Technology-mediated syntax learning: A quantitative study of technology acceptance, autonomy, and achievement among EFL learners

Afif Ikhwanul Muslimin [1] & Fitrana Harintama [2]

Abstract

This study aimed to unravel the EFL students' technology acceptance toward the implementation of Technology-Mediated Syntax Learning (TMSL) and unveil its impact on EFL students' learning autonomy and English Syntax (ES) learning achievement. Therefore, the quantitative study was operated through descriptive analysis and pre-experimental design. The descriptive analysis was done to scrutinize the EFL students' technology acceptance and learning autonomy toward implementing TMSL. The pre-experimental study was conducted to know the effect of TMSL implementation on ES learning achievement. The participants of this study were 121 students who joined the English Syntax course in the English Education Department, Faculty of Education and Teachers Training at a public university in West Nusa Tenggara Province, Indonesia. The results showed that the participants highly accepted TMSL and depicted high learning autonomy scores. The statistical calculation proved significant differences between participants' ES Pre-test and Post-test scores, meaning that TMSL implementation significantly affected ES learning achievement. However, the distinct results of technology acceptance and autonomy analysis from previous studies suggest further investigation, including applying different research approaches. Hence, this study suggests that a technology integration model gains positive output and outcome for the EFL learning context.

[1]Corresponding Author: English Language Education of Universitas Islam Negeri Mataram, Mataram, Indonesia; *Email: afifikhwanulm@uinmataram.ac.id*
ORCID: https://orcid.org/0000-0003-0043-5402
[2] English Language Education of Universitas Islam Negeri Mataram, Mataram, Indonesia;
*Email: fitranaharintama@uinmataram.ac.id*; ORCID: https://orcid.org/0000-0003-1492-1110

1. Introduction

Technology is now inseparable from EFL teaching and learning due to its numerous advantages (Loyless & Shaw, 2020; Muslimin et al., 2023). It can boost EFL students' learning achievement (Matsumoto et al., 2020), promote collaboration in learning (Qi & Derakhshan, 2025), enhance their engagement (Schindler et al., 2017), and increase their interest through visually appealing learning materials (Carstens et al., 2021; Derakhshan & Zhang, 2024). Moreover, technology fosters student autonomy by creating more personalized learning environments (Octaberlina & Muslimin, 2021). Additionally, tools like generative AI help EFL teachers develop interactive pedagogies that cater to differentiated learning (Muslimin et al., 2024).

Given these positive effects, EFL teachers of content-heavy courses, such as English Syntax (ES), should consider integrating technology into their instruction. Teaching ES with technology is particularly beneficial due to the complexity of syntax theories, which demand extensive guidance and time to master (Carnie, 2013; Francis, 1958). However, students often have limited contact hours with teachers, making it difficult to cover the large volume of material (Al-Obaydi et al., 2023). Consequently, many EFL students struggle with Tree Diagram concepts and analysis due to the lack of intensive teacher-student interaction during online learning (Darmawansah & Indartono, 2019). This issue has been observed among EFL students in the English Education Department at a public university in West Nusa Tenggara Province, Indonesia.

To address these challenges, the teacher introduced Technology-Mediated Syntax Learning (TMSL) tools (see Figure 1): 'Syntactic Tree Diagram (STD)' and 'Linguistics Tree Solver (LTS).' STD offers English syntax tutorials, phrase structure rules, and practice exercises, helping students plan their learning and improve their comprehension. LTS allows students to deepen their understanding by applying syntax nodes to sentences and generating visual representations of tree diagrams.

Figure 1
The Interface of STD and LTS
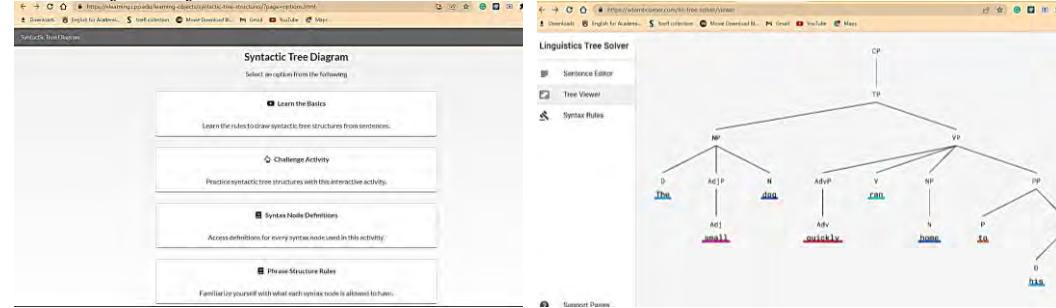
Integrating technology into teaching English Syntax (ES) in an EFL classroom requires students to perceive its benefits (Derakhshan & Shakki, 2024; Mizher et al., 2022). The technology must be easy to operate (Edumadze et al., 2022), compatible with various devices (Chung et al., 2015), and affordable or even free (Alakrash & Razak, 2020). Therefore, the ES teacher should select technology that is best suited to the teaching materials to ensure positive student acceptance (Wang & Luo, 2022). Additionally, students need to be properly familiarized with the technology to use it effectively (Kasim et al., 2024; Solano et al., 2020).

In light of this background, the present study aims to investigate EFL students' acceptance of TMSL and the impact of TMSL on ES learning autonomy and achievement. It also seeks to address the gap in the limited research on the use of TMSL in ES teaching. The study is guided by the following research questions:

1. What is EFL students' attitude toward TMSL implementation?
2. Can TMSL promote students' learning autonomy?
3. What is the impact of TMSL on ES learning achievement?

2. Literature Review

2.1. Technology Acceptance

Myriad scholars have studied technology acceptance (TA) in an EFL setting. Wang and Yu (2022) studied that each component of the Technology Acceptance Model

(TAM) impacts each other in the EFL study context. They claimed that EFL students considered the usefulness of technology as the essential consideration to accept its application to aid EFL learning because the students wanted to be successful in their classes. Hsieh et al. (2017) reminded EFL teachers that they should match the teaching pedagogy, content, and chosen technology to help EFL students achieve better learning. They exemplified the successful use of the LINE App to mediate EFL oral training, which led to the student acceptance of the LINE App for learning. On the different cause-effect direction, Tabak and Nguyen (2013) state that EFL students' acceptance of technology would lead them to learn success. The students should be open to new input to obtain more information about the input (Svedholm-Häkkinen & Lindeman, 2017). Then, students would then accept technology if it provided them with benefits (Vladova et al., 2021). Moreover, technology acceptance among EFL learners is not only shaped by technical functionality but also influenced by emotional and contextual variables (Chen et al., 2023), as well as institutional culture and learner engagement patterns (Shakki, 2022). Reviewing those studies, introducing technology to mediate EFL teaching would trigger students' acceptance, and this acceptance would contribute to the student's success in learning. Therefore, it was worth studying the EFL students' technology acceptance toward introducing TMSL (containing STD and LTS software) to help students achieve ES learning success, especially in comprehending and analyzing Syntax using a 'Tree Diagram' which has not yet been analyzed by scholars.

2.2. Learners' Autonomy

In some studies, learners' autonomy (LA) has become an interesting discussion topic during the implementation of online or distance learning (Dang, 2012; Khotimah et al., 2019; Octaberlina & Muslimin, 2021). The studies mentioned that EFL learners with autonomy characteristics possessed the ability to prepare for their learning (Dang, 2012; Khotimah et al., 2019; Muslimin et al., 2024) and monitor their learning (Octaberlina & Muslimin, 2021), or simply take control of the learning process (Khulaifiyah et al., 2021). Their studies showed that EFL students with those characteristics had already portrayed learning success. Similarly, Ginting et al. (2021) stated that autonomous EFL learners achieved better in language learning than those who were not. However, Benson (2011) stated that EFL learners should also be able

to evaluate their learning to be categorized as autonomous learners. This domain opens opportunities for further research with different contexts or variables.

The introduction of TMSL to EFL students in this research setting also correlates with the enactment of the students' learning autonomy (Cahyono et al., 2022) in learning English Syntax (ES). The triggering factor that led the ES teacher in this study to apply TMSL was to mediate the ES online teaching. It was because the teacher needed to provide an intensive learning guide for the students to comprehend the ES concept and to equip them with the ability to do ES analysis using the 'Tree Diagram'. Therefore, in line with Darmawansah and Indarton's (2019) study, the participants of this study should develop their metacognitive strategy to possess a self-directed learning routine or be ES autonomous learners to achieve learning success. Then, investigating the participants' learning autonomy due to the TMSL implementation was vital since it has yet to be studied and to check TMSL's efficacy to empower EFL learners' autonomy across its domains: preparation, monitoring, and evaluation' (Benson, 2011).

2.3. English Syntax Learning Achievement

Learning achievement had become a variable in some previous studies, connected to other variables as triggering factors. Muslimin et al. (2022) explained that EFL students' psychological factors, i.e., anxiety and attitude, to apply Flipgrid technology would affect their speaking achievement. Taj et al. (2017) stated that technology influenced the EFL students' reading learning achievement. Similar positive results were shown in Kiu et al.'s (2021) study which mentioned that the attendance of technology in EFL teaching and learning helped increase the EFL students' four English skills achievement. Those studies prove that integrating technology in EFL teaching would also provide positive impacts. Nevertheless, they have yet to study how technology affects EFL students' learning achievement in the ES learning context.

Following the positive effect of technology on learning achievement, this study promotes the implementation of TMSL for EFL students' ES learning. The researchers predicted that TMSL would positively impact ES learning achievement.

However, this hypothesis still required empirical investigation through experimental study, which other scholars still need to do.

2.4. Research Framework

Learning English Syntax (ES) during the online learning implementation was challenging for EFL students, including the students in this research setting, since learning ES required the role of teacher to provide very intensive guidance and communication, especially to comprehend ES materials and do syntactic analysis in the form of 'tree Diagram'. Henceforth, the teacher promoted the 'Syntactic Tree Diagram (STD)' and 'Linguistics Tree Solver (LTS)' in the Technology-Mediated Syntax Learning (TMSL) framework to overcome the EFL students' ES learning challenges. Following the suggestion of Darmawansah and Indartono's (2019) study, EFL students should acquire ES comprehension techniques through an inquiry-based learning model or require students to be autonomous learners. Therefore, the researchers also explored the impact of TMSL implementation on the EFL students' autonomy. Moreover, considering previous study findings that TAM would affect learners' learning achievement or success (Tabak & Nguyen, 2013), this study also investigated the EFL students' technology (TMSL) acceptance by adopting the technology acceptance model (TAM) framework. The details of this research framework are presented in Figure 2.

Figure 2
The Research Framework
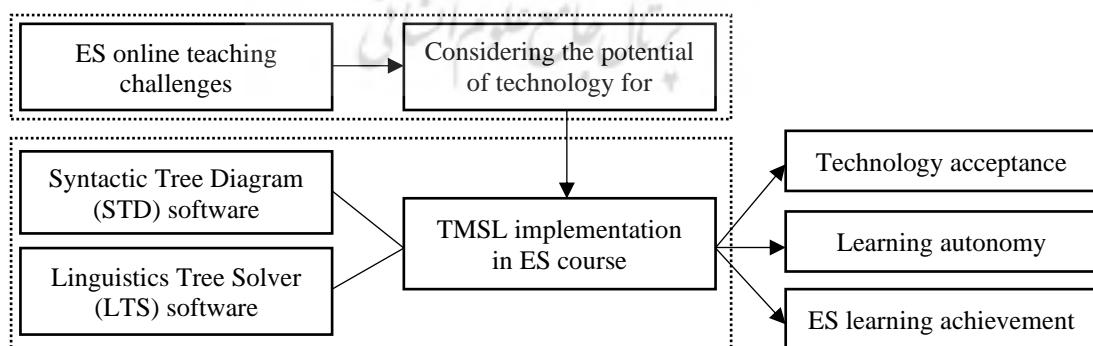
3.   Methodology

3.1. Design

This study employed a quantitative approach with descriptive and pre-experimental study design. A quantitative approach was applied since the primary data format was numerical and analyzed statistically using SPSS version 24 (Weyant, 2022). The designs were chosen due to some of their strengths. First, these designs provide for a relatively large sample size, which increases the study's external validity. Second, the pre-experimental designs allow for some control over variables, which aid in isolating the impacts of technology-mediated syntax learning (TMSL). Third, the designs were chosen due to the university regulation for not allowing randomization of the participants. The university had grouped the classes according to their placement test results. Nevertheless, applying descriptive and pre-experimental study design brought weaknesses in terms of data validity since the participants self-reported their TA and LA. Hence, to maintain the validity, the researchers provided information at the beginning of the survey to make sure that participants would fill out the survey seriously and agree with the consent. Also, the researcher explained how to apply the STD and LTS effectively after the research students did the pre-test and monitored the participants' learning progress during the online learning to scaffold technology operation challenges.

The descriptive study was applied to answer research question one, which intended to seek EFL students' technology acceptance score, and research question two, which looked for the students learning autonomy score after the Technology-Mediated Syntax learning (TMSL) treatment. Then, the pre-experimental study was done to analyze the students' English Syntax (ES) learning achievement after TMSL treatment. The details of the research procedures are presented in Table 1.

Table 1

The Details Research Procedures

No	Variables	Procedure	Analysis
1	Technology Acceptance	EFL Students Experience ES learning by employing TMSL	Descriptive quantitative analysis after Technology Acceptance Questionnaire administration
2	Learning	EFL Students Experience ES learning	Descriptive quantitative

No	Variables	Procedure			Analysis
	Autonomy	by employing TMSL			analysis after Learning Autonomy Questionnaire administration
3	Learning Achievement	Pre-test	TMSL treatment	Post-test	Comparison of Pre-test and Post-test scores (ES learning achievement) after treatment

3.2. Research Participants and Context

The participants of this study were 121 3rd-semester students who joined the English Syntax (ES) course in the academic year 2023-2024. They were registered as Bachelor students in the English Education Department, Faculty of Education and Teachers Training at a public university in West Nusa Tenggara Province, Indonesia. Most of the participants come from middle and low-income families. However, they could access the internet since the majority had already have gadgets and the university provided internet fund support during online learning. The demographic of the participants is presented in Table 2.

Table 2
Demographics of the Participants

Categories	Subcategories	Frequencies
Sex	Male	34
	Female	87
Age	19	67
	20	34
	21	17
	Above 21	3

To understand the research context, the ES course is taught in the fourth semester of each academic year at the university. This course is designed to prepare students to successfully pass the paragraph and academic writing courses in the following semesters. Moreover, this course is prepared to leverage students' linguistics writing monitoring skills to help them writing their bachelor thesis. Since this course becomes the basis of other courses, the students should comprehend Syntax theories and be able to analyze the sentence syntactically through a 'Tree Diagram'. During their Syntax analysis, they were given authentic learning materials from any source including sentences from the published thesis and scientific article. The meetings in the course are established gradually from theory into practice i.e. understanding the

concept of Syntax, understanding, comprehending part of speech, analyzing sentences, and evaluating Bachelor thesis sentence syntactical structure. Reflecting on the student's experience of learning the ES analysis during online learning with the minimum one-on-one guidance from the teacher, therefore, the initiative of the ES teacher is required to increase the ES learning achievement and students' learning autonomy by employing technology.

3.3 Instruments

The present research aimed to answer three research problems related to EFL students'' technology acceptance, learning autonomy, and the effect of TMSL implementation on ES learning achievement. Hence the instruments used to obtain the data were:

a. Technology Acceptance (TA) Questionnaire

The questionnaire was developed by adapting the TAM (Technology Acceptance Model) questionnaire developed by Weng et al. (2018). The adaptation was made to adjust the Wen's et al. (2018) TAM questionnaire to this research context. The adopted questionnaire comprises 15 items: five items analyzing the participants' perceived ease of use, five discussing the perceived technology usefulness, and five searching for EFL students' attitudes toward TMSL. The participants would be required to show their responses in five Likert-scale scores starting from 1 to 5. The higher the score chosen represents their better agreement to respond to the statements.

b. Learners Autonomy (LA) Questionnaire

The learners' autonomy questionnaire was adapted from (Octaberlina & Muslimin, 2021). The questionnaire covered three steps where autonomy characteristics appeared; were being able to prepare (5 items), being able to implement (5 items), and being able to evaluate (5 items) (Benson, 2011; Dang, 2012). This questionnaire used a 5-point Likert-type, in which responses ranged from 'strongly agree' (scored 5) to 'strongly disagree' (scored 1). Then, the ranges were abbreviated into SA = strongly agree, A = Agree, N = Neutral, D = Disagree, and SD = strongly disagree.

c. Documentation

The documentation was applied by collecting two documents: the students' 'Tree Diagram' pre-test and post-test scores and the students' 'Tree Diagram' test results in a picture. The test's scoring system was based on the ES teachers' answer key, which had been prepared before the implementation of both tests. The ES teacher also applied scoring rubrics to score each EFL student's Diagram answer (see Table 3), which adapted Carni's (2013) ES 'Tree Diagram' evaluation rules.

Table 3
The ES 'Tree Diagram' Scoring Rubric for Each Analysis

Score	0	2	4	6	8	10
Criteria	No work has been submitted	The tree Diagram has more than six errors, one of which includes nodes/part of speech labels, wording of sentences, lines or branches that are attached to the tree, and hierarchical ordering. or even there are crossing lines and triangles.	The tree Diagram has 5-6 errors, one of which includes syntax nodes/part of speech labels, wording of sentences, lines or branches that are attached to the tree" and hierarchical ordering. or even there are crossing lines and triangles.	The tree Diagram has 3-4 errors, one of which includes syntax nodes/part of speech labels, wording of sentences, lines or branches that are attached to the tree" and hierarchical ordering. or even there are crossing lines and triangles.	The tree Diagram has 1-2 errors, one of which includes syntax nodes/part of speech labels, the wording of sentences, lines or branches that are attached to the tree, and hierarchical ordering. or even there are crossing lines and triangles.	The tree Diagram is perfect with complete and correct syntax nodes/part of speech labels, the wording of sentences, lines or branches that are attached to the tree" and hierarchical ordering. then, there are no crossing lines and triangles.

3.4 Data Collection and Analysis

The data was collected through the administration of technology acceptance and learners' autonomy questionnaires to the participants to obtain data for answering the first and second research problems. The third research problem data was collected by

documenting both pre-test and post-test scores and the student's Diagram test results in pictures. After the data were collected, the data were analyzed statistically using SPSS version 24. The students' technology acceptance of TMSL implementation and autonomy in ES online learning using TMSL analysis was started by calculating the questionnaire items score and searching for the level of items category. The level of the category is presented in Table 4.

Table 4
The Level of Questionnaire Item Category (n=121)

Item Scores	Levels of category
485-605	Very high
364-484	High
243-363	Moderate
122-242	Low
0-121	Very low

Then, the data analysis for the EFL students' learning achievement was conducted by comparing the total scores of all EFL students' pre-test and post-test scores after the TMSL treatment. It aimed to know the effect of TMSL treatment on improving the EFL students' ES learning achievement.

4. Results and Discussion

The present research aimed to scrutinize the EFL students' technology acceptance toward the implementation of Technology-Mediated Syntax Learning (TMSL) and unveil its impact on EFL students' learning autonomy and English Syntax (ES) learning achievement. Therefore, the results and discussion will be presented following the order of the research objectives.

4.1. EFL Students' Technology Acceptance

The implementation of technology for teaching and learning would produce various reactions from the users (the EFL teachers and students). The reactions could be positive, which could support the process of teaching and learning, or even harmful,

which hinders the potential of technology to exist for users. The introduction of TMSL, through implementing two ES software, namely STD and LTS, to EFL students in this research setting would also trigger their reaction, whether to accept or reject TMSL. However, the introduction of TMSL mainly mediated the ES online learning obstacles where the students needed more comprehensive input and practices to comprehend ES materials and conduct a 'Tree Diagram' analysis. Henceforth, the technology acceptance research was conducted, and the results are presented in Table 5.

Table 5
Students' Technology Acceptance of TMSL Implementation in ES Learning

Subscale	Mean	Standard Deviation	Category
Perceived Usefulness	4.62	0.45	Very High
Perceived Ease of Use	4.96	0.38	Very High
Attitude toward Using TMSL	4.61	0.42	High
Overall Technology Acceptance	4.73	0.40	High

Table 5 (with the details in Appendix A) shows that the participants accepted the implementation of TMSL for ES learning with a 473.4 score or 'High' technology acceptance category. The three domains of the Technology Acceptance Model (TAM) promoted by Weng et al. (2018) have been positively responded to by the EFL students. However, the highest acceptance score among the domains was the EFL students' perceived ease of use, with the highest mean score of 496 or 'Very High' acceptance. The EFL students believed understanding the TMSL features and how TMSL worked was easy. The students could find a clear description in the software on what the features are and how it is operated. In addition, the ES teacher also explained TMSL to the students before implementing TMSL, which increased EFL students' technology familiarity (Edumadze et al., 2022; Kasim et al., 2024; Solano et al., 2020) and positive acceptance of TMSL (Vladova, 2021). The EFL students also considered technology accessibility features as important. They believed that TMSL accessibility features across time, place, and gadgets had motivated them to implement TMSL for learning ES (Azhari & Fajri, 2022; Matsumoto et al., 2020).

Discussing the usefulness of TMSL, the participants believed that TMSL could

increase their learning pedagogy and achievement (Chung et al., 2015) and be adjusted to meet their personal needs. They found that TMSL helped trigger their motivation to learn due to its comprehensive materials presentation (ES nodes and practices) (Carstens et al., 2021; Muslimin et al., 2024). Students could learn and re-learn the ES nodes (in STD software – Syntax Nodes Definitions menu), which they should comprehend to produce correct ES 'Tree Diagram' analysis. These learning and re-learning possibilities aided the EFL students in enhancing their ES material understanding in the ES online learning model due to the limited time of online meetings that reduce intensive (teacher-student) guidance (Azhari & Fajri, 2022).

Following the positive acceptance of EFL students to the usefulness and easiness of TMSL implementation in ES courses, they also showed positive acceptance towards using TMSL. Overall, using TMSL for ES learning would positively influence many aspects of their learning (increasing learning achievement, solving online learning obstacles, elevating positive learning psychology, and meeting personal pedagogy and needs). They also said that TMSL did not give them a negative ES learning experience and recommended a similar application of technology to mediate future ES learning.

The aforementioned positive EFL students' responses toward TMSL acceptance showed that EFL students highly accepted TMSL to be implemented and to mediate ES online learning in this research setting. However, perceived ease of use is shown as the most influential domain in TAM in this study (Edumadze et al., 2022) which depicts different findings from Wang and Yu's (2022) study that put perceived usefulness as the most important consideration for students to accept technology. Therefore, further investigation regarding these different findings which may be impacted by different research participants and contexts is needed for a better understanding of the issue.

4.2 EFL Students' Learning Autonomy
ES online teaching and learning model practice was unavoidable during the Pandemic, which continued progressing until the odd semester of the academic year of 2023-2024 in the present research setting. During its implementation, the ES teacher found that the EFL students needed help comprehending ES materials and

doing ES 'Tree Diagram' analysis because of the limited time in an online class and less intensive learning guidance. Consequently, the ES teacher promoted TMSL to mediate the situation and increase students' autonomy in online learning (Sung et al., 2015). To ensure this intention was achieved, the learning autonomy questionnaire was administered, and the results are described in Table 6.

Table 6
Students' Autonomy Characteristics in ES Learning Using TMSL

Subscale	Mean	Standard Deviation	Category
Planning	470	0.78	High
Monitoring	485	0.56	Very High
Evaluating	421	0.80	High

Table 6 (with the details in Appendix B) showed that the EFL students, participants of this research, were in a high level of autonomy with a total score of 459.2. Reviewing the domains of EFL learner autonomy proposed by scholars (Benson, 2011; Dang, 2012) mentioning that autonomous learners should be able to manage the learning preparation (time, place, and needs), maintain the learning through proper monitoring, and evaluate their learning, this research revealed that the participants could be categorized as a high level of autonomous learners. They depicted the three domains of autonomous learners' experiences: planning, monitoring, and evaluating. Then, the monitoring domains became the most contributive characteristic of the participants' learning autonomy, and the evaluation domains became the least.

According to the learning autonomy questionnaire, the participants were confident using all TMSL software features. They could use them effectively to improve their ES material comprehension, especially to learn ES nodes. They could also adjust the provided ES materials in the TMSL menu with their learning priorities. As a result of this learning pedagogy, they could operate TMSL to improve their ES 'Tree Diagram' analysis and did the ES analysis practices in TMSL software. This fact explained that the participants' engagement in managing their learning had increased (Schindler et al., 2017; Muslimin et al., 2022).

The second highest learning autonomy score domain, EFL students' ability to plan

for learning, was characterized mainly by knowing their learning needs and ability to develop in-person management learning by deciding the most convenient time and place to learn (Sung et al., 2015). The students matched the ES course learning objectives provided in the course outline and their ES teacher's explanation of TMSL implementation for learning targets with their ES comprehension and analysis skills to notify themselves of their genuine ES learning needs. As preparation, the EFL students are also committed to motivating themselves to learn to achieve better learning outcomes, manage their learning emotions, and keep their learning discipline. However, Table 6 showed that many still said that learning ES in the online model was challenging to maintain their self-discipline when the ES teachers' control did not appear at all for the time being.

The last and the least scored learning autonomy domain was evaluation. The low score was attributed to many EFL students being unsure of their ability to evaluate their ES online learning strengths and weaknesses. Also, they needed to figure out their ES online learning progress since the TMSL software did not provide any learning reports or task accomplishment records. This result was in line with Octaberlina and Muslimin's (2021) study that EFL students could manage their planning and monitoring during online TOEFL learning but could not evaluate their learning progress. However, this domain remained in the 'High' category for some reasons. The EFL students could evaluate which TMSL software (STD or LTS) should be applied earlier following their learning needs, find themselves independent of accomplishing ES analysis practice, and do self-evaluation or predict their ES analysis ability. Therefore, this research showed successful technology integration in education due to the achievement of the 'high' level category of learning autonomy domains investigation, supported by Ginting et al.'s (2021) study.

4.3. EFL Students' Learning Achievement After TMSL Treatment

Technology integration in online learning was to mediate learning difficulties and elevate learning achievement (Kiu et al., 2021; Taj et al., 2017). Following the implementation of TMSL in the ES course, the increasing scores were shown by EFL students (see Table 7).

Table 7
EFL Students' Learning Achievement After TMSL Treatment

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	121	2.00	10.00	6.31	2.23619
Posttest	121	4.00	10.00	8.09	1.52428
Valid N (listwise)	121				

The participants' Diagram analysis Pre-test mean was 6.31, and their Post-test mean score was 8.09. There were 1.78 points of increasing test scores. This increasing mean scores indicated the effect of TMSL implementation on the 121 EFL students' learning achievement. Then, the Wilcoxon test using SPSS version 24 was conducted to see a significant difference, and the results were shown in Tables 8 and 9.

Table 8
Wilcoxon Ranks Test Using SPSS Version 24

		N	Mean Rank	Sum of Ranks
PostTest–PreTest	Negative Ranks	2[a]	25.50	51.00
	Positive Ranks	76[b]	39.87	3030.00
	Ties	43[c]		
	Total	121		

Table 8 describes the plots of scores from the Pre-test to the Post-test. Two EFL students experienced negative ranks, meaning their scores declined, (seventy-six) participants had positive ranks (inclining test scores), and forty-three participants had similar scores on both tests. The declining participants' scores could be caused by unreadiness, unhealthy conditions, or other factors that distracted their best performance (Kapfer, 1978). Consequently, it triggered the potential for future research to consider qualitative data to discuss a similar issue.

Table 9
Wilcoxon Statistic Test Results Using SPSS Version 24

	PostTest– PreTest
Z	-7.694[b]
Asymp. Sig. (2-tailed)	.000

Table 9 supported the results portrayed in Table 7 that the implementation of TMSL significantly affected the EFL students' ES online learning achievement. The significance score obtained from the Wilcoxon test was 0.000, which was lower than 0.05, meaning there was a significant difference between Pre-test and Post-test scores. Therefore, TMSL implementation provided theoretical implications as it positively affected ES online learning for elevating EFL learning achievement.

Discussing technology acceptance, learning autonomy, and learning achievement among EFL students, these research results align with several previous studies, while also contributing new insights. The findings demonstrated that integrating technology into EFL instruction enhances learning achievement, as evidenced by improved performance in syntax analysis tasks. This supports prior research that highlights the positive effects of technology on student outcomes. For example, Al-Obaydi et al. (2023), Cahyono et al. (2022), Kiu et al. (2021), and Taj et al. (2017) found that technology-enhanced learning environments can foster higher engagement and better academic performance among language learners. The use of Technology-Mediated Syntax Learning (TMSL) in this study not only increased comprehension of complex syntactic structures but also improved students' ability to analyze and apply these concepts, showing how technology can support skill acquisition in challenging areas.

In terms of technology acceptance, the study's findings echoed Vladova's (2021) conclusion that a positive perception of technology fosters greater engagement and success. Students in this study displayed high levels of acceptance of TMSL, particularly in terms of ease of use and perceived usefulness, which contributed to their willingness to engage with the learning materials. This corresponds to the Technology Acceptance Model (TAM), which posits that students' perceptions of usefulness and ease of use are key predictors of their acceptance of educational technologies (Weng et al., 2018). Moreover, the study reinforces Hsieh et al.'s (2017) claim that aligning technology with pedagogical goals and student needs promotes greater learning outcomes.

Regarding learner autonomy, the results are consistent with findings from Nguyen and Terry (2017), Benson (2011), and Darmawansah and Indartono (2019), which suggest that technology can enhance self-regulated learning by providing students

with the tools to plan, monitor, and evaluate their learning progress. In this study, students exhibited a high degree of autonomy, particularly in terms of their ability to monitor their learning, as they used TMSL to track their progress and adapt their strategies for success. This aligns with the findings of Ginting et al. (2021), who observed that autonomous learners perform better in language learning environments. However, it was noted that students were less confident in evaluating their overall progress, indicating that further support in developing self-assessment skills might be necessary.

Nevertheless, while these findings are promising, they raise questions for further exploration. First, the quantitative data collected in this study offer valuable insights, but the inclusion of qualitative data could deepen our understanding of students' experiences and the underlying factors that drive technology acceptance and learning autonomy. Interviews or focus groups could reveal more about how students navigate technology-enhanced learning environments and what specific features contribute to their autonomy and achievement. Moreover, given the limitations of the pre-experimental design, future studies should consider employing more robust experimental methods, such as randomized controlled trials, to validate these findings and address potential biases.

Second, the rapidly evolving landscape of educational technology presents opportunities for further research. While this study focused on TMSL, there are numerous emerging technologies for teaching syntax that remain underexplored, as highlighted by Muslimin et al. (2024). Investigating the effectiveness of newer tools or comparing them with TMSL would provide a richer understanding of how technology can be leveraged to improve syntax learning in EFL contexts. Such comparative studies could also identify best practices for integrating technology into language instruction, helping to guide future pedagogical strategies.

Finally, the study's limited sample size and specific context restrict the generalizability of the findings. Future research should involve larger, more diverse populations to provide a more comprehensive understanding of how technology acceptance and learner autonomy influence learning outcomes across different settings. By expanding the scope of research, we can gain insights into how these

variables interact in various educational environments and potentially develop more universally applicable teaching methods. Despite these limitations, this study contributes both theoretical and practical implications by demonstrating the value of technology in enhancing learner autonomy and achievement in the EFL classroom.

5. Conclusions and Limitations

The present research aimed to scrutinize EFL students' technology acceptance using the Technology Acceptance Model (TAM) framework in the context of Technology-Mediated Syntax Learning (TMSL) and to unveil its impact on EFL students' learning autonomy and English Syntax (ES) learning achievement. The results indicated that participants accepted TMSL as an effective medium for their ES learning, reflecting a positive attitude attributed to the progressive implementation of TMSL throughout the course. Consequently, EFL students reported achieving a 'High' level of learning autonomy, and their ES learning achievement showed a statistically significant increase.

These findings carry important pedagogical implications. First, the successful integration of TMSL suggests that EFL educators should prioritize the adoption of technology that aligns with students' learning needs and preferences. By selecting user-friendly and accessible tools, teachers can enhance students' engagement and motivation, ultimately leading to improved learning outcomes. Additionally, the positive correlation between technology acceptance and learning autonomy highlights the necessity for educators to foster an environment that encourages self-directed learning. This can be achieved by providing students with opportunities to explore technology independently, thereby enhancing their confidence and competence in using digital resources for language learning.

Moreover, the research underscores the importance of continuous professional development for EFL teachers in effectively integrating technology into their pedagogical practices. Training programs should focus on equipping teachers with the skills to utilize TMSL and other innovative tools, ensuring they can guide students in navigating these resources effectively. Furthermore, the study's findings suggest that future research should explore the diverse factors influencing technology

acceptance and learning autonomy, as indicated by the varying results in previous studies (Dang, 2012; Khotimah et al., 2019; Octaberlina & Muslimin, 2021; Wang & Yu, 2022).

Given the limitations of relying solely on quantitative data, it is advisable for future studies to incorporate qualitative methods or a mixed-methods approach to gain deeper insights into students' experiences and perceptions. Expanding the participant pool across different educational contexts will also enhance the generalizability of the findings. Ultimately, this research contributes valuable theoretical and practical implications for the integration of technology in EFL education, paving the way for future studies to build upon these insights and further enrich the field.

Authorship

All authors were involved in the concept, design, collection of data, interpretation, writing, and critical revising of the article.
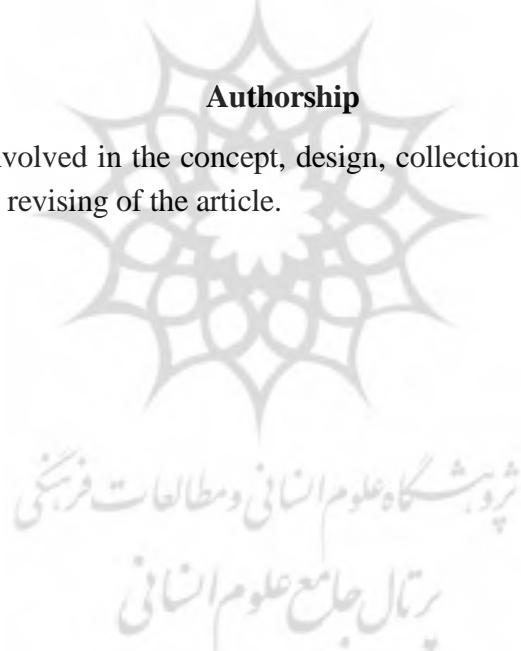
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About the Authors

Afif Ikhwanul Muslimin is an Associate Professor at the English Language Education Department at Universitas Islam Negeri Mataram, Mataram, Indonesia. He is active as a board member of ELITE and TEFLIN (the Indonesian English Educators Association), a certified school assessor, journal editor, reviewer, and contributor to numerous academic initiatives. He has written extensively in the fields of language teaching, linguistics, and English education, and has authored several academic books. His research interests include technology-enhanced language teaching and learning, digital literacy in education, linguistics, and English language education.

Fitrana Harintama is an Assistant Professor in the English Language Education Department at Universitas Islam Negeri Mataram, Mataram, Indonesia. She has published several books on English for Specific Purposes and has conducted research aligned with her academic interests. Her research areas include English testing, linguistics, and English for young learners.

Appendix A
Students' Technology Acceptance of TMSL Implementation in ES Learning

Description of Technology Acceptance		SA		A		N		D		SD		Item Total Score	Category
Perceived Usefulness		n	Score	n	Score	n	Score	n	Score	n	Score		
1	Applying TMSL can increase my ES learning pedagogy and meet my personal needs	45	225	56	224	17	51	3	6	0	0	506	Very High
2	Using TMSL material in the ES course enhances my learning achievement	12	60	67	268	25	75	17	34	0	0	437	High
3	I find the TMSL material and practices are helpful in my online ES course	36	180	70	280	8	24	5	10	2	2	496	Very High
4	Operating TMSL helps me easier to comprehend the nodes of English Syntax	27	135	45	180	37	111	12	24	0	0	450	High
5	Operating TMSL helps me easier to practice the 'Tree Diagram' analysis in English Syntax	31	155	20	80	49	147	21	42	0	0	424	High
						Mean						462	High
Perceived Ease of Use													
6	It is easy to become skillful at using TMSL	56	280	45	180	8	24	12	24	0	0	508	Very High
7	I find it easy to apply the TMSL for ES comprehension and 'Tree Diagram' analysis	47	235	28	112	28	84	10	20	8	8	459	High
8	Using TMSL materials is easy and understandable.	40	200	37	148	39	117	5	10	0	0	475	High
9	TMSL provides me with flexible time and place to learn ES	49	245	45	180	9	27	13	26	5	5	483	High
10	I can access TMSL from any gadgets	78	390	40	160	0	0	3	6	0	0	556	Very High
						Mean						496	Very High

Description of Technology Acceptance	SA		A		N		D		SD		Item Total Score	Category
Perceived Usefulness	n	Score	n	Score	n	Score	n	Score	n	Score		
11 Attitude toward Using Using TMSL for ES online learning is good	23	115	49	196	39	117	9	18	1	1	447	High
12 My experience in applying TMSL in class is favorable	29	145	60	240	20	60	12	24	0	0	469	High
13 It is a positive influence for me to use TMSL in the ES course	37	185	50	200	32	96	2	4	0	0	485	Very High
14 I think it is valuable to implement TMSL in the ES course	20	100	79	316	12	36	10	20	0	0	472	High
15 I think TMSL is a good example of integrating technology for mediating obstacles in EFL learning	18	90	46	184	48	144	7	14	2	2	434	High
Mean											461	High
TOTAL											473.4	High

Appendix B

Students' Autonomy Characteristics in ES Learning Using TMSL

Description of Learning Autonomy	SA		A		N		D		SD		Item Total Score	Category
Planning	n	Score	n	Score	n	Score	n	Score	n	Score	Score	
1 I can motivate myself to be an autonomous learner to learn Diagram using TMSL	29	145	65	260	5	15	16	32	6	6	458	High
2 I can control my emotions to learn 'Tree Diagram' using TMSL	8	40	34	136	54	162	23	46	2	2	386	High
3 I can keep being disciplined to learn Diagram using TMSL	9	45	59	236	19	57	20	40	14	14	392	High
4 I know what I need to learn in TMSL	78	390	32	128	9	27	2	4	0	0	549	Very High
5 I can decide the best place and time to learn Diagram using TMSL	89	445	28	112	4	12	0	0	0	0	569	Very High
Mean											470	High
Monitoring												
6 I know how to use menus in TMSL	26	130	80	320	8	24	7	14	0	0	488	Very High
7 I can operate TMSL to	37	185	60	240	21	63	3	6	0	0	494	Very High

	Description of Learning Autonomy	SA		A		N		D		SD		Item Total Score	Category
	Planning	n	Score	n	Score	n	Score	n	Score	n	Score		
	improve my ES comprehension												
8	I can operate TMSL to improve my ES 'Tree Diagram' analysis	18	90	78	312	21	63	4	8	0	0	473	High
9	I can select which materials in TMSL I should comprehend earlier	56	280	63	252	2	6	0	0	0	0	538	Very High
10	I can solve the ES analysis problems in the TMSL practice menu	12	60	62	248	30	90	17	34	0	0	432	High
				Mean								485	Very High
	Evaluating												
11	I can complete the analysis practice in TMSL autonomously	35	175	56	224	6	18	17	34	7	7	458	High
12	I can monitor my ES analysis ability through practices in TMSL	7	35	67	268	34	102	13	26	0	0	431	High
13	I know which TMSL software (STD or LTS) I should apply to learn ES earlier based on my ES comprehension self-assessment	45	225	65	260	6	18	5	10	0	0	513	Very High
14	I can evaluate the strengths and weaknesses of my ES learning in the online model	16	80	15	60	48	144	29	58	13	13	355	Moderate
15	I can assess my ES learning improvement based on my TMSL learning experience	7	35	9	36	80	240	16	32	9	9	352	Moderate
				Mean								421	High
				TOTAL								459.2	High