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

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Adin Caspary
University of Georgia
Georgia, USA

Diane Boothe
Boise State University
Idaho, USA

Abstract

- Unprecedented demand and shortage of graduates in engineering fields
- Educators focus on cutting-edge technology and promote optimal learning to meet demands of our globalized world
- Prepare students to meet the complex globalized needs particularly in engineering fields
- Unique learning environment for ESP students
- English learners need to collaborate and develop strengths critical to cross disciplinary fields
- This study investigates hands on engineering strategies and experiences of educators who focus on multidimensional aspects of the education of multilingual ESP learners

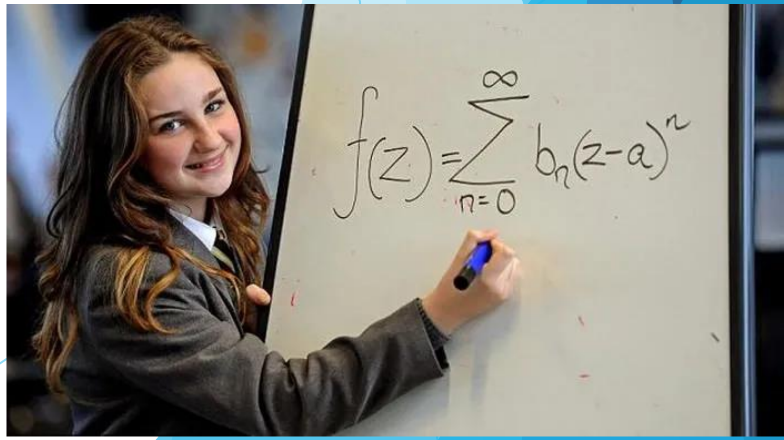
Introduction

- Pilot study addresses the pivotal role of ESP
- Also engineering coursework and technology-enhanced learning
- A curriculum focusing on cross disciplinary learning methodologies offers strategies integral to English and ESP learning.
- Strengthen employability in multinational companies
- Highlight experiences from engineering from a variety of age and ability levels
- Goal-oriented engaging in real world activities

Review of the Literature

Across educational landscape, students and educators are grappling with challenges and learning experiences in the field of engineering that could never have been predicted:

1. **It is necessary to reappraise current ESP courses to find out the extent to which they are designed to meet the needs of graduates in a globalized world (E. Arno-Macia et.al.)**
2. **English proficiency is imperative for engineering students in the USA strengthens employability in multinational companies (v. Murali, et. al.)**
3. **Majority of engineering students in the USA whose first language is not English encounter significant obstacles (Kausar)**
4. **Authors argue for ESP and engineering coursework with an action research plan (J. Lin, et.al.)**
5. **Key aspect of ESP and engineering lies in the learners and their purpose for learning English (L. Fiorito)**



Effectively Communicating ESP in Engineering

- ESP related to the field of engineering will focus on this occupation or profession with reference to the particular vocabulary and skills needed
- "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." (Conversation with H. Teller, a mechanical engineer and Global Vice President, Finished Goods Supply Chain Medical Products Division at Gore)
- "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." (Discussion with W. Coughlin, a mining engineer)
- For younger students, ESP provides learners with opportunities to develop their English skills and cultivate interests in various professions and vocations

Hands-on Engineering Pedagogy

- Numerous avenues to stimulate ESP and engineering by integrating language instruction with students' specialized interests
- Interaction--Collaborative connections and active learning will ensure optimum learning
- Clarification—Summarizing, categorizing, understanding
- Questioning—Relevant questions to drive continued, self-directed inquiry
- Design—Accessible, relevant, and curiosity driven action to justify inquiry
- 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.

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 5-13)

- **STEM engineering toys are educational projects and activities designed to teach students about STEM principles through hands-on discovery and exploration.**
- **STEM engineering toys strengthen the development of critical thinking, problem-solving, creativity, and analytical skills by encouraging students of all ages to build, experiment, and discover.**
- **Examples of STEM engineering toys include building blocks, coding robots, science kits, and math puzzles, aimed at fostering curiosity and building knowledge of STEM-related concepts.**
- **The activities and interaction culminated in clarification and questioning regarding the components of the lesson to strengthen both STEM and English language vocabulary and comprehension.**

Elementary and Middle Level (Ages 5-13)

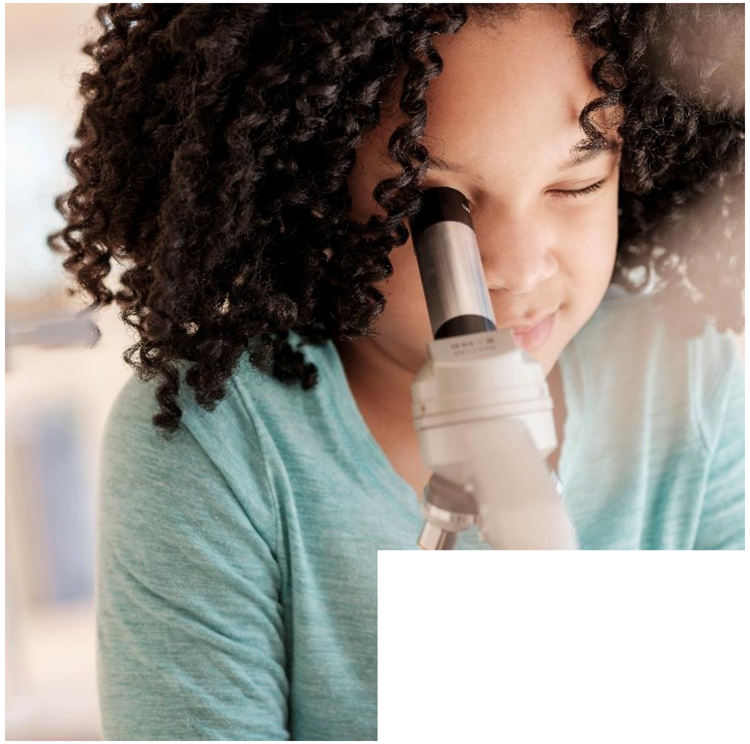
The activities and interaction culminated in clarification and questioning regarding the components of the lesson to strengthen both STEM and English language vocabulary and comprehension.

Examples

- 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
- The Ugears Flight Starter or the UGears Tractor sets are designed for students interested in transport, and feature light 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.
- 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

- 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
- Connect activities to students' cultures to make learning engaging and accessible

Construct and Test a Fully Solar Powered Model Car

Building and testing a solar car combines aspects of electrical and mechanical engineering

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.

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:
Set up the car body (chassis).
Add the axle and wheels.
Add the motor.
Then mount the solar panels.
Once the vehicle is completed, testing begins. 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: The amount of charge that flows through the cross-sectional area of a wire per second.

Photovoltaic cell: A semiconductor device that converts the energy of sunlight into electric energy

Voltage: The electric potential difference between two points that induces a current flow from high potential to low potential. Ex: The voltage difference causes a current to flow from a high potential of +9v to a low potential 0v.

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.

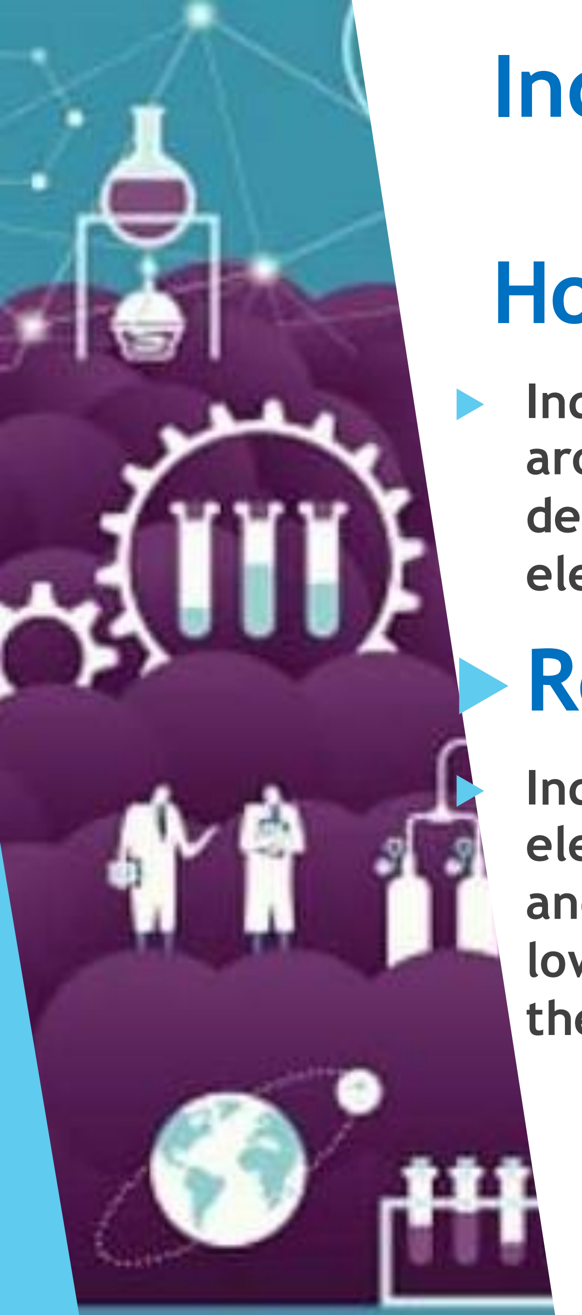
Then if the current levels drop the inductor can increase the current using the extra energy it stored in the magnetic field.

The inductor's main goal is to oppose current change by storing or releasing energy from a magnetic field.

Inductors and Electromagnets

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.



Inductors and 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.

Video link: https://youtu.be/saorl-ATyNY?si=TjNw_DF_-AjY5cQO

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
l: 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

l: 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 (l) 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.

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

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.
- Harnessing the power of multilingualism in engineering is a tremendous asset for all in the interconnected and rapidly evolving educational settings in the United States, Europe and throughout the globe.

Conclusion continued

- 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.

Thank You

Appreciation is expressed to The University of Georgia College of Engineering for photos utilized in this presentation