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Article

Knowledge management and e-Portfolios for sustainability

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Abstract: Integrating sustainable practices within technical university settings has garnered significant attention in recent years. However, there needs to be more progress in merging these practices with active foreign language learning and knowledge management. Recent studies have introduced new perspectives on social constructivism and second/third language (L2/3) acquisition, emphasizing knowledge-building and gender-related factors. This paper presents the methodology of a pilot study conducted during an English for Specific Purposes (ESP) course. The primary instructional technique employed was electronic portfolios (e-Portfolios), which facilitated extensive data collection to compare gender-differentiated lexical production among engineering university students. Two research instruments provided a comprehensive qualitative analysis of professional portfolio texts written in English. The visualization of e-Portfolio data, incorporating lexical and sentiment analysis, revealed specific differences in the characteristics of learners. This approach aims to integrate a broader perspective of ESP with sustainability and university knowledge management, areas that have yet to be explored. This study's convergence of academic and labor market needs highlights the potential to prioritize sustainability goals while fostering and showcasing innovation in higher education.

Keywords: sustainable education; university knowledge management; English for Specific Purposes (ESP); qualitative analysis; electronic portfolios (e-Portfolios)

1. Introduction

The Bologna process and the European higher education area have significantly transformed tertiary education by establishing a system of equivalent degrees, academic flexibility, and high-quality education. In addition to that, there has been a strong commitment to building effective connections between higher education and industry. Consequently, universities—particularly polytechnic institutions—are increasingly focused on preparing future workers for Industry 4.0 and 5.0, with sustainability challenges at the forefront of their mission.

Modern organizations rely on effective knowledge management processes to maintain a competitive edge, a practice significantly transformed by Industry 4.0, as Manesh et al. [1] noted. Hence, sustainable university preparation demands greater attention and acceptance from social actors and educational leaders to initiate a change in institutional culture. This understanding is essential for addressing the complex challenges of knowledge management and ensuring that quality higher education contributes effectively to sustainable advancement [2].

One of the most influential documents shaping the global perspective on sustainability and education for sustainable development is the Agenda 2030 [3]. Within this framework for action, the sustainable development goals (SDGs) have become a blueprint for quality higher education worldwide [4,5].

The 17 SDGs serve as an innovative and transformational toolbox, empowering undergraduates with inspirational means and socially relevant values. Current trends

in sustainable education, through curriculum integration and SDG-focused pedagogies, are paving the way to realize the potential of Agenda 2030 fully [6,7].

Specifically, SDG 4 promotes inclusive and equitable tertiary education [3]. According to Burbules et al. [8], the higher education process should transform educational goals, contexts, spaces, and teaching-learning models. In the context of a technical university, a multi-dimensional solution is required, showing its relevance and representativeness as a learning tool in degree programs.

Another practical challenge in this area is the customized design of the instructional process and its expected outcomes. In the COVID-19 situation, 21 engineering students from the Technical University of Valencia took part in the study implemented from February to May 2021 and required new ways of interaction, support, and mentoring. This involves connecting components such as English for Specific Purposes, engineering e-Portfolios, and university knowledge management to the didactic context in the following manner:

(1) The ESP curriculum aids engineering students in developing the specific language abilities necessary for their field, enhancing their ability to communicate complex ideas effectively.

(2) Academic and professional e-Portfolios provide a meaningful platform for students to document and showcase their competencies, projects, and learning progress, promoting reflective learning and continuous improvement.

(3) University knowledge management integrates previous elements by organizing and disseminating knowledge, fostering a culture of sustainability through shared resources and collaborative learning.

Therefore, with the intersection of these elements in mind, we explore the innovative potential of e-Portfolios and knowledge management systems to enhance engineering and education language acquisition through sustainable practices. Notably, by creating a holistic approach to sustainability education, we ensure that students are well-equipped with the necessary abilities and knowledge to address future challenges.

This research proposes a novel application of a sustainable approach toward refining engineering education and language acquisition. Understanding this aspect of education could improve self-learning epistemologies. To put this in perspective, competence-based ESP training linked with sustainability poses the following research questions:

(RQ1) How effective are engineering e-Portfolios in the ESP context at applying sustainability goals at university?

(RQ2) What effect does e-Portfolio have on the knowledge management of engineering undergraduates?

(RQ3) What are the overall knowledge management gender differences in the e-Portfolio experiment?

The overall structure of the pilot study takes the form of six sections. The first section is the introduction. The second section provides the theoretical background on knowledge management, active learning methodologies, and English for Specific Purposes (ESP), laying the foundation for the experimental part. The third section focuses on the methodology, detailing the experimental testing methods. The fourth and fifth sections present the study findings and discuss their implications. Finally, the

conclusion summarizes the investigation, addresses the research questions, and suggests directions for future exploration.

2. Literature review

2.1. English for Specific Purposes

In the 1970s, the communicative approach to learning foreign languages was developed, focusing on methods for conveying ideas and meanings in languages other than English. Following Hymes [9], we prioritize the "ability for use" with its close connections to motivation. Also, in line with Canale and Swain [10], we agree on using authentic texts and joint communication needs while seeking the right balance of adequacy and error tolerance.

Later, content-based language instruction received the name "English for Specific Purposes (ESP)". It aimed to support international students at institutions where English is the primary language of instruction with their academic writing assignments. Similarly, the concise definition of ESP as the "area of English language teaching that emphasizes job-related language, knowledge, and skills" outlines the mixed dimension of learning objectives [11].

When examining the fundamental components of English for Specific Purposes (ESP) during the past decades, several approaches highlighted by various scholars and practitioners emerge [12–15]:

(a) Needs analysis is crucial for meeting the specific training demands of English students and offering relevant, practical and customized learning scenarios.
(b) Specialized vocabulary and competences are linked to the ESP, which focuses on professional communication needs within a given field or industry.
(c) Contextual learning within ESP prioritizes authentic materials and real-life abilities required in students' professional domains.
(d) Innovation and digitalisation in ESP instruction allow for improved learning systems and interactive, engaging and purposeful preparation for labor market.

Thus, combining the challenges of ability development with integrating second languages enhances the expansion of communicative competences [16]. Additionally, university learners have willingly accepted innovative approaches towards English for Specific Purposes within blended modality due to their flexibility and professional development value.

Another compelling evidence of students' perceptions of ESP courses as preparation for academic and professional communication came from the study of Arnó-Marià et al. [17]. The research, conducted across three campuses—two in Spain and one in Austria—revealed that students generally perceive ESP courses as adequate preparation for future communication needs, showing increased confidence in using English and recognizing the importance of technical communication. Overall, the findings underscore the relevance of ESP courses in equipping students with the necessary skills for international academic and professional environments.

Experts highlight the importance of finding a balance between collaborative and innovative second language instruction in a competitive context while avoiding overburdening learners and professional competence development via ESP [18].

Alternatively, emphasizes the foundations of an effective ESP course organization: needs analysis, learning objectives, materials and methods, and evaluation [19].

Together, this theoretical background of English for Specific Purposes outlines the critical role of a tailor-made structural approach towards the learning process. Furthermore, achieving a balance between collaborative and innovative instructional methods, along with careful consideration of needs analysis, learning objectives, materials, and evaluation, is essential for the effectiveness of ESP programs. These insights highlight the significance of ESP in preparing students with the skills necessary for international academic and professional settings.

2.2. Active learning methodologies

The starting point for approaching this section relies on supporting a student-centered active learning model and meaning construction [20,21]. Hence, constructivist perspectives developed by Jean Piaget and Lev Vygotsky provide remarkable insight into the nature of knowledge acquisition. Whereas Piaget's cognitive constructivism focuses on biological and experiential learning during cognitive development stages, Vygotsky's social constructivism highlights the importance of social interaction and scaffolding in learning and Burner's discovery learning as a part of internal response to the learning environment [22,23].

Over the past century, these theories have significantly influenced modern educational practices, leading to approaches such as enquiry-based learning, collaborative learning, and the use of technology in education. Moreover, the evolution of constructivist theory has seen its principles applied in blended learning, problem- and project-based learning, and problem-based learning, all of which promote active, social, and contextual learning experiences.

In order to deepen their comprehension, students are urged to draw connections between new information and their existing mental models during active learning. The constructivism learning theories propose that knowledge is created via social interaction and not as personal private property but rather as a collective experience.

This interpretation is supported by "The Greenwood Dictionary of Education" edited by Collins and O'Brien [11], who define active learning as:

> "The process of having students engage in some activity that forces them to reflect upon ideas and upon how they are using those ideas. Requiring students to regularly assess their own degree of understanding and skill at handling concepts or problems in a particular discipline. The attainment of knowledge by participating or contributing. The process of keeping students mentally, and often physically, active in their learning through activities that involve them in gathering information, thinking, and problem solving".

All students, regardless of subject area or subject, participate in or contribute to knowledge as part of the learning process. The ability of students to grasp and solve issues in a given area must be continually self-assessed.

In this sense, the instructor's responsibility is to apply learner-centred collaborative teaching strategies that provide gradual information flow. We construct understanding by scaffolding or supporting learners throughout the challenging process of acquiring new abilities [24,25]. The proper interactive system of guiding

students and managing certain aspects of tasks is called to avoid frustration and offer a timely solution when required by pupils (ibid).

Among the most valuable didactic implications of social constructivism selected by Akpan et al. [26], special relevance for us is its self-regulation capacity in terms of knowledge building, group interaction and self-esteem. Besides, the theory entails a serious commitment to pedagogic innovation, stimulates interest and aids retention; it inspires curiosity and facilitates capacity development by taking a reflective look at one's own understanding.

In the context of electronic portfolios as active learning tools in English for Specific Purposes (ESP), these constructivist principles are particularly relevant. They encompass systematic progress within quality and purposeful educational settings, which aligns with the constructivist emphasis on social interaction and collective knowledge creation. e-Portfolios serve as a practical tool for students to document and reflect on their learning experiences, facilitating continuous self-assessment and the construction of knowledge.

2.3. University knowledge management

Knowledge management (KM) in universities is crucial for fostering knowledge-building and enhancing organizational performance. Although the definition of KM varies across different scientific disciplines and practical applications, it is generally associated with innovation and the enhancement of intellectual capital. According to Ode and Ayavoo [27], KM involves organizational activities that utilize context-specific methods to boost innovation efficacy.

Also, the concept of innovation is closely linked to Industry 4.0, encompassing the Internet of Things (IoT), big data, smart factories, digital transformation, and knowledge sharing. Ülker and Otrar [28] outline a valuable connection between Industry 4.0 and University 4.0 through knowledge management and communication, continuous improvement, global competitiveness and digitalization.

While KM in higher education significantly supports innovation and organizational performance, integrating KM into university curricula still presents challenges [29]. These authors suggest that fostering KM in education can lead to internal academic knowledge sharing, which can be transformed into new organizational value. Likewise, Ahmad et al. [30] argue that successful KM in universities requires adequate support and a conducive work environment that promotes the creation, use, and sharing of new information.

Sallis and Jones [31] identify several key elements for effective KM self-assessment: vision and mission, strategy, organizational culture, intellectual capital, learning organization, leadership and management, teamwork and learning community, knowledge sharing, knowledge creation, and digital sophistication. These elements provide a comprehensive framework for integrating KM into educational settings and guide the current investigation.

This pilot study adopts an experimental approach toward connecting organisational knowledge management within an ESP teaching programme, emphasising innovative learning tools. It also examines gender differences in the context of sustainability and capacity-building in L2/L3 specialized preparation.

In approaching the theoretical foundations for the current study, we drew on previously published work from various fields. **Figure 1** plots the connection of the original ideas on education and sustainability to university knowledge management and active learning of ESP. Similarly, the research focus on gender differences includes new insights into information management.

Figure 1. Theoretical background.

Source: Own elaboration.

3. Methodology

Building a quality learning environment, engaging technical learners and involving meaningful social issues is not an easy task. Given the varying circumstances of health-based nature, the starting methodological point of this research was precisely the alignment of ESP foundations to engineering students' needs within the new international reality back in January of 2021.

Firstly, by linking KM to higher education, several applied cases emerged. On the one side, scholars describe this phenomenon in tertiary education institutions as advanced organisations being a valid success, internal transformation and social wealth factor worldwide. On the other, the didactic spectrum of KM varies from using Wiki, applying mediation, and flipped teaching to a simulation game.

Motivated by the need to create a meaningful and KM-based learning environment, we decided to design an academic project by exposing undergraduates to specialized knowledge management and sharing environment. To that end, the e-Portfolio approach provided an appropriate balance between the requirement for practicality and the necessity for ESP-oriented instruction.

Though engineering education generally seems to evaluate "communication, teamwork, lifelong learning and innovation" competences, student activation and measurable learning outcomes and comparable results are strongly recommended

[32,33]. In this regard, to support contextual and sustainable learning, we chose to introduce an electronic portfolio or e-Portfolio.

So, what is an electronic portfolio? Olstad [34] notes that students' e-Portfolios are evidence of achievement and demonstration of abilities, competences or learning acquired from education, training, or work experience. Sodhi and Moon [35] see engineering e-Portfolios as a compilation of individual work on a website for promoting students' projects in addition to their CVs. This study considers the e-Portfolio to be an all-inclusive, sustainable knowledge management tool for providing non-native English learners with new opportunities for professional advancement [36].

Because of the above, we applied a framework for quasi-experimental research planning to the e-Portfolio implementation [37]. In the present context, the relevance of the one-group scheme for ensuring research methodology, instrumentation and validity is linked to the ESP pedagogy. Further, **Figure 2** depicts our methodological proposal stage by stage.

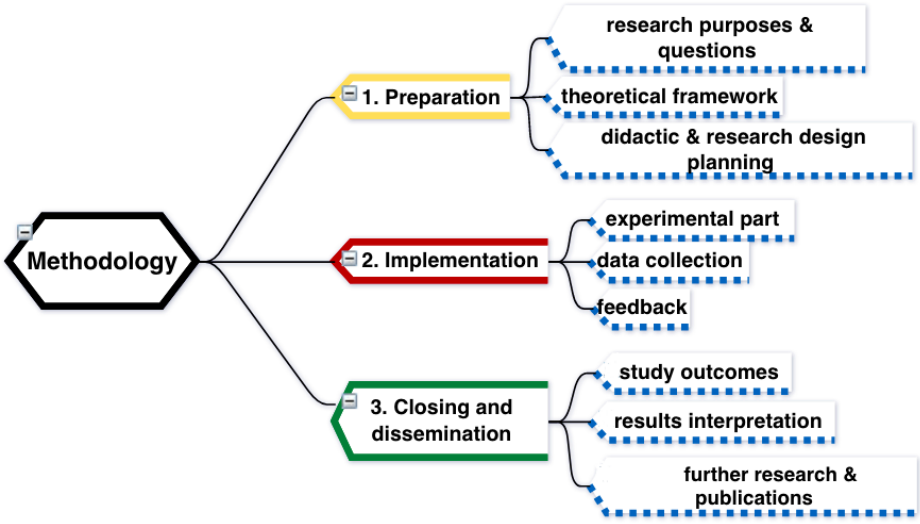

Figure 2. Methodological planning.

Source: Own elaboration.

3.1. Preparation

Originally, we struggled to attain both areas together by concentrating on two significant aspects, research and didactics. Choosing the ESP training domain presents an interesting opportunity to delve into the depth of technical students' portfolios from sustainable and applied linguistics perspectives. Plus, selected theory foundations support not only university knowledge management but also active L2/3 learning. During this stage, the academic staff established the following basis concerning research focus, participants, pedagogic content, timing, among others:

- Participants: 21 (14 female and 7 male) industrial engineering design students of the Technical University of Valencia who composed an international student body (native Spanish, second-generation immigrants, EU and Latin America scholarship holders). These learners represent one complete group of undergraduates taking the ESP course.
- Course type: ESP course, hybrid teaching mode due to COVID-19 circumstances.

- Timing: 2nd semester (February–May 2021), 1–1.5 h per week of class work on the e-Portfolio project and its oral presentation.
- E-Portfolio elaboration (200 words each part).
- E-Portfolio presentation: 10-minute-long PowerPoint presentation.

3.2. Implementation

Then, during the experiment, we maintained planned tasks, activities, and delivery deadlines as well as weekly monitoring sessions for the undergraduates to feel supported but not overly controlled. E-Portfolio users' engagement and feedback are vital factors of successful initiative advance. The initial project presentation and discussion in class was a distinctive opportunity for the users to express their doubts and help to adjust the e-Portfolio composition by eliminating Project 3 item. At the end of the teaching process, another discussion was held to obtain learners' feedback.

Specifically, the steps planned are the following:

(a) E-Portfolio academic project presentation: Hybrid mode teams session during which the participants receive document structure, examples, and assessment rubric. There is also space for questions and answers and e-Portfolio structure discussion.
(b) Weekly status quo online and monitoring interactions in small groups.
(c) Weekly in-class short reminders, collaboration and timeline tracks.
(d) Approximately every two weeks, delivery of e-Portfolio artefacts and their revision by the lecturer.
(e) Final delivery of the written academic project and its public presentation in class.
(f) Participants' feedback and performance assessment.
(g) Research data collection.

3.3. Closing and dissemination

Finally, once the didactic part was over, we reviewed e-Portfolios for analysing data and reporting the results. By connecting the outcomes with the research questions, we found feasible and transparent answers to the questions raised. The integration of two qualitative research tools enabled more coherent looks not only at the e-Portfolio texts from the structural point of view but also allowed a further opportunity to explore gender differences.

Additionally, based on existing good practices, we have engineered architecture of knowledge management adapted to the training within the framework of knowledge creation, knowledge modelling, knowledge sharing and knowledge internationalization.

4. Results

The purposes of this section are varied, as we will see in a moment. Our study aims to demonstrate that e-Portfolios are adequate for undertaking sustainability, offer satisfactory solutions to university knowledge management training and shed light on gender differences. The examples in **Figure 3**, in particular, prove that four months of hard work led to engaging projects. Generation and management of industrial design

projects in English provided the necessary support in organizing knowledge and engaging our students.

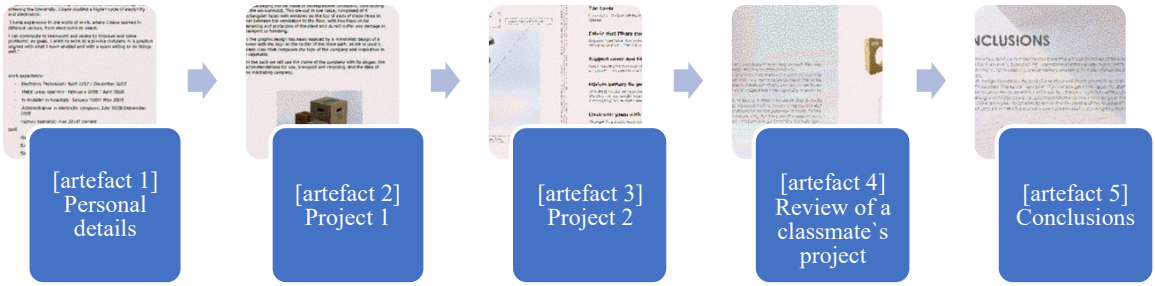

Figure 3. Sample e-Portfolio contents.
Source: Own elaboration adapted from randomized and anonymized project proposals.

Hence, the qualitative approach implemented had originally moved in two different directions. On the one hand, lexical analysis gathered a comprehensive grasp of the linguistic structure of the learners' e-Portfolios. On the other, sentiment analysis supported detecting the emotional tone of the same documents. Consequently, the research instruments applied to educational practices hold surprising findings for patient readers.

4.1. Lexical analysis

Building a reliable analytical methodology takes time but is well worth the effort. As mentioned before, all e-Portfolios were compiled in two separate files: 14 female documents of 13,407 words and 7 male documents of 8547 words. Following specific recommendations, we processed the resulting data via MAXQDA, an excellent research tool containing a module with computer-aided quantitive text analysis [38].

MAXQDA MaxDictio—Word combinations tool was used to detect the most frequent lexical patterns [39]. The initial findings on the most frequently used word combinations (see **Table 1** below) identified that all students prioritize the expression (a) "industrial design", (e) "product development" as the main training focus and area of expertise. Moreover, female participants showed more awareness of other areas such as (b) "transversal competences", (f) "conceptual design", (g) "critical thinking", (c) "time management", (i) "industrial designer" or (k) "design process" whereas male learners ranked higher (d) "graphic design" and (j) "design engineering".

The average document structure and patterns were also processed by MAXQDA MaxDictio Word Tree tool, and the figure below (**Figure 4**) provides an overview of the results [38]. Interactive word tree analysis of separate female and male data suggests interesting insights into the way information is arranged. In the case of feminine outcomes, there is a general tendency to highlight the "part-of" relations emphasising its connection to "part", "design" or "needs" among others. As for the male participants, the straightforward grouping into big categories of "product", "project" or "design" moves from the general to the specific order of things.

Table 1. Word combination analysis of female and male e-Portfolios.

Word combinations	Words	Frequency	%	Range	Documents	Documents %	Female _e-Portfolios	Male _e-Portfolios
(a) industrial design	2	25	3,75	1	2	100,00	19	6
(b) transversal competences	2	17	2,55	2	2	100,00	14	3
(c) time management	2	10	1,50	3	1	50,00	10	0
(d) graphic design	2	9	1,35	4	2	100,00	5	4
(e) product development	2	9	1,35	4	2	100,00	6	3
(f) conceptual design	2	8	1,20	6	2	100,00	7	1
(g) critical thinking	2	8	1,20	6	2	100,00	7	1
(h) high school	2	8	1,20	6	2	100,00	6	2
(i) industrial designer	2	8	1,20	6	2	100,00	7	1
(j) design engineering	2	7	1,05	10	2	100,00	4	3
(k) design process	2	7	1,05	10	2	100,00	5	2
(l) four years	2	7	1,05	10	1	50,00	7	0

Source: Own elaboration based on MAXQDA.

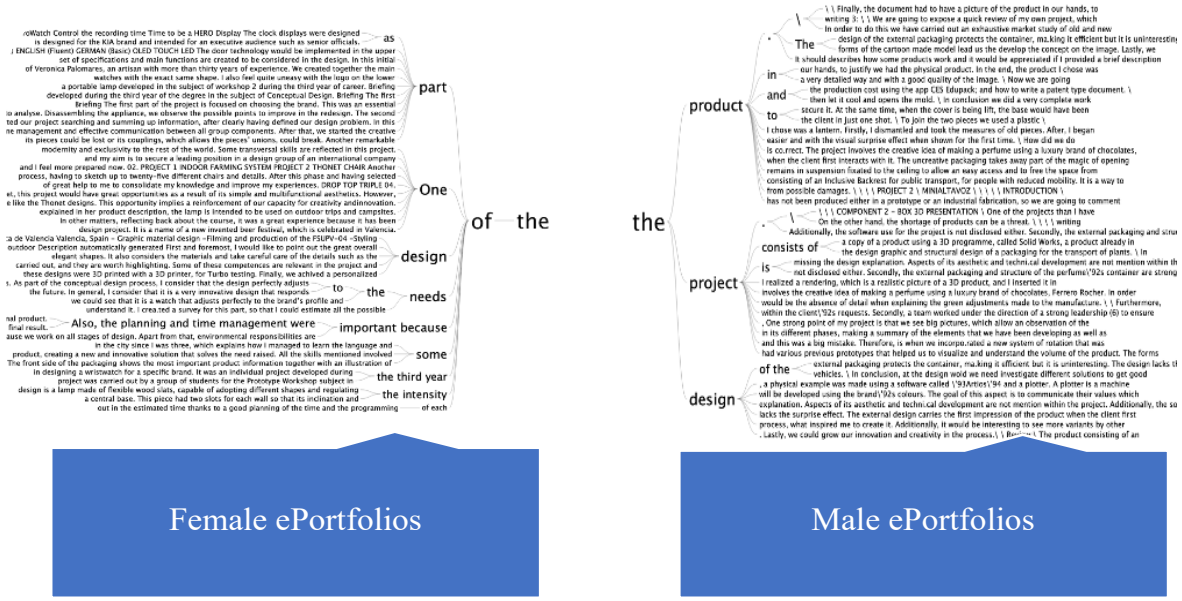

Figure 4. Female and male e-Portfolio structures.
Source: Own elaboration based on MAXQDA.

Both word combinations and word tree approaches described above offer a different manner of expression associated with gender differences. The quantitive analysis supported by visual representations illustrated significant variances regarding each gender representing its ideas in L2/3 lexis structure-wise.

4.2. Sentiment analysis

In the upcoming part, we will focus on the lexicon-based looking at the sentiment-laden words and expressions by applying the Lingmotif sentiment analysis tool [40]. This sentiment-oriented approach helps identify positive or negative opinions existing in text and expressed through words, as Taboada [41] states.

As shown in **Figure 5**, the second half of our experiment calls attention to the text sentiment score and intensity comparison. These observations shape the generally positive perception of academic projects, as the sentiment intensity score reaches almost the same degree of factual representation. Nevertheless, it is apparent from this illustration that a more significant difference lies in the sentiment score, ranging from "extremely positive" to "very positive".

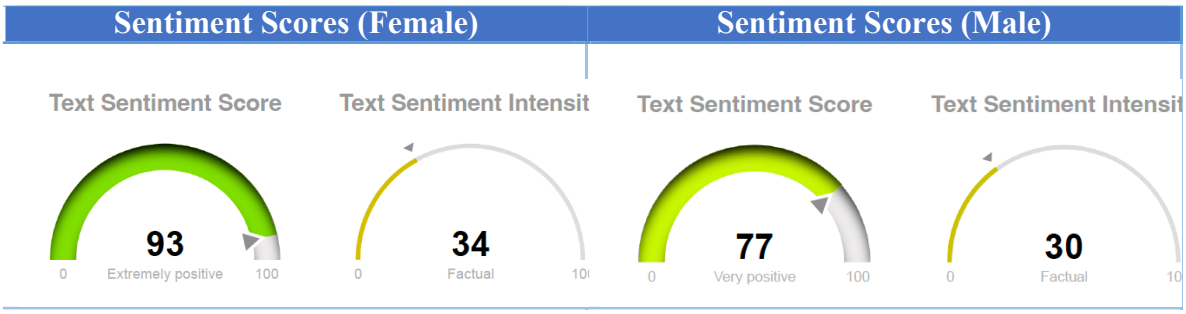

Figure 5. Female and male e-Portfolio sentiment analysis results.
Source: Own elaboration based on Lingomotif.

Further analysis of the Lingmotif female e-Portfolio report suggested the following lists of top positive and negative items and their frequency. On the plus side, the girls use "improve" (5), "solution" (2), "help" (2), "do bit" (1) and "better than" (1). On the downside, they refer to "not good" (1), "do not like" (1) and "collapse". According to these data, an optimistic approach is revealed in this case because of the reduced number of unfavorable evaluations.

Concerning the Lingmotif male e-Portfolio report, the ranking of top positive items comprises this lexicon: "generate" (2), "easier" (2), "strong point" (2), "adjustment" (2) and "keep up with" (1). On the negative side, the tool has collected these examples "plotter" (3), "be missing" (1), "uninteresting" (1), "lack" (1) and "uncreative" (1). Due to the current ESP context, the first negative item on the list might be slightly challenging as the "plotter" is not only a conspirator but also a type of computer graphics printer.

5. Discussion

Although our original motivation was to create a meaningful learning environment for technical learners, much prior work has been devoted to innovating the L2/3 active acquisition process. Unlike Geitz and de Geus [42], the layers of this training scenario include, among other things, more metacognitive reflection and orientation toward knowledge management. An initial objective of the project was to address SDGs 4 (quality education), as well as knowledge management via e-Portfolios.

The lexical analysis findings extend modern communication actions working on these challenges detected by Machado and Elias [43]. Specifically, the first aspect examined here is the linguistic dimension of knowledge building from a gender perspective. In this case, even though all partakers focus on their main professional areas of industrial design and product development, female results are more consistent with a deeper connection to the categories of competences and critical thinking. In

contrast with the previous standpoint, male participants generally set out practical aspects of the task.

Comparing the e-Portfolios structure, we can observe gender differences in the way information is presented, being a "part-of" a typical female and direct category grouping or describing a habitual male routine. Therefore, it is interesting to visualize gender differences in verbal e-Portfolio content and relate them to knowledge management. In other words, gender aspects are the likely cause for representing and producing information in a certain way.

Apropos the sentiment analysis, all students were optimistic about e-Portfolios. However, a minor inconsistency may be related to the technical term "plotter" and its general negative meaning used in male documents. These findings demonstrate an excellent attitude of the learners toward this ESP setting and knowledge management. Hence, the described approach allows an insider and linguist to examine how knowledge is managed, collected, and expressed. Given the qualitative data accompanying contextual information on the setting mentioned above, this advances an original pathway of L2/3 research combined with didactics.

6. Conclusion

This study aimed to verify three research questions: (1) The suitability of e-Portfolios in the ESP context for addressing sustainability goals, (2) e-Portfolio effectiveness in university knowledge management training, and (3) the connection of knowledge management implementation with gender differences. By focusing on Sustainable Development Goal 4, we promoted technical foreign language learning through e-Portfolios, enhancing quality education and employability.

Our findings highlight the importance of knowledge management in labor market preparation and professional identity formation, emphasizing:

(1) Knowledge creation: Developing reflection, communication, and dissemination in teaching and research.

(2) Knowledge modelling: Strengthening relationships between academia and industry.

(3) Knowledge sharing: Fostering a knowledge culture through oral presentations of portfolios.

(4) Knowledge internalization: Spreading tacit knowledge within the community and research circles.

This pilot study underscores the dual role of pedagogy and research in expanding university education to include job market preparation, gender awareness, and sustainability. Understanding gender differences in KM suggests benefits for mixed teams and collaborations.

In conclusion, we developed a framework for active language acquisition and sustainable knowledge management in an ESP setting. Our qualitative analysis provided insights into students' perceptions, strengths, and weaknesses. This study demonstrates the compatibility of language teaching, research, and global goals, potentially inspiring broader educational initiatives. Despite limitations such as the small sample size, future research could further explore the links between sustainability, KM, and active ESP learning, considering gender differences in

technical education. This information can guide the development of job-oriented academic projects with strong gender awareness.

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