



Profiling STEM Students' English Writing Skills Based on CEFR Descriptors within an Outcome-Based Education Framework

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Abstract. Promoting English proficiency is central to nurturing students' scientific communication competence in STEM education. This study aims to profile the English writing performance of Physics students using the Common European Framework of Reference for Languages (CEFR) as an assessment tool within an Outcome-Based Education (OBE) framework. A descriptive mixed-methods approach was employed. Nine first-year Physics students were subjected to a written task where they produced short texts describing and evaluating one of their favorite scientists. An assessment rubric was used as a CEFR-linked framework to probe grammar, vocabulary, cohesion, content relevance, and mechanics. The study results demonstrated a proficiency spectrum from A2 to C1. The higher-level writers (B2-C1) have shown good syntactic control, academic vocabulary, and cohesion, while the lower-level writers (A2-B1) exhibited limited grammatical accuracy and lexical range. Despite exhibiting varying levels of precision, all students managed to express their admiration for the scientists and reflect personally where they were partially achieving ILO 6 (scientific communication) or significantly realizing ILO 1 (scientific attitude and lifelong learning). In conclusion, CEFR-based assessment provides valid evidence for aligning English courses with OBE outcomes for STEM students and can effectively strengthen linguistic proficiency and disciplinary engagement.

Keywords: CEFR-Based Assessment, Outcome-Based Education, STEM-English Writing.

1 Introduction

English proficiency has become a critical requirement for university students in STEM disciplines since global scientific communication occurs in English. English classes at the university should be intended as English for Specific Purposes (ESP), aiming to prepare STEM undergraduates to read, write, and present scientific ideas. However, many non-English majors, including Physics students, struggle to move beyond basic descriptive writing toward analytical and argument-based communication [1]. In other

words, mastering the content of science and using the language to express ideas are distinct approaches in terms of pedagogy of English-medium STEM education.

The Common European Framework of Reference for Languages (CEFR) provides an internationally recognized standard for measuring language performance across six proficiency levels (A1–C2) to address this gap. By using CEFR descriptors, instructors can objectively classify learners' writing competence and monitor their progression over time [2–4]. Simultaneously, Indonesia's higher education system implements Outcome-Based Education (OBE) as an official policy, focusing on outcomes as demonstrable abilities that enable learners to reach the Intended Learning Outcomes (ILOs) of a certain program. In the Physics program, two ILOs are widely related to the ability to express scientific ideas in English: ILO 1, which emphasizes scientific attitudes, ethics, and lifelong learning; and ILO 6, which focuses on effective communication of scientific and technological results.

CEFR defines writing proficiency as a competence in lexical, grammatical, and discursive competence that allows learners to produce coherent, text-appropriate texts for communication purposes [4]. In contrast, OBE emphasizes that education must start from intended outcomes, including the knowledge, skills, and attitudes that students are expected to demonstrate upon completing of a course or program [5]. CEFR descriptive scales combine with OBE principles to create a strong frame for appraising language learning in a STEM background [6]. involves inherent processes of problem-solving, critical thinking, and communicating complex ideas. Writing continues to be the pre-eminent medium for representing these cognitive ideas, and disciplinary writing is a way of revealing and learning how knowledge is produced and communicated within a discourse field [1, 7]. Therefore, English writing by STEM students must evaluate their ability to use correct grammars in generating ideas within their field, their deduction processes, their seminar presentation, and their ethical reasoning processes. Integrating CEFR and OBE calculative frameworks is advantageous. CEFR provides a feasible linguistic measurement frame informed by the relevant writing features, while OBE ensures the language is aligned with the cognitive, psychomotor, and affective aspects of STEM education [1]. Additionally, it has been firmly established that learners' grammatical development inter-roles with their CEFR levels, regarding students' writing production [8]. Nevertheless, few if any empirical studies explore the application of CEFR-type analysis in OBE framing, especially in universities where English courses are usually bereft of disciplinary courses.

The study aims to explore how Physics students' English writing reflects CEFR-aligned proficiency and how these findings inform ILO achievement within an OBE framework. From these aims, the research addresses the following questions: (1) What linguistic characteristics and errors commonly exist in Physics students' writing about scientists? (2) How do these characteristics correspond to CEFR proficiency levels? (3) What do the results imply for designing an English course aligned with OBE and STEM principles, particularly regarding ILO 1 and ILO 6? This study bridges that gap by profiling STEM students' writing within the CEFR framework and mapping the results onto program ILOs. CEFR-based writing assessment provides measurable linguistic indicators that can provide direct evidence for ILO 6, while the thematic and attitudinal content of students' writing offers indirect evidence for ILO 1.

2 Methods

2.1 Research Design

This study employed a descriptive qualitative design with embedded quantitative elements to profile learner performance based on authentic language output [9]. The qualitative dimension focused on analyzing linguistic features, error patterns, and attitudinal expressions in student writing, while the quantitative dimension involved classifying students' proficiency levels according to the Common European Framework of Reference for Languages (CEFR) and calculating the proportion of learners at each level. The dual design was used to describe students' current state according to the standardized framework and to interpret their writing alignment with the ILOs of the Physics program regarding the OBE curriculum.

The English course from which the data were drawn contributes directly to the Physics program's Intended Learning Outcomes (ILOs), formulated under the national OBE system. The course explicitly supports two ILOs:

1. ILO 1: Accustomed to demonstrating good character reflected in scientific attitudes, ethics, discipline, and a sense of responsibility to support lifelong learning abilities.
2. ILO 6: Able to communicate the results of problem assessments and the implementation of science and technology orally, in writing, or through audio-visual means, and be able to lead and collaborate at various levels of roles within a team.

These ILOs are addressed by integrating language learning, disciplinary literacy, and scientific communication. Although the current study focuses on one in-class writing task, the same pedagogical philosophy that links authentic STEM contexts with communicative tasks underlies the entire program to foster observable OBE outcomes.

2.2 Data Collections and Analysis

The participants were nine first-year undergraduate students in Physics, with varied prior exposure to English, enrolled in a compulsory English course at a public university in Indonesia. Their participation in the study was voluntary, and informed consent was obtained. The student distribution by CEFR proficiency level was obtained from the university-mandated General English mapping score. Most students displayed their initial level of general English between A1 and B1, with only one reaching B2 level.

The writing data were collected from an individual writing task titled "My Favorite Scientist." The assignment asked each student to write a short paragraph (100–150 words) describing a scientist of their choice, their scientific contributions, and why the student admired them. This task was chosen because it naturally integrates scientific content, personal reflection, and English linguistic production, thereby eliciting evidence relevant to ILO 6 (communication of scientific results) and ILO 1 (ethical and attitudinal reflection). Before the assignments, the students were already introduced to the STEM context, related vocabulary, and linguistic components. The assignment was completed during a classroom session under instructor supervision, with the use of dictionaries and online translators discouraged to ensure authentic output. All handwritten

submissions were digitized and anonymized using pseudonyms. Students were informed that their work would be used for pedagogical research purposes without affecting their grades. To evaluate students' writing, the researchers adapted a CEFR-aligned writing rubric [2, 3, 6] were designed to capture five key dimensions as seen in Table 1.

Table 1. CEFR-aligned writing assessment rubric.

| Dimensions | Mark | Description of Criteria (A1–C1 Scale) |
|--------------------------------------|------|---|
| Content and Relevance | D1 | Factual accuracy, inclusion of scientific information, and clarity of ideas. |
| Organization and Cohesion | D2 | Logical sequencing, use of connectors, paragraph unity, and coherence. |
| Vocabulary Range and Appropriateness | D3 | Breadth of lexical choice, correct use of scientific terminology, and collocations. |
| Grammar and Accuracy | D4 | Control of tense, subject–verb agreement, and syntax; accuracy in clause formation. |
| Mechanics | D5 | Punctuation, spelling, capitalization, and handwriting legibility. |

Each dimension was scored on a five-point scale. Students' CEFR levels were determined by summing their rubric scores across five dimensions (maximum = 25). The total scores were then converted to CEFR bands following adapted performance thresholds (A1 = 5–9, A2 = 10–13, B1 = 14–17, B2 = 18–21, C1 = 22–24, C2 = 25), corresponding to CEFR levels, which are A1 (basic user, minimal control), A2 (simple user, limited structural range), B1 (threshold user, connected discourse), B2 (independent user, effective but occasional errors), C1 (proficient user, advanced command of language), and C2 (similar to natives).

3 Results and Discussion

3.1 Overview of Students' Writing Performance

The CEFR-based assessment found that the proficiency level of students' writing varied widely among the nine Physics students. Fig. 1 compares students' CEFR-aligned proficiency in General English and STEM-themed writing, revealing notable differences across levels. The result shows a concentration of learners in the lower-intermediate range. While a considerable portion of students were categorized at A1–A2 in General English, their proficiency increased when writing about STEM topics, with 35% reaching B2 and 10% achieving C1. This shift suggests that students are more coordinated and prepared in their writing when they utilize their prior knowledge and language acquisition through the subject and their language of engagement [10]. The practice tries to emphasize that the domain-specific engagement of students and academic writing has a significant effect on how learners will develop their literacy. It further explains that the command of the language can significantly be strong if the learners integrate it with their subject matter [1]. The presence of a C1-level writer in STEM tasks, absent

in general English, underscores that academic literacy develops through authentic, discipline-specific contexts [11]. These findings highlight the domain-specific nature of writing proficiency, emphasizing that linguistic competence is strengthened when integrated with content knowledge under OBE [12].

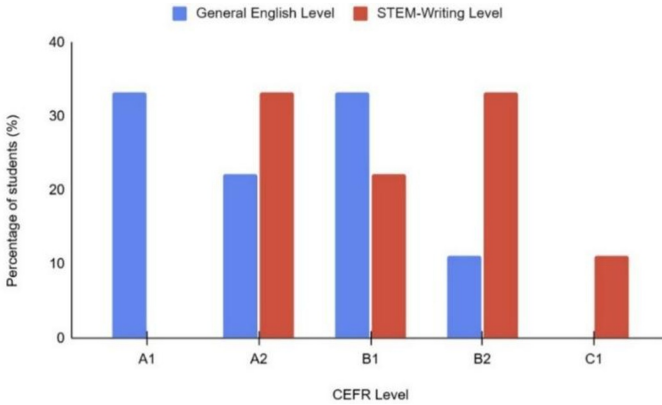


Fig. 1. CEFR proficiency of students majoring in Physics.

Following the comparative overview of students’ CEFR levels in general English and STEM-themed writing (Fig. 1), a more detailed examination was conducted using rubric-based assessment results, as shown in Table 2.

Table 2. Result of the student’s CEFR rubric scoring and their ILO’s achievement profile.

| Student | D1 | D2 | D3 | D4 | D5 | Total Score | CEFR Level | ILO Alignment (Summary) |
|---------|----|----|----|----|----|-------------|------------|---|
| S1 | 4 | 4 | 3 | 3 | 4 | 18 | B2 | ILO6: clear factual writing, ILO1: admiration |
| S2 | 3 | 3 | 3 | 2 | 3 | 14 | A2 | ILO6 basic, needs tense work |
| S3 | 4 | 3 | 3 | 3 | 4 | 17 | B1 | ILO6 moderate, ILO1 strong values |
| S4 | 4 | 4 | 4 | 3 | 4 | 19 | B2 | ILO6 strong, ILO1 curiosity evident |
| S5 | 5 | 5 | 5 | 4 | 4 | 23 | C1 | ILO6 very strong, ILO1 perseverance focus |
| S6 | 4 | 3 | 3 | 3 | 3 | 16 | B1 | ILO6 moderate clarity, ILO1 dedication noted |
| S7 | 4 | 4 | 4 | 3 | 4 | 19 | B2 | ILO6 ethical focus, ILO1 strong reflection |
| S8 | 2 | 2 | 2 | 2 | 3 | 11 | A2 | ILO6 limited, ILO1 minimal |
| S9 | 2 | 2 | 2 | 2 | 3 | 11 | A2 | ILO6 limited, ILO1 minimal |

Overall, students demonstrated solid achievement in content (mean = 3.6) and mechanics (mean = 3.6), showing that they understood the task, stayed on the topic, and controlled at least the most basic writing features. However, performance in vocabulary range (mean = 3.2) and grammar accuracy (mean = 2.8) was comparatively lower, which means that they exhibited not much of specific lexical and incorrectly tense or article use. This pattern reflects the common developmental profile of STEM learners, whose conceptual understanding of science often exceeds their linguistic precision [13]. The CEFR level classification clarifies individual proficiency: three students were evaluated at B2, two at B1, three at A2, and one at C1. The latter revealed almost academic proficiency, framing argumentation using advanced cohesion and physics-specific words, while A2 students used small sentences with repetitive structures. These results align with CEFR descriptors, where B2 and above users can express ideas clearly and in detail within their field [3]. Importantly, all students' texts reflected awareness of scientific values, supporting the achievement of ILO 1 (scientific attitude) and ILO 6 (scientific communication).

3.2 Linguistic Patterns and Common Errors in Students' Writing

Analysis of the students' writings revealed a linguistic profile shaped by varying proficiency levels and disciplinary engagement. The group's CEFR spectrum provides insight into how Physics students, novice scientific communicators, navigate English to express disciplinary knowledge and ethical reflection.

Grammatical accuracy emerged as the principal challenge across levels. Some of the most frequent patterns were tense inconsistency, subject–verb disagreement, and article elimination, for example, “*Marie Curie is born in France and becomes an important scientist,*” or “*He is physicist who discover gravity.*” Such mistakes might indicate partial recognition of English morphosyntax but low automaticity in their application [14, 15]. Such errors are common in EFL learners whose L1 lacks obligatory inflectional markers, as in Indonesian [14]. While A2 and B1 writers often misused past tense forms, B2 and C1 writers utilized correct verb morphologies according to the contextual pattern.

The range of vocabulary equally varied greatly. A2 writers demonstrated restricted vocabulary, relying on high-frequency adjectives (*good, smart, brave*) and verbs (*help, make, find*). In contrast, B2 and C1 writers employed more precise and discipline-specific terms such as *innovation, radiation, contribution, discovery, and nuclear physics*. This lexical sophistication indicates a developmental progression consistent with CEFR descriptors: A2 users “*can use simple everyday expressions,*” while B2 writers “*can produce clear, detailed text using appropriate vocabulary in their field*” [3]. Nevertheless, even advanced writers occasionally struggled with collocation accuracy, as in “*make theory*” or “*do innovation,*” reflecting insufficient exposure to authentic scientific collocational patterns [10].

From a discourse organization standpoint, all students demonstrated thematic coherence, typically following a predictable structure: (1) the scientist's background, (2) the main discovery, (3) the impact on science, and (4) personal admiration. However, the degree of cohesion varied. A2–B1 writers relied heavily on additive connectors (*and,*

then, because) while B2–C1 writers used logical markers (*therefore, however, as a result*), showing greater control over textual cohesion. A noteworthy qualitative feature across levels was the expression of moral and affective stance. Students frequently used evaluative language to emphasize scientists' perseverance and social contributions, such as "*She worked hard even when she was sick*" or "*He uses his knowledge to help people.*" Even though at the more basic levels the structure was supported unclearly, the message was always clear, illustrating that ethical reflection may precede linguistic mastery.

3.3 CEFR Proficiency Levels in Students' Scientific Writing

Mapping student performance onto CEFR proficiency levels revealed clear correspondences between linguistic features and level descriptors. Students at A2 demonstrated limited sentence complexity, producing simple declarative forms and relying on repetition. For example, "*Isaac Newton is my favorite scientist. He is smart and makes gravity. He helps people to learn science.*" Despite syntactic simplicity, these students managed to convey factual information and an emotional stance, comparable to CEFR's A2 criteria for writing: "short, simple texts on familiar topics." [3]. B1 writers produced more connected text with modest cohesive control. They attempted to use relative clauses and transition markers ("who," "because," "after that"), but occasionally over-extended them, resulting in run-on sentences. This aligns with CEFR's B1 descriptor: "Can produce connected text on topics which are familiar or of personal interest." Their use of academic lexis (*experiment, discovery, result*) suggests movement from general language toward disciplinary despite the low level of accuracy.

Students at B2 level demonstrated a stronger grasp of structure and a richer vocabulary. Their sentences were complex but precise: "*Nikola Tesla's innovation in alternating current changed modern technology and made electricity safer and cheaper.*" The use of passive voice, logical connectors, and topic sentences demonstrated discourse competence. These writers correspond to CEFR's B2 descriptor: "Can produce clear, detailed text on a wide range of subjects related to their field." Their main challenge involved using article and idiomatic expression, which are common plateaus before advanced fluency [16]. Finally, the C1 writer exhibited advanced syntactic variety, accurate collocation, and discipline-specific register. His text contained academic transitions (*moreover, consequently, on the other hand*) and evaluative precision (*Her discovery significantly influenced modern medicine*). The vocabulary was varied and contextually appropriate, incorporating domain terminology (*radiation, element, scientific community*). This aligns with CEFR C1 descriptors: "Can express ideas fluently and precisely in complex written texts, using well-structured discourse."

A cross-band comparison supports the suggestion of a developmental continuum of disciplinary writing. Lower-level writers focused almost exclusively on the recollection of facts, while higher-level writers incorporated analytical reasoning and evaluation. Furthermore, linguistic accuracy corresponded with ethical and reflective depth. B2–C1 writers not only used more complex language but also expanded on nuanced moral

arguments (“Curie’s resilience inspires me to face challenges in my studies”). This reinforces the argument that advanced language proficiency enhances the capacity for critical thinking and ethical expression.

3.4 Pedagogical Implications for OBE-Integrated English Course

The intersection of CEFR-based assessment, OBE principles, and STEM pedagogy provides a powerful model for curriculum innovation in English for Physics. The study’s results demonstrate that writing tasks not only measure linguistic competence but also reveal ethical disposition and disciplinary engagement, making them ideal instruments for achieving ILOs. Writing about scientists resulted in strong affect, allowing students to reward their persistence, honesty, and ultimate societal contribution, which are central to scientific ethics. The integration of reflective writing within the STEM framework can operationalize lifelong learning. This supports OBE’s emphasis on holistic competence: not just knowing and doing, but *being*, which means developing the scientific character and responsibility [5].

CEFR rubrics offer explicit performance indicators that can be directly linked to ILOs. A2-level indicators correspond to basic communication, B1–B2 levels correspond to intermediate outcomes, and C1 level represents mastery. The rubrics can serve as diagnostic feedback tools, helping lecturers target specific subskills (grammar accuracy, lexical depth, cohesion) that could elevate students’ proficiency on the CEFR scale. Such progression in CEFR creates constructive alignment, ensuring that learning activities (STEM fieldwork), assessment criteria (CEFR rubrics), and program goals (ILOs) form a coherent developmental pathway [12, 17]. Finally, from an institutional perspective, the integration of CEFR-OBE supports data-driven curriculum evaluation as student writing samples can be used as longitudinal evidence of learning outcome achievement. Thus, English instruction is reframed from a remedial tool to an essential element of scientific formation, allowing future physicists to communicate ethically, globally, and effectively.

4 Conclusion

The study profiled the English writing skills of Physics students through a writing task within the CEFR and OBE frameworks. The results revealed that students’ writing proficiency ranged widely from A2 to C1, indicating diverse linguistic and cognitive capabilities across the subjects. Quantitatively, the strongest performances were observed in content relevance and mechanics, reflecting students’ understanding of scientific concepts and their ability to communicate ideas clearly. However, weaknesses in grammar accuracy and vocabulary range remain prevalent to express complex disciplinary ideas.

The integration of CEFR descriptors enabled a more transparent and internationally benchmarked evaluation of students’ communicative competence. The writing samples demonstrated that higher-proficiency students (B2–C1) could effectively link ideas, use varied sentence structures, and apply scientific terminology appropriately, while lower-

proficiency writers (A2–B1) showed limited control over grammatical forms and lexical choice. Nonetheless, all students exhibited a strong sense of ethical reflection and admiration for scientific inquiry, which are the evidence of their affective and attitudinal development aligned with ILO 1. Simultaneously, their written ability to describe, analyze, and reflect on scientific contributions partially fulfills ILO 6, focusing on scientific communication skills. The findings also underscore the need to integrate language and content learning through CEFR-informed writing tasks embedded within a STEM framework. Aligning CEFR-based assessments with OBE outcomes offers measurable linguistic indicators of progress and fostering character-based learning aligned with institutional objectives. Future research should expand this approach with larger cohorts to examine how CEFR–OBE alignment influences long-term language development and scientific literacy in STEM education.

Acknowledgments. This work is supported by the Directorate General of Higher Education, Research, and Technology, Ministry of Education, Culture, Research, and Technology, Republic of Indonesia, contract No. 127/C3/DT.04.00/PL/2025, and by The Institute of Research and Community Services of Universitas PGRI Semarang, contract No. 035/LL6/PL/AL.04/2024, within the Magister Thesis Research Scheme.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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