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Improvement Difference in Learning by Gender, Overseas Study Intention, and English Proficiency Level Using English Medium Instruction

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Abstract: We examined the effects of English Medium Instruction (EMI) on learning outcomes among technical university students in Taiwan, focusing on variations across gender, overseas study intention, and English proficiency levels. 109 students were included in a survey of this study. A chi-square test was conducted to explore differences in reading, listening, speaking, and vocabulary in English. Significant improvements in listening and speaking skills across all groups were observed without substantial differences in learning outcomes by gender or previous English proficiency levels. Students with overseas study intention showed more advancements in communicative skills, underscoring the need for EMI curricula to align with the student's academic and professional development. Tailored instructional strategies and comprehensive writing courses are necessary to enhance the EMI's effectiveness for college students. Through appropriate policy, practice, and research, EMI can meet diverse student needs and enhance their global competencies in Taiwan's higher education.

Keywords: Technical university, English-medium instruction, Learning result, 4R, Gender

1. Introduction

Bilingual education becomes more important in regions to align with global academic and economic standards. Taiwan also follows such as trend, where English medium instruction (EMI) has been adopted as a key pedagogical strategy in higher education. The governmental initiative to foster bilingual capabilities has been stipulated by the National Development Council and the Ministry of Education in 2022. The widespread implementation of EMI across universities in Taiwan has been well-documented to enhance the English proficiency of students at all levels of education (Ministry of Education, 2023).

The research on EMI practices has been extensively conducted. Chung and Lo (2021), Hua (2019), Huang (2012 and 2018), and Huang and Jhuang (2015) researched the outcomes and methodologies of bilingual education. Despite such research, the impact of EMI on students at technical universities is insufficiently explored regarding differences in learning outcomes across different groups of students by gender, overseas study intention, and previous English proficiency levels. Such a gap in research findings hinders the development of effective pedagogical strategies and policies aimed at enhancing the EMI program.

English, serving as a lingua franca, is crucial in global communication, business, and global academic collaborations, affirming the strategic importance of EMI in higher education (Farias, 2016). The rationale for adopting EMI transcends linguistic proficiency, aligning with the economic, political, and academic objectives of the globalization of higher education. Especially, for the globalization of higher education, EMI is an important medium of instruction for local education systems with global standards (Rahman and Singh, 2020; Doiz and Lasagabaster, 2020). In response to these academic imperatives, the Ministry of Education in Taiwan has supported the following universities to become bilingual hubs: National Taiwan University, National Taiwan Normal University, National Cheng Kung University, National Sun Yat-sen University, National Tsing Hua University, National Chengchi University, and National Taiwan University of Science and Technology. These universities are selected to foster academic and linguistic standards. However, the difference between the students of general and technical universities in their academic capabilities is obvious. Such a difference underlines the necessity of scrutinizing EMI's effectiveness in technical universities, where the academic and linguistic abilities of the students are different from those at other universities (Ministry of Education, 2023).

EMI practices have been examined in nuanced analyses. Gupta and Lin (2023) pointed out the need for reviewing Taiwanese EMI studies and a rigorous critique of the pedagogical and linguistic assumptions behind EMI practices. Tien (2023) explored the

benefits and challenges faced by students in EMI and stated that their English competency significantly influences the effectiveness of EMI learning outcomes. Tseng (2023) proposed improvements in subject knowledge and linguistic skills through EMI, indicating benefits beyond mere language learning. Doran and Rieker (2024) emphasized that EMI must be reviewed from a linguistic structural perspective to assist students in acquiring and applying subject-specific knowledge. Chang, Haynes, Boonsathirakul, and Kerdsomboon (2023) presented that Taiwanese students reported higher levels of comprehension and satisfaction with EMI than students in Thailand.

Despite such results, the perspectives and experiences of students in Taiwanese technical universities need to be explored by investigating how EMI impacts English learning and the potential differences in learning outcomes of students of different genders, home countries, and previous English proficiency levels. The factors affecting different learning improvements were identified to enhance the effectiveness of learning in EMI.

2. Literature Review

2.1. EMI

English is essential in global communication and education. "Three concentric circles of world Englishes," proposed by Kachru, Quirk, and Widdowson (1985), comprise the Inner Circle (native English-speaking countries), the Outer Circle (countries where English serves a significant historical role, such as the Philippines), and the Expanding Circle (countries such as Japan, South Korea, and Taiwan where English is not used widely). This framework contextualizes the rapid adoption of EMI in higher education, in the Expanding Circle, where the influence of English is increasingly pronounced (Macaro, Curle, Pun, An, and Dearden, 2017).

In response to globalization and the dominance of English, the Taiwanese government has emphasized educational reforms. A key component of the reform is the bilingual policy to enhance national competitiveness and English proficiency across the population. This policy has led to the establishment of numerous bilingual educational institutions, underpinned by substantial governmental funding to promote EMI in general and technical universities (National Development Council and Ministry of Education, 2022; Ministry of Education, 2023a, 2023b). While these efforts align with global trends and reflect an attempt to integrate Taiwan into the global educational and economic community, significant challenges also exist including the potential erosion of local culture and the risk of inequities stemming from differences in their prior English education, which undermines the equitable access to quality education advocated by the United Nations' Sustainable Development Goals (SDGs), particularly SDG 4, which emphasizes the promotion of inclusive and equitable quality education for all (Arora and Mishra, 2019; Carlsen and Bruggemann, 2022, and United Nations, 2015).

2.2. EMI for Technical University Students

Being different from general universities, technical universities focus on vocational and technical education to meet the demands of industries. Students in these universities often show lower academic and English language proficiency, which poses challenges in EMI introduction (Chang, 2012). Academic readiness and English proficiency are significant predictors of successful EMI outcomes (Lin and Lei, 2021). Therefore, lower confidence in English proficiency for students of technical universities significantly impedes their motivation and engagement with EMI, thereby undermining their overall academic performance (Huang, 2015). Given that technical universities and vocational schools accommodate more than half of Taiwan's higher education student population (Ministry of Education, 2018), the difference in EMI outcomes between general and technical university students must be minimized through new curriculum designs and pedagogical strategies to enhance the learning outcomes of the technical university students.

2.3. Learning Differences by Gender in EMI

Female students generally outperform male students counterparts in language learning with lower levels of anxiety and more effective learning strategies (Nurlindawati, Yasin, and Hadi, 2022). Male students tend to rely more on memory techniques, which is not effective in EMI which requires understanding and critical thinking (Mahmud and Nur, 2018). Research results in Finland and Norway indicated that female students had greater challenges in EMI despite positive attitudes towards it (Bukve, 2020). While female students perform better in language learning in general, learning in EMI presents challenges that are not addressed by using the general measures to enhance academic performance (Yeh, 2015).

2.4. Learning Differences by Overseas Study Intention

Studying abroad significantly influences students' attitudes toward EMI. Students in other countries' education view EMI as a preparatory tool to enhance their English proficiency and equip them with the necessary skills for successful engagement (Tsui and Ngo, 2017). This motivation aligns with the development of intercultural competencies which are crucial for acquiring global citizenship (Boonsuk and Fang, 2023). Therefore, EMI is not an instructional medium but a bridge to global educational and cultural opportunities for students studying abroad, underscoring the need for programs that effectively support students' motivations and learning objectives.

2.5. Learning Differences by Previous English Proficiency Levels

Variations in English proficiency levels of Taiwanese students complicate the implementation of EMI. English proficiency levels in Taiwan show various linguistic capabilities which impacts the effectiveness of EMI. The Common European Framework of Reference for Languages (CEFR) serves as a guideline to classify these levels, emphasizing the need for tailored educational methods to meet diverse student needs (Council of Europe, 2020). Students with lower proficiency levels (A1 or A2) tend to experience anxiety and face more significant challenges in EMI, which hinders their academic progress and learning outcomes (Huang, 2015). These challenges underscore the necessity for English for Academic Purposes (EAP) courses, which are designed to bridge the gap between student's English proficiency and the demands of EMI courses (Wei and Hricko, 2021). Without adequate preparatory language support, EMI exacerbates educational inequalities, disadvantaging those with lower initial English proficiency (McKinley and Rose, 2022).

A complex interplay of factors influencing EMI outcomes is identified, including institutional type (general vs. technical universities), student demographics (gender and English proficiency), and individual aspirations (such as overseas study intentions). Each of these elements introduces specific challenges and necessitates customized approaches to maximize the benefits of EMI and minimize its potential drawbacks. Furthermore, the implementation of EMI must be critically examined in terms of language acquisition and its ability to deliver content effectively across different disciplines. As English becomes the medium for complex subject matter delivery, the cognitive burden on students with lower proficiency reduces their ability to comprehend and retain the knowledge, which ultimately hampers their overall academic performance and future career opportunities (Hamid, Nguyen, and Baldauf, 2013).

Therefore, EMI in higher education must be adopted considering multifaceted challenges (Su, Cheung and Wu, 2021). Policymakers and institutions must invest more in language education and support systems that address the academic and socio-emotional needs of students. This holistic approach ensures that EMI enhances students' English proficiency and achieves educational outcomes to equip students with the necessary language skills in a globalized community.

3. Materials and Methods

To investigate the different improvements in EMI learning of technical university students by gender, overseas study intention, and previous English proficiency levels, a survey was conducted. 123 undergraduate students from a technical university located in Southern Taiwan were invited to the survey. They responded to an open-ended question: "After completing the EMI course, which competency was improved the most and why?" Their responses were analyzed to obtain nuanced information on the academic and linguistic improvement of the students. Among the respondents, 14 were excluded due to their irrelevance or incompleteness. 88 male and 21 female students responded to the questionnaire available on Google Forms. The responses were classified into pre-defined categories by gender, overseas study intention, and previous English proficiency levels. A chi-square test was conducted to determine significant differences in gender, overseas study intention, and previous English proficiency levels. Python version 4.22 was used for the test.

4. Results and Discussions

4.1. Overall Learning Improvement in EMI

The overall learning improvement in 4R, English literature, attitude, and others, and no improvement was observed for 83, 13, 7, 7, and 13 respondents. The respondents in the 4R group denoted their improvement in general language skills such as listening, speaking, reading, and writing. Substantial improvement in listening and speaking was reported for 41 and 30 respondents, respectively. For reading and writing, 11 and 1 respondents reported improvement. For vocabulary, 12 respondents felt improvement (Table 1). The predominant improvement in listening and speaking was attributed to the interactive nature of the classroom activities of students and teachers in EMI, necessitating a high level of aural comprehension and oral communication. The necessity for

students to comprehend spoken English and respond appropriately in discussions and interactions allowed the respondents to improve in related skills. Vocabulary was also significantly improved. Vocabulary is the backbone of effective communication in the second language, facilitating comprehension and expression. The enhanced vocabulary reflects the increased exposure to English in diverse academic contexts, underscoring the importance of robust language input in EMI.

However, the findings also exposed challenges in EMI. Specifically, improvement in writing was not observed for most respondents. Only one respondent reported improvement, signaling a potential overlook in the curriculum. Writing is an essential academic skill, particularly in higher education where written assignments and exams are mandated. Although wiring writing is not the primary focus of EMI, writing must be more emphasized to teach students the necessary language skills that potentially impact students' educational outcomes. The improvement in attitudes toward learning English was noticeable but its qualitative nature must be further investigated. The improvement in attitude might be related to language proficiency improvement and academic success or only to student perceptions. More male respondents reported improvements in 4R, vocabulary, and attitude than female ones which might be attributed to different learning styles or classroom dynamics involving gender differences. The respondents without improvement must be taken care of as they might not recognize any benefits and fail to meet their learning needs in EMI. The one-size-fits-all approach of EMI is inherent, which might not adequately address the diverse proficiency levels and learning styles of students.

While the EMI courses successfully enhanced the English language skills of the respondents, particularly listening and speaking, improvement in writing and tailored support for the respondents without improvement must be addressed. Though EMI is an effective tool for improving general English competencies, its implementation needs to be more holistic and inclusive to ensure language development across all dimensions. Further research is required to explore how to integrate writing and personalized learning strategies to enhance the overall effectiveness of EMI courses, particularly in technical universities with a wide range of student abilities and academic needs.

Table 1. Overall learning improvements in different dimensions distribution by gender.

Gender	4R				English Literacy		Attitude	Others	No Improvement	Total Number
	Listening	Speaking	Reading	Writing	Vocabulary	Other	Attitude	Others	None	
Female	9	7	4	0	2	1	4	2	0	29
Male	32	23	7	1	10	3	3	5	13	97
Total	41	30	11	1	12	4	7	7	13	126

4.2. Learnbing Improvement by Gender, Overseas Study Intention, and Previous English Proficiency Level

A Chi-square test was conducted to explore the relationship between gender and learning improvement. Their improvements were assessed in three levels 0, 1, and 2.

4.2.1. Effect of Gender

The results of the chi-square test indicated a significant relationship between gender and learning improvements ($\chi^2(2, N = 109) = 11.94$, $p < 0.002$, and a Cramer's V of 0.331) and significant gender-related differences in the learning outcomes from EMI courses. However, the smallest expected score was 2.50 below the preferred threshold of 5 which needed a cautious interpretation of the result. The gender effect on learning improvements indicates the necessity of considering educational dynamics. All female respondents reported a certain degree of improvement, whereas 13 males reported none. Eight female respondents reported improvements in two dimensions with the expected number of 3.27, while only 9 males reported the same, fewer than the expected number of 13.72 (Table 2). The result highlighted gender-related differences in the outcomes of EMI courses. Such differences reflect varying degrees of engagement, motivation, and differences in the pedagogical approaches between male and female respondents. The female respondents reported improvements in multiple areas suggesting that the interactive or communicative methods of EMI were more appropriate for their learning styles. Teaching methods need to be adjusted for male students according to their learning preferences.

Educators and curriculum designers must consider gender-specific educational needs when developing and implementing EMI courses. Tailored teaching strategies to suit the diverse learning styles and preferences of male and female students are required to obtain balanced educational outcomes between them. The importance of continuous monitoring and adjustment of teaching practices is also demanded to ensure inclusive and effective teaching. Gender inclusivity in education must be further discussed and verified. Based on the results, EMI practitioners and policymakers need to reevaluate and refine their approaches. It is also necessary to

explore the underlying reasons for the gender differences in EMI learning improvements to enhance learning outcomes regardless of gender.

Table 2. Learning improvement in EMI by gender.

Gender	Improvement Level 0		Improvement Level 1		Improvement Level 2		Total Number
	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	
Female	0	2.50	13	15.22	8	3.27	21
Male	13	10.49	66	63.77	9	13.72	88
Total	13		79		17		109

4.2.2. Effect of Overseas Study Intention

82 respondents had overseas study intentions while 27 did not. The effect of the intention on learning outcome was not significant (χ^2(2, N = 109) = 3.29, p < 0.19, and a Cramer's V of 0.173). However, reported improvements showed a certain pattern that needed further study. 12 respondents with overseas study intentions reported no improvements higher than the expected number of 9.77. Only 1 student without overseas study intentions reported no improvements, which was fewer than the expected count of 3.22 (Table 3). This finding is paradoxical as respondents with overseas study intentions were more exposed to and engaged with English, potentially gaining benefits from EMI courses, which mirrors the linguistic demands. Such unexpected reports might be attributed to several reasons. The assumption that overseas study intentions strengthen learning outcomes might be wrong due to individual motivation, previous language proficiency, or the inappropriate design and delivery of EMI courses. The respondents with overseas study intentions might have higher expectations or self-imposed pressures, which are not met by the EMI courses. It is necessary to include more subjects in a related study to verify the relationship between overseas study intentions and EMI learning improvements to enhance learning outcomes for all students regardless of their future academic goals. A significant relationship between overseas study intentions and learning improvement in EMI was not observed but the result can be used to assess EMI courses in terms of their teaching structures and delivery efficiencies. Educators and curriculum developers need to consider the result when designing EMI courses to meet diverse student goals to learn English and provide personalized learning strategies within EMI frameworks to align with individual educational plans and goals.

Table 3. Learning improvement in EMI by overseas study intention.

Overseas Study Intention	Improvement Level 0		Improvement Level 1		Improvement Level 2		Total Number
	Real Number	Expected Number	Real Number	Real Number	Expected Number	Real Number	
Yes	12	9.77	56	59.43	14	12.78	82
No	1	3.22	23	19.56	3	4.21	27
Total	13		79		17		109

4.2.3. Effect of Previous English Proficiency Level

Differences in learning improvement at different proficiency levels (A1, A2, and B1) were not significant (χ^2(4, N = 126) = 3.03, p = 0.55, and a Cramer's V of 0.117). Previous English proficiency was not a determining factor for learning improvement. The courses were beneficial to respondents at all proficiency levels. The number of respondents (five) at level B1 was higher than the expected number of 3.58), which suggested that their higher proficiency enhanced learning outcomes more effectively (Table 4). However, the number of samples was too small for the generalization of the result. This underscores the need for a more robust statistical analysis with more subjects. Cramer's V indicated that the impact of previous English proficiency levels was not significant as the respondents with higher English showed remarkable improvements. Therefore, educators and curriculum developers must optimize EMI courses for students at all proficiency levels through the assessment of course content and teaching methods.

Further research is necessary to explore the relationship between learning improvement with previous English proficiency levels of students with a larger sample size or longitudinal data. Qualitative data also needs to be gathered to understand how respondents at different proficiency levels perceive their improvements and interact with EMI coursework.

Table 4. Learning improvement in EMI by previous English proficiency level.

Level	Improvement Level 0		Improvement Level 1		Improvement Level 2		Total Number
	Real Number	Expected Number	Real Number	Real Number	Real Number	Expected Number	
A1	2	2.74	18	16.66	3	3.58	23
A2	9	7.21	46	45.66	8	9.82	63
B1	2	2.74	15	16.66	6	3.58	23
Total	13		79		17		109

4.3. Learning Improvement in Different Dimensions

4.3.1. Learning Improvement by Gender

The 4R, English literacy, attitude, others, and no improvement groups included 83, 16, 7, and 13 respondents. The relationship between gender and learning improvements in the dimensions was not significant ($\chi^2(4, 8.82)$, $p = 0.065$, and Cramer's V of 0.264). The smallest expected number was 1.61, indicating the validity of the chi-square was not ensured due to a small sample size. Four female respondents reported improvements in attitude, which was more than double the expected number (1.61) (Table 5). While learning improvement in dimensions was not significantly different between genders, different learning outcomes between male and female respondents were observed. For instance, there was no respondent with no improvement (the expected number of 2.99) implying a more perceived benefit or engagement to the EMI course of the female participants. There might be underlying gender-specific dynamics that affected respondents' experience in the EMI courses. The dynamics need to be identified in further studies for enhanced EMI course design and pedagogical strategies and personalized approaches. While gender-related differences in EMI learning outcomes were not significant in dimensions, female respondents showed better attitudes toward learning. Further study is required to verify the reasons and to enable better educational practices and policy-making.

Table 5. Learning improvement in dimensions by gender.

Gender	4r		English Literacy		Attitude		Others		No Improvement		Total Number
	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	
Female	20	19.10	3	3.68	4	1.61	2	1.61	0	2.99	29
Male	63	63.89	13	12.31	3	5.38	5	5.38	13	10.00	97
Total	83		16		7		7		13		126

4.3.2. Learning Improvement by Overseas Study Intention

A significant correlation between overseas study intentions and learning improvement was observed ($\chi^2(4, N = 126) = 12.38$, $p = 0.014$, and a Cramer's V of 0.313) (Table 6). The goal of overseas study motivated respondents to engage in EMI but differently according to the course content. The respondents with the intention showed better improvements in vocabulary. As the respondents focused on language learning in local or professional contexts related to global academic environments, they showed greater improvements in attitude and others, too to gain global perspective and intercultural competencies. This difference in learning outcomes between the respondents with and without the intention necessitates the emphasis on global awareness and cross-cultural skills in EMI. Those without overseas study intentions need to practice language skills and increase their vocabulary for employment. EMI must cater to different student groups in the same educational institution. Educators must recognize and incorporate the differences into teaching strategies. By integrating content that fosters global competencies and perspectives, students with overseas study intentions can enhance their engagement and learning outcomes. A balanced approach to strengthen core language skills for those without the intention is also necessary. By designing EMI courses tailored for students with diverse career paths and academic motivation, the effectiveness and relevance of EMI can be enhanced to obtain robust learning outcomes. While overseas study intentions result in enhanced EMI learning outcomes, it is required to optimize the courses to realize EMI's potential as a transformative educational tool.

Table 6. Learning improvement in dimensions by overseas study intention.

Overseas Study Intention	4R		English Literacy		Attitude		Others		No Improvement		Total Number
	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	
No	21	19.76	8	3.80	0	1.66	0	1.66	1	3.09	30
Yes	62	63.23	8	12.19	7	5.33	7	5.33	12	9.90	96
Total	83		16		7		7		13		126

4.3.3. Learning Improvement by Previous English Proficiency Level

A significant relationship between previous English proficiency levels and learning improvements in dimensions was observed ($\chi^2(8, N = 126) = 30.00$, $p < 0.001$, and a Cramer's V of 0.345). However, the expected number was 1.44, indicating the limited number of samples (Table 7). The respondents at level B1 reported improvements in attitudes toward learning with more engagement in the EMI courses. The respondents at levels A1 and A2 showed more improvements in English literacy as there was more room for improvement in language skills. However, their improvements in attitudes were not significant. The results indicated the necessity of different teaching strategies for students at various English proficiency levels. Students with high proficiency benefited more from EMI in enhancing language skills and attitudes because their language skills were satisfactorily improved. Students with low proficiency require foundational language support and educational support to develop basic language competencies. Therefore, educators and curriculum developers need to formulate proficiency-based teaching strategies in EMI. By incorporating targeted teaching for students with low proficiency, the gap in engagement in the course must be filled to enhance their learning experience and attitudes. For students with high proficiency, advanced skills and critical thinking in cross-cultural understanding must be taught. The result emphasizes the importance of accurate assessment and adaptation of EMI courses. Educators must tailor the course content and teaching strategies to meet the diverse needs of students at different proficiency levels accordingly. Personalized learning strategies are demanded for adaptive learning and collaborative projects to improve language ability. Future research is necessary to further investigate the identified relationship with a larger sample size to better understand how to optimize EMI courses for students at different English proficiency levels.

Table 7. Learning improvement in dimensions by previous English proficiency levels.

English Proficiency Level	4R		English Literacy		Attitude		Others		No Improvement		Total Number
	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	
A1	18	17.12	5	3.30	0	1.44	1	1.44	2	2.68	26
A2	46	46.76	11	9.01	0	3.94	5	3.94	9	7.32	71
B1	19	19.10	0	3.68	7	1.61	1	1.61	2	2.99	29
Total	83		16		7		7		13		126

4.4. Improvement in English Literacy

4.4.1. Improvement by Gender

11, 41, 30, and 12 respondents reported improvements in reading, listening, speaking, and vocabulary. There was no significant relationship between gender and overall English literacy improvements ($\chi^2(3, N = 94) = 1.38$, $p = 0.70$, and a Cramer's V of 0.121). The smallest expected number was 2, suggesting inadequacies in the sample size. Female and male respondents had similar degrees of improvement in English literacy indicating that gender did not influence English literacy learning in EMI. This was different from previous research results highlighting female students' superiority in verbal language-related tasks. To generalize the result, the homogeneity of the educational environment, pedagogical approaches in EMI, and the motivational levels of students must be ensured. Gender differences in EMI course learning also need to be considered with individual learning styles, previous educational backgrounds, and linguistic competencies to provide improved EMI courses. EMI practitioners and curriculum designers must monitor and evaluate the influence of gender on learning outcomes. Further research with larger and more diverse samples is required to verify the results and explore their implications for EMI.

Table 8. Learning improvement in English literacy by gender.

Gender	Reading		Listening		Speaking		Vocabulary		Total Number
	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	
Female	4	2.57	9	9.59	7	7.02	2	2.80	22
Male	7	8.42	32	31.40	23	22.97	10	9.19	72
Total	11		41		30		12		94

4.4.2. Improvement by Overseas Study Intention

26 with overseas study intentions and 68 without it reported improvement in reading, listening, speaking, and vocabulary. A significant relationship between overseas study intentions and English literacy improvements was observed ($\chi^2(3, N = 94) = 8.53$, $p = 0.036$, and a Cramer's V of 0.301) (Table 9). Therefore, the overseas study intentions of the respondents affected learning outcomes and improvements though the small sample size hindered the generalization of the result. The pronounced improvement in speaking of the respondents with overseas intentions reflected their motivation and need to enhance proficiency in spoken English for successful communication. This motivation allowed the respondents to engage actively in speaking activities and maximize their exposure to spoken English. The respondents without overseas study intentions prioritized reading and vocabulary for academic success which were less relevant to their perceived needs. The results indicated the importance of aligning EMI pedagogy with the future academic and career goals of students to enhance the relevance and outcome of language instruction. Through EMI courses, personalized learning pathways can be provided to cater to the goals and motivations of students. For those with overseas study intentions, curricula emphasizing speaking and listening are more beneficial as they plan to have a job after graduation. Educators need to be aware of the diverse goals and backgrounds of students when designing and implementing EMI courses. By acknowledging and addressing diverse learning goals, the effectiveness of EMI courses can be enhanced to enhance students' language proficiency regardless of their plans and goals.

Table 9. Learning improvement in English literacy by overseas study intentions.

Overseas Study Intentions	Reading		Listening		Speaking		Vocabulary		Total Number
	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	
No	3	3.04	14	11.34	3	8.29	6	3.31	26
Yes	8	7.95	27	29.65	27	21.70	6	8.68	68
Total	11		41		30		12		94

4.4.3. Improvement by Previous English Proficiency Level

There was no significant relationship between the respondents' previous English proficiency levels and their improvements in English literacy ($\chi^2(6, N = 94) = 6.05$, $p = 0.416$, and a Cramer's V of 0.179). EMI benefited respondents at all proficiency levels in improving English literacy. The EMI courses were efficient for all respondents regardless of their English proficiency levels, which needs to be verified with a larger sample size. For English literacy improvements, the intensity, quality, and pedagogical methods of EMI courses are needed to motivate students and develop learning strategies. Educators and course developers must tailor EMI courses to meet the needs of students at various proficiency levels. For students at various proficiency levels, discussion-based activities must be implemented to enhance learning outcomes. The EMI courses need to be optimized for students at different English proficiency levels.

Table 10. Learning improvement in English literacy by previous English proficiency level.

English Proficiency Level	Reading		Listening		Speaking		Vocabulary		Total Number
	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	Real Number	Expected Number	
A1	3	2.57	7	9.59	8	7.02	4	2.80	22
A2	5	6.20	26	23.11	14	16.91	8	6.76	53

4.5. Discussions

Female respondents reported higher engagement and learning improvement in dimensions. 13 male respondents reported no improvement, indicating a gap between EMI courses and their needs. The significant difference in learning improvement between different genders necessitates pedagogical adjustment of EMI strategies to be tailored to male students' learning styles. Respondents with overseas study intentions reported greater improvements in speaking and attitude toward learning to acquire essential skills. However, 12 respondents with overseas study intentions reported no improvements indicating unmet expectations or a gap in their needs and course design. These results emphasize the importance of curriculum optimization for students's diverse goals and academic demands. The relationship between English proficiency levels and learning improvements also provides important information. While EMI courses benefited respondents at all English proficiency levels, respondents at a high level reported the largest improvement in language skills and attitude. Respondents at low levels showed noticeable improvements in vocabulary but their improvements were limited. These results indicated the need for differentiated instruction to support students at lower levels and offer challenging content for respondents at a high level. The EMI courses must be designed to effectively foster improvements in listening, speaking, and attitude but individual differences in gender, goals, and proficiency must be considered. To maximize the impact of EMI, personalized teaching strategies must be established to meet diverse student needs and goals. By designing curricula that balance communicative practice, literacy development, and academic skill-building, EMI benefits students with diverse goals and English proficiency.

5. Conclusions

We explored the impact of EMI on the literacy and learning improvements of technical university students. Various factors such as gender, overseas study intentions, and previous English proficiency levels were examined in terms of their learning improvements. EMI significantly enhanced overall learning outcomes of English but significant differences were observed between students of different genders and with overseas study intentions. Overseas study intentions influenced improvement in English speaking skills due to the increased motivation and need for proficiency. The respondents' previous English proficiency levels did not have a significant effect on English learning improvement, implying that EMI courses were effective for students at different proficiency levels to learn English. The small sample size affected the reliability of the chi-square test result and hindered the generalization of the results of this study. The EMI courses must designed to tailor pedagogical methods to meet diverse student needs and goals. Personalized learning strategies need to be provided to ensure students' language development. Future research is necessary to validate the results of this study and refine EMI strategies to help students realize their academic and professional potential.

The present study results underscore a need for differentiated and responsive EMI courses for technical university students. The diverse educational needs from differences in gender, overseas study intentions, and English proficiency levels must be addressed by developing tailored strategies. EMI curricula must be designed to be flexible and adaptable and incorporate the method to enhance writing skills and cater to all aspects of English literacy. Regular assessments and refinements of EMI courses are essential to meet global standards and enhance students' language skills and global competencies. Their academic needs must be aligned with Taiwan's global educational standards and competitiveness goals. The effectiveness of teaching strategies tailored to diverse student demographics needs to be verified. The consistent improvements in listening and speaking are enabled by using interactive teaching methods. More structured writing exercises and comprehensive literacy training are necessary in EMI courses. The diverse needs of students can be met by providing personalized learning strategies. Such tailored approaches improve learning engagement and outcomes of students with targeted professional and academic motivations. The results of this study provide a basis for further studies on EMI and English literacy improvement methods. Differences in learning improvements by gender, overseas study intentions, and previous English proficiency levels of students need to be elucidated with larger, more diverse samples and longitudinal studies to assess the effectiveness of EMI pedagogical strategies. Qualitative research can enrich research results and an understanding of the interplay between EMI and students' successful learning optimizing the policy and practice to use EMI as a transformative, inclusive, and effective learning tool.

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