Predicting Teaching Effectiveness Based on Technology Integrated Language Learning

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Abstract

This research aimed to examine the correlation between English teachers' acceptance of Instant Response Systems (IRSs) and their perceived teaching effectiveness. Employing a mixed-methods approach, 151 EFL (English as a Foreign Language) teachers participated in the study. An online survey was employed to collect data regarding teachers' acceptance of IRSs and their perceived effectiveness in teaching. Semi-structured interviews were conducted with 10 teachers to acquire nuanced insights into their perspectives on the effectiveness of integrating IRS tools into pedagogy. Findings revealed that predictors of teaching effectiveness included constructivist pedagogical beliefs, attitudes toward IRS implementation, perceived utility of IRSs, and facilitating conditions. The deployment of IRS-based tools demonstrated a positive impact on student motivation, engagement, and achievement. IRS-based tools were found to energize the class and provide information and feedback in a timely manner which enhanced the capacity of teachers to evaluate students' learning progress.

Keywords: Teaching effectiveness, Information communication technology integration, Instant Response Systems

1 Introduction

The adoption of Information Communication Technologies (ICTs) by educators has been a widely discussed topic. Over the past decades, numerous studies have utilized models such as the Technology Acceptance Model (TAM) [1-2] and the Unified Theory of Technology Acceptance and Use of Technology (UTAUT) [3] to investigate teachers' intentions of using technology in teaching. Recent studies in this field have identified external factors (e.g., provision of technical support from an organization) and internal factors (e.g., an individual's perception of other people's attitudes or interest toward technology) [4] that influence the acceptance of technology use [5].

Among the identified factors, teacher-related elements were found to play a critical role in the successful integration and effective use of technology in teaching. Teachers who perceive learning as the construction of teacher-student interaction and collaboration tend to hold a positive attitude toward the use of ICTs [6]. Technologies not only provide teachers with new teaching ideas and techniques but also enhance the effectiveness of language teaching. Numerous studies have presented empirical evidence of the positive influence of technology integration on learning and teaching. It increases learners' motivation and engagement while facilitating the development of language skills [7-8].

Digital tools, such as Instant Response Systems (IRSs), are commonly used to facilitate students' learning and enhance effective classroom practices [9-10]. IRS tools help teachers identify knowledge gaps during the teaching process, enabling them to take appropriate pedagogical steps to meet teaching goals.

In contrast to previous TAM and UTAUT studies, which aimed to identify the contribution of internal and external factors to teachers' intentions to use technology, the present research includes pedagogical beliefs. It examines constructivist pedagogical beliefs alongside other technology acceptance factors and their influence on EFL teachers' perceived teaching effectiveness and teaching practices. Specifically, the study investigates the relationships between teachers' acceptance of Instant Response Systems (IRSs) and teaching effectiveness. Additionally, teachers' perceptions and attitudes about using IRS in language teaching were explored.

2 Related Work

2.1 Teaching Effectiveness

Evidence has revealed that teaching practices significantly influence students' learning motivation and outcomes [11-12]. Effective teaching increases the likelihood of achieving the desired goals. The term "effective teaching" is used interchangeably with "teaching effectiveness" [13-14], and scholars have interpreted them differently.

According to Olatoye [15], teaching effectiveness involves activities that promote and enhance students' learning after a period of instruction aligned with the learning goals. To foster development, teachers need a clear idea of the instructional practices they intend to employ and must

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design a structure to support it. Teaching effectiveness or effective teaching relies on four components: objectives, students, content, and teachers [16]. It requires teachers to possess deep professional and pedagogical knowledge of their field and an understanding of their students' learning needs and capabilities.

Calaguas [17] conducted a literature review on teaching effectiveness between 2000 and 2009, concluding that teaching effectiveness manifests in six dimensions: personality, subject matter expertise, relational competence with students, professional competence, teaching style, and classroom management style. The results underscore the complexity of teaching effectiveness, involving multiple dimensions. Given the diversity of teaching styles among educators, research suggests that self-evaluation provides insightful information on how teachers perceive their teaching. It allows them to assess their strengths and weaknesses and discover ways to become more effective [18].

2.2 Effects of Using IRSs on Language Teaching

Instant Response Systems (IRSs), also known as Student Response Systems (SRSs) or Classroom Response Systems (CRSs), are recognized tools for formative assessment in English learning [19]. *Kahoot!* is a widely used IRS, offering various question types and fostering real-time student engagement, comprehension, and collaboration [20-21]. Similar benefits were observed with *Socrative* and *Quizizz*, enhancing learning outcomes through active participation and immediate feedback [19, 22].

Incorporating IRS-based activities into instruction is beneficial, aiding teachers in achieving pedagogical goals such as previewing, reviewing, and activating latent knowledge [23]. The present study examines the relationship between English teachers' IRS acceptance and perceived teaching effectiveness, considering multiple factors influencing technology adoption in the literature. The widespread positive impact of IRS on language teaching and learning suggests that integrating educational technologies can enhance both teaching and learning performance.

2.3 Factors Affecting Teachers' Intentions to Adopt Technology

Research on teachers' technology adoption intentions has been a prominent topic in education. Utilizing TAM and UTAUT frameworks, factors like perceived usefulness (PU), perceived ease of use (PEU), computer self-efficacy (CSE), constructivist pedagogical beliefs (CPB), social factors (SF), facilitating conditions (FC), and attitude toward using (ATU) have been studied [4-6, 24-25]. The underlying assumptions of the two models are that the actual use of information technology by individuals is reflected in their intentions to use the technology, and their reactions to the use of technology affect their intentions [3] (see Figure 1).

Core variables in TAM are PU, PEU, and ATU, while UTAUT includes performance expectancy, effort expectancy, SF, and FC (see Figure 2 and Figure 3). Notably, there are conceptual similarities among key variables. For example, PEU is similar to effort expectancy, and PU is similar to performance expectancy. Prior studies concluded that PU and PEU were contributed by CSE [24], impacting technology adoption for both teachers and students. CPB also affects PU and PEU, emphasizing its role in integrating technology into instructional activities [6].

ATU reflects feelings toward technology use, influenced by PU and PEU. SF involves pressure from school leaders, colleagues, and students, positively impacting PU. FC considers users' beliefs about organizational and technical support, directly affecting technology adoption intentions [25].

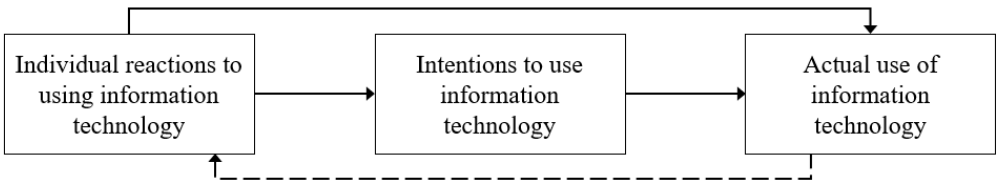

Figure 1. Basic concepts underlying user acceptance model [3]

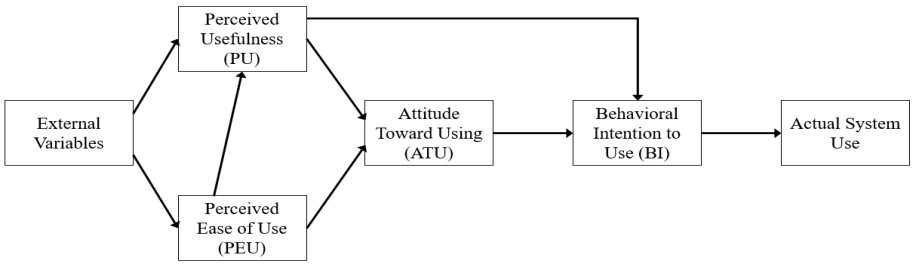

Figure 2. Technology acceptance model [2]

Learning is best accomplished in an active and engaging environment [26]. With the assistance of IRS technology, teachers are able to maximize learning outcomes of students and meanwhile increase their learning satisfaction, which in turn creates within teachers' positive perceptions of their teaching. Seven key variables (FC, SF, CSE, CPB, PU, PEU, ATU) were identified and applied in this research to examine their relationship with perceived teaching effectiveness in a sample of EFL teachers. Teachers' perceptions of how they view the effectiveness of using IRS tools in teaching were also explored.

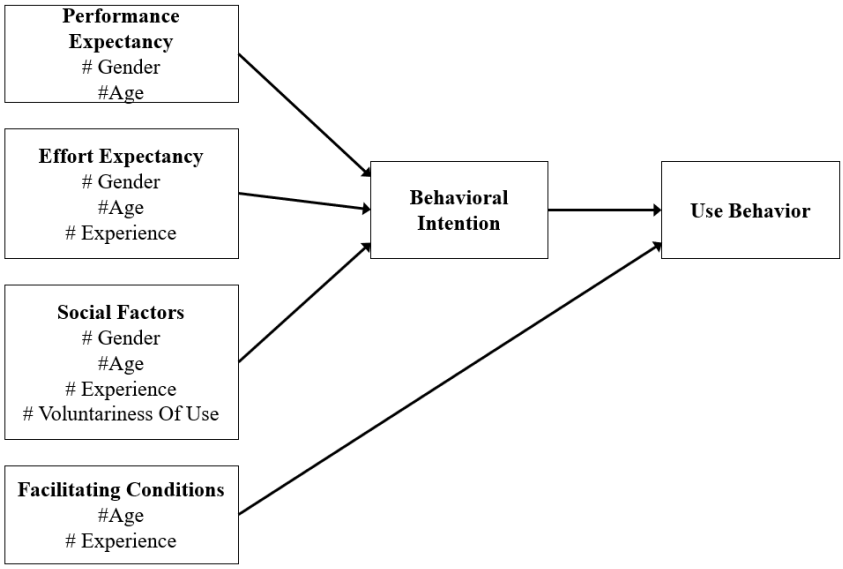

Figure 3. The unified theory of technology acceptance and use of technology [5]

3 Methodology

A mixed-method research design, integrating both quantitative and qualitative data, is deemed suitable for this study as it allows for a comprehensive exploration of research questions [27]. Employing a web-based survey facilitated effective data collection and permitted generalization of results from the sample to the target population. Complementarily, semi-structured interviews were conducted to delve deeper into teachers' attitudes and thoughts regarding the use of IRS, providing rich qualitative insights into how teachers integrate these tools into their teaching practices and their perceptions of effectiveness and usefulness.

The research questions guiding the study are as follows:

1. What is the relationship between IRS acceptance factors and the perceived teaching effectiveness of EFL teachers?
2. What factors influence the perceived teaching effectiveness of EFL teachers?
3. How do EFL teachers perceive the effectiveness of using IRS tools in their teaching?

3.1 Participants

Quantitative data were collected from 151 EFL teachers in Taiwan. They come from different educational settings and they all have used IRS in their own teaching context. The educational settings include elementary school junior high schools, senior high school, universities, and language schools.

3.2 Data Collection

The study employed a self-report questionnaire divided into three sections. The first section gathered demographic information, including gender, age, education level taught, years of teaching experience, and experience with IRS assessment tools. The second section focused on factors related to IRS acceptance, comprising seven domains with a total of 35 items. Items were adapted from validated sources, such as [1-3, 4, 6, 28-29], and [30]. The third section addressed perceived teaching effectiveness, utilizing a modified teaching effectiveness scale developed by Calaguas [17]. The modified scale included four aspects (teacher-related behaviors, subject matter expertise, relational expertise, and personality) and 27 items. All items were measured on a 4-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree), and were adapted to suit the context of the current research. The internal consistency of the survey items was calculated through correlations with Cronbach's αcoefficient. Corrected item-total correlation for each item was examined and they were above 0.7; only one item was below 0.3. The item was removed for further data analysis.

A semi-structured interview with eight questions was used to investigate the attitudes, thoughts, and perceptions of 10 EFL teachers (identified as Teacher A through Teacher J) who had experience using IRS in teaching. The interview, based on TAM factors (PU, PEU, and ATU), was conducted individually, either face-to-face or online via Microsoft Teams, each lasting about 30 minutes. All interviews were recorded and transcribed for analysis.

3.3 Data Analysis

Pearson correlation assessed associations between quantitative variables, revealing their strength and direction. Stepwise regression determined the statistical significance of predictive relationships. For qualitative data, open and axial coding, following Creswell [27] and Strauss and Corbin [31], identified recurring concepts and meaningful statements in three parts: perceived usefulness of IRS, perceived ease of IRS use, and attitude toward IRS use. Codes were organized into categories based on connections between them.

4 Results

4.1 Quantitative Data

As presented in Figure 4, a notable positive correlation, ranging from moderate to strong, was observed among most independent variables. Regarding the dependent variable, teaching effectiveness exhibited significant correlations with all independent variables except for perceived usefulness (PU), where the correlation was 0.082. The most robust correlation was identified between attitude toward using (ATU) and perceived ease of use (PEU) at 0.760 ($p<0.01$), followed closely by ATU and PU at 0.726 ($p<0.01$), and PEU and computer self-efficacy (CSE) at 0.701 ($p<0.01$).

However, no significant relationships were detected between constructivist pedagogical beliefs (CPB) and social factors (SF), CPB and PU, CPB and PEU, CPB and ATU, as well as PU and teaching effectiveness (TE). CPB showed significant correlations only with facilitating conditions (FC) at ($r=0.162$, $p<0.05$), CSE ($r=0.188$, $p<0.05$), and TE ($r=0.522$, $p<0.01$).

Following Pearson correlation analyses, stepwise regression was employed to determine predictor variables. Table 1 displays the results, revealing that constructivist pedagogical beliefs (CPB), attitude toward using (ATU), perceived usefulness (PU) and facilitating conditions (FC) entered the final regression equation for teaching effectiveness. In the first step, CPB was entered into the equation and 0.522 of teaching effectiveness was predicted by this variable. In the second step, both CPB and ATU were entered into the model and their contribution was calculated to be 0.498 and 0.180 respectively. In the third step, CPB, ATU, PU, and FC -- the predictor variables -- were entered into the regression model and their contribution to explaining teaching effectiveness was calculated to be 0.481, 0.299, -0.238, and 0.151 respectively.

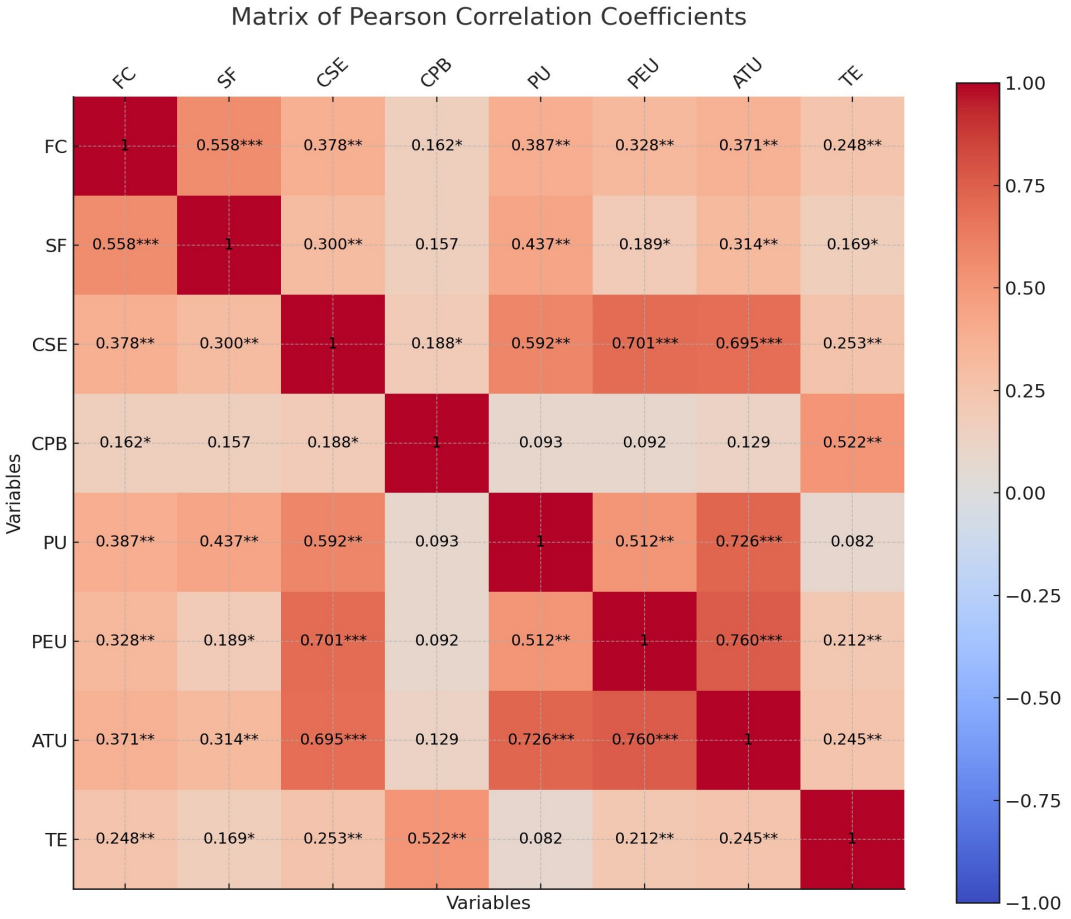

Figure 4. Pearson correlation coefficients for the study variables

Note. *Correlation is significant at 0.05 level (2-tailed). **Correlation is significant at 0.01 level (2-tailed).TE=teaching effectiveness, FC=facilitating conditions, SF=social factors, CSE=computer self-efficacy, CPB=constructivist pedagogical beliefs, PU=perceived usefulness of IRS, PEU=perceived ease of IRS use, ATU=attitude towards IRS use

Table 1. Stepwise regression analysis concerning the prediction of teaching effectiveness

Step	Variable	Coefficient	*SE*	*p*	*t*	R^2	VIF
Step 1						0.272	
	CPB	0.522**	0.60	0.000	7.464	0.272	1.000
Step 2						0.304	
	CPB	0.498**	0.60	0.000	7.206	0.272	1.017
	ATU	0.180*	0.036	0.010	2.605	0.032	10.17
Step 3						0.323	
	CPB	0.498**	0.059	0.000	7.279	0.272	10.17
	ATU	0.326*	0.051	0.001	3.287	0.032	2.133
	PU	-0.200*	0.044	0.044	-2.031	0.019	2.116
Step 4						0.342	
	CPB	0.481**	0.059	0.000	7.039	0.272	1.034
	ATU	0.299*	0.051	0.003	3.025	0.032	2.171
	PU	-0.238*	0.045	0.018	-2.397	0.019	2.191
	FC	0.151*	0.036	0.043	2.041	0.019	1.220

Note. **p<0.001, *p<0.05

Figure 5 demonstrates the t-values corresponding to each coefficient, providing insight into their statistical significance. The high t-value for CPB underscores its strong and significant prediction power. ATU's t-value indicates a reliable positive contribution, while PU's negative impact is also statistically significant, as evidenced by its t-value. FC's t-value, while positive, is lower than the others, which may suggest a weaker statistical significance relative to other variables.

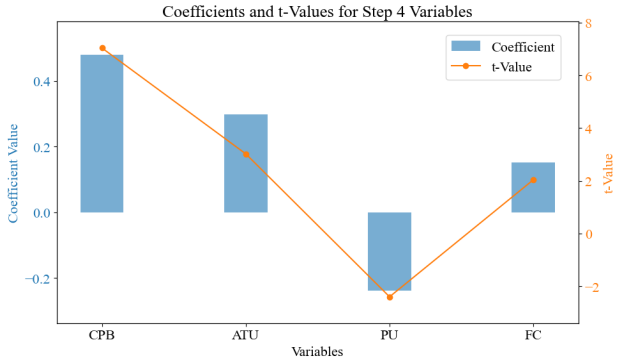

Figure 5. Coefficients and t-values for predictor variables

Scatter plots and a Quantile-Quantile plot are employed to assess the fit of the stepwise regression model. The scatter plot of residuals versus predicted values does not show any systematic pattern, which suggests that the variance of residuals is constant across all levels of predicted values, meeting the assumption of homoscedasticity (see Figure 6). The QQ plot of residuals is used to visually inspect the normality assumption of the residuals. The points in the QQ plot closely follow the reference line, with only slight deviations at the tails, indicating that the residuals approximate a normal distribution, thus satisfying another crucial assumption of the regression model (see Figure 7). The scatter plot of actual versus predicted values shows points dispersed around and along the identity line, which is the line where actual values equal predicted values. While there is some scatter, the points do not deviate significantly from the line, indicating that the model has a satisfactory level of predictive accuracy (see Figure 8).

In contrast, the scatter plots of actual versus predicted values from the Random Forest and XGBoost regression models show a greater deviation from the identity line (see Figure 9 and Figure 10 respectively). This suggests that these models do not perform as well as the stepwise regression model in this particular context. The dispersion of points in these scatter plots is more pronounced and less tightly clustered around the identity line, implying that the stepwise regression model provides a more precise fit for predicting teaching effectiveness.

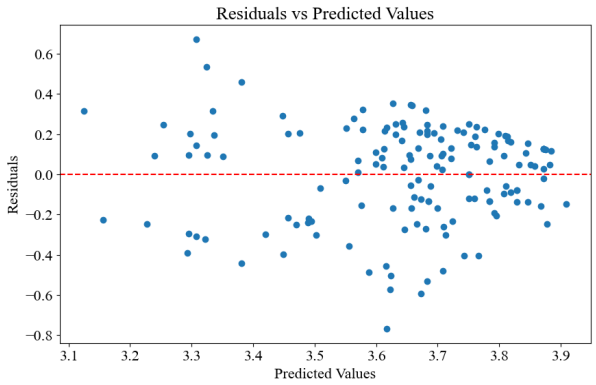

Figure 6. Residual distribution across predicted values

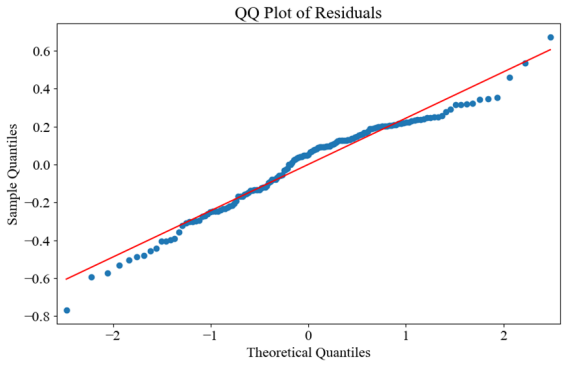

Figure 7. Normality assessment of regression residuals

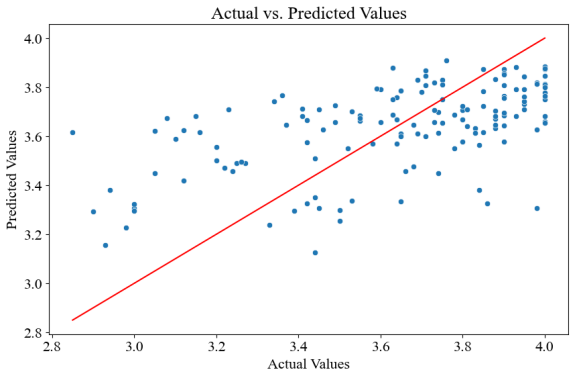

Figure 8. Teaching effectiveness predictions assessed by stepwise regression

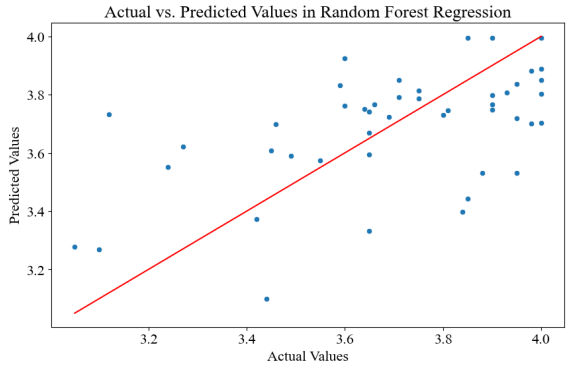

Figure 9. Teaching effectiveness predictions assessed by Random Forest regression

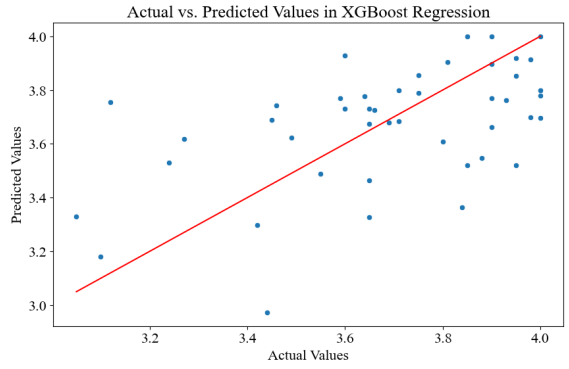

Figure 10. Teaching effectiveness predictions assessed by XGBoost Regression

In combination, these plots demonstrate that the stepwise regression model has a robust fit to the data, with CPB, ATU, PU, and FC contributing significantly to the prediction of teaching effectiveness. Despite the negative coefficient for PU, this may reflect the nuanced relationship between perceived usefulness and the effectiveness of specific instructional tools within varied educational contexts. Overall, the model explains a substantive proportion of the variance in teaching effectiveness, and the diagnostic plots confirm that the key assumptions underlying the stepwise regression analysis are reasonably met. Together, CPB, ATU, PU, and FC collectively contributed to approximately 34.2% of the variance in teaching effectiveness, with CPB making the most significant contribution, followed by ATU, PU, and FC, as illustrated in Figure 11.

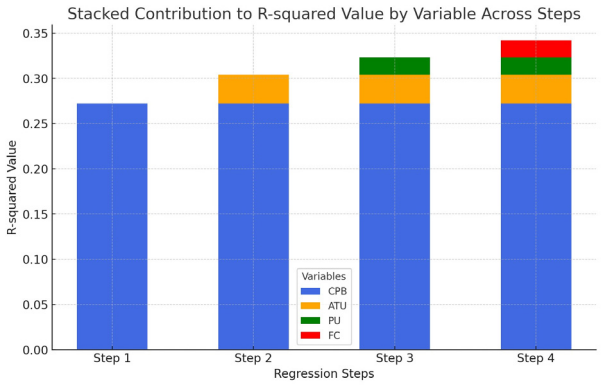

Figure 11. Contributions of CPB, ATU, PU, and FC to teaching effectiveness

4.2 Qualitative Data

Interview data analysis revealed three aspects: perceived usefulness of IRS, perceived ease of IRS use, and attitude toward IRS use. Regarding the perceived usefulness of IRS in English teaching, teachers identified IRS tools as motivators, facilitators of learner engagement, and indicators of learner achievement. The tools increased motivation and engagement, allowed instant checks of students' understanding, and provided attractive audio and visual effects for dynamic learning. Teachers saw IRS tools as supplementary instructional alternatives, enhancing attention span and making classes more enjoyable. The integration of technology was seen as crucial in a digital age, and students' familiarity with technology was highlighted. Teacher H reported:

"IRS tools provide additional alternatives for teachers to conduct instructional activities that supplement traditional methods. In a traditional classroom, students just listen and complete written exercises. The tools allow teachers to create a variety of question types which are presented in a colorful manner with dynamic music. The audio and visual effects extend students' attention span. They are more attentive and class is more enjoyable."

In terms of perceived ease of IRS use, positive sentiments were expressed about accessibility and user-friendly interfaces. However, concerns were raised about the functionality of online platforms, particularly for certain interactive activities. Some teachers felt that too many gamified elements might not be helpful for students with low English proficiency. Teacher F spoke on this topic:

"Online platforms such as *Kahoot!* and *Quizizz* make learning interesting, but they are not able to take the place of some interactive activities I usually do in my class like "information gap." For students with low English proficiency, they especially need more linguistic input and guidance directly from the teacher. It may not be helpful for their learning if teachers include too many gamified elements into the lessons."

The attitude toward IRS use showed a positive reception of technology adoption in teaching. Teachers acknowledged the positive impact of IRS technology, identifying knowledge

gaps and emphasizing the need for teachers to adapt to digital learning environments. Despite the positive attitude toward digital tools, teachers emphasized that technology is a facilitator, not a replacement for teaching. They stressed the importance of the teacher's role in the learning process, viewing technology as one of many instructional strategies rather than a substitute for effective teaching. Teacher B addressed the necessity of learning how to integrate technology into teaching.

"Today, we live in a global village that is connected by digital communication technologies. Teachers have to explore the applications that can help their teaching and adapt themselves to digital learning environments. The trend towards digital education leaves you with no choice."

5 Discussion

5.1 Relationships between Technology Acceptance Factors and Teaching Effectiveness

Previous literature has confirmed the factors that might predict teachers' technology adoption using TAM and UTAUT. Prior studies have also verified that incorporating educational technology into teaching facilitates students' learning and improves their performance [7-8]. However, very little has been found in the existing literature on the association between technology acceptance factors and teaching effectiveness.

The current study found that constructivist pedagogical beliefs (CPB), attitude toward IRS use (ATU), facilitating conditions (FC), and perceived usefulness of IRS (PU) correlated significantly with teaching effectiveness. CPB's ability to explain variance was found to be the most prominent predictor of teaching effectiveness, followed by ATU, FC, and PU.

The current study confirmed the association between constructivist pedagogical beliefs and teaching effectiveness. Shu [32] found that integrating multimedia into English teaching provides an ideal condition for constructivism. The combination of multimedia and constructivism-oriented learning promoted the effectiveness of English teaching as well as students' learning ability. The results are in agreement with Tadesse et al.'s [12] findings, which showed that student-focused learning led to higher perceptions of teaching effectiveness and learning satisfaction. Thus, teachers who view teaching as "student-centered", "problem-solving", and "collaborative-inquiry learning" possess a higher degree of teaching effectiveness.

ATU, the second prominent predictor of teaching effectiveness, was associated positively and significantly with teaching effectiveness. A strong relationship between ATU and teachers' intentions to use technology has been reported in the literature [6, 30, 33]. When teachers possess positive feelings toward the technology they use, they have a strong positive inclination to use the technology in their teaching. This positive inclination towards technology use, in turn, influences the effectiveness of teaching as indicated in the present research. It can be inferred that positive feelings toward IRS in teaching reinforce EFL teachers' perceived teaching effectiveness.

In addition to CPB and ATU, the study showed that PU was a significant indicator of teaching effectiveness. It suggested that the usefulness of technology is an important factor for effective teaching. However, this factor showed a negative correlation with teaching effectiveness, which is contrary to expectations. It suggests that while many teachers find IRS tools to be useful in a general sense, the effectiveness of any educational tools depends on how it is applied in a specific teaching context. In other words, the usefulness of IRS tools may vary depending on factors such as the subject being taught, the level of students, the teaching method used, and the specific learning objectives of the lesson. Teachers need to consider these contextual factors when deciding which instructional tools to use in their classrooms.

With respect to the last predictor of TE, FC was the only external factor that had a significant relationship with TE. FC includes technical support and advice from schools and colleagues as well as the availability of and accessibility to equipment. Research has shown that FC was considered an important determinant for teachers' intentions to use technology [28, 30, 34]. The present study further suggests the importance of FC being recognized. Providing technical assistance is an important precondition not only for technology use but also for effective teaching. Teachers who can receive technical support and advice from schools or colleagues when they have difficulties using IRS tend to perceive their teaching to be more effective.

This present study was unable to demonstrate the relationship between the other three study variables (social factors, computer self-efficacy, and perceived ease of IRS use) and TE. This result implies that EFL teachers perceived social influences, their ability to use IRS, and the ease of use of IRS as not helping them teach effectively.

5.2 Teachers' Perceptions of Using IRS in English Teaching

The interview investigated EFL teachers' acceptance of IRS-based tools and understood the influence of using those tools on their teaching. Generally, most teachers showed a very positive attitude toward IRS technology assistance in English teaching.

In line with previous findings in IRS studies [23, 35], this study reinforces the importance of adopting IRS-based tools in teaching. This study also supports the notion of Reynolds and Taylor [23]. It indicates that IRS-based tools have a strong impact on students' motivation and engagement. The audio-visual effects, instant feedback, and gamification elements increase students' engagement with materials cognitively, behaviorally, and emotionally, thus increasing the likelihood that students will recall information as it has truly been learned.

EFL teachers encounter challenges while using IRS tools in class. Lack of technical knowledge, difficulties accessing an internet connection, and glitches in the online platform create barriers to classroom implementation. Internet infrastructure is another concern that arises when adopting technology in the classroom for EFL teachers. This result matches those observed in stepwise regression analysis, which indicated that FC was one of the contributing factors

to teaching effectiveness. Interview data show that teachers didn't hold strong beliefs about internet infrastructure. They mentioned that they don't tend to ask for assistance from the institution when technical problems occur during teaching; instead, they prefer to deal with the problems themselves. The results seem to be consistent with the qualitative study conducted by Huang et al. [34], which showed that technical support and facilitating conditions mattered to a large degree when it comes to EFL teachers' adoption of technology.

IRS tools provide a wide range of features and functions for teachers to energize and facilitate learning engagement. However, some instructional activities involving negotiation, information exchange, and communication cannot be fully replaced by digital tools.

6 Conclusion

This study investigated the impact of facilitating conditions, social factors, computer self-efficacy, constructivist pedagogical beliefs, perceived usefulness of IRS, perceived ease of IRS use, and attitude toward IRS use on teaching effectiveness among EFL teachers in Taiwan. It explored teachers' perceptions of the effectiveness of using IRS-based tools in teaching. Constructivist pedagogical beliefs, attitude toward IRS use, and facilitating conditions positively influenced teaching effectiveness, while perceived usefulness of IRS had a significant negative effect.

Moreover, the study offers empirical insights into the influence of IRS-based tools on language learning. Interview results revealed both drivers and barriers to the adoption of IRS-based tools in the EFL teaching context. Teachers reported that IRS tools energized classes and provided timely feedback on students' learning progress. However, identified barriers included technical deficiencies, Internet infrastructure issues, a lack of computer skills, and related technological knowledge gaps hindering EFL teachers from incorporating IRS-based tools into their classes.

Limitations in the study should be acknowledged. Firstly, the results only suggest associations between variables, and causal relationships cannot be confirmed. Secondly, reliance on self-reports for data collection may introduce discrepancies between teachers' reported perceptions and their actual behaviors in class. Lastly, individual factors such as age, gender, or the level of education taught were not considered. Future research incorporating these factors may contribute to a more comprehensive understanding of the relationships between IRS acceptance factors and teaching effectiveness. Additionally, a longitudinal study could provide insights into changes in teachers' perceptions of IRS integration over time.

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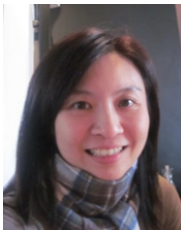

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