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Enhancing Language Learning through PBL in an Aviation Engineering Class

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Abstract

English for specific purposes is a field of teaching and learning that focuses on English language skills in context. It bridges the gap between general language knowledge and specific communication skills to enable students to meet the demands of their future professional field. For instance, aviation maintenance engineering requires the knowledge of highly specialized terminology. By providing appropriate and relevant linguistic tools, ESP enables aviation students to successfully perform job-related tasks and become more professionally competent within the aviation industry.

While ESP has a role in improving language learning, the student's experience can be further enhanced by incorporating Project-Based Learning into the curriculum to make learning more meaningful through inquiry-driven, task-based, and problem-solving paradigms. One key advantage of ESP in this regard is its adaptability, which means it can be adapted into a functional course. According to Dudley-Evans and St Johns (1998): "ESP was, for example, very influential in showing how a communicative language curriculum could be turned into either a functional-notional syllabus or a task-based syllabus" (Dudley-Evans & St Johns, 1998).

The purpose of this article is to demonstrate a PBL method used in an ESP class aimed at aircraft maintenance engineers. The project involves students assembling a model aircraft jet engine. The goal of the project is to help students develop adequate knowledge about aircraft jet engines by acquainting them with the names and functions of the engine's parts and also teaching them about its complex operation. Moreover, the project trains students on how to log their in-class activities into a weekly log that tracks their progress. At the end of the project, students reflect on their experience by completing a questionnaire that evaluates the outcomes of their learning. This helps the instructor assess the effectiveness of the project on the student's language learning.

Keywords: aviation English, aviation maintenance engineering, ESP, PBL

1. Introduction

John Dewey, an American philosopher and an educational reformer, once said: "Give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking, or the intentional noting of connections; learning naturally results" (1916). Dewey is recognized as one of the early proponents of project-based learning, as he argues that learning is best attained through practical experience. His education theory is labeled 'progressive' and emerged as a "product of discontent with traditional education" (Dewey, 1938). Dewey rejects the limitations of traditional classroom pedagogy, which is centered around rote learning and does not allow students the freedom of critical thinking, analysis, and inquiry. He believes that experience offers better educational pathways, and therefore, educators should capitalize on practical scientific methods to enhance learning outcomes. Indeed, learning becomes more rewarding when students are given the chance to engage, question, analyze, and critique.

Experience alone, however, is not sufficient. Dewey insists that the quality of experience is paramount to determining the effectiveness of learning outcomes. According to him, some experiences can be "mis-educative": "Any experience is mis-educative that has the effect of arresting or distorting the growth of further experience. An experience may be such as to engender callousness; it may produce lack of sensitivity and of responsiveness. Then the possibilities of having a richer experience in the future are restricted" (1938). Dewey makes a stark claim that traditional learning methods offer the wrong quality, which render students callous to ideas and incapable of acting intelligently in new situations (Dewey, 1938). His viewpoint is not a rejection of traditional pedagogy, but rather a critique of “defective and wrong character” experiences (Dewey, 1938). Dewey relays the task of providing quality experience unto the educator, whose responsibility is to “arrange for the kind of experiences which, while they do not repel the student, but rather engage his activities are, nevertheless, more than immediately enjoyable since they promote having desirable future experiences” (Dewey, 1938). Dewey defines desirable experiences as ones that “live fruitfully and creatively in subsequent experiences” (1938). Therefore, it is the responsibility of educators to create an innovative learning environment that positively impacts future experiences. This can be achieved by promoting experiential learning through problem-solving skills, project-based tasks, and cognitive simulations. Not only that, but educators also need to foster communities driven by curiosity, doubt, critique, and involvement.

Dewey does not only emphasize a hands-on experience, but he places equal significance on the knowledge and reflections that follow it. He establishes an organic relationship between two elements of experience: the act of doing (experience), which he calls ‘active,’ and the teachings it confers onto the learner, which he calls ‘passive.’ Such a relationship produces an immense learning value:

“The connection of these two phases of experience measures the fruitfulness or value of the experience. Mere activity does not constitute experience. It is dispersive, centrifugal, dissipating. Experience as trying involves change, but change is meaningless transition unless it is consciously connected with the return wave of consequences which flow from it. When an activity is continued into the undergoing of consequences, when the change made by action is reflected back into a change made in us, the mere flux is loaded with significance”. (Dewey, 1916)

According to Dewey, experience yields thinking, and once thought about a particular situation is aroused, it causes learners to reflect on that situation outside school and engage with it, ultimately connecting existing habits with effective responses to that experience (Dewey, 1916). Therefore, a hands-on experience with its active and passive elements, one that engages both the mind and the body, can contribute significantly to intellectual growth, which can have long-lasting effects on learning.

There are numerous ways to make experience, or project-based learning, more effective in education. To begin with, it is essential to understand that PBL is regarded as one form of student-centered learning in which students become active participants in their language learning process (Ali, 2019). Student-centered learning has garnered widespread attention from schools and universities, particularly during the COVID-19 outbreak in 2020, when traditional learning methods were either unavailable or not a viable option for everyone. Ultimately, the need for self-learning, or learning autonomy, became paramount to compensate for the educational deficit that resulted from worldwide school closures. Moreover, it became necessary for students to take unique ownership of their educational journey and further enhance their language learning in order to catch up.

Self-learning has numerous and far-reaching benefits. One of the important benefits is that it fosters a sense of ownership over one's education. When students take responsibility for their own learning, they become more motivated and engaged in the process. Also, they would develop a growth mindset that embraces challenges and sees failures as opportunities for growth. This mindset not only enhances academic performance but also prepares students for the demands of their future careers. Furthermore, self-learning promotes critical thinking skills. Instead of passively receiving information from teachers or textbooks, students actively seek knowledge through various sources such as books, online resources, or practical experiences. This active engagement with the material encourages a deeper understanding of, and the ability to analyze, information critically. Most importantly, self-learning allows individuals to take control of their education and pursue knowledge at their own pace and in their own way. It encourages independence, critical thinking, and problem-solving skills, all of which are essential in today's rapidly changing world.

This paper explores how PBL enhances language learning through a student-centered approach in an aviation maintenance engineering class.

2. Literature Review

PBL is a creative way to enhance language learning since it: “involves students refining and honing their language skills through completion of projects both in and outside the classroom” (Laverick, 2019)”. Because ESP involves teaching specific language terminology within a specific context, traditional teaching methods might hamper the acquisition of new vocabulary. This is largely due to the fact that some vocabulary cannot be fully acquired using traditional teaching methods such as word mapping, reading for comprehension, or word card strategies. One must understand that most existing vocabulary teaching methods are utilized for written discourses. Speech discourse, on the other hand, requires different teaching strategies. Aviation students, for example, are expected to learn, understand, report, and communicate core aviation terminology that is mainly used in spoken discourse. The reason is that speech is a central source of communication between aviation personnel, such as pilots, air traffic controllers, and aircraft maintenance engineers. A simple miscommunication of spoken words like oil and fluid between aviation maintenance engineers, or miscommunication between pilots and air traffic controllers during a routine flight, can compromise the safety of the industry's operation. According to Bradley Hillis (2019): "Out of the 508 case studies present on the National Transportation Safety Board's database, 49 accidents were found to have been at least partially caused by some form of miscommunication. It can be assumed that roughly 10% of all commercial aviation 11 incidents involve a critical miscommunication that at least partially contribute to the outcome of the accident" (Bradley Hillis, 2019). Supporting aviation language with relevant linguistic tools and effective communication skills is paramount to avoid such undesirable outcomes. That is why teaching technical language through situations, experiences, and projects is instrumental in minimizing language miscommunication. The basic aim for learning language among aviation students is to obtain more operational efficiency in spoken language rather than linguistic correctness in written language.

2.1 Language Learning through PBL

Learning adequate operational aviation English terminology can be fully and positively realized through PBL. To demonstrate, a task of assembling a jet engine model was incorporated into the curriculum of a project-based class named TAS (Transferrable Academic Skills), which is taught one hour per week. TAS is not subject-specific but a class that combines the four English language skills (reading, writing, listening, and speaking) through teamwork activities. In TAS, students are divided into groups and instructed to assemble a turbofan jet engine model in a period of six weeks. Below are the different stages planned by the instructor for the students to follow every week.

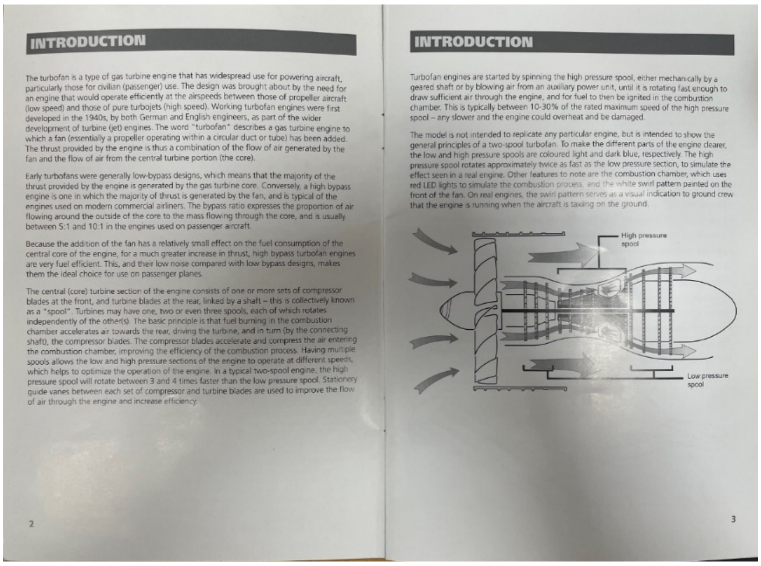
Figure 1.

2.2 Week 1

Figure 2.

In this session, which is the first class of the engine assembly, students are divided into groups of 3-4 students. Each group is handed a box containing jet engine parts, an instruction manual, screwdriver, screws, and other fastening tools. Group members are asked to look at the box (Figures 1 and 2) and see the contents to understand what their finished project would look like. The instructor encourages students to guess how the different parts fit together using their previous knowledge of engine parts taught in another reading class. Moreover, the instructor asks questions about the meanings of some of the technical words printed on the box, such as "fully functional," "motorized," "low & high-pressure turbines," and "combustion chamber," to elicit feedback from students. This preliminary stage should take approximately 10 minutes of class time. It allows students to discuss key terminology when putting the engine together and also allows them to divide the workload among their group members.

In the next step, the teacher asks students to read the introduction in the instruction manual (Figure 3), which contains background information about jet engines. Students are encouraged to utilize their reading skills and underline the main ideas about the topic and the supporting details. At the same time, the teacher highlights core vocabulary (words and phrases) that have frequent occurrences in the students' discussions about jet engines.



INTRODUCTION

The turbofan is a type of gas turbine engine that has widespread use for powering aircraft, particularly those for civilian (passenger) use. The design was brought about by the need for an engine that would operate efficiently at the airspeeds between those of propeller aircraft (low speed) and those of pure turbojets (high speed). Working turbofan engines were first developed in the 1940s, by both German and English engineers, as part of the wider development of turbine (jet) engines. The word "turbofan" describes a gas turbine engine to which a fan (essentially a propeller operating within a circular duct or tube) has been added. The thrust provided by the engine is thus a combination of the flow of air generated by the fan and the flow of air from the central turbine portion (the core).

Early turbofans were generally low-bypass designs, which means that the majority of the thrust provided by the engine is generated by the gas turbine core. Conversely, a high bypass engine is one in which the majority of thrust is generated by the fan, and is typical of the engines used on modern commercial airliners. The bypass ratio expresses the proportion of air flowing around the outside of the core to the mass flowing through the core, and is usually between 5:1 and 10:1 in the engines used on passenger aircraft.

Because the addition of the fan has a relatively small effect on the fuel consumption of the central core of the engine, for a much greater increase in thrust, high bypass turbofan engines are very fuel efficient. This, and their low noise compared with low bypass designs, makes them the ideal choice for use on passenger planes.

The central (core) turbine section of the engine consists of one or more sets of compressor blades at the front, and turbine blades at the rear, linked by a shaft – this is collectively known as a "spool". Turbines may have one, two or even three spools, each of which rotates independently of the other(s). The basic principle is that fuel burning in the combustion chamber accelerates air towards the rear, driving the turbine, and in turn (by the connecting shaft), the compressor blades. The compressor blades accelerate and compress the air entering the combustion chamber, improving the efficiency of the combustion process. Having multiple spools allows the low and high pressure sections of the engine to operate at different speeds, which helps to optimize the operation of the engine. In a typical two-spool engine, the high pressure spool will rotate between 3 and 4 times faster than the low pressure spool. Stationery guide vanes between each set of compressor and turbine blades are used to improve the flow of air through the engine and increase efficiency.

2

INTRODUCTION

Turbofan engines are started by spinning the high pressure spool, either mechanically by a geared shaft or by blowing air from an auxiliary power unit, until it is rotating fast enough to draw sufficient air through the engine, and for fuel to then be ignited in the combustion chamber. This is typically between 10-30% of the rated maximum speed of the high pressure spool – any slower and the engine could overheat and be damaged.

The model is not intended to replicate any particular engine, but is intended to show the general principles of a two-spool turbofan. To make the different parts of the engine clearer, the low and high pressure spools are coloured light and dark blue, respectively. The high pressure spool rotates approximately twice as fast as the low pressure section, to simulate the effect seen in a real engine. Other features to note are the combustion chamber, which uses red LED lights to simulate the combustion process, and the white swirl pattern painted on the front of the fan. On real engines, the swirl pattern serves as a visual indication to ground crew that the engine is running when the aircraft is taxiing on the ground.

3

Figure 3.

Table 1 presents some of the core vocabulary taken from the instruction manual.

Table 1.

Nouns	Verbs that go with nouns
Aircraft	Power
Turbofan Engine	Operate
Thrust	Provide \ generate \ increase
Air	Flow
High bypass \ low bypass	-
Compressor blades	Rotate
Turbine blades	-
Shaft (spool)	Rotate
Efficiency	Improve

The teacher writes the words on the board and asks students to think about the context in which they are written. For example, thrust is a technical word in aviation used to describe the power of jet engines. Students are encouraged to find the verbs that go with the word thrust, such as provide or generate. After that, students should be able to express a meaningful idea using the two keywords. The resulting idea should look like this: A jet engine provides\generates thrust. At this point, students should have learned about the context in which thrust is used. At the same time, they should have learned that jet engines produce thrust, and that thrust is responsible for powering the aircraft. More ideas can be elicited from students following the same fashion, which is exemplified in Table 2.

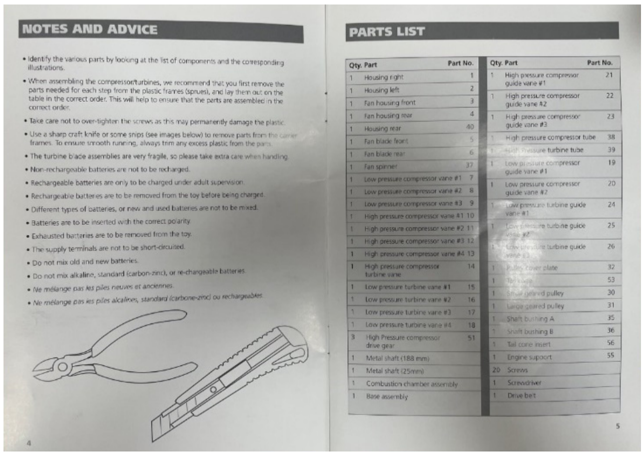
Table 2 presents example sentences and ideas.

Table 2.

Example Sentences \ Ideas to be Discussed
A turbofan engine powers the aircraft.
The turbofan engine operates efficiently.
Air flows through the engine core.
The compressor blades rotate efficiently to compress the air.
Fuel and air mixture are ignited in the combustion chamber.

The aim of this task is to help students practice reading and speaking about jet engines in a technical context. This task usually takes 15-20 minutes of class time.

In the following part of session 1, students are asked to read the "Notes and Advice" page (Figure 4), which gives instructions and some advice on handling the jet engine properly.



NOTES AND ADVICE

- Identify the various parts by looking at the list of components and the corresponding illustrations.
- When assembling the compressor/turbines, we recommend that you first remove the parts needed for each step from the plastic frames (sprues), and lay them out on the table in the correct order. This will help to ensure that the parts are assembled in the correct order.
- Take care not to over-tighten the screws as this may permanently damage the plastic.
- Use a sharp craft knife or some snips (see images below) to remove parts from the carrier frames. To ensure smooth running, always trim any excess plastic from the parts.
- The turbine blade assemblies are very fragile, so please take extra care when handling.
- Non-rechargeable batteries are not to be recharged.
- Rechargeable batteries are only to be charged under adult supervision.
- Rechargeable batteries are to be removed from the toy before being charged.
- Different types of batteries, or new and used batteries are not to be mixed.
- Batteries are to be inserted with the correct polarity.
- Exhausted batteries are to be removed from the toy.
- The supply terminals are not to be short-circuited.
- Do not mix old and new batteries.
- Do not mix alkaline, standard (carbon-zinc), or re-chargeable batteries.
- *Ne mélange pas les piles neuves et anciennes.*
- *Ne mélange pas les piles alcalines, standard (carbone-zinc) ou rechargeables.*

4

PARTS LIST

Qty.	Part	Part No.	Qty.	Part	Part No.
1	Housing right	1	1	High pressure compressor guide vane #1	21
1	Housing left	2	1	High pressure compressor guide vane #2	22
1	Fan housing front	3	1	High pressure compressor guide vane #3	23
1	Fan housing rear	4	1	High pressure compressor tube	38
1	Housing rear	40	1	[illegible] pressure turbine tube	39
1	Fan blade front	5	1	Low pressure compressor guide vane #1	19
1	Fan blade rear	6	1	Low pressure compressor guide vane #2	20
1	Fan spinner	37	1	Low pressure turbine guide vane #1	24
1	Low pressure compressor vane #1	7	1	[illegible] turbine guide [illegible]	25
1	Low pressure compressor vane #2	8	1	[illegible] turbine guide [illegible]	26
1	Low pressure compressor vane #3	9	1	[illegible] cover plate	32
1	High pressure compressor vane #1	10	1	[illegible]	53
1	High pressure compressor vane #2	11	1	[illegible] geared pulley	30
1	High pressure compressor vane #3	12	1	Large geared pulley	31
1	High pressure compressor vane #4	13	1	Shaft bushing A	35
1	High pressure compressor turbine vane	14	1	Shaft bushing B	36
1	Low pressure turbine vane #1	15	1	Tail cone insert	56
1	Low pressure turbine vane #2	16	1	Engine support	55
1	Low pressure turbine vane #3	17	20	Screws	
1	Low pressure turbine vane #4	18	1	Screwdriver	
3	High Pressure compressor drive gear	51	1	Drive belt	
1	Metal shaft (188 mm)				
1	Metal shaft (25mm)				
1	Combustion chamber assembly				
1	Base assembly				

5

Figure 4.

Before reading the page in detail, students should predict the content and think about the safety precautions that should be taken while assembling the engine. At this point, the teacher highlights essential words and phrases centered around the theme of safety at work and checks whether they match the student's answers. Example answers are listed in Table 3.

Table 3 presents example sentences and ideas.

Table 3.

Example Sentences \ Ideas about Safety at Work
Remove the parts
Ensure that parts are assembled in the right order
Don't overtighten the screws
Use a sharp craft knife
Trim excess plastic
Take extra care when handling

The aim of this task is to inform students about potential safety hazards that might occur during the engine's assembly and to think about the hand tools needed to help them complete the task, such as clippers, craft knife, or file. This part should take approximately 10 minutes of class time.

At the end of session 1, students are asked to read the "Parts List" page (Figure 5) and cross-check them against existing parts to ensure no piece is missing. At the same time, they should acquaint themselves with the names of each part of the engine by linking what they read in the manual with what they see. For example, the teacher asks students to find the "fan blades" among the parts and ask them to think about their purpose. An exemplary answer should look like this: fan blades are used to provide thrust which propels the aircraft forward. In doing so, the students synthesize words and phrases from the early tasks of the class to explain the operation of the fan blades. By now, students should be able to understand that thrust is generated by the fan blades. The learning outcome of this task should reveal that students can communicate correct operational language in the right context in a spoken discourse.

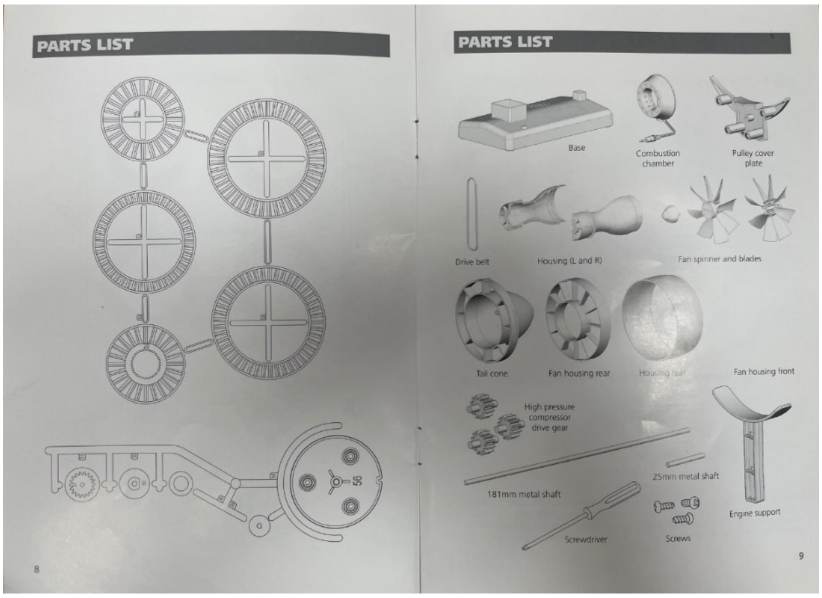


Figure 5.

2.3 Weeks 2 to 5

In the subsequent four classes, students start putting the parts of the jet engine together by following the step-by-step manual instructions. As Figure 6 shows, each step explains the assembly of a specific engine part. For example, step one involves assembling the "low-pressure compressor". In this step, students should understand simple instructional phrases such as: secure with three screws and fit the drive gears to the rear and apply it during assembly (Figure 7). The purpose of this task is to ensure that students follow manual instructions to achieve the correct results. During this stage, the teacher can ask students to think about the purpose of the low-pressure compressor and how it differs from the high-pressure compressor.

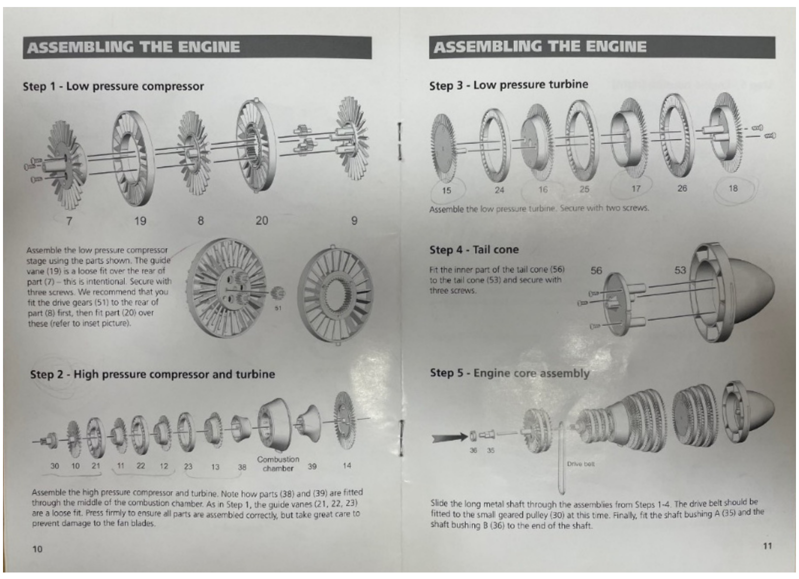


Figure 6.

Figure 7.

Table 4 summarizes the tasks, the learning objectives, and the targeted vocabulary required in class from weeks 2 to 5.

Table 4.

Week	Task	Targeted Vocabulary	Learning Objectives
2	Do the following steps: • Step 1: low-pressure compressor • Step 2: high-pressure compressor and turbine • Step 3: low-pressure turbine	Compressor Turbine Drive gears Fit (v) Secure (v) Tail cone	• Students should recognize a range of complex engine parts and be able to fit them together • Students should be able to explain the assembly process by using core vocabulary
3	Do the following steps: • Step 4: tail cone • Step 5: engine core assembly • Step 6: engine housing (right) • Step 7: engine housing (left)	Shaft Drive belt Geared pulley Shaft bushing Housing Lugs Locate (v)	• Students should recognize a range of complex engine parts and be able to fit them together • Students should be able to explain the assembly process by using core vocabulary
4	Do the following steps: • Step 8: fan housing • Step 9: fan housing/engine core assembly • Step 10: drive pulley	Fan housing Engage (v) Rear	• Students should recognize a range of complex engine parts and be able to fit them together • Students should be able to explain the assembly process by using core vocabulary
5	Do the following steps: • Step 11: fan blade assembly • Step 12: fitting fan assembly • Step 13: battery installation • Step 14: adding label to base • Step 15: fitting engine to base	Fan blade Reposition (v) Attach (v) Spinner Battery compartment Base	• Students should recognize a range of complex engine parts and be able to fit them together • Students should be able to explain the assembly process by using core vocabulary

2.4 Week 6

Session six marks the end of the engine assembly stage. By this class, the groups should have finished assembling the jet engine, installed the batteries, mounted the engine on the plastic base, and plugged the wire into the socket in the base. Successful assembly should show the engine running with rotating fans and compressor blades. If, by any chance, the engine does not run or the fan blades do not rotate, students should disassemble the engine from the last step to locate the fault and reassemble the engine one more time.

3. Method

A mixed-method approach was used to evaluate the proficiency of students' language and the efficiency of their aviation operational knowledge pre and post-engine assembly. This method is conducted in the form of quantitative and qualitative assessments. Employing both methods allows ESP educators to obtain an overarching understanding of students' linguistic and operational competency in the aviation engineering field. While qualitative methods provide rich descriptions and insights into language use by reading the students' rationale of system operation, quantitative methods offer statistical analysis that can validate or refute these findings. By combining these two approaches, educators can triangulate their data to enhance the credibility and reliability of their results. The target participants of this study are 22 Arab university foundation-level students aged 18 years old who scored 5.0 in the IELTS exam prior to entering university, and who took the TAS class in Fall 2023. Figure 8 shows a flow chart of the implementation of the assessment method:

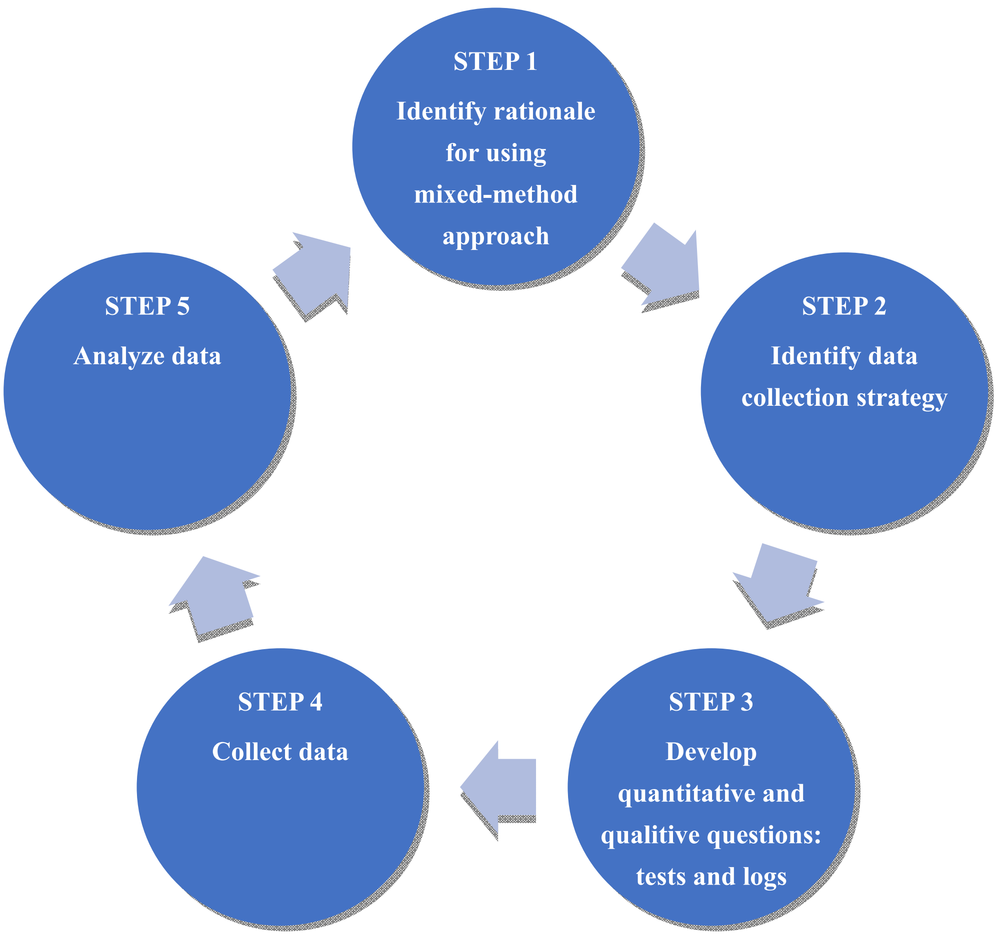


Figure 8.

3.1 Quantitative Approach

In this assessment approach, students are asked to complete two vocabulary exams: the first one is conducted one week before the commencement of the project and the other, two weeks after completion. The exam consists of 60 questions ranging from multiple-choice, true or false, matching, and fill-in-the-blank questions that focus on aviation terminology. The terminology covered in the two exams centers around aircraft structures, materials and properties, aerodynamics, forces of motion, engine types and components, hand tools, and safety. Table 5 illustrates students' performance range in both exams which is graded out of 60% and the passing grade is 36%:

Table 5.

Band	Range	First Exam	Second Exam
F	0 – 10%	-	-
E	11 – 20%	1 student	-
D	21 – 30%	5 students	2 students
C	31 – 40%	8 students	11 students
B	41 – 50%	7 students	5 students
A	51 – 60%	1 student	4 students
		22 students	22 students

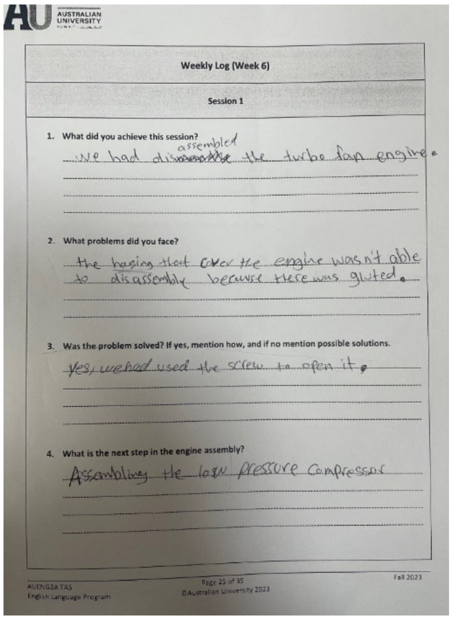
Table 6 provides data analysis for each student's performance.

Table 6.

Student	First Exam Score	Second Exam Score	Analysis
1	38%	54%	16% +
2	18%	32%	14% +
3	32%	40%	8% +
4	60%	58%	2% -
5	42%	38%	4% -
6	46%	48%	2% +
7	30%	36%	6% +
8	38%	38%	\
9	24%	40%	16% +
10	22%	32%	10% +
11	38%	28%	10% -
12	36%	56%	20% +
13	36%	36%	\
14	42%	48%	6% +
15	28%	30%	2% +
16	46%	34%	12% -
17	34%	32%	2% -
18	24%	46%	22% +
19	44%	44%	\
20	34%	42%	8% +
21	42%	32%	10% -
22	42%	56%	14% +
	Pass: 13 students Fail: 9 students	Pass: 15 students Fail: 7 students	Improved performance: 13 students Decreased performance: 6 students Same performance: 3 students

3.2 Qualitative Approach A

The second assessment method is self-reflection, which involves students filling out a weekly log in which they write down the tasks they have carried out in the class (Figures 9 and 10). Students are given six sessions to assemble the engine; each session is one hour long. The purpose of the log is to enable students to track down their progress in each session, state any technical problems that they have faced and the solutions they have applied, and introduce the next step in the assembly process. It is extremely important for the instructor to allocate ten minutes of class time for students to log their session's achievements. This step trains students in the idea of logging technical tasks as stipulated by civil aviation authorities and provides a way of assessing students' operational knowledge. For example, the UK Civil Aviation Authority states in the forward of its Aircraft Maintenance Engineering Logbook that the layout and format of the logbook: "enable a methodical and progressive recording of personal data and ongoing work experience by the user, thereby enabling a quicker and more accurate assessment of the user's technical knowledge and experience by a regulatory authority, employer or assessor" (Authority, 2008).



AUSTRALIAN UNIVERSITY

Weekly Log (Week 6)

Session 1

1. What did you achieve this session?

we had assembled the turbo fan engine.

2. What problems did you face?

the husing that cover the engine wasn't able to disassembly because there was gluted.

3. Was the problem solved? If yes, mention how, and if no mention possible solutions.

yes, we had used the screw to open it.

4. What is the next step in the engine assembly?

Assambling the low pressure compressor

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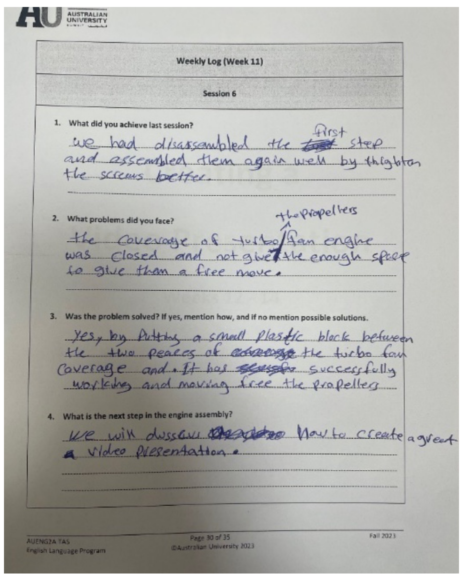
Figure 9.



AUSTRALIAN UNIVERSITY

Weekly Log (Week 11)

Session 6

1. What did you achieve last session?

we had disassembled the first step and assembled them again well by thighten the screws better.

2. What problems did you face?

the coverage of turbo fan engine was closed and not give the propellers the enough space to give than a free move.

3. Was the problem solved? If yes, mention how, and if no mention possible solutions.

yes, by Putting a small plastic block between the two peaces of the turbo fan coverage and. It has successfully working and moving free the propellers

4. What is the next step in the engine assembly?

We will dusscus how to create a great video presentation.

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Figure 10.

3.3 Qualitative Approach B

The second type of qualitative assessment is a questionnaire of open-ended and closed-ended questions conducted at the end of the project. When students have finished submitting their completed project at the end of the semester, they are given a questionnaire by their instructor that tackles three areas: students' operational knowledge, students' linguistic competency, and teaching method. The purpose of this questionnaire is to elicit students' feedback about the course objectives and their impact on their learning experience. Table 7, 8, 9 summarizes the three sections of the questionnaire and the students' feedback:

Table 7. Part A

Closed-ended Questions: Operational Knowledge	1 Very poor confidence	2 Poor confidence	3 Unsure	4 Fairly confident	5 Extremely confident
1. How would you rate your level of confidence in knowing about aircraft jet engine components and system operation?				5	17
2. How would you rate your level of confidence in being able to explain the operation of aircraft jet engines?		1	1	11	9
3. How would you rate your level of confidence in assembling and disassembling aircraft jet engines?			2	5	15
4. How would you rate your level of confidence in troubleshooting aircraft jet engines?		1	5	9	7

Table 8. Part B

Closed-ended Questions: Linguistic Competency	1 Extremely disagree	2 Disagree	3 Unsure	4 Agree	5 Extremely agree
1. I find it easier to learn aviation English using PBL.					22
2. The linguistic tools used in class are clear and relevant to the course.				1	21
3. PBL increased my knowledge of aviation terminology.					22

Table 9. Part C

Open-ended Questions: Teaching Method	Positive feedback	Negative feedback
1. What did you like the most about using PBL for language learning?	22 (students' feedback: fun to do \ exciting \ manual work \ easy to understand)	
2. What did you NOT like the most about using PBL for language learning?		3 (students' feedback: time limit \ team member not collaborating \ dangerous tools)
3. Do you recommend this type of learning to other students? Why\why not?	22	

3.4 Results and Findings

The results of both assessment approaches delineate an improved performance in both language proficiency and operational knowledge. In terms of the quantitative assessment, 68% of students passed the second vocabulary exam which was conducted at the end of the project, as opposed to 59% before the beginning, with an overall 9% increase in language proficiency.

With regards to the qualitative assessment conducted in the form of logging, students demonstrated a deeply informed understating of the process of jet engine assembly. For example, Figures 9 and 10 show the log entry for one student. It can be noticed that the student's log entry in the first session (Figure 9) was quite rudimentary and was expressed in short and basic English. However, the student's log entry in the last session (Figure 10) illustrates a highly informed expression, in which s\he presented the problem they faced in class and the technical solution they applied. Similar improved language proficiency was noted among 11 other students who were able to express technical issues easily toward the end of the project. Other students were noted to find logging a redundant task and did not provide adequate input.

In terms of the qualitative questionnaire given to students at the end of the project, 22 students gave a positive feedback about the use of PBL in enhancing their linguistic competency and aviation operational knowledge. The only negative feedback given by students was about time limits, managing student collaboration, and dealing with potentially dangerous hand tools.

3.5 Discussion

Quantitative analysis enables educators to measure and quantify variables accurately. By assigning numerical values to variables, educators can collect precise data that can be easily analyzed using statistical techniques to determine students' language proficiency. This allows for greater objectivity and reliability in course findings.

With regards to the qualitative assessment (logging), it has a dual role. For students, self-reflection is beneficial as it helps them analyze in-class situations from different perspectives and develop a more nuanced understanding of complex concepts. Moreover, it helps them set goals, make improvements, and encourage them to make informed decisions. On the other hand, self-reflection is a resourceful assessment tool for the instructor. Because it delineates the student's cognitive progress, self-reflection provides a pragmatic approach to determining whether the tasks have been accurately completed and whether the session's learning outcomes have been successfully fulfilled.

Lastly, student feedback through questionnaires allows educators to evaluate the effectiveness of their teaching methods. By actively seeking student input, teachers can gauge whether their instructional strategies are engaging and effective or need improvement. This information enables educators to make necessary adjustments to better cater to the diverse learning needs of their students. Moreover, student input contributes to the overall improvement of the educational system. Students often have unique perspectives on various aspects, such as curriculum design, assessment methods, or learning activities. Their insights can help identify areas that require enhancement or modification. Educators create an inclusive learning environment where all voices are heard by actively listening to students' opinions and incorporating them into decision-making processes. This collaborative approach not only enhances teaching practices but also empowers students by giving them a sense of ownership over their education while contributing to continuous improvement within the educational system as a whole.

4. The Benefits of PBL

Learning through PBL has a great set of benefits. The first benefit is that it promotes deep engagement and interaction with the learning material. John Dewy states that: "An individual must actually try, in play or work, to do something with material in carrying out his own impulsive activity, and then note the interaction of his energy and that of the material employed" (1916). It is a well-known fact that students are inherently unique; they do not share the same interests as their peers and arguably prefer to learn in their own way and at their own pace. Fortunately, PBL allows students to navigate their way of learning and to interact with the material in a way of their choosing. For example, some students prefer doing small-scale but rather challenging tasks such as driving screws, fitting drive gears to the turbines, or fitting drive belts to the shaft (Figure 11). Performing tasks on such a scale requires deep concentration and attention to detail as the small parts drive the engine's subassemblies, like the compressors and the turbine. Improper fittings of small parts can render the engine inoperative, which will only manifest when the whole engine is assembled and ready for testing. If the engine does not operate successfully, students would have to discuss the different ways of locating the fault and the solutions to fix it.

On the other hand, other students prefer doing large-scale but less challenging tasks, such as attaching the tail cone to the engine core assembly, fitting the engine housing, or installing the fan housing (Figure 11). Such tasks do not usually require deep attentiveness as they involve assembling less complex parts. In any case, the instructor should support the diversity of student engagement by offering consistent guidance and support when needed. When students are offered the chance to engage differently with the material at hand, they will be able to provide input, give feedback, suggest learning resources, ask questions, and predict outcomes, all of which can enhance their knowledge about the project.

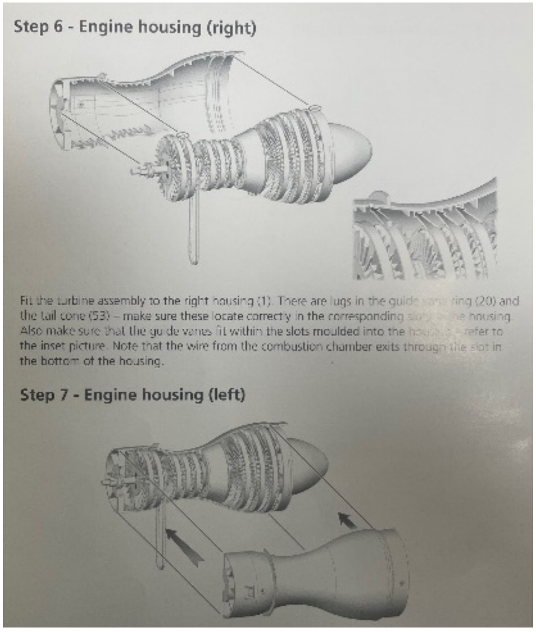

Figure 11.

Secondly, PBL provides a meaningful context for language use. Instead of focusing entirely on grammar rules or vocabulary lists, students are engaged in authentic tasks that require them to apply their linguistic knowledge. For example, the jet engine project involves assembling different engine parts and observing the engine's operation. This practical application allows learners to see the relevance of their learning and make connections between classroom instruction and real-life engineering. Furthermore, PBL fosters critical thinking skills as students analyze information, evaluate options, and make decisions throughout the entire process. This cognitive engagement enhances their ability to understand complex tasks, express ideas coherently, and solve problems effectively.

The third and most important benefit of PBL is improving cognition. Learning in the 21st century greatly emphasizes cognitive abilities to measure student success in a rapidly changing society. 21st century learning competencies now center around 4Cs: Collaboration, Communication, Critical Thinking, and Creativity. It is arguably the educators' responsibility to cultivate a learning environment centered around the 4Cs to successfully prepare students to deal with the challenges of today's age. According to Ester Kurniahtunnisa (2023): "Students with critical thinking skills are more observant in making complex choices and providing reasonable ideas for a problem. In addition to critical thinking skills, the ability that students need to have is the ability to think creatively. Students can solve problems with the creativity they have". (Kurniahtunnisa, 2023) Project-based learning offers significant advantages for language learners by promoting active engagement, providing meaningful contexts for language use, fostering critical thinking skills, and encouraging creativity. By incorporating this approach into language classrooms worldwide, educators can create a more dynamic and effective learning environment for their students.

5. The Challenges of PBL

While the benefits of incorporating PBL in an ESP class are remarkably significant, the challenges cannot be overlooked. The first challenge is time management. PBL requires careful planning and ideal time management. It can be challenging for both students and teachers to allocate sufficient time for project completion while also fulfilling curriculum goals within a given timeframe (Aldabbus, 2018). Therefore, it is essential to create a detailed project plan. This involves breaking down the project into smaller tasks and assigning specific deadlines to each task. This is exemplified in the aviation engineering class by dividing the project into stages and outlining the specific tasks that should be carried out in each stage. By having a clear roadmap of what needs to be done and when, students can better allocate their time and ensure that they stay on track.

Moreover, because PBL is primarily self-paced, it would be challenging to manage each student's participation according to a predetermined time without reducing the quality of their input. That is why it is important to establish clear expectations regarding participation. Educators should communicate their expectations to students from the beginning of the project. This includes encouraging students to ask questions, share their thoughts, and participate in discussions. By setting these expectations early on, students will understand the importance of active engagement in class. Additionally, providing constructive feedback is essential for managing student participation effectively. Teachers should acknowledge active participants while also encouraging those who are less engaged to contribute more frequently.

Another challenge is assessment complexity. Assessing students' performance in PBL can be more complicated than traditional assessment methods. Evaluating individual contributions within a group project can be subjective and may require additional effort to ensure fairness and accuracy in grading. Therefore, varied assessment methods, such as qualitative and quantitative, should be employed. Quantitative exams only may not always measure students' true abilities or knowledge retention. Incorporating qualitative exams in the assessment plan allows for a more comprehensive evaluation of students' skills. Kajfez and Creamer emphasize the importance of mixed approach method in evaluating students' outputs by asserting that: "Collecting, analyzing, and discussing the qualitative and quantitative strands of a study through mixing can strengthen a study when one set of data is inadequate, can provide further insight if needed to explain an observed phenomena, can allow exploratory findings need to be generalized, or can help explain contradictory findings" (2014).

Moreover, implementing PBL effectively requires adequate teacher training and ongoing support. Teachers need to be well-versed in facilitating project-based learning and providing guidance to students throughout the process. This is achieved by investing in professional development opportunities, workshops, and conferences where educators can enhance their teaching techniques and stay updated with the latest research in engineering education. Additionally, financial resources should be provided to ensure that teachers have access to quality instructional materials and technology that can enhance their teaching practices.

Perhaps the most critical challenge that might affect the feasibility of the project is the material's cost and availability. Due to a lack of local resources, some materials have to be purchased from an international supplier. Ordering products from abroad can be costly and time-consuming, especially if customs regulations or transportation disruptions are involved. This can increase lead times and make it difficult for educational institutions to make last-minute amendments to the curriculum. Moreover, international shipping also poses the risk of hidden costs such as import taxes or customs duties. When purchasing items from international sellers, schools may be surprised by unexpected fees upon delivery. These additional expenses can significantly increase the overall cost of the product, which schools may not have the budget for. This issue constitutes a significant barrier to implementing PBL which needs to be thoroughly addressed (Aldabbus, 2018).

While project-based learning offers many advantages in terms of student engagement, real-world application of knowledge, and improved cognition, it also poses challenges related to planning, student participation, assessment, and material availability. Nonetheless, with careful planning, support, and guidance from educators and educational administrators, these challenges can be overcome. Schools play a crucial role in supporting teachers, as they are the backbone of the education system. By providing teachers with the necessary resources, professional development opportunities, and a positive work environment, schools can empower educators to excel in their roles and ultimately create an enriching educational experience for all learners involved.

6. Conclusion

Having outlined the implementation of project-based learning in an aviation English class and the findings of the mixed-method approach, it can be argued that PBL has perceptible implications for improving language learning. The data analysis gathered in this article supports this hypothesis by providing empirical evidence. Upon the completion of PBL, aviation engineering students demonstrated improved communication capabilities using technical language. Furthermore, students demonstrated enhanced language proficiency in both written and spoken discourses. This should serve as the cornerstone for students when moving to the diploma level in which background technical language is paramount to succeed as aviation engineers. Ghosheh Wahbeh, Najjar, Sartawi, Abuzant & Daher (2021) assert that: "PBL works through the integration of language skills when students use the language to negotiate an authentic and real-life problem, as well as through working in groups and communicating to solve these problems. These activities provide students with opportunities to employ language in and outside the classroom and thus increase students' language fluency" (Ghosheh et al., 2021).

In the end, it is safe to conclude that Dewey's educational philosophy has positively impacted educators worldwide and, in fact, has become interwoven with recent educational theories such as constructivism, learner-centered theory, experiential knowledge, and progressive education (Williams, 2017). By applying Dewey's principles to today's education, teachers can cultivate an environment where students are engaged and enthusiastic about applying what they have learned to real-life scenarios. As Essien (2018) argues: "PBL is a better toll to give [students] the opportunities and encouragement to use language with an emphasis on communicative purposes in real-world settings, rather than solely focus on accuracy as in traditional teaching" (Essien, 2018). Therefore, future educational venues should capitalize more on employing PBL in different subject areas to cater to the 21st century specialized industrial pedagogy.

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