Investigating the Effectiveness of an Interactive IRF-Based English Grammar Learning System

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Abstract—Computer-supported language learning has the potential to promote relevant work in support of instant, interactive language discourse that fulfils educational purposes and fosters individual language learning. This study presents an interactive IRF-based English grammar learning assistant system (EGLA) that aims to improve students' grammatical knowledge and correct their grammar errors and misspellings if they have any. A quasi-experimental design is adopted to examine its effects on an English grammar achievement test for three classes of junior high school students. These three classes were assigned to the experimental group and control groups A and B. The experimental group used EGLA that harnessed IRF moves, control group A used EGLA but without IRF moves, whereas control group B received an IRF-based English grammar discourse from an English tutor in the classroom. The results demonstrated that the experimental group was significantly better than control group A, but was not significantly different from control group B. The results are discussed, and directions for further investigation are provided.

Keywords—IRF; question and feedback; grammar learning; CALL

1 Introduction

There is no doubt that instructional dialogue between the teacher and students is an essential part of how students learn. In general, it has been widely shown that the characteristic sequence of tripartite dialogic structure (IRF) entails: (1) initiation of a known-answer question by the teacher, (2) a student response to that question, and (3) teacher feedback or evaluation of that response [1]. In this way, the instructor can clearly grasp the students' learning progress by questioning, immediately provide appropriate feedback according to their learning responses, and further extend or elaborate on instructions and so improving student learning. Several studies have suggested the benefits of IRF in language learning. According to [2], the IRF routine was successfully applied and replicated in informal peer-to-peer foreign language interactions. Vaish employed IRF exchanges in English courses at elementary and junior high schools [3], while Mondada and Doehler taught children aged 10-12 years old French as a second language with the IRF sequence in Switzerland [4]. Although effective language interaction through IRF dialogue can improve student understand-

ing, and language teachers can correct language errors by providing feedback, teachers must contend with heterogeneous language ability levels of students and limited class time, which are the main challenges encountered when teaching [5]; Pauli also found that teachers often ask new questions or offer further explanations without explicitly reviewing the answer or statement of the student [6]. If feedback was present, it was in most cases non-specific and had the form of praise: "good"; or, "that's right". However, concerns can be raised regarding the dominance of teacher talk in this context, the persistence of IRF as the principal form of discourse, the brevity of student responses, and the lack of sustained interaction with individual students [7]. Research has indicated that providing students with a one-on-one computer assisted learning system is a productive method for encouraging learners of various language proficiency levels to learn in an enjoyable way [8]. Computer-assisted language learning (CALL) is effective because it is readily available, creates abundant individual practice opportunities, and enables the learner to control the learning experience [9], and may even outperform traditional instruction [10]. This approach not only highlights the potential to provide instructional resources, unlimited practice opportunities and scaffolds for students of various language proficiency levels, and for expanding, deepening and widening students' language learning, but can also provide students with a sense of empowerment and foster their language proficiency in listening, speaking, reading and writing through self-learning [11]. It is thus possible that CALL provides a promising avenue to develop specific instructional dialogue skills by interacting via a computer, similar to how students interact with a specialized teacher during language instruction. Moreover, there are many interactive design variables, such as instructional approaches or pedagogies, which can be used with computer technology and are worth investigating [12]. Unfortunately, little research explores the learning factors or automatic interaction design in the computer-based learning environment which may enhance the effectiveness of language learning. Therefore, the challenge of developing an intelligent, interactive language learning system involves determining how to employ the available instructional dialogue strategies to help students' individual language learning, and to improve their language proficiency.

As mentioned above, this paper attempts to integrate IRF strategies and automatic/interactive technology to develop an English grammar learning system to improve students' grammatical knowledge and correct their grammar errors and misspellings. This system can ask questions automatically and, according to the responses from learners, gives feedback adaptively to guide the learners to correct their grammar. Therefore, the issues to be dealt with in this study include the system's interactive dialogue designs based on the IRF strategy, adoption of automatic recognition techniques involved with grammar parser and error detection, and adaptively providing different types of feedback based on learner responses. In addition, the present study was to ascertain the effects of using this system to support computer assisted English grammar learning as compared to an English grammar teaching with IRF strategy. We have organized the rest of this paper in the following sections: the first presents a literature review that introduces IRF characteristics and its interpretation, and states some feedback principles and types, and provides an overview of the technological support relevant to the grammatical parser and error detection that we use. The second

section introduces the architecture of this system and its component implementations. The third section describes in detail the experimental design and procedure. The evaluation results are discussed in the fourth section. Finally, section five presents the conclusions and suggestions for future research.

2 Literature review

2.1 The IRF dialogue

It has been widely shown that the characteristic sequence of tripartite dialogic structure that dominates instructional discourse consists of an initiation, a response, and feedback (IRF) [13][14]. In general, the basic three part sequence entails: (1) initiation of a known-answer question by the teacher, (2) a student response to that question and (3) teacher feedback or evaluation of that response, where responsibility for management of the interaction rests with the teacher throughout [1][15]. The IRF structure possesses flexible features, so that teachers can repeat and use various forms, particularly in the "F" move within the "triadic dialogue", depending on the activity goal [16]. Lee claimed that the instructor could provide the third move as "follow-up" by using techniques such as evaluation, justification, counter arguments, clarification and meta-talk, which can stepwise achieve the purposes of correcting errors, clarifying misconceptions, and guiding learning by repeated cycles of questioning and feedback [17]. Thus far, the IRF model commonly mimics teacher-student instructional dialogue, and has been used in various language learning scenarios [18] [19]. For example, Hardman, Abd-Kadir, and Smith [20] investigated the efficacy of the IRF strategy when teaching English to elementary school students in traditional classrooms. Temmerman used IRF to assist upper-level students in two elementary schools with foreign language learning [21]. Waring adopted the IRF method to aid adults in learning English as a second language [19]. Groenke and Paulus [22] investigated the effects of integrating the IRF strategy and online chat rooms into a collaborative English learning environment for junior high school students. Likewise, Kasper reported how beginner learners of German relied on German native speakers to manage interactions with IRF routines recorded in NS/ learner discourse outside of the classroom context [2].

2.2 The type of feedback

Feedback has been widely cited as an important facilitator of learning and performance [23]. It is a direct, effective way to clarify erroneous concepts, extend thinking, or strengthen knowledge [24][25]. Extensive research not only underpins the importance of feedback in enhancing achievement levels, but also emphasizes the obligation of teachers to effectively integrate feedback in the learning experience [26]. Hattie and Timperley [27] stated that the feedback can be used to reduce discrepancies between current understandings and performance and a certain goal, and stressed that effective feedback should offer information about these discrepancies. Based on

the Feedback Intervention Theory presented by Kluger and DeNisi [28], they claimed that feedback needs to focus on specific issues, and that if feedback is too elaborate then this may cause a cognitive overload or may even direct the receiver's attention away from the focal task. Increasing research has produced evidence suggesting there are numerous ways for feedback to be presented within teaching and learning activities, such as prompting-answer and giving-answer feedback [29], positive and negative feedback [28], explicit and implicit feedback [30], immediate and delayed feedback [31], discrepancy and progress feedback [32] and so on. In addition, Hattie and Timperley [27] distinguished four levels of feedback, each with a differential effect on learning. These are: (1) feedback on the task, (2) feedback about the processing of the task, (3) feedback about self-regulation, and (4) feedback about the self. They further showed that *feedback on the task* was the most effective in enhancing learning, provided the information is useful in improving either the use of strategies or self-regulation. Moreover, employing corrective feedback with proper explanations in real-time is one of the best feedback methods for students, because it can enhance their knowledge construction and strengthen their conceptual understanding through an interactive process [33].

While numerous digital techniques are available, the effectiveness of feedback is maximised if it is effectively linked to the student's learning. Feedback mechanisms have been designed into some learning systems or educational software created for use outside the framework of the traditional classroom. For example, Hatziapostolou and Paraskakis [34] presented the Online FEdback System and designed an e-learning tool to enhance feedback reception based on how the feedback is communicated to the students, and it is anticipated that this will motivate students to engage more in this process. Narciss et al. [35] conducted log-file analyses of an experimental study in which learners were exposed to various tutoring feedback strategies while performing multi-trial error correction tasks presented by a web-based educational system. Tsai, Tsai, and Lin. [36] developed a TRIS-Q system involving formative assessment and different feedback types to enable students to perform self-assessment when desired. Lin et al. [37] proposed the Across-Unit Diagnostic Feedback System (AUDFS) using an across-unit diagnostic feedback mechanism, which provided feedback that can be used to recommend remedial learning paths for students, and inform the students of the priorities of the paths to understand which weak units and concepts within a unit should be remedied first. Students can thus refer to the instructions and use the provided corresponding remedial materials to conduct remedial learning in a systematic way.

2.3 Grammatical parser technique

More recently, with the development of language recognition technology, more advanced techniques such as natural language processing, and parsing or syntactic analysis have been applied to CALL applications. For example, Lee et al. [38] applied Latent Semantic Analysis techniques to a CALL system to give adult learners immediate writing feedback to learn academic essay writing. Harbusch et al. [39] developed a Sentence Fairy CALL system for elementary students to enhance their English

writing through the use of the Natural Language Processing technique. Chang et al. [40] developed a Chinese sentence learning system and designed several self-explanatory prompts to help non-native Chinese speakers in learning how to use Chinese grammar and sentence structures. A set of syntax-tree-based materials based on the grammar parser technique was also utilized for remedial learning. It is worth noting that parsing or syntactic analysis techniques have been used to generate formal descriptions of the structure of a text and to tags parts of speech, and that this approach can be utilized to recognize the strings of a language and assign each string one (or more) syntactic analyses. The common parsing tools, such as the Link Grammar parser [41][42], can parse English sentences into different graphic labels, and links connect pairs of words to present the semantic relationships of parts of speech to the nearby vocabulary items. Another approach is the Stanford Parser [43], which can tag the parts of speech for the entire sentence and show the parts of speech tags as well as a final parsing tree. These grammar parsing tools have the potential to support different levels of language use [44] and different processes in linguistic analysis, and can thus offer opportunities for CALL programs to extend autonomous syntactic processing. For this reason, this study makes use of a grammatical parser technique which is able to handle the specific characteristics of English grammar, to help this English grammar learning system carry out grammar checking automatically and more efficiently.

3 IRF-based English Grammar Learning Assistant System

The goal of developing the IRF-based EGLA system is to build a computerized IRF-based English grammar instructional dialogue environment for learners with self-learning opportunities, in order to achieve concept acquisition with regard to English grammar. The system is expected to provide flexible chances for individual students to carry out English grammar practice within the limited teaching time. A series of grammar questions (related to English grammar rules such as infinitives, causative verbs, gerunds, the future tense, past progressive tense, frequency adverbs, comparative degrees, and superlative degrees) and supportive corresponding feedback, including the correct answer, an explanation of the answer, and supplementary learning materials, was provided in the IRF-based EGLA system, which assisted the learners in addressing their English grammatical misconceptions. All of these questions and the related feedback were examined and confirmed by five expert teachers who teach English in junior high schools in southern Taiwan.

3.1 System architecture

The architecture of the IRF-based EGLA system is depicted in Figure 1, which has three modules, including the IRF based interactive dialogue, errors and grammar checking, and the adaptive learning. The details of each module are described as follows.

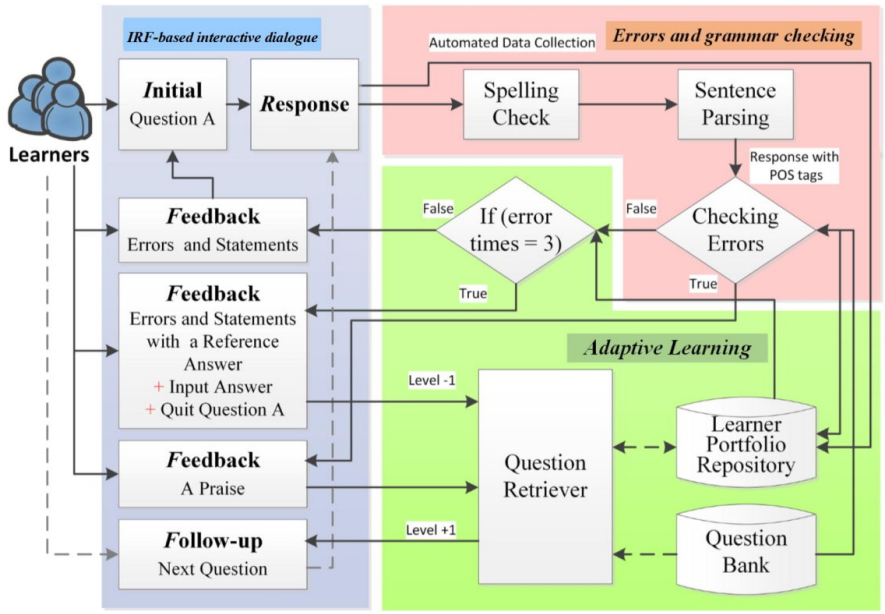

Fig. 1. The IRF-EGLA system's architecture and its modules

IRF-based interactive dialogue module: This module is responsible for maintaining the IRF interaction with each individual learner. Referring to the principles noted in Jonassen [45] and Shute [23], learning feedback should show more information, instead of just simple results (correct/incorrect) or correct answers, as learners need to be told where their problem-solving process went wrong and coached from that point onward. Moreover, if the feedback is too long or too complex it could decrease students' attention, and so a hierarchical approach to feedback was used in this study. The detailed IRF-based interactive dialogue scenario is shown in Figure 2. All learners received grammatical questions with the difficulty level 2 when they interacted with the system for the first time. And the learners replied to a question incorrectly, then the module launched a corrective feedback program using the *Errors and grammar checking module*, which is capable of offering the first layer hints to correct the learners' English grammar misconceptions or misspellings. That is, if the learner has minor errors in their response sentence the first time they offer an answer, then this module will determine their errors and give them the hints needed to fix their mistakes. If they reply to incorrectly the second time, this module will offer simple grammar explanations and encourage them to try again. It will then provide the correct answer and a detailed grammatical explanation if they still answer incorrectly. In contrast, if they answer three questions correctly then they will get questions from more difficult level, or if they answer incorrectly three times then the module will offer easier questions or provide more grammar instruction. Unlike a conventional interactive CALL system design, we referenced actual feedback from teaching dialogues and developed various types of corrective feedback or follow-up interactions, such as repetitions, recasts, and prompts related to requests for clarification, justifica-

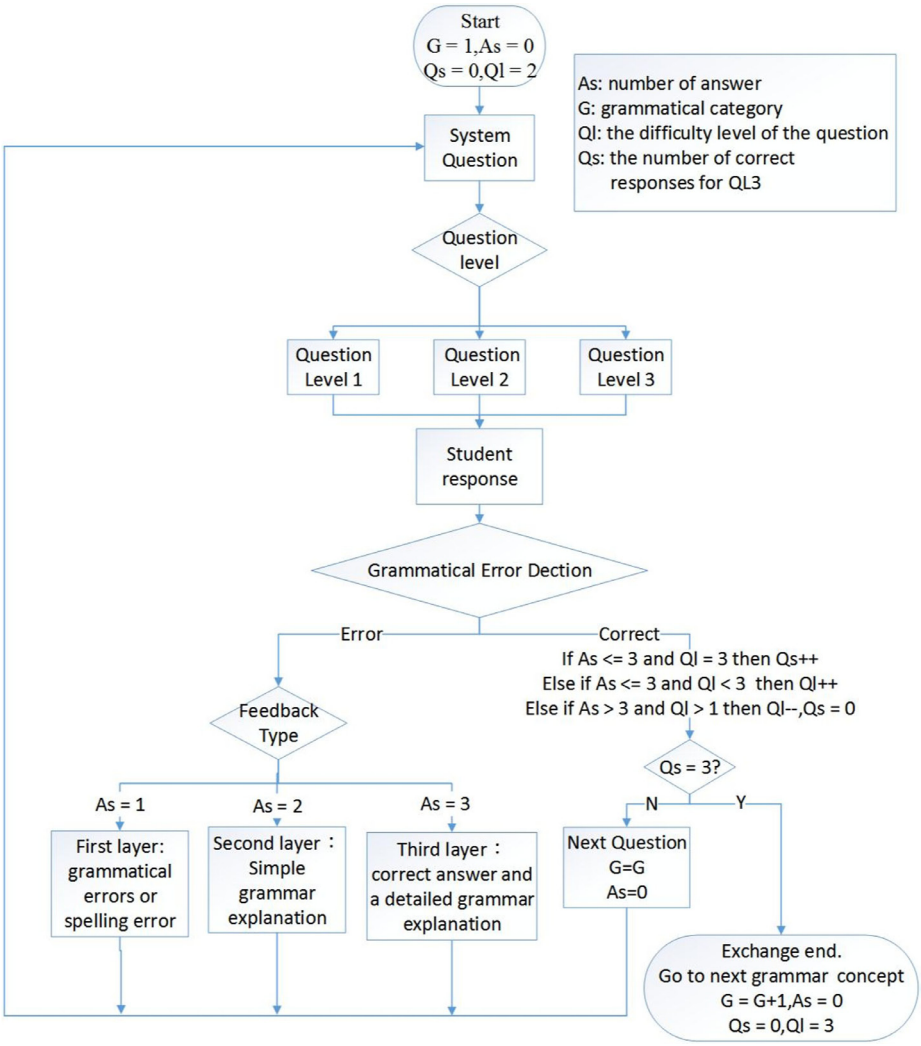

Fig. 2. Computing the threshold of the IRF's eigenvalue

tion, and explanation, which are used in the module, thereby correcting grammatical errors, clarifying grammar misconceptions, and guiding the students to understand English grammar through repeated question–feedback cycles.

Errors and grammar checking module: This module is responsible for automatically detecting, interpreting, analysing and diagnosing the grammatical errors that the students responded with. This study employees a free and open-source spell checker, "GNU Aspell," to look for misspelled words and examine the students' English sentences, as well as the Stanford Parser tool, developed by Klein and Manning [43], to parse the grammatical structure of the sentences and decompose them into several separate characters with marked parts-of-speech tags, in order to produce the final

parsing tree. The parsing tree is then compared with the already-defined templates approved by English expert teachers, which were embedded in the system to help to check incorrect grammar rules and misspellings. As such, any differences between the corrected sentences, as identified through grammatical parsing, were analysed, regardless of whether the answer was correct or not, and this module connected with the interactive dialogue module to execute related follow-up feedback to find the grammatical errors.

Adaptive learning module: To avoid the "one-size-fits-all" approach of providing the same questions and set of links to all individual learners, this module performed personalized adjustments to help the IRF-based interactive dialogue make a decision as to whether to move on to a simpler or more difficult grammar concept level, or maintain the same level and continue to provide different IRF cases after the current IRF move had closed. These personalized adjustments, as determined from the students' interaction trajectories, including personal learning portfolios, students' response content and system feedback records, and the number correct answers and errors in the students' responses, were then been traced and recorded in the Learning Portfolio Repository.

3.2 System implementation

The IRF-based English grammar learning assistant system (EGLA) works as if mimicking the teacher's role, and supports interactive IRF dialogue activities by including a series of questions and adaptive follow-up feedback based on detecting, analysing, and judging the students' grammatical responses for English grammar learning. Individual students can log into the system to improve their English grammar by answering giving questions and receiving appropriate feedbacks according to the IRF moves. When students answer a question, the system provides diverse, immediate corresponding feedback, including the correct answer, an explanation of the answer, and any supplementary learning material to address the related misconceptions if the student failed to correctly answer the question. In addition, when the learners failed to correctly answer the easiest grammatical question related a concept, the system then offered a complete set of grammar instructional materials to help address this issue. A screenshot from the IRF-EGLA is shown in Figure 3. A question and an appealing picture describing grammar concepts are shown on the left part of the screen. The learner can add his or her answer into the text field under this question. After the answer is submitted, the IRF-EGLA will offer various appropriate feedback messages on the right side. For example, if the response is correct the first time then some feedback, including praise, encouragement, repetitions, recasts, and prompts related to requests for clarification, justification, and so on, are shown by the IRF-EGLA, and it also records learners' current states and then offers another difficult question. Otherwise, the well-designed feedback dialogue will be implemented to help students to improve their understanding of grammatical concepts and correct any misspellings. If the number of response errors are in excess of the amount set in the system, the IRF-EGLA will conclude that the student does not understand this grammatical concept and so provide full explanations and grammar instruction.

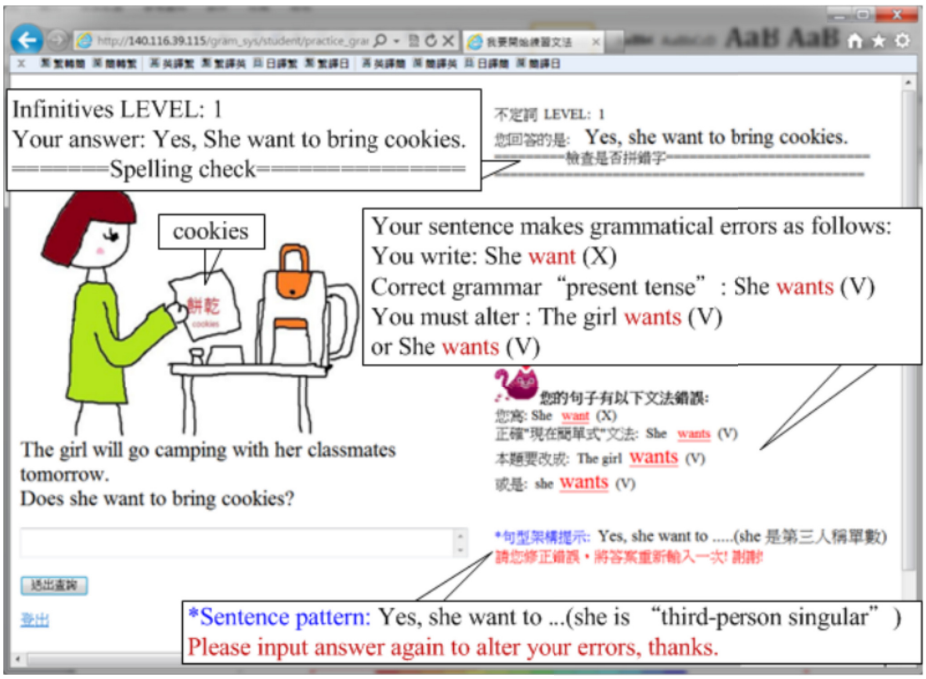

Fig. 3. Screen capture from the IRF-EGLA system

4 Experimental Design and Procedure

This study wanted to explore whether applying the IRF strategy to English grammar practice in the EGLA system would have positive learning effects, and to compare the results with students participating in IRF-based English grammar learning activities in a classroom. We thus performed a pre-test/post-test non-equivalent control group design with three classes of junior high school students in Taiwan. The target population was comprised of 100 students in the eighth grade. Thirty-five students in one class served as the experimental group, which was exposed to the EGLA system that used the IRF strategy. In the other two classes, 31 and 34 students served as control groups A and B, respectively. Control group A was exposed to the EGLA system but without integrating the IRF strategy (the non-IRF EGLA just gave simple feedback of whether the answer was correct or not. It is important to note that, unlike the IRF-EGLA system version, if the student submits three incorrect answers in a row, the non-IRF EGLA system only shows the correct answer without the elaborated feedbacks or explanations), whereas control group B received real IRF-based English grammar courses with an English teacher in a classroom. The three groups were exposed to the same content and materials with regard to the grammar rules. Figure 4 presents the experimental procedure. In the first week, all the students participated in a 1 hr pretest that was used to evaluate whether the three groups had equivalent basic prior knowledge of English grammar. Before the English grammar learning activity,

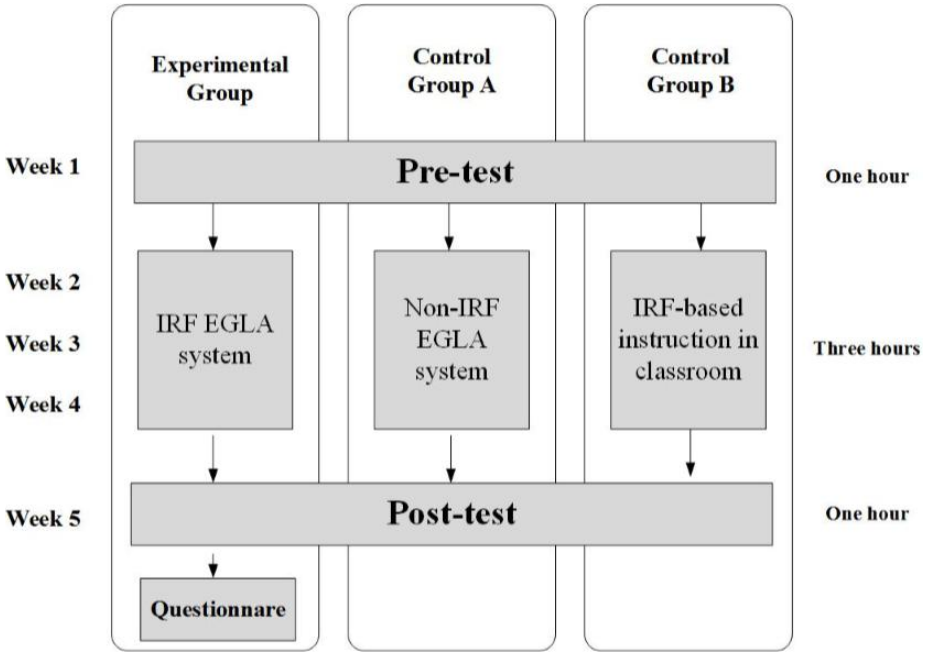

Fig. 4. Experimental design and procedure

the instructor briefly introduced the login procedures of the EGLA system to the experimental group and control group A. During the next three weeks the students in the experimental group, control group A, and control group B learned English grammar by using the IRF–EGLA system, by using the non-IRF EGLA system, or through IRF-based English grammar instructional discourse with the teacher, respectively. Additionally, after finishing the post-test in the last week, the experimental group also completed a questionnaire survey about the feasibility and their perceptions of using the IRF-EGLA system, and semi-structured interviews were also conducted.

4.1 Instruments

Grammar achievement test: Two paper-based grammar tests were conducted collaboratively by three English teachers serving in junior high schools before and after the experiment as the learning pre- and post-tests. All of two grammar test contents was designed to meet the students' level. Before the experiment, we also undertook a pilot study, aiming to assess the two paper-based grammar tests for reliability and validity. The pre-test consisted 30 items that were subjected to analysis after finishing the pilot study, and the results showed the Cronbach's alpha was 0.951, as well as the post-test consisted of 42 items and its Cronbach's alpha was 0.959. It indicates that two tests have high reliability and internal consistency, and three experienced English teachers' judgement was employed as expert validity for these two grammar tests.

Interactive logs stored in EGLA system: In order to understand the students' learning interactions when participating in the IRF-EGAL or non-IRF EGLA activities, we constructed a learning portfolio in EGLA system for each participant, and all the results were thus recorded in the system.

Questionnaire: The questionnaire, which covered three different dimensions, including the system's feasibility, the participants' willingness to learn using it, and the system's usability, evaluated whether the IRF-based EGLA system satisfied the learners' needs. It was employed to gain an in-depth and holistic understanding of students' perspectives regarding the usability and feasibility of the IRF-EGLA system. The questionnaire items were defined using a five-point Likert scale, and the split-half coefficient of the questionnaire was 0.91. To increase the validity, the wording of the questionnaire items was reviewed by one learning technology expert and two English teachers. Moreover, several semi-structured questions involving using the IRF-EGLA system were constructed, such as: How did you feel when participating in the IRF activities in the system? And did you enjoy the IRF-based learning activities? We had one-on-one interviews using these questions with eight randomly selected students. Each interview took approximately 10 min, and all of the interviews were audio recorded with the permission of the interviewees, and then fully transcribed for analysis.

5 Results and Discussion

5.1 Learning performance of the three groups

Descriptive statistics on the scores of the pre- and post-test were used to calculate the means and standard deviations, and a paired-sample t-test was conducted to determine the learning effect on the scores of the pre-tests and the post-tests taken among the three groups.

Table 1. Descriptive statistics and paired-samples t-test for the pre-tests and post-tests

Variable	Pre-test *M (SD)*	Post-test *M (SD)*	*t(df)*	*p*	*Cohen's d*
IRF-based (N=35)	60.31 (26.48)	66.31 (27.75)	2.392(34)	.022*	.820
Non-IRF (N=31)	46.48 (27.89)	46.58 (26.44)	.045(30)	.964	.015
No EGLA (N=34)	62.68 (24.93)	63.29 (27.94)	.415(33)	.681	.144

Note: *p<.05

Table 1 shows that there was a significant effect in scores in the Grammar achievement test pre-test/post-test (t-value = 2.392, p = .022 < .05), the means of the pre-tests and the post-tests were 60.31 and 66.31 respectively and effect size is large (d = .820) for the experimental group which indicated significant progress, while the other two groups didn't achieve a significant effect in scores in the grammar achievement test pre-test/post-test. This confirms the IRF-EGLA system is able to improve learners' English grammar understanding. The t values of both control

groups A and B were not significant, which means that the non-IRF EGAL system and the traditional IRF English grammar teaching cannot improve learners' English grammar understanding as much as the IRF-EGLA does. Moreover, the statistical results indicated that the pre-test scores could predict the post-test scores. To exclude the differences in prior knowledge of English grammar, a one-way ANCOVA was adopted to compare learning achievement among classes. The analysis regarded the experiment treatment as the independent variable, posttest score was the dependent variable, and pretest score was the covariate. A test for homogeneity of variance was conducted, which showed no significant effect ($F_{(2,96)} = 2.84$, $p = .063$); that is, the data met the requirement for homogeneity of variance. Posttest scores were adjusted by removing the influence of the pretest from posttest scores. The statistical results were analysed (see Table 2), and the post-test scores revealed a significant effect between the experimental group and control groups ($F_{(2,96)} = 3.72$, $p = .029 < .05$), and a moderate effect size (η^2) was .071. The Bonferroni post-hoc comparison further indicated that the pair adjusted means of the experimental group were significantly better than those of the control group A ($t = 2.69$, $p = .025 < .05$), but were not significantly difference with that of control group B ($t = 1.58$, $p = .352 > .05$). This indicates that using the IRF-EGLA system is significantly better than using a non-IRF EGAL system, but is not superior to using the traditional IRF-based English grammar discourse approach. Unexpectedly, the pair adjusted means of control group A and control group B also yielded no significant difference ($t = -1.162$, $p = .744 > .05$), which indicates that using a non-IRF EGAL system and using traditional IRF English grammar teaching had no difference with respect to the students' understanding of the English grammar rules.

Table 2. The post-hoc of pairs adjusted means for the three groups

Groups	adjusted means	difference	*t(df)*	*p*	*Cohen's d*
IRF vs. Non-IRF	63.308, 55.508	7.800	2.69(68)	.025*	.652
IRF vs. No EGLA	63.296, 58.926	4.382	1.580(63)	.352	.386
Non-IRF vs. No EGLA	55.508, 58.926	-3.418	-1.162(67)	.744	-.284

Note: *$p<.05$

Due to the surprising finding that the performance of the experimental group that used the IRF-EGLA system was not superior to the control group B that had the traditional IRF-based English grammar discourse, a further investigation of the participants' interactive log data in the Learning Portfolio Repository was used to interpret the possible reasons for the non-significant difference in the post-test scores of the experimental and control group B (the ANCOVA result). In surveying the participants' performance in terms of the questions answered, there was a high unfinished rate (67%) or a high casually answered answer rate (53%) among the low-achieving students (the lowest 30% of all participants). This implies that the low-achieving students with low English literacy may not have understood the meaning of the English grammar questions, so they were unable to cope with or complete all of them. Therefore, if the statistical analysis excludes the low-achieving students (the lowest

30% of the pre-test scores) in the three groups, the results do indicate that the experimental group was significantly better to both control group A ($t = 3.722$, $p < .010$) and control group B ($t = 5.80$, $p < .001$), while the performances of both control groups were still not significantly different ($t = 1.965$, $p > .05$). Another major reason for this unexpected finding may be that the IRF-EGLA system's feedback is derived from the students' responses, so the low-achieving students must understand the meaning of the feedback regarding their mistakes when they respond or need to revise their answers. It is generally agreed that students' prior capacity or literacy need to be considered to avoid cognitive overload [46], which also implies that the system we established needs more scaffolding mechanisms to support low-achieving students. To put it another other way, if the EGLA system does not have a proper feedback mechanism, then learners could perform worse than with a traditional IRF-based English grammar discourse approach. This may be because the system only provides direct feedback in terms of the answer being right or wrong, and only shows the correct answer without other explanations that could help the learners who do not understand the relationship between the correct answers and grammar rules. It also confirms that the establishment of a question and answer system with a lead-in and explaining feedback, such as the IRF-model based mechanism, is vital for improving learning performance.

In short, the results indicated that the EGLA system based on IRF is more beneficial than the other version without IRF, although there were no significant differences from adopting IRF strategy in a traditional classroom. Although the findings are not in agreement with those of Nagata [47] and Corbeil [48], which indicated that computer-based grammar instruction is more effective than traditional instruction, with statistically significant results. Some factors noted in prior studies should be noted here. Wegerif [49] claimed that software designed to provide simple IRF sequences has the potential for interacting with the responses of the students; furthermore, it may be possible to add prompts for discourse into the software so that it can provide further structure for reflective action. Beauchamp and Kennewell [50] investigated how technology can be harnessed to facilitate orchestration by teachers and learners that will guide the formers' efforts to improve learning through the use of ICT. They further highlighted that when adopting ICT as part of students' practice, there was a tendency for the interactivity to become more superficial and authoritative as the technology was foregrounded. They thus stressed that expert orchestration of resources is the key factor in converting interactions into learning, and noted that only when ICT was sufficiently embedded in teachers' pedagogical knowledge did the technology contribute positively to learning [50]. Additionally, it is important to note that the features of IRF that act to facilitate learner involvement and construct the potential for learning include the following: *direct error correction, content feedback, prompting, extended wait time, repairing, turn completion, teacher echo,* and *extended use of IRF turn taking* [51]. We assumed that whether the IRF involved a web-based or traditional learning environment, and would have positive or negative consequences for learning, would most likely depend on the nature of the elicitation and follow-up feedback moves, which in turn influence the depth and extent of learners' responses with regard to the triggered English grammar self-examination or self-

reflection processes. Incidentally, one of the findings of this study was that the nature of the dialogue interactivity seemed to be more influential in affecting English grammar learning than just the use of ICT. This allows for the comparison of having an IRF pattern or not and including it in different instructional contexts, given its documented effectiveness in a web-based English grammar learning environment where no teacher is present. The most successful learning was characterized by more dialogic interaction amongst participants, whether in an English grammar learning system or in the classroom setting, which seemed to foster students' English learning or greater understanding of English grammar concepts. This is good, because it indicates the potential for ICT that takes into account individual differences and provides appropriate guidance to provide a suitable structure that can help achieve the research goal of 'intelligent instructional dialogue'.

5.2 Questionnaire analysis

The questionnaire analysis covered three different dimensions, including the system's feasibility, the participants' learning willingness, and the system's usability, and several comments involving using the IRF-EGLA system are shown in Table 3. A one-sample *t*-test of its scores was used to determine whether the learners' are satisfied with the operations of the IRF-EGLA system, and the results indicated that they had positive perceptions of the system feasibility ($t = 4.549$, $p < .001$) and willingness to learn by using it ($t = 3.722$, $p < .010$). However, the system usability was slightly lower than the other two results. This may be because the IRF-EGLA system still requires more work. As seen in the answers to the open questions of the questionnaire, some learners felt that the responses provided by the system did not come quickly enough, which reduced their concentration and their performance. Another reason may be that the IRF-EGLA system's accuracy in analysing the students' responses only reached 93%. The students' responses contained 560 sentences, and the system could only determine 523 of these accurately, and thus a few students did not receive corrective feedback when needed. This incorrect feedback was caused partly by a disadvantage of the parsing-based approach: When increasingly more types of errors must be included and analysed, the grammar becomes progressively complicated, exponentially increasing the number of ambiguous parses [52]. Knutsson et al., argued that all language learning environments using automatic language technology could encounter problems with the program's accuracy [44], and that sentence judgments made by an automated mechanism cannot yet yield 100% agreement with the teachers [53]. Another reason may be that the system's frequent use of questions, especially if they constituted the first act of serial IRF moves, might be tedious for students. Nevertheless, most learners had positive attitudes toward the IRF-EGLA system, and felt that the system could help improve their understanding of English grammar rules.

Overall, researchers are not in full agreement as to whether it is valid or not to use the approach applied in this work to evaluate question use, but they do agree that such an evaluation should be based on an improved understanding of the nature of interactive learning and the multifunctional nature of dialogue within it [54][55]. Moreover,

the IRF-EGLA system merely provides feedback focusing on students' grammar errors, and some researchers argue that this is not very constructive [56], while others suggest that feedback on errors is helpful despite the fact that it seems to be difficult to obtain strong scientific evidence for this [44]. Regardless, the main focus in this study is on integrating the IRF strategy into a web-based English grammar learning environment, with the results showing that it did indeed improve the junior high school students' grammar understanding and achieved the goal of adaptive English learning for individual students. Another advantage was also found that the learners had the opportunities to be in control of the self-learning tempo during interacting with the system and were able to move at their own pace to complete the learning. On the contrary, learners who learned without using system as aids need to depend on teachers totally for raise new questions without involvement for self-development.

Table 3. The means and SDs for learners' perceptions of system feasibility and usability and learner willingness

Section 1 (system feasibility)	**M**	**SD**
1. The exercise questions adapt to my skill level.	3.66	1.07
2. I understand the system's corrective messages.	3.49	1.27
3. I can revise incorrect sentences.	4.00	1.01
4. Having to revise mistakes makes me feel tired.	2.51	1.18
5. The system assists me in revising errors to reduce setbacks.	3.66	1.12
6. The related pictures make learning feel relaxed.	3.97	0.94
7. Exercises on the computer are better than exercises in books.	3.66	1.24
8. There are too many corrective messages on the screen.	3.22	0.99
9. I review the vocabulary words in the exercises.	3.51	1.18
10. I cannot spell many vocabulary words from the exercises.	3.00	0.96
11. I still cannot answer questions after reading them and viewing the pictures.	3.77	1.11
Average	***3.50***	***0.65***
Section 2 (willingness to learn)		
12. Using the system raises my interest in learning English.	3.66	1.01
13. I can learn English better using the system.	3.11	0.98
14. I would like the chance to learn English on similar systems.	3.57	0.96
15. I am willing to use the next version of this system.	3.60	1.02
Average	***3.48***	***0.76***
Section 3 (system usability)		
16. The system is stable.	2.94	1.14
17. The system is fast enough for me.	2.31	1.01
18. The system is easy to handle.	3.40	1.15
Average	2.86	0.95
Summary	***3.39***	***0.66***

Note: $N = 35$.

6 Conclusion

The ultimate goal of this study is to integrate IRF moves into an interactive English grammar learning system, which attempted to extend or intensify students' English grammar concepts and clarify their grammar misunderstandings or misspellings by questioning and providing adaptive corrective feedback. The verified results from an experiment indicated a significant effect for students who learned with the IRF-based English grammar learning system, despite no statistically significant differences compared with those who underwent IRF-based English grammar discourse in the classroom. It should be noted we are not claiming that an intelligent tutoring system of feedback from a computer-supported language-learning program can completely replace traditional teaching. In fact, most current CALL systems cannot process unconstrained language use. Computer programs able to make some more advanced processing in limited domains, such as those called intelligent language tutors, are excluded from our work. Instead, we hope to increase the power of the computer to engage in easy and meaningful instructional interactions with individual students, including feedback and guidance, supporting different learning levels, and enabling effective grammar learning by junior high students in web-based English learning environments. We believe that this study will contribute to a better understanding of the role of computer-supported language learning in complex interactive processes, such as dialogic-based English grammar learning, and that this will help researchers or developers better understand or think of new design directions for instructional purposes in the future. Moreover, the students participating in web-based interactive language learning should be considered during the development of instructional or learning strategies, in order to provide them with appropriate language knowledge and correct, reinforce, and improve their language proficiency. Finally, ongoing improvements to the IRF EGLA system could include providing some suitable scaffolding support with relevant feedback for lower achieving students, increasing the possibilities for reflection on how the IRF English grammar learning works, improving the accuracy of the system's grammar detection, considering different questioning techniques and more feedback patterns, and elaborating the IRF dialogue structures via the use of more suggestions from expert teachers.

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