



Effects of an Instant Response System integrated learning activity on EFL students' learning achievement and perceptions

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1. Introduction

When shifting their focus from teaching to learning, many teachers seek strategies to increase students' active participation and involve them in the learning process. According to [Bonnell and Eison \(1991\)](#), active learning refers to 'involving students in doing things and thinking about the things they are doing' (p. 2). This broad definition has led to variations in meaning; active learning can refer to teaching methods (e.g., interactive instruction), educational applications (e.g., mobile learning or inquiry learning), learning activities (e.g., peer learning, class discussion or formative assessments) or learning experiences (e.g., positive learning perceptions) ([Hung, 2017](#)). In practice, when a more specific instructional design is tailored to support active learning, students' thinking improves during the learning process.

However, active student participation is not always easy to implement because it involves many dimensions. First, it is challenge to maintain student motivation and concentration over time when the lecture format is adopted in a large class of over 50 students. Lack of learning motivation can result in a negative learning atmosphere in the classroom and determine learning achievement ([Chang & Lin, 2019](#)). Second, the lecture classes typically support some level of student involvement. Hand raising is a common method that teachers use to increase student responsiveness ([Chern, 2010](#)). However, it only provides some students with opportunities to ask questions and involve in discussions with the instructor within limited contact hours ([Kent, 2019](#)). Sometimes participation appears unbalanced when the instructor is in favour of certain students who are most willing to speak in the classroom, which gave the limited

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opportunities for the rest of students to respond in the interactive learning process (Chern, 2010). Third, given this particular classroom culture in many Asian EFL learning contexts (e.g., Taiwan), students are hesitant to voice their ideas or ask questions, perhaps owing to the fear of making mistakes or embarrassing themselves in front of peers. They express reticence in classroom activities where instructors attempt to involve them during lectures (e.g., Shao & Gao, 2016). These are factors that determine students' active learning and engagement.

1.1. Integrating IRS into the class

The instant response system (IRS) opens a new way for instructors to overcome the challenges outlined above (e.g., Chang & Lin, 2019; Hung, 2017). IRS, known as click technology or student response systems, offers an opportunity for language instructors to create interactive activities (e.g., Chang & Lin, 2019; Hung, 2017). Many researchers have reported that IRS helps reduce student disengagement and passive participation while motivating student learning and fostering their active learning (e.g., Barr, 2017; Kent, 2019).

IRS works using transmitters, which allow users to submit responses, and receivers, which collect user-submitted data (Kent, 2019). In the classroom, IRS allows a teacher to aggregate students' responses and displays a tallied report on a projection screen (Kent, 2019). In a simple classroom format, instructors design formative assessments that pose questions to students and wait for responses. Once time has run out, the results are immediately displayed on the board for the whole class to view (Hung, 2017). This system can quickly generate a summary report of students' responses by automatically evaluating them based on pre-set stored answers.

Such aggregate data helps instructors understand student comprehension and permits them to intervene in a way that is likely to avoid confusion (Wang, 2017). The feedback in the IRS systems is anonymous, supporting students' psychological safety and acceptance of quizzes during course activities (Barr, 2017). Meanwhile, the instructor can provide immediate focused feedbacks connecting to the students' needs while using IRS to modify their teaching methods. Therefore, IRSs have been used to not only increase engagement and motivation (e.g., Hung, 2017; Wang, 2017) but also promote a positive learning environment (Chang & Lin, 2019).

Although several free IRS tools are available, such as Kahoot!, Socrative and Creatist, ZUVIO was used in the present study. ZUVIO is supported on students' personal mobile devices on both iOS and Android. It supports a Meridian interface and language that accords with local culture. This is helpful because when limited class hours exist, fast and easy-to-deploy technologies are welcome for language instructors to remain focused on course objectives and reduces distractions from technical problems (Wu et al., 2017).

ZUVIO has three components that facilitate interactive lessons: a cloud-based database and server, a mobile application and a set of web services (Fig. 1). Within the ZUVIO environment, a cloud-based server stores and maintains all data while a web-based mobile application offers learning functions, information and individual learning records. Students can easily use any personal mobile device to submit responses through ZUVIO. The app's web services play a key role in supporting instructional activities and teaching strategies, including class information (e.g., QR code access), class management (e.g., for online grouping or participation checking) and instruction (e.g., for individual and peer evaluation). Using these tools, instructors can monitor students' access to questions and their submitted responses after launching IRS question-and-answer activities. Fig. 1 visualises the process of such IRS-integrated activities.

1.2. Student perceptions

Several studies have examined students' learning perceptions in language classrooms and have reported that IRS provides students

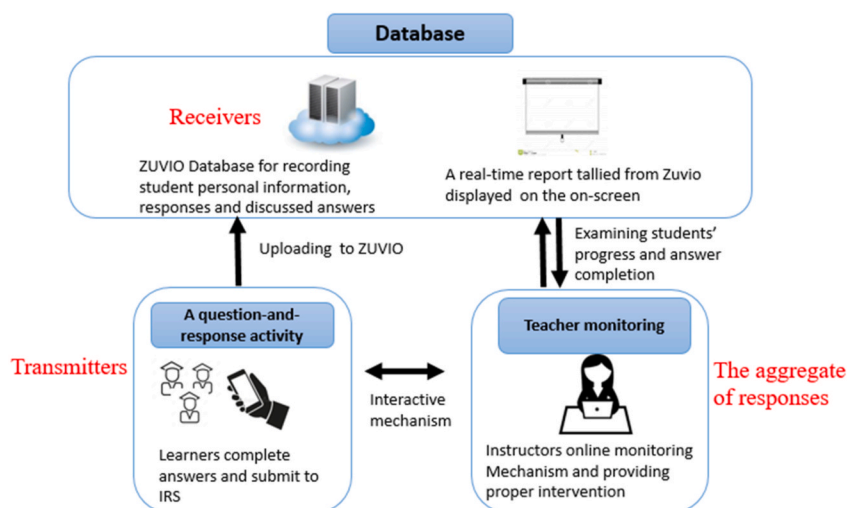


Fig. 1. The IRS-integrated learning activities.

with positive learning experiences. For example, [Chang and Lin \(2019\)](#) stated that IRS is a potential tool for enabling an optimum learning atmosphere, and thus supports students in their awareness of opportunities to communicate and increases active participation in class activities. [Wang \(2017\)](#) also reported that IRS is a way of effectively enhancing students' and teachers' interactions, which in turn improves course attendance and learning performance. In general, the participants in her study held positive perceptions of IRS-integrated course activities ([Wang, 2017](#)). [Hung's \(2017\)](#) study, which incorporated IRS into EFL reading lessons, further demonstrated students' positive perceptions of course activities, including the dimensions of interactivity with the teacher, interactivity with peers, attendance, participation, motivation, attention and overall satisfaction. In light of these findings, the current study will further investigate the dimensions of learning atmosphere, attitude, confidence and learning achievements to better examine students' perceptions.

1.3. Peer instruction

During instructional activities that employ IRS, teacher-centred interaction is often seen. The typical IRS question-and-answer structure works as follows: the teacher poses questions, assesses students' responses and then offers feedback if necessary (e.g., [Cardoso, 2011](#); [Hung, 2017](#)). The initiation-response-feedback structure works against active learning principles and devalues student-centred learning interactions in IRS applications ([Chang & Lin, 2019](#); [Hung, 2017](#)). For example, [Cardoso \(2011\)](#) explored L2 learners' perceptions of IRS in an EFL learning context using a question-and-answer mechanism. Although the findings revealed students' enhanced motivation to learn and increased class participation, the teacher-dominated nature of vocabulary acquisition exercises in his study have been criticised ([Song et al., 2017](#)). [Hung \(2017\)](#) suggested that by adopting peer instruction (PI) techniques, students have significantly more positive perceptions of their own learning.

PI, which [Hung \(2017\)](#) emphasises as important in reinforcing active learning and positive learning perceptions using IRS, is adopted in the current study. The use of PI is advocated by Mazur and his colleagues ([Watkins & Mazur, 2010](#)), as it focuses on peer interaction instead of teacher-dominated learning. PI stresses student discussions and cooperative learning using think-pair-share techniques, which first engage students to work individually, then prompt them to share thoughts with peers and then share thoughts with the rest of the class ([Watkins & Mazur, 2010](#)).

Shortly, IRS with PI could be helpful tools for EFL language instructors when conducting meaningful interactive activities, as they enable active learning among peers in a large class setting. Additionally, IRS-integrated activities using PI with formative assessments support the integration of meaning and form within interactive activities (e.g., [Hung, 2017](#)). IRS with PI remains affordable for interactive activities, as they help students enhance learning achievements and thereby foster positive perceptions toward IRS-integrated learning.

1.4. Purpose of the study

These claims require further investigation because using IRS with PI to enhance EFL classroom learning achievement and perceptions in instructional design remains underexplored. As for the learning contexts in support of interactive activities in the general EFL course for non-English major students with elementary level English proficiency, the main concern is boosting active learning for learners' optimal EFL input comprehension and language use; in other words, the course objective is to help students show an increase in learning achievement while supporting positive perceptions of language learning associated with the use of target language in classroom practice. When applied to the current contexts as stated above, the IRS-integrated activity with PI could be conducive to scaffold learning when compared to non-IRS learning with PI. It can assist students to submit their answers to be demonstrated to the class without favouring certain students' responses. IRS with PI may play a catalyst in support of reducing passive learning, thereby fosters a positive learning atmosphere while lowering their anxieties to express their thoughts in this particular setting. Therefore, the research questions in this study are as follows:

- Q1: Were there any differences in students' learning achievements between IRS and non-IRS methods in an EFL context?
- Q2: Were there any differences in students' learning perceptions between IRS and non-IRS methods in an EFL context?

2. Methods

2.1. Participants

The participants included two classes of second-year students enrolled in mandatory GE classes on a four-year course at a technical university in south Taiwan. 102 students with non-English major undergraduate at an elementary level participated in the study. The average age was around 20. One class was assigned for the experimental group consisting of 52 students, guiding by IRS-integrated activities. The other class was the control group consisting of 50 students, guiding by non-IRS activities. The two groups had the same English teacher, who had taught English for more than ten years. The independent variables were the different teaching methods, and the dependent variables were learning achievement in English language (including listening, reading, vocabulary and grammar), and the learners' perceptions toward IRS-integrated activities.

2.2. Instructional design and the IRS

A compulsory GE course integrated IRS activities in class. The course was a four-skill language class that ran for two semesters. The first one emphasised listening and reading skills while the second focused on speaking and writing skills. The current study was conducted during the first semester, so more emphasis was placed on receptive listening and reading skills. However, grammar and vocabulary were also covered to expand students' linguistic knowledge. Learning performance assessments were conducted to measure students' proficiency in listening, reading, grammar and vocabulary. Although speaking and writing skills were not directly linked to performance assessments, they played important roles in facilitating students' interlanguage use. The course sought to help students communicate more effectively and increase their English language confidence. In addition to focusing on these principal learning goals, both classes in the study were to implement PI and emphasise interaction between peers.

While the study lasted for ten weeks, the lessons were designed to be six weeks long. Six 50-min lessons were included in the study. Four units were chosen (e.g., grocery shopping and campus life), each of which contained a vocabulary builder, grammar practice, a 2-min daily life conversation video and a short passage. Table 1 depicts the three phases of each session as a series of focused activities, as well as their estimated durations.

- Phase 1 focused on warm-up activities by introducing themes and their related vocabulary items. It also provided students with more opportunities to review learnt content.
- Phase 2 served as a formative assessment requiring students to answer a series of pre-designed questions based on course content, using either IRS-integrated techniques (for the experimental group) or PowerPoint slides (for the control group). Students were allowed to work with peers and would receive feedback from peers or teachers.
- Phase 3 entailed a guided activity—after measuring student comprehension based on formative assessment results, the instructor provided assistance or instruction to review learnt materials based on students' problem areas as highlighted in Phase 2.

In both groups, Phases 2 and 3 consisted of four steps. Phase 2 encompassed three events: (1) students responded to a question individually; (2) before revealing the correct answers, the instructor asked students to work with peers to either keep or change their submitted answers; and (3) the teacher led a class discussion by inviting students to explain their responses. In Phase 3, the instructor revealed the correct answer and provided additional feedback based on aggregate reports before moving on to the next question. Three sets of questions were designed in the question-and-answer activity. The first set consisted of three three-item multiple choice questions and was completed individually. In the second set, students worked in pairs to answer two three-item multiple choice questions with multiple answers. Finally, groups of students answered a short-answer question in the final set. All questions consisted of relevant vocabulary items, grammar points and short reading and listening passages.

In the experimental group of IRS users, questions were presented as ZUVIO-based formative assessments. Students used their own devices to complete the quizzes in each set of question-and-answer activities. Once the instructor ensured that all students had logged on to the system, she then activated the pre-designed questions. All the students had equal access to the IRS questions and submitted their responses within the same limited time frame. The control group followed an identical learning process, except their questions were presented in PowerPoint slides. Students in this group were invited to share their answers by either raising their hands or being nominated by the teacher to share their thoughts. The teacher also invited those who had given correct responses to explain their answers.

Fig. 2 demonstrates the examples of both the IRS-integrated (the left-hand side) and non-IRS-integrated questions (the right-hand side), including grammar questions in Fig. 2a—2b; listening questions in Fig. 2c—2d; reading questions in Fig. 2e—2f. During each quiz, results were displayed on-screen between questions in percent form, and the distribution of responses (e.g., grades or text-based answers) was displayed on either a bar chart or aggregated texts at the end of the quiz (aggregated report, Fig. 2g). While no aggregate data were presented in the control group (Fig. 2h), the teacher led a discussion by reviewing all the questions to reinforce student comprehension.

Both groups had their comprehension assessed individually, discussed solutions in pairs and communicated to understand different perspectives on specific questions. All participants in both groups had opportunities to express what they learnt, and this helped them increase their use of the target language.

2.3. Experimental procedures

Fig. 3 maps the research procedure. Both groups took part in pre- and post-test. The non-IRS activity was for the control group while the IRS-integrated activity was for the experimental group. An informal interview was conducted to collect detailed, in-depth feedback. Post-test questionnaires were distributed on the topic of learners' perceptions in regard to the learning task. In order to ensure a

Table 1
Instructional design sequence.

Sequence	IRS intervention (Experimental group)	Non-IRS intervention (Control group)
Phase 1 (10 min)	-Warm-up activity or review of learnt materials	
Phase 2 (30 min)	-Formative assessment using IRS	-Formative assessment using PowerPoint slides
Phase 3 (10 min)	-Guided discussion or review of key points	

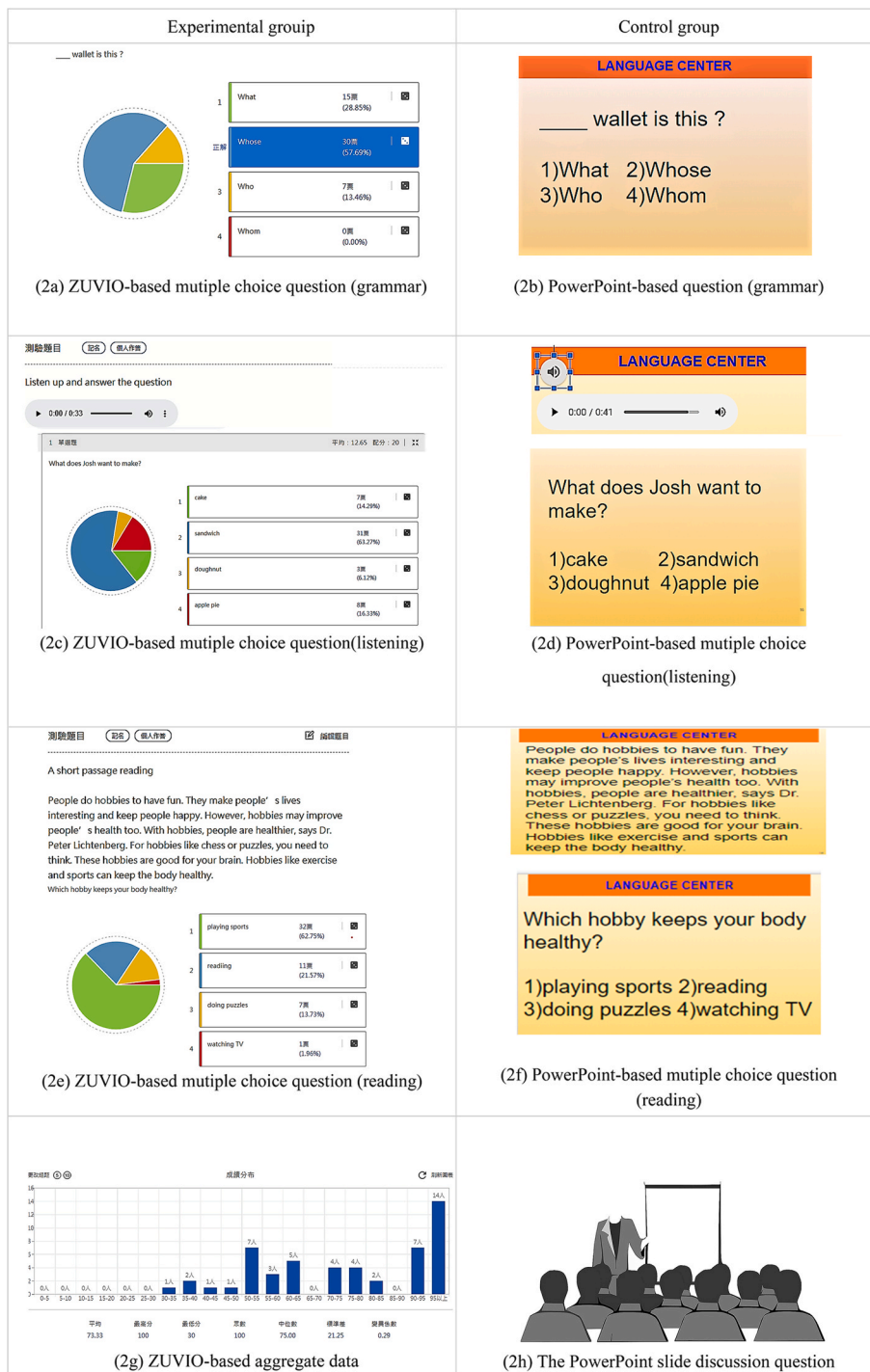


Fig. 2. The learning activities.

similar entry level for each group, the pre-test was administered. The mean scores were 33.94 for the experimental group ($SD = 9.96$), and 34.07 for the control group ($SD = 9.87$). The t -test result shows that there was no significant difference between the two groups ($t = -1.85, p > 0.05$), showing that the two groups of participants had equivalent prior knowledge before the study.

2.4. Instruments

Two experienced teachers and the researcher developed the achievement test with reference to learning content, and the teachers

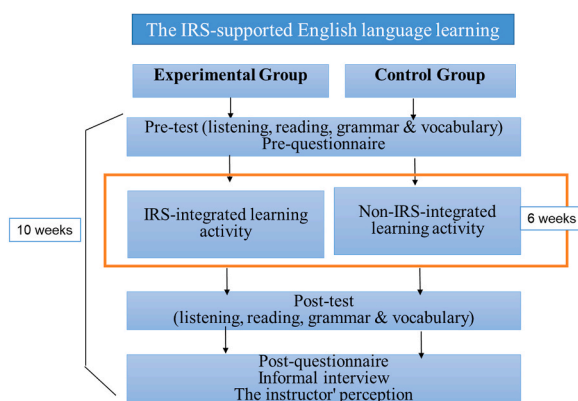


Fig. 3. Research procedure.

worked together to ensure content validity of the test. The achievement test took the form of a paper-based post-test, which was to assess the students' primary language learning. It was developed in line with the formative quizzes used for IRS activities. The test consisted of four parts – reading, listening, vocabulary and grammar – each of which consisted of five multiple-choice questions. The number of available marks for each section was 25, and the total score was 100 (Appendix 1). The Kuder–Richardson reliability index for the test was 0.83.

The questionnaire for learning perceptions consisted of ten items on a five-point Likert scale and was adapted from the questionnaires used by Hung (2017) and Chou et al. (2017) themselves based on the questionnaires of Blasco-Arcas, Hernandez-Ortega & Sese (2013). One professor of English and one professor of education collaboratively examined the questionnaire to ensure verify the accuracy and validity of the questions. The questionnaire covered ten dimensions of the learning experience: learning atmosphere, participation, attention, attitude, confidence, interactivity with the teacher, interactivity with peers, learning support, learning achievement and satisfaction (Appendix 2). For example, the question asking 'The activities made me more attentive during class activities' is to examine student attention, while the questions asking 'The activities encouraged me to take part in class more than I would otherwise.' is to understand student participation. The Cronbach's alpha for the questionnaire was 0.87.

An informal interview was conducted to collect detailed feedback. The students in the experimental group were invited to, and agreed to, participate in individual interviews (Appendix 3) in order to gather their opinions and experiences of IRS use. For example, students were asked to respond to the question of '(1) Are there the advantages in integrating IRS into course activities?' Mandarin Chinese was used when conducting interviews individually, and each lasted about 5–7 min.

The interviews data from these questions were audio-recorded and transcribed. A blind coding approach was adopted to ensure reliability. The researcher and an English teacher with experience in qualitative analysis independently listened to recordings, and checked the transcripts. The data, re-examined by the researcher and another language teacher, was then coded and categorised for later verifying the findings from quantitative data.

2.5. Data analysis

Quantitative and qualitative data were collected for analysis. Descriptive statistics were used to describe the means (M), SDs and adjusted means (*AdjM*) for achievement test. In terms of learning achievement, analysis of covariance (ANCOVA) was used to compare the final learning results of the two groups; by using the pre-test and the achievement test as covariates, this method eliminates the effect of any existing differences on the final results. Multivariate analysis of covariance (MANCOVA) and post-hoc comparison were conducted to establish whether there remained a significant difference in respect of learning achievement on the subscales of the post-test. One-way MANOVA was used to analyse students' perceptions of learning activities. In addition, the students from the IRS-integrated group and the instructor were invited to take part in interviews; qualitative data from their responses to open-ended questions was coded and categorised to verify the findings from quantitative data.

Table 2

Descriptive statistics of the two groups.

	Experimental group (N = 52)					Control group (N = 50)				
	Pre-test		Post-test			Pre-test		Post-test		
	M	SD	M	SD	AdjM	M	SD	M	SD	AdjM
Vocabulary (25)	10.48	3.36	19.49	3.54	19.45	12.88	2.86	16.04	5.39	16.01
Grammar (25)	8.17	2.25	18.50	3.94	18.51	6.56	2.13	15.97	6.31	15.97
Reading (25)	9.05	3.16	19.36	3.95	19.35	8.12	2.91	15.92	5.45	15.90
Listening (25)	6.36	2.09	14.36	2.91	14.32	6.38	2.03	13.82	3.37	13.85

3. Results

3.1. Q1: were there any differences in students' learning achievements between IRS and non-IRS methods?

The study aimed to examine whether IRS-integrated activities affect EFL learning. To answer the first research question, Table 2 shows descriptive statistics, including *M*, *SD* and *AdjM*, for the learning results of the two groups. Both groups showed an improvement on the post-test. However, the ANCOVA results (Table 3) show a significant difference in the achievement test between the experimental group and the control group ($F(1, 99) = 26.93, p = 0.001, \eta^2 = 0.54$). When examining the partial Eta-squared (0.28), it is shown that the IRS-integrated activity had a significant effect (Cohen, 1994) on academic achievement in English.

Table 4 shows the results of the MANCOVA. The four subscales for learning achievement in the post-test differed significantly between the two groups (Wilks' lambda = 0.73, $F(4, 96) = 8.70, p = 0.000, \eta^2 = 0.27$). The Bonferroni method was then used to analyse the confidence intervals. The results of the post-hoc comparison indicated that the IRS-integrated group experienced better learning outcomes than the non-IRS group in the three dimensions of a short reading, grammar and vocabulary.

3.2. Q2: were there any differences in students' learning perceptions between IRS and non-IRS methods?

To better understand the students' perceptions of learning with the IRS learning activity in the language classroom in the second research question, the students' ratings for the following ten dimensions were collected and analysed, shown in Table 5. One-way MANOVA was performed, and the results showed that a significant multivariate effect on ten items among these two groups: Pillai's Trace = 0.64; $F(10, 91) = 16.37, p = 0.001, d = 0.64$. Univariate independent one-way ANOVAs found significant main effects for the learning conditions regarding IRS in aspects of attention, with the significance level set at 0.0125 (0.05/4), learning atmosphere ($F(1, 100) = 78.61, p < 0.001, d = 0.43$), participation ($F(1, 100) = 81.25, p < 0.001, d = 0.44$), attention ($F(1, 100) = 51.82, p < 0.01, d = 0.34$), attitude ($F(1, 100) = 73.72, p < 0.001, d = 0.41$), confidence ($F(1, 100) = 48.04, p < 0.01, d = 0.32$), interactive with teachers ($F(1, 100) = 48.12, p < 0.01, d = 0.33$), interactive with peers ($F(1, 100) = 68.90, p < 0.001, d = 0.41$), support learning ($F(1, 100) = 65.64, p < 0.01, d = 0.39$), learning achievement ($F(1, 100) = 3.25, p > 0.05$), learning satisfaction ($F(1, 100) = 59.12, p < 0.01, d = 0.37$). The effect size was around medium, from 0.32 to 0.44. LSD in post hoc tests, setting each test at a significance level of 0.00625 (0.0125/2), revealing that the IRS-integrated group was significantly higher than the non-IRS group, with respect to the above items. Specifically, the two groups differed significantly in almost every dimension, except for item 9 (learning achievement), where the students expressed reservations concerning the potential of IRS for improving their learning on the course. The students in the experimental group were highly accepting of IRS learning activity and gave it higher ratings than those in the control group.

3.3. Informal interview

Table 6 presents the results of the informal interviews regarding the IRS group's positive and negative views on IRS. Part A outlines the benefits of integrating IRS into the classroom settings. Students perceived increased attention in class as the greatest benefit of IRS, while an encouraging atmosphere was ranked as the second greatest benefit. One student noted a 'warm' learning atmosphere during classroom activities, saying she 'was interested' and '[could] talk to her partner to find out answers' (IRS-0509-s104). She felt less anxious about answering ZUVIO-based questions, and enjoyed working with peers and groups to reaffirm her understanding. As outlined in Part A, students' positive feedback (A-1 to A-10) was in line with the questionnaire results, which included approval of learning activities (A-1 to A-8), improved attention (A-1), enhanced interactivity (A-3, A-7) and reduced anxiety (A-10).

Conversely, time spent on answering questions using personal devices and worrying about not completing all questions on time were ranked as the two least helpful components of IRS integration. One student indicated that he checked every question with peers before submitting his answers: 'I wrote a short sentence with my partner [...] we tried to spell an unfamiliar word [but] as we kept discussing it, time was running out. [...] I was nervous and worried about the results' (IRS-0509-s505). When time was almost up, the student felt anxious and found that he had misspelled several words. Most negative feedback pertained to issues like time spent using devices and wireless connectivity (B-3, B-8), learning attitudes (B-4) and anxiety (B2). Although several uncertainties about IRS use remain, the results herein demonstrate the feasibility and helpfulness of integrating IRS in language classrooms.

4. Discussion

Research has indicated ways of successfully activating students' active learning, along with different modes of technology integration. Consistent with recent recommendations for IRS technologies (e.g., Hung, 2017b; Kent, 2019), this study has examined the IRS implementation and proved its value with positive results of learning outcomes and perceptions in EFL learning contexts. According to

Table 3
ANCOVA analysis of the two groups.

Group	<i>N</i>	<i>M</i>	<i>SD</i>	<i>AdjM</i>	<i>F</i>	Pairwise comparison
Experimental group	52	61.75	11.01	61.77	26.93***	$E > C$
Control group	50	71.73	8.13	71.70		

*** $p < 0.001$.

Table 4
MANCOVA analysis of the two groups.

SV	Df	SSCP				Wilks'	F			
	1	Vocab.	Gram.	Reading	Listening		Vocab.	Gram.	Reading	Listening
Pre-test	1	-.924 7.063 0.963 8.462	-6.775 51.818 7.063 62.083	.886 -6.775 -.924 -8.118	-8.118 62.083 8.462 74.380	.914*	.042	1.901	.042	8.047
Between Group	1	302.978 221.461 302.164 46.175	222.058 162.312 222.058 33.842	303.795 222.058 302.978 46.299	46.299 33.842 46.175 7.056	.73***	14.55***	5.953*	13.26***	.384ns
Within Group (error)	99	2066.279 180.266 184.590 253.160	184.590 -534.866 2699.132 306.965	180.266 2254.775 -534.866 275.875	253.160 275.875 306.965 915.057					
	101									

*** $p < 0.001$; * $p < 0.05$; NS $p > 0.05$.

Table 5
MANOVA analysis of the two groups.

Variable	C	N	M	SD	F	Post hoc tests	Partial
1. Learning atmosphere	E	52	4.86	0.35	78.61***	E > C	0.43
	C	50	3.80	0.67			
2. Learning participation	E	52	4.84	0.35	81.25***	E > C	0.44
	C	50	3.74	0.61			
3. Learning attention	E	52	4.65	0.33	51.82**	E > C	0.34
	C	50	3.69	0.62			
4. Learning attitude	E	52	4.74	0.32	73.72***	E > C	0.42
	C	50	3.80	0.48			
5. Learning confidence	E	52	4.65	0.23	48.04**	E > C	0.32
	C	50	3.70	0.59			
6. Interactive with teachers	E	52	4.62	0.41	48.12**	E > C	0.33
	C	50	3.71	0.65			
7. Interactive with peers	E	52	4.73	0.45	68.90***	E > C	0.41
	C	50	3.76	0.77			
8. Support learning	E	52	4.82	0.67	65.64**	E > C	0.39
	C	50	4.09	0.45			
9. Learning achievement	E	52	4.06	0.79	3.25		0.32
	C	50	3.88	0.76			
10. Learning satisfaction	E	52	4.66	0.56	59.12**	E > C	0.37
	C	50	3.79	0.89			

*** $p < 0.001$; ** $p < 0.01$; Experimental group (E); Control group (C) 0.001.

the findings, IRS technology supports students in actively participating in class activities using the target language. In light of individual feedback about ZUVIO use in a tailored design, IRS technology assists students in language development through peer interaction. This result accords with the study conducted by Kent et al. (2019). His finding indicate that incorporating IRS into instruction must involve more than pre-, during- and post-classroom activities; instead, IRS must contain well-structured strategies to provide interactive learning opportunities for all participants, help focus attention on content, and highlight knowledge gaps (Kent, 2019). As for the improvements in vocabulary, grammar and reading, the experimental group outperformed the control group. This echoes the findings of several prior studies regarding English learning achievement (e.g., Chou et al., 2017; Hung, 2017; Kent, 2019; Wang, 2017), which thereby supports the helpfulness of IRS in language learning settings. A further examination of the findings identifies two potential explanations for the performance differences between the two groups: adaptive scaffolding and intensive interactivity.

Both groups had equal access to the resources, including PI learning techniques, guided activities and learning materials. They also had the same teacher, who had carefully designed lessons to meet course requirements. However, while gauging student understanding, the IRS-integrated students received adaptive scaffolding from the instructor. They were involved in more intensive and interactive class discussions compared to the non-IRS group, which enabled them to reach target comprehension levels. As shown on Fig. 2, it demonstrates the differences in the groups' course activities, in terms of grammar questions (Fig. 2a—2b); listening questions (Fig. 2c—2d); short-answer reading questions (Fig. 2e—2f). In particular, the results (Fig. 2g) were displayed on-screen between questions in percentage form, either on a bar chart or in an aggregate text at the end of the quiz in the experimental group, whereas no aggregate data were shown in the control group (Fig. 2h).

Table 6
Results of the IRS-integrated group informal interviews.

Type	Representative Quotes	percentage
Positive (Part A)	A-1. "The activity made me attentive during class activities."	82%
	A-2 "Using IRS in the classroom learning atmosphere is encouraging. "	78%
	A-3. "The activity reinforced me to work with peers and group members. "	76%
	A-4. "Using IRS to check my in-class understanding after discussing with peers was effective. "	75%
	A-5. "The activity made me take a more active part in the lesson".	71%
	A-6 "The activity encouraged me to answer the questions without feeling anxiety. "	62%
	A-7 "I felt comfortable sharing my answers when working with peers to agree on a response. "	60%
	A-8. "The ZUVIO learning record gave me opportunities to review my errors and reflect on my learning."	58%
	A-9. "I like to work with English and put what I have learnt into practices. "	53%
	A-10. "I felt less anxiety when I saw others having the same problems as me in the summary report. "	50%
Negative (Part B)	B-1. "Using IRS to reach the final answers for quizzes takes time. "	71%
	B-2. "Due to limited time, I felt nervous and had problems answering all the questions. "	68%
	B-3. "Improper spelling appeared in questions. "	65%
	B-4. "I was unsure if using IRS improved my learning achievement. "	60%
	B-5. "Sometimes the quiz time was too limited and short when we were discussed answers."	53%
	B-6. "Some instant messages would display on my mobile that indirectly influenced my quiz. "	42%
	B-7. "I was still unfamiliar with the this formative quizzes compared to paper-based quizzes. "	30%
	B-8. "Because of poor connectivity, my mobile phone sometimes disconnected from the internet while I was taking the quiz, which directly influenced my scores. "	12%

4.1. IRS for supporting adaptive scaffolding

The IRS feedback and summary reports in the experimental group allowed the instructor to clearly identify students' struggles with specific aspects of the material and thus organise appropriate scaffolding. For example, when the tallied report demonstrated that over 30% of students misunderstood the linguistic concept of possession, the instructor adjusted her teaching methods by re-explaining the concept and asking students to review the relevant components of the lesson. She then immediately posed a similar question to re-test students' understanding of possession using peer answers and group responses. [Pagano and Paucar-Caceres' \(2013\)](#) study on IRS indicated that 'timing and frequency of formative assessment and feedback on students' level of understanding is critical to participation, and ultimately completion, but can only be beneficial to students if the feedback itself is scoped, focused and clear' (p. 95). The present study agrees with the view that instructor feedback in the IRS group was more focused, clearer and more immediate compared to the non-IRS group. Overall, IRS supports adaptive scaffolding by giving students focused instruction, reinforcing just-in-time learning, helping clarify students' misunderstandings and connecting their learning to their pre-existing knowledge.

4.2. IRS for supporting intensive interactivity

Both groups carried out the guided activities and emphasised the importance of peer discussion. The IRS group saw increased opportunities for task involvement and classroom interactivity. This is because real-time instruction is interactive and classroom interaction is interwoven with the instructional style. For example, the instructor assessed who responded correctly or incorrectly based on the tallied report (which was only displayed on the teacher's ZUVIO interface), and then either led a class discussion or invited those who responded correctly to explain the rationale for their answers. Conversations between teachers and students or between students and students regarding the construction of knowledge (e.g., reviewing particular pages or working on specific exercises) increased. Although PI enhances students' interactivity, IRS with PI further supports intensive interactivity, and assists teachers in creating meaningful conversations among students ([Hung, 2017](#); [Kent, 2019](#)). This also led to an inviting learning atmosphere and stimulated students' desires to actively participate, which echoes to [Wang's \(2017\)](#) study on Mandarin instruction using IRS, and thus substantiates IRS's applicability in increasing student engagement during course activities. IRS is a catalyst for promoting intensive interactivity between teachers and students, among students, and between students and their learning materials.

4.3. IRS for supporting instructor intervention

The instructor also played a key role in this study. She mentioned that IRS was a beneficial tool in helping her provide immediate and focused teaching: 'I can decide what to do in the next stage if many students are still troubled with the part we covered—either by giving them some extra exercises to lead them to re-think [concepts] or by leading a whole-class discussion to facilitate their understanding' (IRS-0502-t02). According to her, 'question-and-answer activities to check students' comprehension in this context was greatly tailored [...] [they] can quickly identify students' problems or uncertainties and properly organise the learning process to reduce their anxiety'. In addition, during the class, the IRS-integrated students appeared to have a sense of belonging and were more relaxed when the summary reported incorrect responses. She claimed that students were generally positive about not being the only person who answered incorrectly (IRS-0502-t10), and occasionally 'the whole class laughed when a very low percentage of students replied correctly' (IRS-0502-t12). This indirectly helped create a rapport between students and teachers, fostered a warm learning atmosphere and put less pressure on students during later guided activities.

The above discussion explains IRS's positive outcomes. Along with its functionality of instantly-tallied response reporting, IRS also

has the strength of giving focused real-time feedback. It thus leads to a change in teaching methodology that 1) helps teachers provide adaptive scaffolding for student comprehension, 2) creates intensive interactivity for building more chances for discussions between individuals, peers, groups or the whole class, and as such, 3) it promotes learning achievement.

4.4. Alternate prospective

No significant differences were found between the groups in terms of listening comprehension; the IRS learning group did not outperform the non-IRS group in the listening test. The interview data, however, revealed useful information. Several students (IRS-0509-s201, IRS-0502-s303 and IRS-0509-s605) stated that when working with peers in class, IRS helped them retain new words, gain awareness of grammar points and improve their reading skills. However, they still experienced difficulties comprehending audio-visual materials in the target language because of the speed of the colloquial English used. This is in line with Vandergrift and Goh's (2012) finding that listening skills are harder to acquire than other linguistic abilities (see also Roussel, 2011). While reading, students can pay specific attention to any part of the text they choose; while listening, however, learners must develop a certain level of language proficiency to process complex linguistic knowledge in the context of continuous incoming speech-flow. In such scenarios, student may struggle with unfamiliar vocabulary. Overall, the short timeframe dedicated to the unit was not enough for students to develop linguistic decoding and processing skills.

5. Limitation

Some limitations should be clarified. First, although IRS has been shown to promote learning achievements and create a positive learning atmosphere, this effect could be a factor of the system's novelty. Thus, a longitudinal investigation is recommended to examine the long-term influences of IRS applications on student learning. Second, a question-and-answer mechanism with PI was used in this study to reduce the instructor's authority in class. In developing more student-centred activities when using IRS in the classroom, it is strongly recommended that teachers build upon the system. Student question generation could be an alternative method for keeping students motivated and challenged. The final limitation concerns technical problems. Some students preferred submitting answers in the last one or 2 s of the answering period, so if the Internet lagged, they may have failed to submit their answers. In such cases, instructors must remind students of the importance of timing.

6. Conclusions

The study presents empirical evidence supporting IRS use in language instruction for students at an elementary English language level. The course units used IRS learning as an instructional foundation and sought to identify an effective way to rapidly gauge students' understanding of learnt materials during course activities, thus enabling the provision of ample immediate and feedback to promote student learning and participation. Drawing on the findings presented above, an alternate IRS technique was the driving force in effective learning. A real-time report tallied from ZUVIO informed the instructor of students' comprehension of specific concepts to facilitate student learning, while frequency of peer discussion and feedback about shared responses enhanced classroom interactivity. This suggests that IRS class facilitates the language instruction in an EFL setting.

That said, our findings on IRS merely lay a foundation for our further comprehension of knowledge acquisition in IRS-integrated activities. Although promising results were obtained for the students who participated in the study, longer and more intensive studies are required to assess the sustainability of such teaching innovations, particularly in foreign language classrooms. Differences in learning environments, local cultures, education levels, and individual participants can yield varying study results—as an example, the participants in the present study being non-English majors would have impacted the overall results. To further support the use of IRS technology in language education, it is recommended that other studies apply a design similar to the one herein to other student groups in different learning contexts.

Declaration of competing interest

The manuscript has no funding and therefore the author declare no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.system.2021.102637>.

References

- Barr, M. L. (2017). Encouraging college student active engagement in learning: Student response methods and anonymity. *Journal of Computer Assisted Learning*, 33(6), 621–632.
- Blasco-Arcas, L., Buil, I., Hernández-Ortega, B., & Sese, F. J. (2013). Using clickers in class. The role of interactivity, active collaborative learning and engagement in learning performance. *Computers & Education*, 62, 102–110.

- Bonnell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom*. Washington, DC: George Washington University Press.
- Cardoso, W. (2011). Learning a foreign language with a learner response system: The students' perspective. *Computer Assisted Language Learning*, 24(5), 393–417.
- Chang, C., & Lin, H. C. K. (2019). Classroom interaction and learning anxiety in the IRS-integrated flipped language classrooms. *The Asia-Pacific Education Researcher*, 28(3), 193–201.
- Chern, C. (2010). General English programs at universities in Taiwan: Curriculum design and implementations. *Chang Gung Journal of Humanities and Social Sciences*, 3(2), 253–274.
- Chou, P. N., Chang, C. C., & Lin, C. H. (2017). Byod or not: A comparison of two assessment strategies for student learning. *Computers in Human Behavior*, 74, 63–71.
- Cohen, E. G. (1994). Restructuring the classroom: Conditions for productive small groups. *Review of Educational Research*, 64(1), 3–35.
- Hung, H.-T. (2017). The integration of a student response system in flipped classrooms. *Language, Learning and Technology*, 21(1), 16–27.
- Kent, D. (2019). Technique efficacy when using a student response system in the reading classroom. *Language, Learning and Technology*, 23(1), 26–35.
- Pagano, R., & Paucar-Caceres, A. (2013). Using systems thinking to evaluate formative feedback in UK higher education: The case of classroom response technology. *Innovations in Education and Teaching International*, 50(1), 94–103.
- Roussel, S. (2011). A computer assisted method to track listening strategies in second language learning. *ReCALL*, 23(2), 98–116.
- Shao, Q., & Gao, X. A. (2016). Reticence and willingness to communicate (WTC) of East Asian language learners. *System*, 63, 115–120.
- Song, D., Oh, E. Y., & Glazewski, K. (2017). Student-generated questioning activity in second language courses using a customized personal response system: A case study. *Educational Technology Research & Development*, 65(6), 1425–1449.
- Vandergrift, L., & Goh, C. C. M. (2012). *Teaching and learning second language listening*. New York: Routledge.
- Wang, Y. H. (2017). The effectiveness of integrating teaching strategies into IRS activities to facilitate learning. *Journal of Computer Assisted Learning*, 33(1), 35–50.
- Watkins, J., & Mazur, E. (2010). Just-in-time teaching and peer instruction. In S. Simkins, & M. H. Maier (Eds.), *Just in time teaching: Across the disciplines, and across the academy* (pp. 39–62). Sterling, VA: Stylus Publishing.
- Wu, Y. C. J., Wu, T., & Li, Y. (2017). Impact of using classroom response systems on students' entrepreneurship learning experience. *Computers in Human Behavior*, 1–12.

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