. | 0 | 0 | 8 (80%) | 1 (10%) | 1 (10%) | 3.30 |
| 2 | English is important for my career as a prospective educator or professional in mathematics. | 1 (10%) | 0 | 5 (50%) | 1 (10%) | 3 (30%) | 3.50 |
| 3 | I will use English in my future academic activities or work. | 0 | 1 (10%) | 4 (40%) | 3 (30%) | 2 (20%) | 3.60 |
| 4 | I have had positive experiences learning English before. | 0 | 1 (10%) | 6 (60%) | 2 (20%) | 1 (10%) | 3.30 |

| No. | Statement | SD | D | N | A | SA | Mean |
|---|---|---|---|---|---|---|---|
| 6 | I feel motivated to improve my English. | 0 | 1 (10%) | 2 (20%) | 4 (40%) | 3 (30%) | 3.90 |
| 8 | I enjoy learning English and consider it important. | 0 | 2 (20%) | 4 (40%) | 3 (30%) | 1 (10%) | 3.30 |

*Note.* n = 10. Values are numbers of students, with percentages in parentheses. SD = strongly disagree (1); D = disagree (2); N = neutral (3); A = agree (4); SA = strongly agree (5). Means were calculated from the response frequencies.

Responses in this category were dominated by the neutral option. Motivation was the only item on which a clear majority agreed: seven students agreed or strongly agreed that they felt motivated to improve their English (M = 3.90). Five students expected to use English in their future academic activities or work (M = 3.60), and four agreed that English was important for their careers as prospective educators or mathematics professionals (M = 3.50). On the remaining items the neutral option was chosen most often: eight students were neutral about needing English to understand academic texts in mathematics, and six were neutral about their previous experiences of learning English. With this distribution, means between 3.30 and 3.60 reflect neutrality more than agreement. The students appear to value English in general but to be uncertain about its specific role in their mathematics studies.

*Current competence and language lacks*

Table 2 presents students' self-perceived proficiency and specific difficulties.

**Table 2.** Current competence and language lacks

| No. | Statement | SD | D | N | A | SA | Mean |
|---|---|---|---|---|---|---|---|
| 7 | I am confident using English in class. | 0 | 2 (20%) | 5 (50%) | 0 | 3 (30%) | 3.40 |
| 9 | I can understand simple academic texts in English. | 0 | 3 (30%) | 5 (50%) | 1 (10%) | 1 (10%) | 3.00 |
| 10 | I can speak English in everyday conversation. | 1 (10%) | 2 (20%) | 4 (40%) | 2 (20%) | 1 (10%) | 3.00 |
| 11 | I can write reports or short assignments in English. | 10% | 20% | 60% | 10% | 10% | 2,65 |
| 12 | I can understand lecturers' explanations or videos in English. | 1 (10%) | 2 (20%) | 6 (60%) | 1 (10%) | 0 | 2.70 |
| 13 | I still struggle to speak fluently in academic contexts. | 0 | 2 (20%) | 4 (40%) | 4 (40%) | 0 | 3.20 |
| 15 | I have difficulty understanding technical terms in English. | 0% | 0% | 70% | 30% | 10% | 3.30 |
| 16 | I need to improve my grammar and vocabulary to support my studies. | 0 | 0 | 2 (20%) | 4 (40%) | 4 (40%) | 4.20 |

*Note.* n = 10. Values are numbers of students, with percentages in parentheses. SD = strongly disagree (1); D = disagree (2); N = neutral (3); A = agree (4); SA = strongly agree (5). Means were calculated from the response frequencies.

Students' self-assessed competence was modest, and neutral responses again predominated. Three students felt confident using English in class (M = 3.40), two could understand simple academic texts in English (M = 3.00), and only one could understand lecturers' explanations or videos in English (M = 2.70, the lowest mean in the questionnaire). Four reported that they still struggled to speak fluently in academic contexts (M = 3.20). The clearest result was the need for language knowledge: eight students agreed or strongly agreed that they needed to improve their grammar and vocabulary to support their studies (M = 4.20, the highest mean in the questionnaire).

*Skill priority and perceived difficulty*

Two items asked students to choose the most important skill for achieving their goals and the skill they found most difficult (Table 3).

**Table 3.** Skill priority and perceived difficulty

| Skill | Most important skill, n (%) | Most difficult skill, n (%) |
|---|---|---|
| Speaking | 7 (70%) | 6 (60%) |
| Reading | 2 (20%) | 0 |
| Writing | 1 (10%) | 1 (10%) |
| Listening | 0 | 3 (30%) |

*Note.* n = 10. Values are numbers of students, with percentages in parentheses. Each student chose one skill for each question (items 5 and 14).

Seven students chose speaking as the most important skill for achieving their goals, two chose reading and one chose writing; none chose listening. Six students chose speaking as the most difficult skill, three chose listening and one chose writing; none chose reading. Speaking was therefore both the most valued and the most challenging skill for this group. Because each student could choose only one skill and the pattern rests on seven and six students, it shows which skill was most salient to the students rather than how they weigh the four skills against each other.

*Learning preferences and professional requirements*

Table 4 presents students' learning preferences and their needs related to the mathematics field.

**Table 4.** Learning preferences and professional requirements

| No. | Statement | SD | D | N | A | SA | Mean |
|---|---|---|---|---|---|---|---|
| 17 | I learn better through discussions and group work. | 1 (10%) | 1 (10%) | 6 (60%) | 1 (10%) | 1 (10%) | 3.00 |
| 18 | I prefer learning through real-life activities or simulations. | 0 | 1 (10%) | 4 (40%) | 2 (20%) | 3 (30%) | 3.70 |

| No. | Statement | SD | D | N | A | SA | Mean |
|---|---|---|---|---|---|---|---|
| 19 | I often use videos, apps, or the internet to learn English. | 0 | 0 | 7 (70%) | 1 (10%) | 2 (20%) | 3.50 |
| 20 | I understand the material better when the lecturer provides examples relevant to my field. | 0 | 0 | 5 (50%) | 2 (20%) | 3 (30%) | 3.80 |
| 21 | I need to understand how to communicate professionally in my field. | 1 (10%) | 0 | 4 (40%) | 3 (30%) | 2 (20%) | 3.50 |
| 22 | I need to master the technical terms used in mathematics. | 0 | 0 | 5 (50%) | 1 (10%) | 4 (40%) | 3.90 |
| 23 | I hope this course will help me communicate effectively in academic and professional contexts. | 0 | 1 (10%) | 6 (60%) | 1 (10%) | 2 (20%) | 3.40 |
| 24 | I need to learn how to explain mathematical concepts using English. | 0 | 1 (10%) | 4 (40%) | 4 (40%) | 1 (10%) | 3.50 |
| 25 | I want this course to focus on language skills relevant to mathematics. | 1 (10%) | 0 | 5 (50%) | 3 (30%) | 1 (10%) | 3.30 |
| 26 | I want learning materials that are practical and relevant to real-world needs. | 0 | 0 | 4 (40%) | 4 (40%) | 2 (20%) | 3.80 |
| 27 | Learning facilities (such as LCDs, internet, books) support the English learning process. | 0 | 1 (10%) | 5 (50%) | 1 (10%) | 3 (30%) | 3.60 |
| 28 | I have the opportunity to practice English outside of class. | 1 (10%) | 0 | 5 (50%) | 2 (20%) | 2 (20%) | 3.40 |

*Note.* n = 10. Values are numbers of students, with percentages in parentheses. SD = strongly disagree (1); D = disagree (2); N = neutral (3); A = agree (4); SA = strongly agree (5). Means were calculated from the response frequencies.

Preferences in this category were also marked by many neutral responses (40% to 70% per item), but some tendencies emerged. Six students wanted learning materials that are practical and relevant to real-world needs (M = 3.80), and five agreed that they understood the material better when the lecturer gave examples relevant to their field (M = 3.80) and preferred real-life activities or simulations (M = 3.70). On field-related needs, five students agreed that they needed to master the technical terms of mathematics, four of them strongly (M = 3.90), and five agreed that they needed to learn how to explain mathematical concepts in English and to communicate professionally in their field (both M = 3.50). Only two students preferred discussions and group work (M = 3.00), the lowest-rated preference.

### *Discussion*

Because the data come from ten students' self-reports, the findings describe perceived needs, that is, subjective needs in Basturkmen's (2010) terms, rather than independently established requirements of the target situation. Within this limit, the data suggest a perceived gap between the importance students attach to English and the competence they believe they have. According to Hutchinson and Waters (1987), effective English teaching should be based on the reasons why students need the language in particular target situations. The

perceived gap was clearest for speaking and for understanding English-medium explanations; for the other skills, most students chose the neutral option, so the data do not show a clear gap. In Richards' (2001) terms, the priority these students expressed is to improve oral communication, which they associate with the professional demands of mathematics teaching.

One of the most notable findings is the contradiction in students' skill priorities. Seven students chose speaking as their top priority, yet six considered it the hardest skill to master. This pattern illustrates the value of combining present situation analysis and target situation analysis, as suggested by Dudley-Evans and St John (1998), which allows teachers to treat students' current ability as a starting point and the competence expected in the workplace as the goal. The result also contrasts with the expectation, stated in the Introduction, that Mathematics Education students might prioritise written skills; instead, it agrees with ESP studies in other fields that identify speaking as the main communicative need (Ananta et al., 2025; Riza & Ratmanida, 2023). Students' stated need to master the technical terms of mathematics also illustrates Basturkmen's (2010) distinction between subjective needs, which students perceive, and objective needs, which must be established from the target situation; confirming whether technical vocabulary is the main objective need would require lecturers' views and an analysis of course materials. Integrating technical mathematics vocabulary would nevertheless make English teaching more relevant to students' professional expectations.

Students' learning preferences also showed an orientation towards practical and field-relevant methods. Five students stated that they understood the material better when the lecturer gave examples from mathematics, and three regularly used videos, apps or the internet to learn English. This is in line with Hyland's (2006) view that needs analysis should be a continuous process that considers students' professional and academic contexts, not only linguistic aspects. The ESP course should therefore draw on input from various sources, including students and other stakeholders, as Brown (1995) suggests. The high proportion of neutral responses also deserves attention: half or more of the students chose the neutral option on 16 of the 26 Likert items. Several explanations are possible. Students may have had little experience of using English in their mathematics courses, some items may have been too general, or students may have been reluctant to commit to a position. The data cannot distinguish between these explanations, so the suggestion that students' needs are not yet clearly formed remains one possible interpretation; follow-up interviews or open-ended questions would be needed to test it. With these cautions, a focus on speaking skills and technical vocabulary appears to be a reasonable starting point for ESP courses for this group.

## E. CONCLUSION

This exploratory study suggests that the Mathematics Education students surveyed are aware of the importance of English for their future but perceive a gap between their motivation and their competence. Speaking emerged as both their top priority and their greatest difficulty, and most students reported a need to improve grammar and vocabulary. Because these findings rest on ten students' self-reports, many of which were neutral, they should be read as tentative indications for this group rather than as established needs.

With this caution, the findings suggest that an ESP course for these students could strengthen oral skills and integrate English with mathematics content, for example by teaching technical vocabulary through explanations of mathematical concepts and by using digital media for practice. These suggestions should be tested and refined through a larger needs analysis before they are used to design a curriculum.

This study has several limitations. First, the sample included only ten students from one programme, so the results cannot be generalised. Second, the questionnaire was not formally validated and revise if the items were reviewed by experts, and its reliability was not estimated. Third, neutral responses dominated many items, and the two single-choice items could not show how students weigh the four skills relative to one another. Fourth, the data are students' self-assessments rather than proficiency measures, and they represent only the students' perspective; lecturers' views would allow subjective needs to be compared with objective needs, as Basturkmen (2010) recommends. Future research should involve whole cohorts across semesters, use a validated instrument with a rating or ranking item for each skill, add interviews and proficiency measures, and include the perspectives of lecturers and other stakeholders.

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**Appendix: Needs Analysis Questionnaire**

Part A collected demographic information. Part B contained the 28 items below. Items 5 and 14 were single-choice questions; all other items were rated on a five-point scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

1. I need English to understand academic texts in mathematics.
2. English is important for my career as a prospective educator or professional in mathematics.
3. I will use English in my future academic activities or work.
4. I have had positive experiences learning English before.
5. Which skill is the most important for achieving your goals? (Listening / Speaking / Reading / Writing)
6. I feel motivated to improve my English.
7. I am confident using English in class.
8. I enjoy learning English and consider it important.
9. I can understand simple academic texts in English.
10. I can speak English in everyday conversation.
11. I can write reports or short assignments in English.
12. I can understand lecturers' explanations or videos in English.
13. I still struggle to speak fluently in academic contexts.
14. Which skill do you find the most difficult? (Listening / Speaking / Reading / Writing)
15. I have difficulty understanding technical terms in English.
16. I need to improve my grammar and vocabulary to support my studies.
17. I learn better through discussions and group work.
18. I prefer learning through real-life activities or simulations.

19. I often use videos, apps, or the internet to learn English.
20. I understand the material better when the lecturer provides examples relevant to my field.
21. I need to understand how to communicate professionally in my field.
22. I need to master the technical terms used in mathematics.
23. I hope this course will help me communicate effectively in academic and professional contexts.
24. I need to learn how to explain mathematical concepts using English.
25. I want this course to focus on language skills relevant to mathematics.
26. I want learning materials that are practical and relevant to real-world needs.
27. Learning facilities (such as LCDs, internet, books) support the English learning process.
28. I have the opportunity to practice English outside of class.