International Journal of Innovative Research and Scientific Studies, 8(5) 2025, pages: 35-52

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Integrating STEAM activity in language learning: A study in Yunlin rural elementary school

Huang, Peiwen[1], Yang, Hsiao-Tung[2], Chan, Chun-Ya[3], Yan, Cheng-Xu[4], Hwang, Yanling[5*]

[1,2,3,4]*National Formosa University, Taiwan.*
[5]*Chung Shan Medical University, Taiwan.*

Corresponding author: Hwang, Yanling (*Email: yanling_h@yahoo.com*)

Abstract

STEAM education is being promoted and emphasized worldwide. In the process of STEAM activities, students are no longer passively acquiring knowledge; they can even improve their motivation to learn, interest, and problem-solving skills [1]. English picture books are also frequently connected with STEAM activities. However, in remote areas like Yunlin County, small schools face the problems of not only teacher shortages but also limited time for English learning [2]. Since there was very little research on STEAM education in rural primary schools in Yunlin County, the purpose of our study was to implement an experiment combining English picture books with STEAM activities for these schools. The results provided empirical evidence on integrating STEAM education with language learning and instructional strategies for cross-disciplinary teaching in rural primary education.

Keywords: Elementary students, Language learning, Motivation, STEAM.

DOI: 10.53894/ijirss.v8i5.8566
Funding: This study received no specific financial support.
History: Received: 19 May 2025 / **Revised:** 20 June 2025 / **Accepted:** 24 June 2025 / **Published:** 16 July 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

The concept of STEM originated from the American National Science Foundation (NSF) in 1986 [3]. The American scholar Georgette Yakman added the Art to STEM to become STEAM in 2011 [4]. STEAM education, which refers to Science, Technology, Engineering, Art, and Mathematics education, is being promoted and emphasized worldwide. The Australian education ministers agreed on a National STEM School Education Strategy to be implemented from 2016 to 2026. In 2015, American President Trump also allocated $200 million annually to improve STEM education [5]. Taiwan's Ministry of Education supports STEAM in science and technology curricula, which were improved in 2018. Taiwan's policy was to promote all schools to integrate courses to assist students in learning different fields in the 12-year Basic Education program in 2019 [6].

In the process of STEAM activities, students are at the center of learning. Students are no longer passively acquiring knowledge; they can even improve their motivation, interest, and problem-solving skills [1]. As for the learning context with STEAM, learning environments that support student learning in the classroom not only include the instructional practices teachers use but also their assessment practices as well as the ways they support equitable participation across students with diverse abilities and interests [7].

Meanwhile, President Tsai announced a major policy of a "2030 bilingual country" in 2017. Therefore, bilingual schools and bilingual experimental courses have sprung up in various countries and cities [8]. In terms of bilingual education in language teaching, scholars have observed how Content and Language Integrated Learning (CLIL) has steadily established its teaching principles and has gradually become a dominant methodology in all sectors of education that are sensitive to bilingual education over the years [9]. It was contended that the implementation of CLIL in different subjects and tasks could help students learn content and a second language in various ways [10]. To assist students' linguistic competence, activities should be designed to promote their use of the language [11]. English picture books are also frequently connected with STEAM activities. Readers could learn knowledge and make an impression through artistic handiwork, which helped them to remember the information more effectively [12].

However, in some small schools in remote areas like Yunlin County, they had to face the problems of not only teacher shortages but also limited time for English learning [2]. Furthermore, the lack of teachers who could teach bilingually and cross-disciplines was a critical issue in rural areas.

Since there was very little research on STEAM education in Yunlin County's rural primary schools, the purpose of our study was to implement an experiment combining English picture books with STEAM activities for these schools. The study aimed to investigate whether children's motivation to learn English and their English abilities would improve.

1. To what extent do picture books with STEAM activities enhance students' English learning?
2. To what extent do picture books with STEAM activities enhance students' learning motivation?
3. How do students perceive picture books with STEAM activities in English learning?

2. Literature Review

2.1. Development of STEAM Education

The traditional course no longer meets the current demand for 21st-century skills due to the framework for 21st-century skills. Gogus argued in his 2015 chapter "Reconceptualizing Liberal Education in the Twenty-First Century" that the liberal education curriculum should emphasize learning how to think and learn, Ge et al. [13] it was one of the reasons STEM became STEAM.

STEAM education is composed of five main components: Science, Technology, Engineering, Art, and Mathematics. In terms of science, it is hoped that students can discover problems using scientific knowledge and explain natural phenomena or principles through the process of exploration [14]. In terms of technology, students used management, understanding, and evaluation methods to develop innovative technologies. Therefore, students might learn technologies and develop analytical and hands-on skills to operate new technologies, thereby enhancing their ability to use technology. In terms of engineering, using the systematic process of engineering design to create ideas [3] could help students improve their problem-solving abilities and increase their interest in engineering. In terms of mathematics, it could enable students to analyze, interpret mathematics in context, and utilize mathematical concepts, formulas, facts, and tools to explain problems.

STEAM education continues the STEM spirit. In addition to emphasizing that "hands-on" activities can provide more learning experiences and enhance "problem-solving" abilities [15] it also added art to foster innovation, rich emotion, and creativity, while simultaneously integrating science, technology, engineering, and mathematics to develop real-life applications. STEAM education is also known as "interdisciplinary education" because it combines these five main aspects and employs a teaching method that can be applied and related to each other [16]. The interdisciplinary education focused on how to combine and integrate knowledge in various fields. The goal of interdisciplinary education was not to teach a lot of knowledge or to teach it deeply [17] but to teach students how to use the knowledge in real life through guidance and learning from the process.

In 2017, there was one model created by Quigley et al. [7] known as the STEAM Classroom Assessment of Learning Experiences (SCALE), it suggests that well-executed STEAM learning experiences draw on a set of desirable knowledge (instructional content) and pedagogy (learning context). To achieve powerful learning outcomes, the types of content selected, the ways in which content areas are integrated, and the problem-solving skills taught must be included in the instructional content domain. STEAM education fosters problem-solving skills and student interest in science and technology through real-world applications [18].

2.2. Content and Language Integrated Learning (CLIL)

CLIL, the acronym for "Content and Language Integrated Learning," was launched in 1996 by UNICOM, the University of Jyväskylä (Finland), and the European Platform for Dutch Education. It was recognized as a teaching methodology by the European Commission in its Communication No. 449, Promoting Language Learning and Linguistic Diversity. Over the years, scholars have observed how CLIL has steadily established its teaching principles and has gradually become a dominant methodology in all sectors of education that are sensitive to bilingual education [19]. CLIL is a strategy that has been proven to be effective in teaching a second language.

Several different pedagogical models have been developed to classify CLIL teaching methods, the most recognized of which is Coyle's 4Cs framework. There are four factors that are present simultaneously to make CLIL effective [20]:

- Content - Progress in knowledge, skills and understanding related to a specific course

- Communication - Using language and learning how to use it accurately
- Cognition - Developing thinking skills that connect concept formation, comprehension and language
- Cultural - Exposure to different perspectives and shared understandings that lead to a deeper understanding of others and self

The implementation of CLIL has been a point of research since its introduction, with results suggesting extensively positive outcomes. Several studies argue that CLIL develops students' content learning and cognition through a foreign language [10, 21, 22]. It was contended that the implementation of CLIL in different subjects and tasks could help students learn content and second language skills in various ways [10]. The teacher focused on meaningful and collaborative interaction in the CLIL classroom, which enhanced students' higher-order thinking skills [22]. To assist students' linguistic competence, activities should be designed to promote students' use of the language. Nevertheless, it is important to design the CLIL strategy carefully so that they can benefit from it [11]. Making learners more familiar with the foreign language, providing increased exposure, which needs to be accompanied by scaffolding output opportunities, thereby enhancing their foreign language motivation and reinforcing their cognitive engagement [23]. Combining the CLIL method with the necessary knowledge and skills to create STEAM-based curricula has been promoted in European school education, and many studies support this approach [24].

2.3. STEAM and English Picture Book

Learning English picture books could improve the effectiveness of English learning, achieve a good auxiliary effect, and allow students to learn more about different plots and diverse learning methods [25]. In addition to learning English in learning English picture book stories, Lin [26] believed that learning English picture books could promote free learning and willingness, allowing students to learn in a relaxed environment and making them more receptive to education. Shi [27] suggested that English through diffuse thinking and picture books could enhance students' creative thinking abilities and brainstorming skills, thereby aiding students in thinking and responding more effectively through course discussions and interactive teaching. This approach could increase children's motivation for learning English. Incorporating English picture book stories into the teaching curriculum, along with adopting a story structure design for picture books, might facilitate student participation and strengthen their sense of engagement. Including question-based thinking, examinations, and quizzes within the story structure teaching could integrate learning and diversify educational methods.

Hou [28] believed that the images in picture books possess a certain degree of visual advantage. The images in picture books not only enhance readers' understanding of color, spatial structure, and spatial transformation but also assist readers in filling gaps in their comprehension of the content. Lin [29] believed that the written language of picture books was not only for "seeing," but also for "listening." Then, by "listening," you could comprehend the story. In light of the storyteller's use of facial expressions, body language, and intonation, listeners increased their interest. On the other hand, musicality was more emphasized in the narration of the text, so that listeners could feel the language and match the images with the picture, which was easy to catch and remember at the same time [30]. This was the reason the study added "chant" to the teaching method.

Lindsay Simmons worked at a children's science center, and she ran seven weeks of summer camps every year for kids in first through eighth grade, with the goal of engaging students and igniting passions for STEM with English picture books. She believed that STEAM with picture stories combined could empower readers to leverage their knowledge from any subject to innovate, which was a more authentic way to practice solving problems [31]. English picture books were frequently used to connect STEAM. Readers could learn knowledge and make an impression through artistic handiwork, and this method also helped them to quickly remember the knowledge.

2.4. Yunlin Education Current Status

According to the latest statistics from the Ministry of Education (Taiwan) [32] Yunlin County had the largest number of rural schools and the largest number of remote schools among all counties and cities. There were one hundred and thirteen rural schools, including Lianmei Elementary School. According to the National Elementary School's survey and research on the implementation of English teaching in Yunlin County [17] and the distribution of rural schools in Taiwan and children's teaching difficulties [33] the large urban-rural gap, small school scale, remote school location, small number of students in the class, teacher shortage, high teaching turnover rate, lack of cultural stimulation, and lack of English learning resources were all factors affecting the implementation of English teaching in rural elementary schools. Specifically, in Yunlin County, and also significantly limited the variety of English teaching methods and children's willingness to learn English.

Therefore, there was an urgent need to extend teaching resources in Yunlin primary schools. This was also a significant goal of the current study.

3. Methodology

3.1. Research Study

The design of the current study was a quasi-experimental design. A rural primary school, Lianmei Elementary School in Yunlin County, was chosen to help reduce the urban-rural education gap. The aim of this research was to simultaneously improve the language ability, art creativity, and scientific knowledge of elementary school students through a STEAM-based curriculum.

This research will conduct a total of 160-minute STEAM-based English teaching curriculum for four sections (refer to the following graph1) in the 112 semester. Pre-test questionnaires on English ability and learning motivation would be

administered in the first section to understand their background and English ability; post-tests would be administered in the last section.

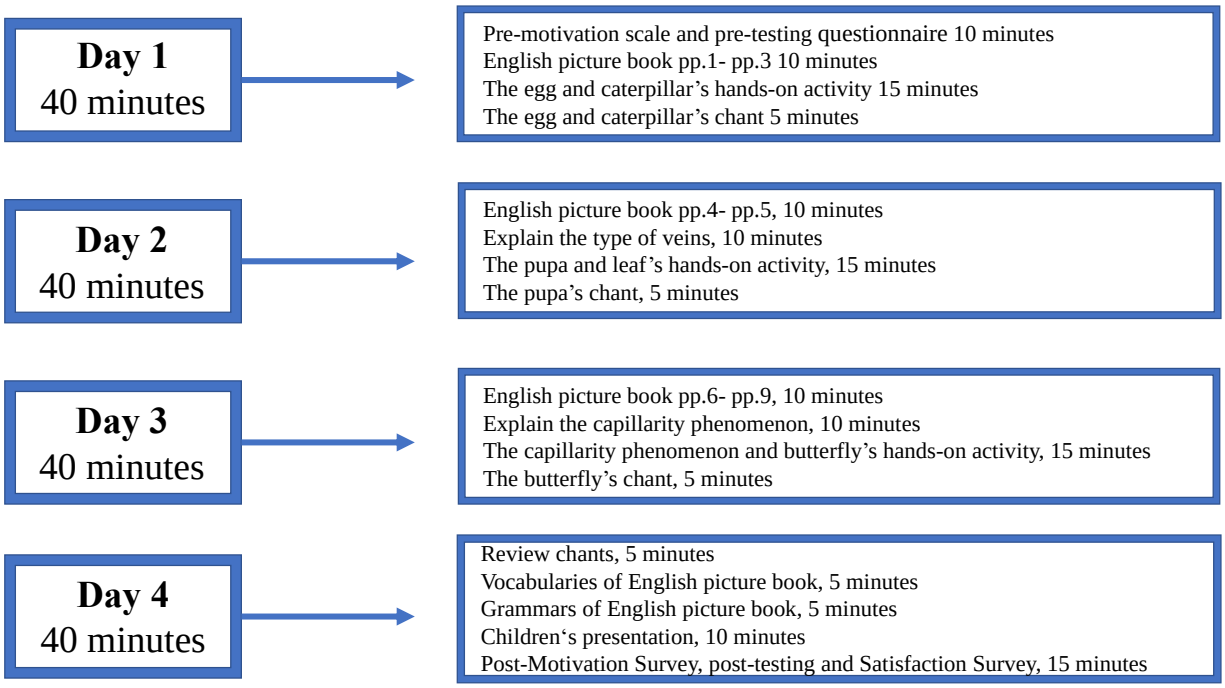


Figure 1.
STEAM-Based Curriculum Process.

3.2. Participants

Lianmei Elementary School in Yunlin County was purposefully chosen for its rural setting; the number of faculty and students was under 100. The target participants would be twenty-five students in the fifth and sixth years at Lianmei Elementary School.

3.3. Instruments

3.3.1. Teaching Materials

English picture book titled "I'm a Caterpillar" would be adopted for two main reasons. The first reason was that the picture book could make students impressed with visual appeal. The second one was that the content of this book includes natural science and is presented entirely in English. Musical appeal catchy chants would be applied to help students strengthen their impression.

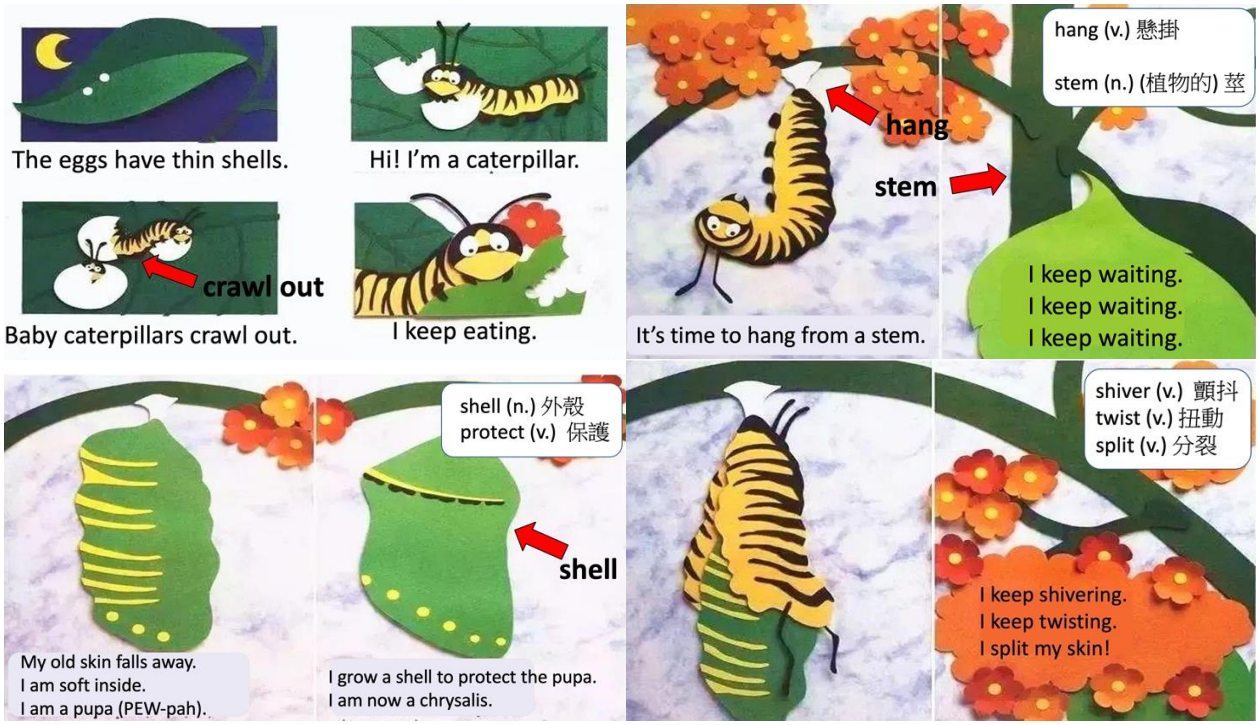
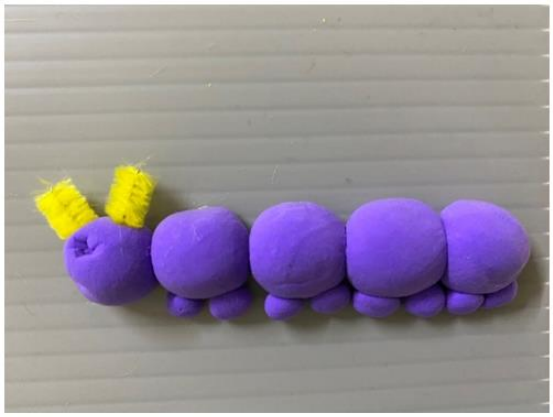


Figure 2.
English picture book's PPT "I'm a Caterpillar".

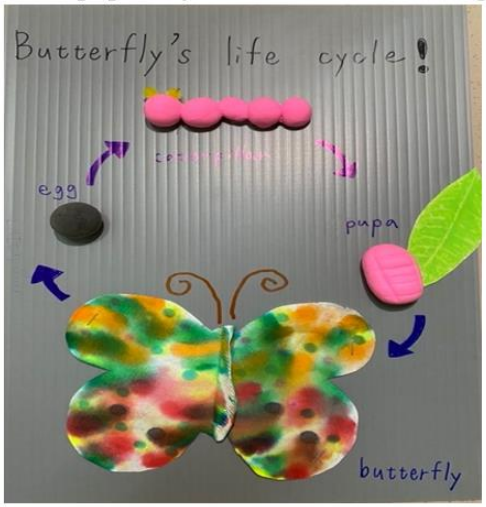
Regarding hands-on STEAM activities that engage with the picture book, a butterfly's life cycle will be created to facilitate learning. The hands-on activities allow students to do more than just sit and listen to the lesson; they can also make the learning more dynamic and creative. There will be vocabulary, grammar, and chant teaching related to the English picture book. Finally, students will create a butterfly life cycle. Below is the PPT for hands-on STEAM activities.



The caterpillar clay DIY

The pupa clay DIY and Vein Drawing

Butterfly DIY (Capillary Action)



Butterfly's life cycle

Figure 3.
PPT for Hands-on STEAM activities.

The study combined English picture books with STEAM hands-on activities. It is hoped that students could not only learn language in the course but also acquire knowledge of natural sciences for integrated learning. In addition, the hands-on activities in the course would also incorporate "Art" into the STEAM activities.

3.3.2. English Vocabulary Pre and Post-Test

In order to determine whether the students' English ability had improved, pre- and post-tests would be created based on the teaching materials. In the pre-test and post-test, the participants would approximately take 10 minutes to complete the vocabulary tests. The test consisted of three parts. The first part was "fill in the blanks," the second part was "circle the answer," the third part was "match the words," and the last part was "complete the sentence". The test type would consist of English ability assessment tests. Pre-tests and post-tests would be organized with the same vocabulary but different types of questions to maintain consistency.

When finishing designing the test, it will be submitted to two English teaching experts from elementary school and university levels for face validity. Five elementary students will be invited to test it prior to the experiment.

3.3.3. Learning Motivation Scale Questionnaire

To acquire elementary students' learning motivation, the study will adopt the questionnaire from the Learning Motivation Scale [34] with a reliability value of 0.917. The original questionnaire contained a total of 20 questions and was divided into four categories: 1-4 questions entitled "Expected Value," 5-8 questions "Self-efficacy," 9-11 questions "Passivity," and 12-15 questions "Instrumentality" (see Appendix 1 for details). To accommodate this specific STEAM picture book activity, the questionnaire will be modified to fit the current status.

3.3.4. Course Satisfaction Questionnaire

This course satisfaction questionnaire will be delivered after completing the four courses. The questionnaire was designed by researchers to gather students' perceptions of picture book learning with hands-on STEAM activities (see Appendix 2). The pilot test would be done to verify the reliability level before the experiment.

3.3.5. Research Procedure

The English experiment teaching is expected to take place in the 112th semester. To assist remote elementary students in exploring language learning through picture books with STEAM activities, the researcher will first organize a college students to prepare instructional design and STEAM activities. The researcher will lead the team in designing teaching instructions and teaching aids, and will conduct a pilot study to verify the validity of the survey questionnaires.

3.4. Expected Results

1. To enhance students' interest in learning English.
2. To strengthen students' impressions through STEAM activities.
3. To improve students' use of language through STEAM activities.
4. To combine natural science with English to achieve interdisciplinary learning.
5. To implement USR in rural primary schools to shorten the English learning gap.

3.5. Advisor Guidance

1. Professor would guide the design of the research.
2. Professor would help to give recommendations on the literature reviews.
3. Professor would assist with the design of the questionnaire.
4. Professor would assist in arranging the teaching schedule with the elementary school English instructor before going for the real experiment study.

4. Data Analysis

The purpose of the study was to implement an experiment combining English picture books with STEAM activities for rural primary schools in Yunlin County. The study aims to investigate whether children's motivation for learning English and their English abilities improve.

The participants in this study consisted of 25 elementary school students, including 11 males and 14 females, who were in the fifth and sixth grades. The participants' information is described in Table 1. Among them, 8 students had never attended English tutoring classes, 2 students had attended for one year, 3 students had attended for two years, 4 students had attended for three years, 7 students had attended for five years, and one student was unsure of their attendance history.

Table 1.
The participants' background information.

Category		Number of people	Percentage%	Total people
Gender	Male	11	44%	25
	Female	14	56%	
Grade	Five	16	64%	25
	Six	9	36%	
Years of taking extra	Never	8	32%	
lessons about English	One	2	8%	
Two		3	12%	25
Three		4	16%	
Five		7	28%	
Unknown		1	4%	

4.1. To What Extent Do English Picture Books with STEAM Activities Enhance Students' English Learning?

The result compares the differences of pre- and post-scores of the English test, which is shown in Table 2. The mean score of the post-test (M=78.00) is much higher than the mean score of the pre-test for English comprehension (M=46.32).

Table 2.
The comparison table of pre- and post-English tests.

	Mean	N	Sid. Deviation	Std. Error Mean
Pre-test	46.32	25	12.828	2.566
Post-test	78.00	25	20.421	4.084

Note: $P < 0.05$.

The findings from Table 3 showed major significant differences between students' pre-test and post-test (t: -6.940, df: 24, p< .001). This result supported the idea that the STEAM English activities could enhance students' English learning.

Table 3.
The t-test analysis of pre and post English test.

	M	SD	Std. Error Mean	t	df	Sig. (2 tailed)
Pre-test– Post-test	-31.68	22.823	4.565	-6.94	24	<0.001*

Note: $P < .05$.

4.2. To What Extent Do Picture Books with STEAM Activities Enhance Students' Learning Motivation?

In the findings from Table 4, the after-test learning motivation is higher, except for question 2. In question 2, ‘‘The teaching of English picture books combined with hand-made activities makes me more enthusiastic about learning, the post-test (M=4.00) is a bit lower than the pre-test (M=4.08).

Table 4.
The comparison table of the Learning Motivation Scale.

Questions		**M**	**t**
1. The teaching of English picture books combined with hand-made activities is very attractive to me.	Before	3.6	-2.165
	After	4.16	
2. The teaching of English picture books combined with hand-made activities makes me more enthusiastic about learning.	Before	4.08	0.811
	After	4	
3. The teaching of English picture books combined with hand-made activities is very interesting.	Before	3.68	-2.221
	After	4.24	
4. The teaching of English picture books combined with hand-made activities can improve my motivation for English learning.	Before	3.56	-1.853
	After	4.04	
5. The teaching of English picture books combined with hand-made activities can increase my confidence	Before	3.44	-2.324
	After	4.04	
6. The teaching of English picture books combined with hand-made activities has brought me a different English learning experience than before.	Before	3.72	-1745
	After	4.16	
7. The teaching of English picture books combined with hand-made activities makes me feel happy	Before	3.52	-2.322
	After	4.2	
8. The teaching of English picture books combined with hand-made activities makes me like English.	Before	3.56	-1.693
	After	4.04	
9. The teaching of English picture books combined with hand-made activities makes me feel bored.	Before	3.36	1.821
	After	2.6	
10. The teaching of an English picture book combined with hand-made activities is too difficult, so it makes me refuse to learn.	Before	2.84	1
	After	2.522	
11. The teaching of English picture books combined with hand-made activities is not my type.	Before	2.52	0
	After	2.52	
12. The teaching of English picture books combined with hand-made activities can give me enough brainstorming.	Before	3.52	-2.486
	After	4.16	
13. The teaching of English picture books combined with hand-made activities can help me improve my learning and thinking.	Before	3.56	-2.622
	After	4.2	
14. The teaching of English picture books combined with hand-made activities makes it easy for me to understand English.	Before	3.68	-1.512
	After	4.08	
15. The teaching of English picture books combined with hand-made activities has greatly helped me in my study.	Before	3.64	-1.745
	After	4.08	

Note: $P < 0.05$.

In the finding from Table 5 in question 1 ($p = 0.041$), 3 ($p = 0.036$), 5 ($p = 0.029$), 7 ($p = 0.029$), 12 ($p = 0.020$), and 13 ($p = 0.015$), there were significant differences between students’ pre-test and post-test scores ($p < 0.05$) on STEAM learning motivation. The results support that STEAM English activities can enhance students’ English learning motivation.

Table 5.
The t-test analysis table of the Learning Motivation Scale.

Questions	M	SD	t	df	Sig. (2 tailed)
1. The teaching of English picture books combined with hand-made activities is very attractive to me.	-0.560	1.294	-2.165	24	0.041*
2. The teaching of English picture books combined with hand-made activities makes me more enthusiastic about learning.	0.080	0.493	0.811	24	0.425
3. The teaching of English picture books combined with hand-made activities is very interesting.	-0.560	1.261	-2.221	24	0.036*
4. The teaching of English picture books combined with hand-made activities can improve my motivation for English learning.	-0.480	1.295	-1.853	24	0.076
5. The teaching of English picture books combined with hand-made activities can increase my confidence.	-0.680	1.464	-2.322	24	0.029*
6. The teaching of English picture books combined with handmade activities has provided me with a different English learning experience than before.	-0.440	1.261	-1.745	24	0.094
7. The teaching of English picture books combined with hand-made activities makes me feel happy	-0.680	1.464	-2.322	24	0.29*
8. The teaching of English picture books combined with hand-made activities makes me like English.	-0.480	1.418	-1.693	24	0.103
9. The teaching of English picture books combined with hand-made activities makes me feel bored.	0.760	2.087	1.821	24	0.081
10. The teaching of English picture books combined with handmade activities is too difficult, so it discourages me from learning.	0.320	1.600	1.000	24	0.327
11. The teaching of an English picture book combined with handmade activities is not my type.	0.000	1.384	0.000	24	1.000
12. The teaching of English picture books combined with handmade activities can give me enough brainstorming.	-0.640	1.287	-2.486	24	0.020*
13. The teaching of English picture books combined with hand-made activities can help me improve my learning and thinking.	-0.640	1.221	-2.622	24	0.015*
14. The teaching of English picture books combined with handmade activities makes it easier for me to understand English.	-0.400	1.323	-1.512	24	0.144
15. The teaching of English picture books combined with handmade activities has greatly helped me in my studies.	-0.440	1.261	-1.745	24	0.0947

Note: $p < 0.05$.

4.3. How Do Students Perceive English Picture Books with STEAM Activities in English Learning?

Table 6 presents the means of students' satisfaction with English picture books with STEAM activities. Since Taiwanese students' neutral opinions usually stand for agreement by default, researchers counted neutral selections as an agreeable percentage. Questions 1 and 4 showed that ninety-six percent (96%) of all respondents agreed that English picture books with STEAM activities met their expectations of learning English and provided them with a different experience. For Questions 2 and 7, the majority of students (96%) also indicated that English picture books with STEAM activities effectively enhanced their English motivation and offered opportunities for thinking and brainstorming. These students also expressed a strong desire to learn science and technology subjects through English picture books with STEAM activities. In Question 9, almost 92% stated that they felt more confident when learning science and technology subjects in English, and over 50% of students demonstrated mastery of English vocabulary related to science subjects in Question 8. Additionally, students believed that chanting could help them remember English more easily, and they could describe the butterfly life cycle independently in Questions 10 and 11. The results indicate that students are satisfied and pleased with English picture books with STEAM activities.

Table 6.
Course Satisfaction Questionnaire with STEAM activities.

Satisfaction	SA.	A.	N.	D.	SD.
1. English picture book teaching with STEAM activities in this lesson has met my expectations for learning English.	11(44%)	7(28%)	6 (24%)	0	1 (4%)
2. English picture book teaching with STEAM activities in this lesson has increased my motivation for learning English.	11(44%)	7(28%)	6 (24%)	0	1 (4%)
3. English picture book teaching with STEAM activities in this lesson has increased my sense of achievement in English.	11(44%)	7 (28%)	6 (24%)	1 (4%)	0
4. English picture book teaching with STEAM activities in this lesson has successfully brought me different experiences.	13(52%)	6 (24%)	6 (24%)	0	0
5. English picture book teaching with STEAM activities in this lesson made me more willing to actively participate in English learning.	11(44%)	6 (24%)	7 (28%)	0	1 (4%)
6. English picture book teaching with STEAM activities in this lesson made me realize that this type of teaching method is not suitable for me.	3 (12%)	3 (12%)	8 (32%)	5 (20%)	6 (24%)
7. English picture book teaching with STEAM activities in this lesson provided me with enough brainstorming and thinking	11(44%)	7 (28%)	6 (24%)	1 (4%)	0
8. Through this activity, I learned English related to plants.	11(44%)	7 (28%)	7 (28%)	0	0
9. I felt more confident learning about "science" subjects in English.	10(40%)	7 (28%)	6 (24%)	1 (4%)	1 (4%)
10. I felt that using chanting as a method helped me to memorize English more easily.	8 (32%)	6 (24%)	9 (36%)	2 (8%)	0
11. I could explain the life cycle of a butterfly in English by myself.	9 (36%)	5 (20%)	7 (28%)	2 (8%)	2 (8%)

Note: N = 25.

5. Discussions and Conclusion

Since there was limited research on STEAM education in rural primary schools of Yunlin County, the purpose of our study was to implement an experiment combining English picture books with STEAM activities in these schools. The study aimed to investigate whether children's motivation to learn English and their English proficiency improved.
The findings are listed as follows.

1. Due to the significant difference in test scores before and after the activity, it can be concluded that the picture books with STEAM activities can enhance students' English learning.
2. Picture books with STEAM activities enhance students' learning motivation because they don't just passively listen to the lectures.
3. Most students found the learning to be interesting and innovative in STEAM activities.

The following section discusses three aspects of using picture books with STEAM activities to enhance students' learning, including language performance, motivation, and satisfaction.

5.1. Picture Books with STEAM Activities Enhance Students' Learning

In this study, researchers have found that the use of picture books combined with STEAM activities in the English language learning curriculum can significantly enhance students' performance in the language. The pre- and post-test results have shown a notable improvement, indicating that the incorporation of picture books and STEAM activities can effectively boost students' English language skills. Several factors could have contributed to these results. Firstly, the use of picture books could have facilitated a more engaging and immersive learning experience for students, as they can provide vivid visual aids and stimulate students' imagination. Moreover, STEAM activities could have provided a practical and hands-on approach to learning, which can help students better understand and internalize English language concepts.

Furthermore, our findings are consistent with previous research. Tu [25] investigated the effect of using English picture books in a curriculum on the vocabulary development of third-grade elementary school students. The results of pre- and post-tests indicated a significant improvement in the students' vocabulary, suggesting that the use of English picture books can effectively enhance students' language learning outcomes. Additionally, another study by Quigley et al. [7] demonstrated that the STEAM teaching approach can facilitate interdisciplinary learning and improve overall learning outcomes.

The current study extends these findings by demonstrating the effectiveness of combining picture books with STEAM activities in the English language learning curriculum. Our results not only support previous research on the benefits of

using picture books and the STEAM approach but also provide evidence for their combined effect on English language learning outcomes. These findings have important implications for English language teachers and curriculum designers, as they suggest the potential of incorporating picture books and STEAM activities in English language learning to enhance students' language proficiency and overall learning outcomes.

5.2. Picture Books with STEAM Activities Enhance Students' Learning Motivation

The study reveals that the use of picture books with STEAM activities in the English language learning curriculum can enhance students' motivation to learn. The comparison table of the Learning Motivation Scale shows that teaching English with picture books combined with hands-on activities can improve students' motivation. Students can learn English through picture books and hands-on activities. They are no longer just passively listening to lectures but can learn English through discussions and practical activities, which increases students' willingness to learn.

Additionally, our results align with prior research studies. Lin [26] strongly believes that learning English picture books can facilitate a more self-motivated and receptive learning experience, while promoting a relaxed learning environment that encourages students to engage in education. During the STEAM activities, the focus of learning shifted towards the students. They were no longer passive recipients of knowledge, but rather actively involved in the learning process. This approach not only increased their motivation and interest in learning but also improved their problem-solving skills [1]. As a result, our study supports that English picture books with STEAM activities can enhance students' English learning motivation.

5.3. Students are Satisfied and Enthusiastic in English Picture Books with STEAM Activities

Through research results, researchers can conclude that students are satisfied with and interested in English picture books with STEAM activities. Most students found the learning experience to be engaging and innovative. Although this kind of alternative learning cannot be implemented in regular school classes, it can indeed improve learning effectiveness and boost students' confidence. It also meets their expectations for learning English and provides an alternative approach that can promote their willingness to learn English.

In the study Yang [15], it was also found that combining hands-on activities with picture book contexts could effectively increase students' motivation to learn. The participants needed step-by-step guidance from the teacher at the beginning. However, later, students were willing to think independently and ask questions. This approach successfully aroused their interest and motivation. Similarly, hands-on activities were also a segment that students enjoyed. Learning through hands-on activities is something that students are very passionate about, and it can foster their willingness to think and try. Therefore, English picture books with STEAM activities can indeed provide better learning experiences for students.

5.4. Limitation of the Study

However, the drawbacks of the STEAM-enhanced class are that the frequent switching between hands-on activities and English picture book teaching can divert students' attention, which may lead to some students struggling to follow the course. If the switching frequency is reduced, teachers will be able to control the course's progress and order more effectively, allowing students to focus better on the course content.

Moreover, researchers observed that students' English proficiency levels vary across different grades, which can affect their ability to learn the course material. Specifically, researchers noted that students in higher grades with a stronger foundation in English were better able to grasp the material, while those in lower grades with weaker English foundations struggled to keep up with the course.

5.5. Conclusion

The purpose of our study is to implement an experiment combining English picture books with STEAM activities for rural primary schools in Yunlin County. The research enhances elementary students' language performance, motivation, and satisfaction. However, the STEAM-enhanced class has drawbacks. Frequent switches between hands-on activities and English picture book teaching can divert students' attention, leading to difficulties in following the course. Reducing the switching frequency allows for better control and focus on the course content. Additionally, variations in students' English proficiency across grades affect their ability to grasp the material, with stronger English foundations aiding comprehension. We also used chants to facilitate easier recall of English. Adjusting the instructional design and considering students' English levels can lead to more effective learning.

Figure 4.
English Vocabulary Chant Slide: "Pupa" and students displaying AR-Based Vocabulary Projects

5.6. Recommendations for Further Research

1. Researchers suggest extending the entire testing period for a semester-long duration. This will increase the credibility of the research results but also allow for a greater variety of English content, thereby enhancing the diversity of the study.

2. Frequent switching between hands-on activities and English picture book teaching should be avoided, as it can divert students' attention and hinder their learning progress. We suggest that curriculum design should be progressive and avoid constant intermixing, as this may cause confusion for students.

3. Researchers suggest that English teachers in the future can incorporate more group tasks into their teaching curriculum, which will allow students to engage in practical exercises and interact with their classmates, with a greater emphasis on fostering students' teamwork and communication skills.

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Appendix 1.
Learning Motivation Scale Questionnaire.

英文學習動機量表

親愛的小朋友:

這份問卷主要是想了解你們學習方面，而填寫的內容沒有一定的標準答案，也沒有對錯分別。每題請依照自己的狀況、學習，在適當的格子內打勾。感謝你們提供寶貴的想法與意見，給我們有更大的改善空間，謝謝合作，祝福學業進步。

國立虎尾科技大學

一、個人基本資料

1. 就讀學校:

2. 班級:_____年_____班_____號　姓名:_____

二、問卷填答

題號	內容	非常同意	同意	無意見	不同意	非常不同意
1	英文老師上課內容非常吸引我。					
2	英文老師非常有教學熱忱。					

3	英文老師上課內容非常有趣。					
4	英文老師上課可以提升我的英語學習動機。					
5	英文課可以增加我的自信心。					
6	英文課可以帶給我許多不同的英語學習體驗。					
7	英文課會讓我感到快樂。					
8	英文課讓我變得喜歡英文。					
9	英文老師上課內容通常都是考試範圍，沒有其他活動安排。					
10	英文課內容很困難讓我想拒絕學習。					
11	英文老師的上課方式不適合我。					
12	英文老師的教學可以讓我有足夠的腦力激盪。					
13	英文老師的活動課程可以增進我的學習思考。					
14	英文老師的教學使我容易理解英文。					
15	英文老師的教學讓我對學習幫助很大。					

Appendix 2.
Course Satisfaction Questionnaire

滿意度調查表

一、個人基本資料

3. 就讀學校:

4. 班級:_____年_____班_____號　姓名:_____

5. 英語有沒有補習 □有，補幾年了(____)年 □沒有

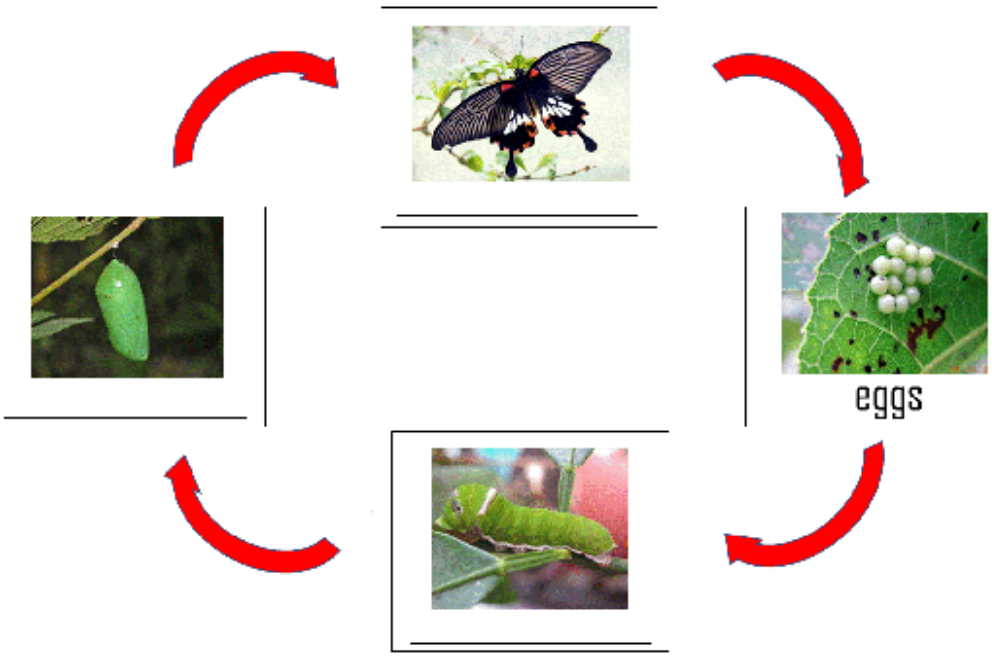
二、滿意度調查填寫

題號	內容	非常同意	同意	無意見	不同意	非常不同意
1	本次英文繪本教學結合手作活動有達到我對學英文的期待。					
2	本次英文繪本教學結合手作活動有提升我的英語學習動機。					
3	本次英文繪本教學結合手作活動有增加我對英文的成就感。					
4	本次英文繪本教學結合手作活動有成功帶給我不同的體驗。					
5	本次英文繪本教學結合手作活動讓我願意更主動參與英語學習。					
6	本次英文繪本教學結合手作活動讓我發現這種上課方式不適合我。					
7	本次英文繪本教學結合手作活動有讓我達到足夠的腦力激盪及思考。					
8	透過本活動，我學到與植物相關的英文。					
9	我覺得用英文學習「自然」科目更有自信。					
10	我覺得用Chant(朗誦)的方式幫助我更容易記憶英文。					
11	我可以自己用英文說明蝴蝶的一生。					
12	我最喜歡的英語結合STEAM手作活動，請排序 1.黏土毛毛蟲DIY 2.黏土蛹DIY	_____				

	3.葉脈拓印 4.黏土蝴蝶DIY	
13	對本次活動的建議與分享	

班級: 姓名: 座號:

I. A butterfly's life cycle: Use the words from the word bank to fill in the blanks. (根據圖片，使用字庫填上適當的字。)



caterpillar butterfly chrysalis egg(s)

II. What are we doing now?: Circle the correct answer for each of the following sentences. (依照下列句子圈選出正確的答案。)

1. It's already afternoon, I still keep eat / eating / eats lunch.
2. It's eleven p.m., it's time to going / go / goes to bed!
3. I wait, and wait, and wait. I keep wait / waiting / waited.
4. It's time to does / do / doing my homework, so I stop playing.

Appendix 3.
pre-test of English vocabulary.

III. You know what it means: Look at the pictures and match them to the correct words. (依照圖片連連看，連到正確的單字。)

nectar	protect	vein	twist	straw	pupa

IV. You know what it means: Use the words from the word bank to complete the sentences. (使用字庫裡的單字完成句子。)

1. Look! Baby caterpillars _____.
2. What does this cake _____ like?
3. The weather makes me _____ this morning. What a cold day!

taste	shiver	crawl out

Appendix 4.
Post-test of English vocabulary.

班級: 姓名: 座號:

I. A butterfly's life cycle: Look at the pictures and match them to the correct words. (仔細看圖片並連到正確對應的英文單字。)




caterpillar butterfly chrysalis egg(s)

II. What are we doing now?: Put the words correctly in order to make sentences. (畫線部分重組句子)

例句: keeps / all day / Someone / singing /, it really bothers me.

➡ Someone keeps singing all day, it really bothers me.

1. I wait, and wait, and wait. keep / I / waiting /.

➡ I wait, and wait, and wait. _____

2. It's eleven p.m., to / time / it's / go / bed / to /!

➡ It's eleven p.m., _____

3. It's / to / time / do / homework / my /, so I stop playing.

➡ _____, so I stop playing.

4. It's already afternoon, eating / still /, / I / keep / lunch

➡ It's already afternoon, _____

III. You know what it means: Look at the pictures, choose the right answer and circle it. (依照圖片將正確的單字圈起來。)

1.  walk twist protect

2.  nectar rabbit pupa

3.  vein nectar straw

4.  pupa vein twist

5.  straw twist protect

IV. You know what it means: Use the words from the word bank to complete the sentences. (使用字庫裡的單字完成句子。)

1. What does this cake _____ like?
2. The weather makes me _____ this morning. What a cold day!
3. Look! Baby caterpillars _____.

taste	shiver	crawl out