The Pivotal Role Coupling ESP and Engineering: Preparation for the Globalized Landscape

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Abstract

The unprecedented demand and unique learning environment for English for Specific Purposes (ESP) learners and engineering students is continually evolving as educators focus on cutting-edge technology and best practices to promote optimal learning to meet the needs of our complex interdisciplinary globalized world. Across the educational landscape, educators are grappling with challenges and learning experiences in the field of engineering that never could have been predicted. For numerous highly capable students enrolled in university engineering programs, English is not the native language and adaptation of the curriculum for diverse abilities is essential as employers expect a broad range of transferable competencies to prepare students for the global workforce. In an increasingly internationalized context, it is necessary to reappraise current ESP courses to find out the extent to which they are adapted to the needs of engineering graduates in a globalized world [1]. How do we effectively communicate and emphasize collaborative learning in engineering and revitalize the ESP learning experience in the technology enhanced learning environment of the 21st century? Innovative learning and ESP teaching must be at the forefront of educational endeavors. This pilot study addresses the pivotal role of ESP, engineering coursework and technology-enhanced learning to ensure that students explore and expand their acquisition of knowledge. English proficiency is imperative for engineering students, facilitating international collaboration, access to cutting-edge research, and strengthening employability in multinational companies [2]. The study will focus on hands-on engineering pedagogy at and below the university level. It will investigate teaching strategies that create a culture of innovation coupled with collaboration to strongly impact outcomes and inform practice to bolster engineering content as well as communication and English language skills. Professors and students will be interviewed, and specific hands-on activities will be shared. This presentation includes instructional methods that focus on active learning environments, highlighting experiences from engineering, and emphasizing direct ESP preparation to ensure success and promote purposeful collaboration and engaged learning. These connections interwoven with engaging methodologies and active learning featuring evidence-based best practices will ensure optimum learning for ESP engineering students as they set active goals integral to their success.

Keywords: *ESP, Engineering, Technology, Globalized, Methodologies, Collaboration*

1. Introduction

This contribution focuses on ESP that often refers to teaching English to a particular group of learners for a specific vocation or content area such as engineers, airline pilots, the travel industry or personnel in the medical field. It is not exclusive to the teaching of English and ESP strategies can be adapted to any language and numerous professions for near-term and long-term needs. During the English instruction, relevant components of vocabulary are introduced that relate to the academic language required for the profession being addressed. This paper and pilot study explore the field of Engineering and the ways that ESP will relate to the multifaceted needs of individuals in the engineering field. Not only does ESP focus on specific university subject areas or professions, but these components can also be introduced at a younger age in elementary or vocational secondary schools. By considering a variety of ages and levels, students' preparation, expectations and performance in engineering coursework will strengthen the relationship between subject material knowledge and language acquisition. The key focus of this paper will be hands-on engineering pedagogy at the university level; however, we will also include grammar, vocabulary, and discourse patterns relevant to this discipline at the elementary and secondary levels. By introducing a goal-oriented approach at an early age, students are encouraged to engage in real-world activities that motivate them to excel and pursue their interests and career aspirations integrating language instruction with their specialized interests, and ensuring practical application in their chosen fields. For educators planning to design and implement an ESP engineering instruction program, this contribution offers examples and a framework of activities relating to action oriented hands-on methodology and builds a case for incorporating ESP to meet the urgency level of preparing students for our complex interdisciplinary globalized world.

2. Review of the Literature

The majority of research on ESP and engineering focuses on successes and challenges at the university level and is conceptualized according to workforce disciplines such as engineering from a learner-centered approach [3]. Kausar points out that, "Despite the global emphasis on English proficiency, the majority of engineering students whose first language is not English often encounter significant specific obstacles such as limited vocabulary, pronunciation issues, anxiety, inadequate practice opportunities, linguistic deficiencies, psychological factors, institutional constraints and pedagogical shortcomings" [4]. Kausar presents a study examining the challenges faced by non-native engineering students in acquiring English language skills and explores the role of ESP in engineering education, emphasizing its impact on academic success, employability, and professional communication [4]. Additionally, ESP focusing on the integration of curriculum design theory for aircraft engineering is an essential area incorporating English as the target language for crucial practical mastery [5]. The authors argue that the construction of courses within an action research plan and a framework for how this might be accomplished are essential to effectively design an aircraft ESP engineering course [5]. The incorporation of ESP also extends to younger students who are beginning to consider career choices. Floris and colleagues in Italy point out that within this trajectory, academic adjustment becomes essential. This refers to students' ability to cope with academic challenges, critically engage with learning methodologies, organize their time effectively, actively participate in lectures, and accurately interpret instructors' expectations [6]. York posits that academic success is influenced not only by cognitive factors but also by satisfaction, perseverance, the activation of motivational processes, and the ability to engage in critical self-assessment [7]. The key aspect of ESP lies in the learners and their purposes for learning English. ESP students often already have some acquaintance with English and are learning the language in order to pursue a vocation or communicate a set of professional skills and perform job-related functions [8]. Fiorito explains that an ESP program is therefore built on an assessment of purposes and the needs and the functions for which English is required. He emphasizes that ESP concentrates more on language in context than on teaching grammar and language structures. English is not taught as a subject separated from the students' real world but integrated into a subject matter area important to the learners [8]. Providing regular interaction and quality teaching will significantly help ESP and engineering students in their educational experience.

3. Effectively Communicating ESP in Engineering

As with any language taught for specific purposes, ESP related to the field of engineering will focus on this occupation or profession with reference to the particular vocabulary and skills needed. Despite the seemingly limited focus, a course of ESP focusing on numerous aspects of engineering can have a wide-ranging impact. During a conversation with H. Teller, a mechanical engineer and Global Vice President, Finished Goods Supply Chain Medical Products Division at Gore, he commented that "In highly technical industries where competition is on a global scale, an ability to both convey and receive very specific, detailed, and often nuanced information is critical to ensure cross regional collaboration is effective and can be conducted at the pace of worldwide competition." In a further discussion with W. Coughlin, a mining engineer, he pointed out that, "Engineering is all about numeric data, numbers, but a good understanding of English is needed to ensure that the data used to generate the numbers is the correct data set." English for academic purposes, taught to students before or during their degrees, is one sort of ESP. For younger students, ESP provides learners with opportunities to develop their English skills and cultivate interests in various professions and vocations. Another significant role of ESP is the fact that the activities enable educators to conduct various vocabulary and reading activities, paired and independent reading with learners including hands-on activities and active learning. Moreover, educators can incorporate engineering subject specific labs and exercises according to their learners' abilities which will promote development of both language and content skills.

4. Hands-On Engineering Pedagogy

There are numerous avenues to stimulate ESP and engineering by integrating language instruction with students' specialized interests, ensuring practical application in their chosen fields and capturing their enthusiasm. An educational curriculum based on Science, Technology, Engineering and Math (STEM) focused on teaching the basic principles of STEM-related subjects provides a foundation for students to expand their abilities and focus on the engineering field. The key to teaching these disciplines is a hands-on approach, that is responsible for the development of a unique set of skills. Language learning, specifically ESP in engineering, can be incorporated into these sample activities. Numerous kits and building projects are found online that focus on engineering and incorporate language competencies to encourage learners of all ages. Multiple sites exist with university level engineering activities and ESP language building skills transferable to the workplace. Fredrik points out that language barriers pose significant challenges in globalised and multilingual workplaces. Whether your team speaks multiple languages, comes from diverse backgrounds, or navigates culturally unique language usage, these differences can hinder effective communication, disrupt workflows, and affect employee efficiency and morale [9]. Among the key suggestions supporting ESP in the field of engineering are the following:

Assess Primary Language Proficiencies: Provide language instruction and use clear language focusing on essential vocabulary related to engineering tasks.

Emphasize Visual Aids: Use diagrams, models, and demonstrations to explain concepts, which can help overcome language barriers.

Encourage Collaboration: Group work allows students to learn from each other and practice communication skills in a less intimidating environment.

Connect to Culture: Find opportunities to link the activities to students' cultural backgrounds or familiar experiences to increase relevance and engagement.

Focus on Hands-On Learning: The physical nature of engineering activities helps make abstract concepts concrete and provides opportunities for students to learn through doing.

Leverage Technology: Encourage trial and error, as it's a natural part of the engineering process and encourages persistence and confidence.

Foster a Supportive Environment: Encourage open communication, patience, and empathy among employees to break down language barriers [9].

5. Learning Experiences from Engineering

What follows is a variety of sample activities for various age levels focusing on Engineering. Each of these activities should include an understanding of English vocabulary that accompanies the lesson prior to initiating the activity.

Elementary and Middle Level (Ages 6-13)

STEM engineering toys are educational projects and activities designed to teach students about STEM principles through hands-on discovery and exploration. They strengthen the development of critical thinking, problem-solving, creativity, and analytical skills by encouraging students of all ages to build, experiment, and discover. STEM toys are a fascinating and innovative category of educational tools designed to ignite young minds and introduce them to the world of STEM [10]. Examples include building blocks, coding robots, science kits, and math puzzles, aimed at fostering curiosity and building knowledge of STEM-related concepts. For example, a puzzle set features one or multiple moving parts that are based on a basic principle of mechanics. STEM building toys are a unique category as they can be easily adapted and are for students of any age. Elementary school children are starting to develop specific hobbies and preferences. The Ugears Flight Starter or the UGears Tractor sets are designed for students interested in transport, and feature rubber-band mechanisms that launch light paper planes in the air and send a tractor off with a speed of 2 inches per second respectively [11]. Numerous kits and building projects can be found online that focus on engineering and incorporate language competencies to encourage learners of all ages.

High School Level (Ages 14-18)

Engineering activities for high school ESP students should be hands-on, visually oriented, and encourage collaboration to build both technical skills and language proficiency. Examples include building marble roller coasters and self-propelled balloon cars, designing solar-powered ovens for sustainability, and constructing shelters for weather challenges. Incorporate visual aids, allow for group work, and connect activities to students' cultures to make learning engaging and accessible. Students use engineering design principles to construct and test a fully solar powered model car. Building and testing a solar car combines aspects of electrical and mechanical engineering [12].Several options and kits exist, the "Junior Solar Sprint" (JSS) Car Kits is one example that can be purchased with direction from the federal government [12]. Using the JSS kit from Solar World, students are provided with a photovoltaic panel that produces ~3V at ~3W. An optional accessory kit includes wheels, axles and drive gears. A chassis must be built additionally. Balsa wood provides an excellent option though many others are available. The testing of the solar car culminates in a solar race between classmates.This engineering curriculum aligns to Next Generation Science Standards. Students should be directed to construct their cars in the following manner:

1. Set up the car body (chassis).
2. Add the axle and wheels.
3. Add the motor.
4. Then mount the solar panels.
5. Once the vehicle is completed, testing begins.
6. The activity culminates in a race!

Also consider the following:

- While using the materials listed above give students the freedom to choose their own designs.
- Photovoltaic cells do not deliver nearly as much power to a motor as a battery does. Keep your solar cars light.
- Judge where your motor should go BEFORE you add it to the body.
- Make sure your panels point towards the sun and that they are steady.

Vocabulary/Definitions to support ESP students are:
axle: The supporting shaft on which a set of wheels revolves.
chassis: The frame that holds the body and motor of an automobile together.
conductor: A material that allows electricity to move through it easily. That is, it is a material with low electrical resistance, one in which a small voltage will produce a fairly large current.
current: Movement of electrons.
photovoltaic cell: A semiconductor device that converts the energy of sunlight into electric energy.
voltage: Designates "electric pressure" that exists between two points and is capable of producing a flow of current when a closed circuit is connected between the two points (can also be considered with the analogy of elevation: just as a hill will have water flow down it, a voltage will have current flow in the direction from high to low) [12].

University Level

The following activity is designed for advanced ESP engineering students to prepare them for the field of engineering in the workplace and is inspired by engineering coursework at the University of Georgia in the USA.
Inductors and electromagnets:
What are they:
Inductors are one of the main components used in electrical circuits from computers to the power grid. Inductors oppose changes in current. When there is an increase in current the inductor resists the change in current flow by storing the extra energy in a magnetic field. Then if the current levels drop the inductor can increase the current using the extra energy it stored in the magnetic field.The inductor's main goal is to oppose current change by storing or releasing energy from a magnetic field.
Why it matters:
The important part of inductors for this activity is that when electrical current is passed through them, they resist the increase in current by creating a magnetic field which means inductors can be used to make electromagnets.
How are they made:
Inductors are usually made by wrapping copper wire around a core material. This material changes depending on the application but for making an electromagnet iron is one of the best core materials.
Real world use:
Inductors can be seen on telephone poles and in most electronics. They are used in transformers to step up and down AC power. They can also be used to filter low or high frequencies out of AC signals. In addition, they are used to make electromagnets.
Formulas for solenoids (wire wrapped uniformly around a core material):

Formula for inductance:

$$L = \frac{\mu N^2 A}{l}$$

L: inductance
u: permeability of the core material (number changes based on core material)
N^2: number of turns
A: cross sectional area of core
□: length of coil of wire
A higher inductance is directly related to a higher magnetic field strength (B). In solenoids magnetic field strength can more directly be shown by the formula below, which shows how magnetic field strength increases with current.

$$B = \frac{\mu N I}{l}$$

B: magnetic field strength
u: permeability of the core material
N: number of turns
I: current through the wire
□: length of coil of wire
If the magnetic field formula is combined with formula for inductance it shows direct correlation between magnetic field strength and inductance in the case of solenoid (wire wrapped uniformly around a core).

$$B = \frac{LI}{NA}$$

L = inductance
N = number of turns
I = current through the wire
A = cross sectional area of the core
Activity:
Obtain enamel-coated copper wire. Do not use bare copper wire because it shorts and acts as one turn giving a weaker field. Iron is a good core material for electromagnets, because it has a high (ų) value which directly increases the magnetic field strength. Then wrap the wire around the nail. The formula shows that as the number of turns (N) increases the magnetic field strength increases. Wind the wire so that it is densely packed around one area because as the length of the area covered (□) with the coil increases the magnetic field strength decreases. Then connect the wire to a battery to create a magnetic field. The larger the battery the more current it can supply which increases the current variable (I) and magnetic field strength (B). This shows the relation to all the sections of the magnetic field formula shown below which will help to get the strongest electromagnet possible with our materials.

$$B = \frac{\mu N I}{l}$$

5. Conclusion

The results of this pilot study highlight the value of the relationship between ESP and engineering experiences in engaging learners of all ages and preparing them for the global workplace. In view of these findings, it is recommended that educators at all levels be provided support through professional development from all stakeholders so that they can make crucial connections between ESP and engineering for learners and become cognisant of the value of best practices to ensure optimum learning and sustainability. Educators continue to play a central role in building connections with students as they gain academic knowledge, as well as experience through practice, to become educators and citizens who make a difference in our global workforce. By strengthening the existing support and focusing on crucial implications relating to the unique learning environment for ESP learners and engineering students, increased opportunities will be available. This will result in significant benefit to the students and future employers by retaining valuable expertise, building capacity, and coupling language and content skills. Leveraging seamless service and avoiding the disruption of sudden workforce departures due to inability to meet job expectations will ensure a smooth transition from the university to the workplace. Acquiring language, addressing job responsibilities and crucial engineering knowledge provides an innovative, transformative, and equitable educational environment that prepares students for success as they pivot from the classroom to the global marketplace.

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