STEAM up Your English: A Project-Based Approach to Technical English in VET

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Abstract: In Vocational Education and Training (VET), students must master technical and technological skills and apply them in real-world communicative contexts, often in English, now widely recognised as the lingua franca of science, technology and business. This article explores the application of Project-Based Learning (PBL) within a Science, Technology, Engineering, Arts and Mathematics (STEAM) approach to develop English language skills in technical contexts in VET. The study addresses the limited integration of technical English with vocational subjects in Portuguese VET curricula, despite the growing importance of English-language proficiency for employability, professional mobility, and communication in technology-related fields. The research followed a developmental research design with a predominantly qualitative, interpretative orientation, focusing on the design, implementation and formative evaluation of the digital course 'Tech Talks: STEAM up your English'. Implemented through Moodle, the course was designed for a second-year class of 20 students enrolled in a Vocational Course in Electrotechnics and involved six teachers from linguistic, sociocultural and technical subject areas. The learning environment combined PBL and STEAM principles with active learning strategies, digital resources and gamification. Data were collected through pre- and post-implementation questionnaires, semi-structured interviews, participant observation, usability tests, and Moodle activity reports; qualitative data were subjected to content analysis and closed-ended items were summarised using descriptive statistics. The findings, largely based on participants' self-reported perceptions, indicate high levels of engagement and motivation, a positive perception of PBL's contribution to understanding technical content, and perceived gains in teamwork, communication, and technical English vocabulary. Teachers reported benefits for their professional development and stronger interdisciplinary collaboration, while time for joint planning, technical constraints and students' limited use of asynchronous support emerged as the main challenges. This study presents a contextualised and interdisciplinary model for integrating technical English with vocational subjects in VET through PBL and STEAM, demonstrating its feasibility and positive reception among students and teachers. Further studies with larger samples and objective measures of learning outcomes are needed to validate these results and the perceptions reported by participants.

Keywords: Project-Based Learning; STEAM; Vocational Education and Training; English for Specific Purposes; Gamification

1. Theoretical and Practical Framework and Objectives

In the digital age, schools face the challenge of preparing their students for an ever-changing labour market that requires skills beyond traditional curriculum content (Cruz et al., 2023; Khafah et al., 2023). In Vocational Education and Training (VET), this challenge is particularly significant: students must not only master technical and technological skills, but also apply them in real communicative contexts, often in English, which is recognised as the lingua franca of science, technology and business (Crystal, 2003), and a key factor for employability and professional mobility in the 21st century.

Despite the growing importance of technical English in Science, Technology, Engineering, Arts and Mathematics (STEAM)-based professional contexts, VET curricula in Portugal have clear gaps in this area. An analysis of the curriculum for the Electrotechnics VET course, Level IV of the Portuguese National Qualifications Framework (NQF), reveals that only one English language subject - covering general topics - is included in the sociocultural component of the three-year programme, with no systematic link to the course's technical subjects. This situation contrasts with the guidelines of the European reference framework 'Key Competences for Lifelong Learning' (European Commission, 2019), which emphasises the need to develop competences in an integrated and contextualised manner, and with the 'Digital Competence Framework for Citizens' (DigComp) (Vuorikari et al., 2022), which emphasises the ability to communicate and access information in digital environments, often mediated by the English language.

Against this backdrop, the present study has been conducted as part of the Master's Degree in Technologies to Support STEAM Education at the School of Technology of the Polytechnic University of Cávado and Ave (UPCA). The study proposes a pedagogical solution: the digital course 'Tech Talks: STEAM up your English', implemented on Moodle, designed in accordance with the principles of Project-Based Learning (PBL) using a STEAM approach,

and aimed at a second-year class of students enrolled in the Electrotechnics VET course. This solution combines active methodologies and digital resources, integrating the development of technical English with Electrotechnics content and incorporating gamification elements.

The research question guiding the study is: What potential and/or challenges does PBL bring to STEAM education in VET? Based on this question, the following objectives were defined: (i) to develop educational activities to improve technical English skills applied to technical and technological areas of VET; (ii) to propose a project-based approach that integrates the STEAM domains; (iii) to identify challenges and opportunities in the implementation of PBL in STEAM learning environments within VET contexts; and (iv) to explore students' and teachers' perceptions of PBL's contribution to students' linguistic and technical skills. Given the exploratory nature of the study, objective (iv) is addressed through participants' perceptions and observational evidence rather than through standardised measures of language proficiency.

2. Pedagogical Practice

This section presents the main theoretical foundations and practices that guided this work, the target audience, the application context, the course developed, and the research and data collection methodology.

2.1 Theoretical Foundations and Related Practices

Project-Based Learning (PBL) is an active methodology grounded in constructivist principles of learning, in which students actively construct their knowledge through processes of discovery, experimentation and critical thinking (Hsiao et al., 2022). As a learner-centred approach focused on solving real-world problems, PBL is particularly relevant when applied in Science, Technology, Engineering, Arts and Mathematics (STEAM) contexts, promoting interdisciplinarity and the development of cross-curricular skills such as creativity, collaboration and self-regulation (Fernández-Morante et al., 2022; Diego-Mantecón et al., 2021a).

Empirical research on PBL in STEAM contexts has generally reported positive outcomes. Fernández-Morante et al. (2022), in a study involving around 800 secondary school students in Spain, demonstrated that participation in interdisciplinary STEM projects improved students' self-perceived competences in areas such as critical thinking, problem-solving, collaboration and self-regulation. Diego-Mantecón et al. (2021a), evaluating the STEAM-PBL approach using the Kids Inspire Kids for STEAM (KIKS) format with students from four European countries, found that this methodology facilitates the development of key competences, including multilingual skills, when projects are carried out in a non-native language. Hsiao et al. (2022), in a quasi-experimental study with pre- and post-tests involving 366 students, concluded that integrating PBL with the Cognitive-Affective Interaction Model (CAIM) produced better results in terms of STEAM knowledge, creativity and practical performance than PBL alone. However, these studies were conducted in general secondary education, and none of them addresses the integration of foreign language learning with technical subjects in Vocational Education and Training (VET), which is the gap the present study seeks to explore.

Regarding language skills, Imbaquingo and Cárdenas (2023), drawing on classroom observations and teachers' questionnaires, reported that PBL increased ninth-grade students' motivation and fostered progress in their English reading skills. Yong and Saad (2023), in a mixed-methods study with 35 undergraduates learning English as a second language, found that students perceived PBL as promoting active language use, grammatical improvement, and the development of communicative and digital skills, while also identifying challenges related to the time required for implementation.

In the specific context of VET, Roemintoyo and Budiarto (2023), in a qualitative study based on the accounts of six educators in VET schools, found that PBL contributed to more dynamic and collaborative learning environments, emphasising that educators' commitment and institutional support are critical factors for successful implementation. Regarding gamification as a complementary strategy, Garcia-Iruela et al. (2021), analysing platform activity and grades of VET students over one academic year, found that gamification may improve user experience and engagement, with effectiveness depending on the pedagogical design and the characteristics of the context.

From an instructional design perspective, the study by Cruz et al. (2023) on an online PBL course for teaching mathematics demonstrates the feasibility of adapting this methodology to digital environments, highlighting the importance of usability testing and formative assessment in improving the resources developed - a perspective aligned with the principles of developmental research (Richey et al., 2004).

2.2 Target Audience and Implementation Context

The study was conducted at a VET school in northern Portugal that offers programmes in STEAM-related fields. The school provides each student with an iPad for educational purposes and uses the digital platforms Moodle and Teams, so both students and teachers were already familiar with digital resources. Twenty second-year students enrolled in an Electrotechnics VET course, aged between sixteen and eighteen, took part in the study, along with six teachers from various subject areas: English, Portuguese, Integration Area, Information and Communication Technologies, Digital Systems, and Electricity and Electronics.

The pre-implementation questionnaire revealed that only two students were familiar with the acronym STEAM and one had heard of PBL. Students' self-assessment of their English language skills against the descriptors of the Common European Framework of Reference showed a heterogeneous distribution (A1: five; A2: four; B1: seven; B2: two; C1: two). Difficulties were also reported with technical English: 35% of students indicated that they were unable, or only able with great difficulty, to read technical instructions in English, and 30% gave the same answer regarding communicating technical instructions. Nevertheless, the data revealed a high level of motivation to participate in innovative and practical activities: 16 of 20 students expressed enthusiasm for taking part in lessons that differed from traditional classroom approaches, and 14 agreed or strongly agreed that technical English is important for their professional future. These data were used to characterise the participants and to inform the design of the course; they were not intended as a baseline for a pre- and post-comparison of proficiency.

2.3 The Digital Course 'Tech Talks: STEAM up Your English'

The course was developed and implemented on the Moodle platform (version 3.11) and structured around five main topics, as shown in Figure 1: (1) Introduction to the Course, featuring an orientation video, an interactive map and an introductory forum; (2) ElectroTechEnglish, featuring interactive vocabulary-building activities (Electric Flashcards, Electric Speech, Electric Dictation) in HTML5 Package (H5P) and a collaborative glossary of technical terms; (3) Power Up your English, featuring tutorials on digital storytelling and activities involving the creation of storyboards and Do-It-Yourself (DIY) videos on domestic electricity; (4) Short Circuits, featuring a Digital Escape Room on electrotechnics themes and suggestions for Massive Open Online Courses (MOOC) in English; (5) WATT's up, a forum for support and knowledge sharing amongst participants. It was implemented over eight weeks in May-June 2025, in sessions held during Portuguese, English, Integration Area, Information and Communication Technologies, Digital Systems and Electronics classes.

The course also incorporated a gamified rewards system - VOLTS - consisting of twelve digital badges awarded based on objective criteria for completing activities and on qualitative criteria defined by the tutors. The course's visual identity, including the virtual tutor character Electra, was designed using artificial intelligence tools (Canva, D-ID Creative Reality Studio, Speechgen.io) to create an engaging environment for the participants' age group. The activities were designed to work both in a classroom setting and independently, with non-sequential progression, allowing for flexibility in each student's learning journey.



Figure 1: course orientation map

From a pedagogical perspective, the course adopted an interdisciplinary and transdisciplinary approach, integrating content from technical subjects with English language learning. Students collaborated to create a

technical glossary, produce English-language videos on domestic electricity, and completed linguistic and technical challenges in the Digital Escape Room, drawing on knowledge from various curricular areas to produce the final outputs.

2.4 Research Methodology and Data Collection

The study adopted a developmental research design (Richey et al., 2004), centred on the design, implementation and formative evaluation of a digital educational solution tailored to a real teaching need and to participants' profiles (Amado, 2017), and framed by the interpretative paradigm, which emphasises the meanings participants attribute to their experiences (Coutinho, 2014). The orientation is predominantly qualitative; quantitative data from closed-ended questionnaire items were not used to test hypotheses but, given the small number of participants (20 students and six teachers), were summarised descriptively to characterise perceptions and triangulate the qualitative findings. Similar exploratory designs have been used in research on STEAM projects (Diego-Mantecón et al., 2021a) and in the development of online PBL courses (Cruz et al., 2023).

Data were collected before, during and after implementation using five instruments: questionnaires, semi-structured interviews, participant observation, usability tests and Moodle activity reports.

- *Questionnaires*: Students and teachers answered pre- and post-implementation questionnaires in Microsoft Forms, combining closed-ended items, mostly on five-point Likert scales, with open-ended questions. The pre-implementation questionnaire addressed prior knowledge of PBL and STEAM, expectations, self-assessment of English and technical English skills, and was used to characterise the participants and inform the course design. The post-implementation questionnaire addressed the experience with the course, perceived skills development, the learning environment, perceived usefulness and suggestions, and provided the data reported in Tables 1 and 2. All 20 students and all six teachers answered both questionnaires.
- *Semi-structured interviews*: After implementation, six students, purposively selected to represent different levels of academic performance, were interviewed using a flexible script on expectations, most meaningful activities, difficulties and coping strategies, autonomous work outside class, perceived impact, gamification and suggestions. Interviews were audio-recorded with consent and transcribed verbatim.
- *Participant observation*: The first author carried out unstructured participant observation during sessions, recording field notes focusing on students' reactions, interactions with the digital resources and informal comments.
- *Usability tests*: At the start of implementation, five students used the course in a natural setting while the researcher observed, without intervening, navigation, understanding of instructions and the functioning of the resources.
- *Moodle activity reports*: Activity completion and access reports were consulted to identify general participation patterns, without a systematic count.

Qualitative data analysis, namely interview transcripts, answers to open-ended questions, field notes and usability records, followed the principles of content analysis (Bardin, 2016). After a 'floating reading' of the full corpus, the data were coded manually, using analysis grids, into a priori categories derived from the research objectives and the themes of the instruments: initial expectations; engagement in the activities; perceived development of competences, including technical English, technical subject knowledge and transversal skills; difficulties and coping strategies; assessment of the learning environment and gamification; teachers' professional development and interdisciplinary collaboration; and suggestions for improvement. Coding was carried out by the first author, and the categorisation was discussed with the co-authors. Closed-ended questionnaire items were analysed with simple descriptive statistics, namely frequencies and percentages; no inferential statistics were applied, given the size and non-probabilistic nature of the sample. Moodle activity reports were used descriptively to support triangulation by comparing evidence from different sources within each category and noting both convergences and divergences. In the following section, results are identified according to their source.

3. Results and Discussion

This section presents the results by data source, distinguishing between students' self-reported perceptions, teachers' perceptions, observational evidence (field notes and usability tests), and Moodle activity reports. Finally, the study's implications and the recommendations drawn from it are discussed.

3.1 Students' Results

The collected data indicate active participation and an overall positive perception among the students. Table 1 summarises key quantitative indicators from the post-implementation questionnaire.

Table 1: Summary of students' self-reported results (post-implementation questionnaire, n = 20)

Dimension	Indicator	Result
Participation	Self-reported active participation in activities	18/20 (90%)
	Self-reported completion of tasks outside school hours	11/20 (55%)
Favourite activities	Digital Escape Room	9/20 (45%)
	Explanatory videos	6/20 (30%)
	Vocabulary enrichment activities	4/20 (20%)
Difficulties	No significant difficulties	6/20 (30%)
	Technical English vocabulary as the main obstacle	14/20 (70%)
Impact of PBL	PBL made it easier to understand the content (agree/strongly agree)	14/20 (70%)
Skills developed ("yes")[a]	Teamwork	14/20 (70%)
	Communication	13/20 (65%)
	Technical English	11/20 (55%)
	Skills specific to their field	11/20 (55%)
	Creativity	9/20 (45%)
	Problem-solving	9/20 (45%)
Learning environment	Appealing or very appealing visual identity	20/20 (100%)
	Interesting and motivating activities	17/20 (85%)
Future usefulness	Knowledge useful for academic/career progression	15/20 (75%)
	Intention to continue accessing the course on Moodle	13/20 (65%)

[a] Answers to "Did the course contribute to your development in the following areas?" (yes / partially / no). All remaining students answered "partially", except for problem-solving (two "no")

The most highly rated activity was the Digital Escape Room, followed by the explanatory videos and vocabulary enrichment activities, indicating a preference for interactive formats closely linked to the course's technical context. The strategies students reported for overcoming difficulties – the use of machine translation tools, repeating activities, and support from peers and the teacher – suggest the use of self-regulation and autonomous learning strategies, in line with the principles of PBL (Fernández-Morante et al., 2022).

The learning environment was rated very positively: 100% of students considered the course's visual identity appealing or very appealing, and 85% rated the activities as interesting and motivating. Students' open-ended comments illustrate their positive view of the learning environment: "It's an amazing experience"; "I enjoyed this experience; it was something new, and I think it was very useful for the future". These data reflect satisfaction rather than evidence of learning gains.

The semi-structured interviews converged with the questionnaire data on the most meaningful activities – the creation of DIY videos, the Digital Escape Room and the electrical component identification activities – which were described as practical and relevant to the real world: "Because it's different; it takes us away from our daily routine" (student 1). All interviewees viewed the gamification system positively: "The badge gives you more motivation to reach your goals" (student 5); "The rewards motivate you to keep going" (student 6). One student acknowledged that "if there weren't any badges, I might not have participated as much" (student 4). While this confirms the motivating role of the badges, it also suggests that some participation may have been driven by extrinsic rewards, a limitation of gamification noted in the literature (Garcia-Iruela et al., 2021). However, the interviews also revealed heterogeneous levels of engagement - "I know it could have helped me more, but I didn't do much to make that happen" (student 3) - and all six interviewees stated that they had completed the tasks only during class time. This diverges from the 55% of questionnaire respondents who reported working outside school hours, so self-reported out-of-class work should be interpreted with caution. The interview accounts are consistent with Garcia-Iruela et al. (2021), whose platform data showed that VET students' activity in a gamified course was concentrated during school hours and that gamification did not lead them to work more in their free time. The interviews also revealed a perceived gap in the English syllabus regarding the technical content of the vocational course: "I don't really see our course reflected in the English lessons" (student 1), which corroborates the problem identified in the initial contextual analysis.

3.2 Teachers' Results

The six teachers involved evaluated the project very positively. Table 2 summarises the main results of the teachers' post-implementation questionnaire. As with Table 1, these results reflect teachers' perceptions. The

items under 'Perception of students' are teachers' ratings of students' performance on a qualitative scale (e.g., from 'Satisfactory' to 'Very Good'), not independent assessments of learning.

Table 2: Summary of teachers' perceptions (post-implementation questionnaire, n = 6)

Dimension	Indicator	Result
Professional development	Developed skills in active teaching methodologies	6/6 (100%)
	Positive impact on professional development	6/6 (100%)
	Intention to apply PBL and STEAM in the future	6/6 (100%)
Main challenges	Time for collaborative planning	5/6 (83%)
	Interdisciplinary collaborative work	4/6 (67%)
	Adapting to digital tools	3/6 (50%)
Perception of students	Student engagement and motivation: Good to Very Good	6/6 (100%)
	Teamwork: Good to Very Good	6/6 (100%)
	Communication in technical English: Satisfactory to Very Good	6/6 (100%)
	Independence in carrying out tasks: Satisfactory to Very Good	6/6 (100%)
Interdisciplinary collaboration	Positive assessment of cross-areas collaboration	6/6 (100%)
	The project contributed to greater coordination of the curriculum	6/6 (100%)
	Collaborative work was considered enriching	6/6 (100%)

The main challenge identified was the need for time for collaborative planning, mentioned by five of the six teachers, which is consistent with the constraints highlighted by Diego-Mantecón et al. (2021a). Among the most striking insights in the open-ended responses were the reconfiguration of the teacher's role - from knowledge transmitter to facilitator of learning - and the observation of spontaneous changes in students' language use: "Students began spontaneously using technical vocabulary in English, referring in English to the tools and instruments they were using in the practical workshop sessions" (Teacher 4). This observation reported by one teacher suggests a transfer of learning to non-formal contexts, indicative of meaningful and situated learning (Imbaquingo and Cárdenas, 2023; Yong and Saad, 2023), although it would need to be confirmed through systematic observation assessment. One teacher also proposed new follow-up activities, namely the creation of a webpage by the students featuring the results of their projects and the development of an interactive physical quiz on technical vocabulary.

3.3 Observational and Moodle Data

The usability tests revealed satisfactory overall usability, with most students finding the course structure intuitive. However, technical constraints were identified: incompatibility of the 'Electric Speech' activity with the Safari browser on iPads, difficulties uploading videos, and hesitation when navigating between external tools and Moodle. These findings led to adjustments to the course and confirmed the relevance of usability testing as a formative assessment tool in developmental research (Richey et al., 2004; Cruz et al., 2023).

Participant observation indicated a generally high level of students' engagement with the activities, with spontaneous expressions of satisfaction linked to the rewards system and the Digital Escape Room. A preference was also observed for direct, face-to-face support from the teacher over asynchronous forums, which were underused. Moodle activity reports, consulted descriptively, were consistent with these observations: completion of the Digital Escape Room was high, and the forums were rarely used. They also showed considerable variation in the number of accesses between students, with some who had completed group tasks recording few individual accesses, which may reflect uneven contributions to group work (Hsiao et al., 2022). This trend points to the need to develop strategies that promote students' digital autonomy and the more effective use of asynchronous channels of educational communication.

3.4 Impact and Recommendations

Bearing in mind the exploratory nature and small scale of the study, the findings suggest that digital courses based on PBL and STEAM are feasible and well accepted as a means of addressing the gap in technical English in Portuguese VET curricula; that gamification, when coherently integrated with pedagogical objectives, is perceived as motivating by VET students; and that interdisciplinary work can support teachers' professional development, provided that time for joint planning is ensured.

Based on these findings, the following measures are recommended: (i) to extend the duration of the course's implementation, as suggested by students and teachers, to enable deeper mastery of the methodologies and language skills and to assess linguistic progress; (ii) to invest in pre-training for teachers in PBL and STEAM approaches and to schedule time for joint planning, given that five of the six teachers identified planning time as the main challenge; (iii) to develop specific strategies to promote student autonomy and the use of

asynchronous support channels, given the underuse of the forums and the preference for face-to-face support observed during implementation; (iv) to ensure the technical compatibility of resources with the devices used by students, in response to the problems identified in the usability tests; and (v) to consider extending the model to other VET courses in STEAM areas, adapting the technical content to the profile of each course, once its effects on learning have been examined using more robust designs.

4. Conclusions

This study explored the integration of Project-Based Learning (PBL) with a Science, Technology, Engineering, Arts and Mathematics (STEAM) approach, supported by digital technologies, as a pedagogical approach to developing technical English skills in Vocational Education and Training (VET). The implementation of the 'Tech Talks: STEAM up your English' course was marked by high self-reported participation and positive perceptions among students and teachers. Three levels of findings should be distinguished. Regarding participants' perceptions, most students reported that PBL made the content easier to understand and noted progress in teamwork, communication and technical English. All teachers reported benefits for their professional development and positive student engagement. Regarding observed evidence, participant observation and teacher reports indicate strong engagement in interactive activities, such as the Digital Escape Room, and instances of spontaneous use of technical English vocabulary in workshop sessions. By contrast, usability tests and Moodle activity reports revealed technical constraints, underuse of asynchronous forums and uneven individual participation. Regarding learning outcomes, the study did not include direct pre- and post-measures of language proficiency or technical knowledge and therefore does not allow conclusions about actual learning gains, which remain to be demonstrated. Taken together, the results suggest that PBL in a STEAM environment is a feasible and promising approach for contextualising English language learning in VET, rather than establishing its effectiveness.

The results are consistent with the existing literature on PBL in STEAM contexts (Diego-Mantecón et al., 2021a, 2021b; Fernández-Morante et al., 2022; Hsiao et al., 2022) and on the role of PBL in developing foreign language skills (Imbaquingo and Cárdenas, 2023; Yong and Saad, 2023), suggesting that this approach may also be relevant to the specific context of VET. The link with the European frameworks 'Key Competences for Lifelong Learning' (European Commission, 2019) and 'DigComp' (Vuorikari et al., 2022) reinforces the study's alignment with educational policy guidelines for the 21st century.

The project's impact extended beyond the immediate classroom context, prompting teachers to develop new pedagogical initiatives and sparking the school management's interest in applying for an Erasmus+ project to expand and internationalise the approach. These developments suggest that the intervention was valued by the school community, although its scalability and transferability to other educational contexts remain to be examined.

The study has some limitations. First, its contextualised and small-scale nature – one class, one school, one course – and the short implementation period restrict the generalisability of the results. Second, most evidence on learning derives from self-report instruments, which are subject to social desirability and novelty effects. Third, no objective pre- and post-assessment of technical English proficiency and no comparison group were included. Future studies should therefore consider longer implementations, diverse contexts and larger samples, as well as objective measures of learning, such as pre- and post-tests of technical vocabulary and task-based assessment of oral and written production, ideally combined with a comparison group (e.g., Hsiao et al., 2022), so that the potential identified here can be validated and explored in greater depth.

Ethics Declaration

The study was conducted in accordance with ethical principles for educational research. Authorisation was obtained from the school where the study was conducted, and informed consent was obtained from the participants and, where applicable, their legal guardians. Participation was voluntary, and the confidentiality and anonymity of the data were ensured throughout the research process.

AI Declaration

In writing this paper, the authors used DeepL to assist with English translation. However, the ideas, concepts, and arguments presented in this work are solely those of the authors.

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