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Original scientific paper

DEVELOPING AN OUTCOME-BASED LEARNING CURRICULUM IN ESP

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Abstract. *The aim of this research is to develop an outcome-based ESP curriculum for undergraduate chemistry and biology majors utilising the CBL paradigm. The current study aims to explore the effective application of an ESP curriculum linked with outcome-based learning methodologies in scientific education. A mixed-methods design was employed, consisting of a case study scenario in a higher education institution for chemistry and biology students as well as a Likert scale questionnaire to assess their perception of the alignment between the case study activity and learning outcomes. Finally, a factor analysis was conducted to gain insights into the correlation between the case study activity and skill-based outcomes and identify areas where case studies may be particularly effective in promoting ESP learning. The findings suggest that the inclusion of subject-specific scenarios in the ESP curriculum, particularly through case study-based learning, is crucial for chemistry and biology students. Finally, the study recommends that the ESP curriculum for science students should be designed in alignment with outcome-based learning approaches, where case study-based learning is considered an effective approach to acquiring academic and professional skills.*

Key words: *case study-based learning (CBL), curriculum development, English for Specific Purposes (ESP)*

1. INTRODUCTION

A combined major programme in chemistry and biology was launched at Suleyman Demirel University (SDU) in January 2023. Therefore, it was decided to provide an elective ESP course designed for students studying chemistry and biology to help them with their linguistic and specific skills. While conducting the ESP course, the educators faced multiple challenges, including: 1) teachers' insufficient knowledge of the chemistry and biology fields, which hindered their ability to play a leading role; 2) students lack of ready materials to provide for students, which leads to inadequate input, resulting in ineffective output; and 3) unsatisfactory learning outcomes for both learners and instructors.

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Lee and Luykx (2005) and Lee et al. (2008) noted that ESP instructors often receive little assistance and are uninformed about the appropriate methods for teaching science to English Language Learners (ELLs). This lack of support includes inadequate professional development opportunities for teachers to comprehend the intricacies of language register and repertoire within the subject area (Poza, 2016). In addition to this, according to Stojković (2019), there is a lack of both ESP books and ESP teaching methodology books on the market, which also creates problems for ESP teachers.

Consequently, many teachers focus solely on teaching scientific vocabulary (Bruna, Vann, & Perales Escudero, 2007; Halliday & Martin, 1993) and overlook the previously mentioned grammatical aspects of science education. Moreover, it should be stated that the distinctive structure of scientific language often makes it difficult for individuals to grasp and apply scientific concepts.

As noted by Fang (2005) and Norris and Phillips (2003), the exceptional features of scientific language present a major obstacle to learners. Therefore, teachers had to come up with such tasks and exercises, and look for suitable materials that would be interesting to everyone, especially those students with an advanced level of English.

Taking into consideration all of the above-mentioned issues, instructors at SDU have compiled six units for an ESP course related to chemistry and biology. Each unit includes an introduction, fundamental principles of the subject matter, language skills, grammar, and a unit review section. The units are titled Chemistry in Our Lives, Life on Earth, Bonding, Plants, Acids & Bases, and Homeostasis & Animal Anatomy (see Figure 1).

Fig. 1 Cover pages of units of ESP compiled materials

The initial step in designing an ESP course is to establish clear learning outcomes that are based on experiences and skills required for learners' future needs. An analysis of learners' requirements, selection of learning objectives, creation of situational output tasks, and task chain visualisation are all steps in the design process. In order to better understand the requirements and desires of chemistry and biology students, questionnaire surveys and in-depth interviews were conducted with undergraduates and content professors. The design of chemistry and biology-related units with output activities that encourage students to seek out appropriate learning materials and build relevant skills and knowledge was guided by needs analysis, which enabled us to link prospective outcomes with particular teaching objectives and learning outputs. Based on OBE, we incorporated case study-based learning (CBL) methodology to completely include the ESP curriculum's language- and subject-specific qualities.

According to Zafirovska and Xhaferi (2022), 69% of participants noted that role-play activities, skill-focused exercises, visual aids, and interactive projects in subject-specific field settings should be included in ESP textbooks. Thus, to facilitate effective teaching and learning, the course employed several techniques, including case studies, discussions, group work activities, problem-solving tasks, critical thinking exercises, individual work, project work, matching, and gap-filling exercises, in addition to traditional reading, speaking, writing, and listening skills. Thus, we will give examples of science dissemination case studies that are aligned with the learning outcomes of the units. In order to further establish the congruence between case study activities and learning outcomes, factor analysis was carried out utilising NA results.

This article presents a study carried out by ESP instructors for science students (chemistry and biology) that aims to construct a learning outcome focused on the decision of the content and skills, the creation of lesson plans, and choice of teaching methods and resources, and underscore the scientific dissemination case study scenarios in practice to improve learning outcomes alignment.

2. Literature Review

ESP is an approach which gets effective, productive, and proper concepts from different theories and blends them into an integrated system. It has its peculiar characteristics, such as learner-centeredness, correlation with specialised subjects, and dwells on both designing and educating. ESP includes some features from Communicative Language Teaching (CLT), Task-Based Language Teaching (TBLT), Project-Based Learning (PBL) (Richards and Rodgers, 2014). For this reason, outcome-based education (OBE) has become the dominant curriculum design model in many parts of the higher education system, and ESP is not an exception. Outcome-based education (OBE) emphasises the learners' knowledge, understanding, and demonstration of skills, as well as their ability to apply what they have learned to future roles. In the OBE structure, the curriculum activity and evaluation of students are driven by learning output (Killen, 2000).

In addition to this, the use of case study-based learning (CBL) aligned with outcome-based education, provided us with insights on how to tackle the aforementioned issues. CBL is a technique employed to enrich learning by introducing case studies for students to resolve (Davis, 2004). CBL has been shown to offer pedagogical benefits such as enhancing students' intrinsic motivation to learn, critical thinking skills, self-evaluation and reflection, and effective collaboration (Kulak & Newton, 2017, Facione, 2000; Ferrari & Mahalingam, 1998; Ennis, Millman, & Tomko, 2005). CBL has been widely used in education, with observed variations in outcomes based on academic discipline (Herreid, 2012; Grady, Gouldsborough, Sheader & Speake, 2009).

When implemented as a group activity, case study-based learning (CBL) can enhance communication skills, as noted by Fernandez-Santander (2008) and Savery (2006). Moreover, CBL is a learner-centred approach that encourages students to take responsibility for their learning, leading to the development of critical thinking and transferable skills essential for lifelong learning beyond academia, according to Hartfield (2010). As reported by Biggs and Tang (2011), CBL is an evidence-based teaching strategy that helps students to learn and apply applicable knowledge, retain pertinent information, and enhance their communication abilities.

On a separate note, as part of a systems-based approach to curriculum creation, the concept of learning outcomes initially surfaced in the 1960s (Stufflebeam et al., 1985). It is well acknowledged that a thorough assessment of learners' requirements is necessary for the identification and acknowledgment of learning outcomes. Needs analysis allows instructors to create more suitable teaching materials for students (Čapková, Kroupová, 2017) and identify which academic tasks to incorporate into the current syllabus (Muhammad & Abdul Halim Raof, 2019). Needs analysis should be conducted based on the target needs, necessities, lacks, and wants of the learners (Nation & Macalister, 2010).

Designing an adequate curriculum for ESP is time-consuming and requires relevant and appealing materials that respond to students' needs and interests. Bula and Diaz-Ducca's (2017) research found that authentic, effective, and purposeful tasks, along with pair and group work were desired activities for ESP classes while learners' needs analysis would assist teachers in identifying content and selecting materials according to ESP typology (Hutchinson and Waters, 1987, p. 17; Robinson, 1991, p. 53). Figure 1. shows that the needs analysis (NA), which entails informal talks between teachers and students to decide lesson style, is the first stage in determining goals and outcomes for a course. This may be the basis for course planning and result determination and is crucial for learning about the informational requirements of students (Shaw and Dowsett, 1986, pp. 47–49). The use of surveys, rating exercises, observation, and teacher consultation are other techniques for performing needs analysis. The first stage is to determine the needs of the learners. The next stages are to construct learning outcome statements, decide on the necessary content and skills, create lesson plans, and choose teaching methods and resources.

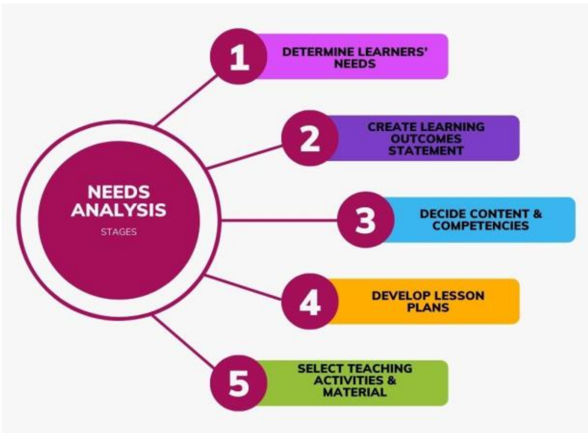

Fig. 2 Stages of Needs Analysis (Richards, 2013, p. 23)

3. METHODOLOGY

This study aims to answer the following research questions:

RQ1. What is the undergraduate chemistry and biology students' perception of the alignment between the case study activity and the learning outcomes?

RQ2. What skills are most effectively employed to improve the alignment between ESP curricula and learning outcomes for chemistry and biology students in higher education?

The current study is mixed in nature, utilising both qualitative and quantitative data analysis methods to develop outcome-based ESP curriculum. Firstly, study was focused on understanding and describing students' needs, setting learning outcomes, assessment criteria, case study-based learning strategy, and curriculum implementation. Secondly, data was analysed by using the Likert scale questionnaire to evaluate their perceptions towards case study-based learning. Finally, factor analysis was conducted on the Likert scale questionnaire responses to gain insights into the relationship between the case study activity and multiple skill-based learning outcomes and to identify areas where the case study may be particularly effective in promoting learning. By using these insights teachers could maximise the impact of the case study activity on student learning. The following statistical tools were utilised in data analysis: descriptive statistics for quantitative items, consisting of means, standard deviations, figures and tables, as well as statistical methods which identify correlations within a set of variables (factor analysis).

To successfully incorporate case studies into scientific lectures, teachers must establish the course's learning outcomes, ensure materials are readily available, introduce the case study, facilitate discussions, assess student participation, and evaluate the effectiveness of case study activities. The research study aimed to evaluate the effectiveness of a case study activity designed to support understanding of the fourth unit called 'Plants' taken from compiled ESP materials so that undergraduate students majoring in chemistry and biology researched about a new plant species that was discovered in the Altai mountains. The case study activity required students to study the plant's physical characteristics, analyse its structure and function, and create an infographic to illustrate how its parts work together to carry out life processes. The Likert scale questionnaire was administered to 42 chemistry and biology students to assess their perception of the alignment between the case study activity and the intended learning outcomes. Five questions were asked, ranging from 5 to 1, where 5 is completely, 4 means very much, 3 implies moderately, 2 stands for slightly, and finally 1 is for not at all.

Table 1 Likert scale survey of chemistry and biology students

Q1	Q2	Q3	Q4	Q5
To what extent did the case study activity help you acquire new vocabulary words about plants?	To what extent did the case study activity help you apply your knowledge of plant anatomy?	To what extent did the case study activity help you demonstrate an understanding of plant organisation?	To what extent did the case study activity help you develop your ability to collaborate with other team members?	To what extent did the case study activity help you develop your critical thinking skills ?

4. RESULTS AND DISCUSSION

Step 1 is to analyse and define students' needs, develop learning outcomes, establish assessment criteria, develop a case study scenario, and implement it into a curriculum. Step 2 includes information about perceptions of students towards case study-based learning in ESP classes, and step 3 contains information about the relationship between the case study activity and multiple skill-based learning outcomes and identifies areas where the case study may be particularly effective in promoting learning.

The present situation analysis (PSA), target situation analysis (TSA), and learning situation analysis (LSA) indicate that chemistry and biology students at SDU have a uniform learning background, requiring general academic listening and speaking skills, as well as reading and writing skills necessary for comprehending academic and scientific literature, producing subject-specific writings, and delivering oral presentations. Moreover, the survey results show that students enjoy group work and solving subject-specific case studies, while instructors mention academic freedom and varied teaching techniques and materials as advantages of the ESP course. However, needs analysis highlights drawbacks such as a lack of coursebooks on chemistry and biology majors and networking with science teachers, ESP teachers have insufficient science knowledge, and gaps in the curriculum. Therefore, we strongly believe that if ESP teachers are aware of the students' needs, they can design courses that offer equal opportunities for students to learn and improve their English language skills at the post-secondary level.

The next stage is identifying and writing learning outcomes that are comprehensible and easy to apply which involves three key stages. Firstly, a list should be made of all the key approaches, significance, or competencies that are vital to the lesson, course, or programme. It is important to consider all domains of learning, including cognitive, emotional, and psychomotor, for a well-rounded curriculum. Secondly, suitable action verbs should be selected to convey the level of accomplishment expected from the learners in relation to the identified approaches, significances, or competencies. Two important aspects of writing learner-centred and specific learning outcomes are emphasised. Learner-centred outcomes focus on the learners' achievements and should begin with the phrase "By the end of the lesson/course/programme, learners will be able to...". Specific outcomes characterise the desired performance of learners and should be measurable for subsequent assessment. The use of vague verbs such as "know" and "understand" should be avoided in writing learning outcomes to ensure that they are specific and measurable.

For instance, one of the learning outcomes in the ESP course for chemistry and biology students sounds like: By the end of course, students will be able **to discuss** a wide range of subject specific topics. Learning outcome is aligned with the next stage decision on course content which provides compiled units with different learning activities and teaching strategies. Once the specialised content has been established, the subsequent stage is to develop lesson plans. The choice of activities must consider resources, class size, study materials, and intended coursework to ensure their applicability in the learning process. It is crucial to bear in mind that when developing and delivering an ESP course and lessons, students are primarily studying the language in the context of other disciplines. In other words, they are acquiring knowledge and skills that will aid them professionally in the future. Therefore, the last stage implementing contemporary teaching methodologies is essential to enhance learning outcomes.

Case-study learning activities in ESP courses for students studying chemistry and biology require a lot of planning and preparation. ESP teachers may successfully include case studies into their courses by following a few simple procedures. Teachers should first identify the course's distinctive educational outcomes before selecting a relevant case study that matches with the students' academic or professional sector. Second, teachers should make certain that all relevant materials, such as case study materials and accompanying worksheets, are easily accessible to students. Third, teachers should explain the case study procedure and its objectives to the class, encouraging students to assess it, identify the issue or problem, and explore alternative solutions. Fourth, educators should foster a discussion in which students may express themselves and share their expertise. Finally, instructors should assess students' participation and evaluate the effectiveness of case study activities in achieving the ESP course's learning outcomes. Thus, Table 2 shows an overview of the case study scenario on the fourth ESP unit called ‘Plants’ that was compiled for chemistry and biology students. ‘Plants’ is the fourth unit in a compiled collection of in-house ESP resources for chemistry and biology students, and is meant to provide students with a thorough grasp of topics on plants. Table 2. below shows the alignment with the lesson learning outcome, teaching activities, case study scenario, its requirements, evaluation criteria, and outcome-based subject specific skills. A case study activity was assigned to

Table 2 Overview of the alignment between learning outcomes and case study of the fourth unit “Plant” of compiled ESP materials for chemistry and biology students

Unit 4: Plants	
Learning Objective	Identify plant parts and their functions
Learning Activities	▪ Read the passage titled ‘How are plant bodies organised?’; ▪ Compete Venn diagram comparing dicot and monocot characteristics of plants;
Case Study Scenario	A group of botanists are studying a new plant species that has been discovered in Altai mountains which is located in the eastern part of Kazakhstan and is known for its diverse flora. The plant appears to have unique physical characteristics that indicate a novel way of organising its body. The botanists are tasked with studying the plant and identifying how its body is organised.
Requirements	▪ Study physical characteristics of chosen plant and identify its body organisation in small groups; ▪ Analyse its structure and function; ▪ Create infographic on how parts of the plant work together to carry out its life process;
Evaluation Criteria	▪ Accurately design an infographic; ▪ Understand and interpret other teams’ information; ▪ Give clear explanation on other teams’ infographics;
Learning Outcome-Based Skills	Students will be able to: ▪ Consolidate new vocabulary ▪ Collaborate with other team members; ▪ Develop critical thinking skills to organise clear infographic; ▪ Apply their knowledge on plant anatomy; ▪ Demonstrate an understanding on plant organisation;

support general understanding of the Section A of compiled ESP materials about plants and its organisation. It helps to present skill-based learning activities that give students the chance to put their knowledge and abilities to use in practical situations. Students could investigate the structure and anatomy of plants, consider how new scientific knowledge will affect future research and development, and produce infographics and presentations on scientific subjects of their choice.

Students majoring in chemistry and biology were divided into groups and assigned the case study scenario shown in the table above. The scenario involved each group acting as botanists researching a new plant species discovered in the Altai mountains to identify its unique physical characteristics and novel way of organising its body. At the end of the activity, students presented their created infographics to the rest of the class.

To evaluate the effectiveness of the case study activity on achieving intended learning outcomes related to vocabulary acquisition, application of knowledge of plant anatomy, understanding of plant organisation, collaboration, and critical thinking skills, the Likert scale questionnaire was disseminated. The survey results indicated that the case study activity was effective in helping students achieve the intended learning outcomes. Specifically, the majority of students reported that the case study activity completely or very much helped them acquire new vocabulary words about plants (69%), apply their knowledge of plant anatomy (92%), demonstrate an understanding of plant organisation (59%), develop their ability to collaborate with other team members (71%), and develop their critical thinking skills to organise a clear infographic (76%).

Table 3 The Likert scale results from the first year chemistry and biology students

Questions	n	1	2	3	4	5	Mean	SD
1. To what extent did the case study activity help you acquire new vocabulary words about plants?	42	0%	0%	9.52%	21.43%	69.05%	4.05	0.73
2. To what extent did the case study activity help you apply your knowledge of plant anatomy?	42	0%	0%	7.14%	7.14%	85.72%	4.62	0.49
3. To what extent did the case study activity help you demonstrate an understanding of plant organisation?	42	0%	2.38%	16.67%	30.95%	50%	3.62	1.25
4. To what extent did the case study activity help you develop your ability to collaborate with other team members?	42	0%	0%	16.67%	42.85%	40.48%	4.00	0.92
5. To what extent did the case study activity help you develop your critical thinking skills?	42	0%	0%	9.52%	30.95%	59.53%	4.13	0.96

Table 3 shows that 69.05% of the students reported that the case study activity completely or very much helped them acquire new vocabulary words about plants. The mean score for the first question was 4.05 out of 5, suggesting that the activity was moderately effective in helping students learn new vocabulary related to plants. The majority (85.72%) of the 42 students reported that the case study activity completely or very much helped them apply their knowledge of plant anatomy. The mean score for the second question was 4.62 out of 5, indicating that the case study activity was perceived as highly effective in helping students apply their knowledge of plant anatomy. Exactly, 50% reported that the case study activity moderately or completely helped them demonstrate an understanding of plant organisation. The third question's mean score of 3.62 out of 5 indicates that the case study activity was only moderately successful in assisting students in demonstrating their comprehension of plant organisation. Additionally, 40.48% of participants said that participating in case study activities significantly or fully helped them improve their capacity for teamwork. The case study exercise was deemed to be fairly helpful in assisting students in growing their capacity for teamwork, as indicated by the mean score for the fourth question of 4 out of 5. Finally, 59.53% said that participating in case study activities entirely or significantly aided them in honing their critical thinking abilities. The case study exercise was rated as having a moderately successful impact on students' ability to develop critical thinking abilities, according to the mean score for the fifth question, which was 4.13 out of 5.

To consolidate, it is noted that the survey aimed to investigate the effectiveness of a case study activity on students' learning outcomes. For each of the five items, participants were asked to score the activity's efficacy on a scale of 1 to 5. For each question, the standard deviation (SD) values were computed to evaluate the consistency of the answers. The findings revealed that the SD values varied from 0.49 to 1.25, demonstrating that the responses were largely reliable and grouped around the mean score. The survey findings appear to be trustworthy overall, and the case study activity was thought to be successful in reaching its targeted learning goals, according to the consistent SD values. The majority of participants felt that the case study activity was moderately to extremely helpful in attaining the desired learning results. The mean scores for each question varied from 3.62 to 4.62.

The Likert scale responses from the survey were used to do a factor analysis in order to better understand how the case study activity and the learning outcomes were aligned. Based on the scree plot and the eigenvalues, two factors, which are shown in Table 4. The association between each survey question and each factor is shown by the factor loadings.

Table 4 Factor loadings between questions

Questions	Factor 1	Factor 2
Q1	0.745	0.831
Q2	0.885	0.057
Q3	0.887	0.097
Q4	0.822	0.898
Q5	0.882	0.825

Two variables, variables 1 and 2, were shown to be responsible for 70.8% of the variation in survey responses. Factor 2 was connected with the learning outcomes related to cooperation and critical thinking abilities, whereas Factor 1 was associated with the learning outcomes related to the application of knowledge of plant anatomy and organisation (Table 5).

Table 5 Factor Analysis Results for Survey Questions on the Effectiveness of a Case Study Activity

Factor	Survey questions	Factor loading	Factor scores	Mean	SD
Factor 1	Question 2, 3, 4	0.885	122	29.0	7.7
Factor 2	Question 1, 4, 5	0.745	95	22.6	7.1

For Factor 1, the factor score for each respondent can be calculated as follows:

Factor score for respondent =
(Q1 x 0.745) + (Q2 x 0.885) + (Q3 x 0.887) + (Q4 x 0.822) + (Q5 x 0.882)

where Q1 to Q5 represent the Likert scale responses for each survey question. The factor score for each respondent may be determined similarly for Factor 2 as follows:

Factor score for respondent =
(Q1 x 0.831) + (Q2 x 0.057) + (Q3 x 0.097) + (Q4 x 0.898) + (Q5 x 0.825)

The factors that each question was most strongly connected with were shown by the factor loadings for each question. High factor loadings on Factor 1 in Questions 2, 3, and 4 show that these questions were most strongly connected to the desired learning result about the use of knowledge of plant anatomy and organisation. High factor loadings on Factor 2 indicated that Questions 1, 4, and 5 were most significantly connected to the targeted learning outcome about teamwork and critical thinking abilities. In order to assess the overall degree of alignment between the case study activity and the learning outcomes, the factor scores for each factor were computed. Factor 1 and Factor 2 each had factor values of 122 and 95, respectively. These results show that the case study activity and the desired learning goals for applying knowledge of plant anatomy and organisation (Factor 1) and for developing teamwork and critical thinking abilities (Factor 2) are highly aligned.

Additional details on the overall degree of alignment between the case study activity and the targeted learning objectives were supplied by the mean and standard deviation of the Factor scores. Indicating a rather high level of alignment between the case study activity and the desired learning outcomes linked to the application of knowledge of plant anatomy and organisation, the mean score for Factor 1 was 29.0 with a standard deviation of 7.7. A significantly lower level of alignment between the case study activity and the targeted learning goals linked to teamwork and critical thinking abilities was indicated by the mean score for Factor 2 of 22.6 with a standard deviation of 7.1.

Overall, the findings point to the case study activity on researching a plant species in the Altai Mountains as being successful in assisting students in achieving the learning goals linked to the application of knowledge of plant anatomy and organisation, teamwork, and critical thinking abilities. The findings of this study provide light on how well a case study activity works in educating undergraduate students about a novel plant species, its physical traits, and organisational structure. The results can be used to improve the design and implementation of future case study activities in this area.

5. Conclusion

The study aimed to develop an outcome-based ESP curriculum utilising the CBL approach for undergraduate students majoring in chemistry and biology. A mixed-methods design was employed to investigate the effective implementation of the curriculum aligned with outcome-based learning approaches in science education. The findings suggest that case study-based learning, particularly through subject-specific scenarios, is crucial for promoting ESP learning for chemistry and biology students. The factor analysis results indicate that the case study activity was effective in promoting academic and professional skills. Therefore, the study recommends designing ESP curriculum for science students in alignment with outcome-based learning approaches, where case study-based learning is considered an effective approach to acquiring academic and professional skills.

This research has effectively created an outcome-based ESP curriculum for undergraduate chemistry and biology students in Kazakhstan that includes case study-based learning. The six assembled units: Chemistry in Our Lives, Life on Earth, Bonding, Plants, Acids & Bases, and Homeostasis & Animal Anatomy—integrate case study scenarios, requirements, lesson learning objectives, instructional activities, and assessment criteria with outcome-based subject-specific abilities. These units were compiled and collected based on the needs analysis, which included interviews with subject teachers and feedback from science students. Moreover, to better understand the alignment between the case study activity and the intended learning outcomes, the researchers conducted a factor analysis using the Likert scale responses from the survey. This result emphasises how well case study methodologies for scientific dissemination work to improve the alignment of learning objectives. In addition to this, the implementation of the CBL approach within an ESP curriculum not only promotes a deeper understanding of the subject matter but also fosters critical thinking, problem-solving, and communication skills.

In conclusion, this study contributes to the growing body of research on outcome-based education and advances the understanding of its application in the context of ESP. Future research may examine the applicability of these conclusions to different academic situations and topic areas, as well as the long-term effects of the CBL strategy on students' academic achievement and readiness for their professional life. It is advised that educators and curriculum designers think about using outcome-based learning in their ESP curricula in the light of the obtained results in this study. Not only does this approach align with the principles of outcome-based education, but it also holds the potential to significantly improve student learning and engagement. Ultimately, by embracing innovative pedagogical methodologies like CBL, the field of ESP can further advance and better prepare students to excel in their respective disciplines.

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