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Exploring the Role of 5E-Based Online Activities in English Language Students' Critical Thinking and Creativity

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Abstract

The 5E Learning Cycle Model (Bybee, 1990) is an instructional design model which has roots in inquiry-based learning and constructivism and has received much support in non-EFL-related literature as a way to improve 21st-century skills, such as critical thinking and creativity, among students and to prepare them for an amazing occupational future. However, little work has been done on the model concerning English language students; hence, this study dealt with the effect of 5E-based online activities on English language students' critical thinking and creativity. The study utilized a mixed-method grounded theory method approach. A sample of 60 adult English language students studying in a pre-IELTS class at a private language academy took part in the study during a 12-session semester, in addition to an extra session at the beginning of the semester, in which they received instruction with regard to the platforms to be used, namely Easyclass and Nearpod. Student interviews and self-reflections, teacher interviews, self-reflections, and field notes were applied to extract qualitative data, and student self-assessment checklists were used to gain quantitative data. The analysis of the quantitative and qualitative data via an independent sample t-test, inductive thematic analysis, and grounded theory demonstrated that the employment of 5E-based online activities culminated in the improvement of EFL learners' critical thinking and creativity. The findings have theoretical and practical implications not only for 21st-century language practitioners' education and competencies but also for curriculum development.

Keywords: 5E Learning Cycle Model, 21st-century learning skills, Critical thinking, Creativity, Easyclass

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INTRODUCTION

There have been several learning instructional models for various purposes throughout the history of education. The 5E Learning Cycle Model is an instructional design model defining a sequence of learning based on John Dewey's experiential learning philosophy and also David Kolb's experiential learning cycle applied to improve learners' metacognition (Bybee et al., 2015). This model, which presents a framework for theories rooted in constructivist learning and can be efficiently applied in the process of teaching, was later developed by Roger Bybee of the Biological Science Curriculum Study (BSCS) in the 1980s. Moreover, the 5E Learning Cycle Model is one of several instructional approaches following inquiry-based science. It contains five specific components which are as follows: engage, explore, explain, elaborate and evaluate (Bybee et al., 2015). The engage stage in the 5E model is eliciting prior knowledge and questions from learners to motivate them to learn. In the explore stage, students collect data and make observations to carry out the tasks or activities, and all these explorations are given formal names in the *explain* stage. The students are allowed to satisfy the formerly held questions and extend their act of learning to other topics in the *elaborate* stage. Both students and teachers are provided the chance to reflect upon what was learned in the evaluation stage (Bybee et al., 2015). The 5E Learning Cycle Model can be used to foster each of the 21st-century learning skills entitled the 4Cs since what influences the 4Cs is the process of learning rather than the content of learning (Kivunja, 2015). Creativity and critical thinking, communication, and collaboration (i.e., the 4Cs), which are the subheadings of creativity and innovation skills, are terms commonly known in modern classrooms. Critical thinking and creativity are the two cognitive skills on which this study concentrated.

The 21st Century Skills movement has recognized multiple abilities that learners are required to learn to be successful individuals in the future, and it has also created a framework to foster those abilities. The framework

contains not only skills relevant to content and knowledge, but also skills related to creativity and innovation, media and technology, and profession and life (Partnership for 21st Century Learning, 2015). Educators, organizational leaders, and policymakers believe the 4Cs are critical skills for students to acquire so that they would be able to master the necessary skills for the demands of the recent and upcoming workforce in the 21st century.

LITERATURE REVIEW

Significance of Research on Critical Thinking and Creativity

Based on Partnership for 21st Century Learning (2011), critical thinking is defined as learning how to reason as effectively as possible, use systems thinking, judge, and decide well, and creativity is defined as the ability to develop new and worthwhile ideas applying a wide range of techniques. Critical thinking encompasses creative working with other individuals and responding openly to new aspects. Tsui (2002) stated that it was critical to teach learners what to think and how to think by applying their higher-order cognitive skills. Hence, students should be provided with chances to start thinking deeply to be prepared to confront challenges in their future professions and private lives. This will also require educators to alter their teaching manner so that learners can take their learning into their control.

Equally important, creativity is an essential skill for the 21st century, in addition to technical skills and core subject proficiency (Partnership for 21st Century Learning, 2011). Creative activities are tools that allow learners to talk about their recently learned knowledge in a new way. The newly acquired knowledge is synthesized and personalized, and such consolidated learning will turn into an experience that lasts long after the class.

According to Sun (2016), English learners need to develop in such a way that they turn into not only entirely competent language communicators but also critical thinkers and constructive social individuals. The goal is not

merely focusing on developing skills and mimicking the natives in the English language, but to foster a social responsibility sense in English learners. Moreover, Eaton (2010) states that English classrooms should shift their focus from grammar, rote learning, and memorization to learning language use and cultural knowledge so that students will be able to connect to others around the world. Consequently, learners and teachers had better resort to a sort of a conceptualized field that is mostly student-centered, collaborative, and technologically driven.

An activity-based program that enjoys a vivid inquiry direction can create chances to foster these skills. Learners require opportunities to go through data collection and present their outcomes by applying charts, graphs, or other methods. A study done by Boddy, Watson, and Aubusson (2003) revealed that students' higher-order thinking increases after being taught via the 5E Learning Cycle Model. Non-routine problem-solving skill is among the 21st-century skills. Problem-solving is done through careful examination of a wide range of data, pattern recognition, and data selection to realize a problem and recommend a solution. Other subcategories of problem-solving are innovation and creativity.

The results of this study could contribute to policy makers' and educators' understanding of 5E-based online activities informed by the 5E-Cycle Model as instructional activities in the format of a mixed-method study. Results might also inform activities and practices appropriate for professional learning about 5E-based activities in all English academic centers. The outcomes of this study could also end in practical knowledge for implementing 5E-based online activities into an existing English curriculum, specifically the IELTS curriculum. Moreover, future studies can scaffold skills such as critical thinking benefiting from online websites such as Easyclass although some other studies have already been done through other sorts of online platforms such as blogging (Fathi & Nourzadeh, 2019), and also applying wiki (Rahimi & Fathi., 2021).

Critical Thinking, Creativity and 5E Learning Cycle Model

According to Marboot, Rouhani, and Mirzaei (2020), critical thinking development among English language students is considered a vital aim in the field of education and that is why there have been lots of studies about it in all educational settings. Critical thinking has been referred to even before the revolution of information technology. After publishing Benjamin Bloom's framework entitled the *Taxonomy of Education Goals* (1956), critical thinking emerged as a vital skill in the world. Based on Bloom's new taxonomy version, cognitive learning is carried out in six levels of remembering, understanding, applying, analyzing, evaluating, and creating that are essential skills to transfer students from their simple thoughts to their deeper ones (Anderson & Krathwohl., 2001).

The RED acronym was another framework that was released by Watson-Glaser. The *R* refers to recognizing assumptions; the *E* refers to evaluating arguments and the *D* alludes to drawing conclusion (Pearson, 2009). Both of these frameworks support the critical thinking definition put forward by Partnership for the 21st Century Learning (P21) (2012). According to the definition given by P21 (2012), critical thinking demands that learners have the capability of looking at problems in new ways and be able of connecting the idea of learning across disciplines and subjects. According to Maley and Bolitho (2015), the right conditions enable learners to stay creative, particularly in language, because the language makes us create new associations, new meanings, and playful combinations. These items can be addressed in classrooms, discovered, and simultaneously enjoyed in-class environments at all levels.

The Inquiry-based Learning Model which was supported by the Partnership for the 21st Century Learning Framework not only has equipped educators with a structure for instruction and assessment guidance; but has also referred to the abilities of 21st-century students (McTighe & Wiggins, 2011). Based on the framework, critical thinking and creativity are categorized as learning and innovation skills, and 21st-century learners need

to master them if they desire to become ready for their future life (Partnership for 21st Century Learning, 2011). This study could effectively be considered to be based on two theoretical frameworks: constructivist and inquiry-based learning theories. The claim will be justified in the following paragraphs.

According to Uno (1999), inquiry learning was defined as a technique motivating learners to explore or construct data by themselves rather than obliging teachers to reveal the data directly. They were assumed to develop skills, go through evidence analysis and evaluation, start experiencing as well as discussion, and speak with their peers about their understanding. Problems were solved collaboratively and investigations are planned. Better learning would happen in collaborative environments than in competitive ones. This model enabled students to raise questions, observe, go through analysis, start explanations, come to conclusions and ask new questions.

On the other hand, the constructive learning theory holds that learners are active thinkers constructing their understanding out of their interactions with the due environment, phenomena, and other peers. In a constructivist environment, students spend time sharing conversations about their current thoughts. Interacting with substances, organisms, objects, and facilities, they try not only to extend a huge number of experiences on which they have constructed their thinking but also to express their thoughts via writing (Sharma & Gupta, 2016; Omotayo& Adeleke, 2017).

The 5E Learning Cycle Model was providing a prior built-in structure so that a constructivist classroom could be created (Boddy, 2003). The 5E Model would sequence learning experiences for learners to create chances so that they could construct and understand a concept by passing time (Everett, 2009). The 5E Learning Cycle Model divides instruction into different stages depending on established planning method and goes in the same direction as contemporary theories which are about the manner people learn, constructivist opinions relevant to the nature of science, Jean Piaget's development theory (Kalina & Powell, 2009). There are also many studies

examining the effect of the 5E learning model on students' achievement. Cakir (2017) has cited some studies done by Acıslı (2014), Aktas (2013a), Dasdemir (2016), Dikici, Turker, and Ozdemir (2010), and also Ozsevgec, Cepni, and Bayri (2007). All those studies that were cited in Cakir (2017) revealed that the Learning Cycle could lead to superior concept retention, greater achievement, better process skills, and greater reasoning abilities if this model was compared with traditional pedagogy.

PURPOSE OF THE STUDY

The purpose of the paper is to study the effect of 5E-based online activities on English students' critical thinking and creativity skills. The ability of the current educational system to provide students with the essential skills to turn them into universal collaborators, appropriate communicators, critical thinkers, and capable individuals to apply today's complicated technologies has already been of paramount importance for educational and business leaders. The Partnership for 21st Century Skills (P21) which is a national advocating organization for the necessity of preparing each learner with the 21stcentury skills states that education in the 21st century is demanding for learning 21st-century themes and core subjects, innovation skills, technology, and media literacy as well as career and life skills (Partnership for 21st Century Learning, 2015).

Therefore, the learners in the present study were provided with 5E-based online activities to investigate whether they can be beneficial in improving English language students' critical thinking and creativity. To meet the aims of the study, the following research questions were designed:
1. To what extent do 5E-based online activities develop the English language students' critical thinking?
2. To what extent do 5E-based online activities develop the English language students' creativity?

METHOD

Participants

The participants were Iranian English language students who were studying at Islamic Azad University, Karaj branch and had not participated in any IELTS classes before. Both male and female students who were approximately aged from 21 to 24 years old, and were interested in participating in pre-IELTS preparation courses announced their interest in this specific class. A word-of-mouth snowball sampling was applied to identify the participants so that students could introduce their peer classmates or friends who desired to take part in such a preparation course.

The population was composed of 121 participants, but 40 students were interested in participating in this preparation course, and 20 students took part in the study via snowball sampling procedure. After administrating the pre-IELTS proficiency test, the results showed that they were at the pre-intermediate level through the official band score released by IELTS. Ultimately, 60 students were selected as participants in all phases of this research after the sampling procedure. In the following step, the teacher-researcher assigned 30 of them quite randomly to the control group and the rest 30 students to the experimental group.

Instrumentation

Various kinds of materials and instruments were applied in this mixed-method study. According to Yin (2018), benefiting from various types of data sources paves the way for the researchers to triangulate data and strengthen construct validity.

Data Collection Procedure

Each of the instruments will be explained in detail in the following sections, but first, a general description will be given about the data collection procedure in this study. To conduct this research, the first-researcher had the

role of the teacher for both control and experimental groups. That was to reduce the impact of external variables that could decrease the internal validity of this study. First of all, the teacher signed up in Easyclass which was the study virtual environment and created two classes there, and then she selected 12 free 5E-based activities as the study treatment from Nearpod platform. The academic semester which was held in an IELTS academy located at Karaj lasted for 12 weeks (12 pre-IELTS sessions); however, there was one 150-minute extra in person session (introduction class) for students before the treatment period. They learned how to sign up, sign in, pick up their assignments, leave their assignments and chat with other students or the teacher in the discussion section of Easyclass. They also joined Easyclass as learners: 30 learners in the experimental and 30 in the control group.

The study utilized the twelve free Nearpod 5E-based online activities that were described in detail in the heading titled "5E-based online activities" in the following section as treatment and uploaded them on Easyclass as assignments with a specific one-week time limit for the experimental group. The students in the experimental group received the treatment as their assignments. Furthermore, six IELTS reading and also six IELTS listening tasks that had been taken from https://ielts-up.com/reading/ielts-reading-practice.html, and https://ielts-up.com/listening/ielts-listening-practice.html were considered assignments with a one-week specific time limit to be carried out by the students in the control group on Easyclass. The students in both groups were supposed to pick up their pre-defined assignments on Easyclass and consequently, assign and leave them again there. Students in both groups received teaching based on the books titled "Get Ready for IELTS Reading: Pre-Intermediate A2+", and "Get Ready for IELTS Listening: Pre-Intermediate A2+". The objective of teaching these books was to enhance the IELTS students' reading and listening performances. These books were written by Geyte (2012), and Short (2012), respectively. There was one class each week which lasted about 2 hours. Therefore, students in both groups received consecutively

their 12 particular assignments in 12 weeks. It is significant to mention that the participants were allowed to upload their delayed assignments on Easyclass though the delayed assignments were shown in red color instead of green on Easyclass. It is worthy to mention that the students in the experimental group and the teacher answered their pre-and post-self-reflections at the end of classes 3 and 12. Finally, at the end of the course, twelve male and female students in the experimental group were randomly interviewed by the teacher.

The Virtual Classroom Environments

This study applied two virtual environments: Easyclass and Nearpod. Easyclass which can be surfed at https://www.easyclass.com/ was the virtual environment in which the experimental-group and control-group assignments which had already been described were uploaded by the teacher and downloaded by the students. Easyclass creation aims to provide instructors and their students with a free virtual classroom run by Learning Management System (LMS) (Mayyas & Bataineh, 2019). The secure, user-friendly and also, the time-saving environment of Easyclass enables teachers to create their digital classes, save their materials relevant to the course online, implement their class discussions, determine assignments for their students, administer tests and exams, grade and post their feedback to their learners (Mayyas & Bataineh, 2019).

Nearpod at Nearpod.com applied in this study was not the main virtual environment in which the research was conducted, but it was, in fact, the place where the slides contained the shared 5E-based activities. The teacher-researcher preferred to shift these Nearpod 5E-based online activities to Easyclass since Nearpod environment participation required both the instructor and students to pay annually a subscription fee to use the website.

5E-Based Online Activities

The 5E-based online activities available in Nearpod contained parts such as

testing students' prior knowledge, watching a relevant clip, teaching vocabularies based on the 5E-phase referred to in the 5E Learning Cycle Model (Engage, Explore, Explain, Extend and Evaluate). One free sample of 5E-based activities which has a preview and was used as an assignment for the experimental group participants titled as Human Trafficking is accessible at https://nearpod.com/t/english-language-arts/9th/what-is-human-trafficking-L42593328 (Note: the 5E-based lesson plan is given on slide 5). Subjects and contents of these activities encompass topics learners seek in English Language Arts (ELA), Social Studies, and Science. They are relevant to the basic curriculum and follow standards. These ready-to-run assignments provide the instructors with the required 5E-based resources for a lesson that is entirely literacy-infused. Each of these 5E-based online activities is planned around the 5E Learning Cycle Model to be an inquiry-based learning experience. The twelve present study assignments which were given as treatment to the students in the experimental group had been categorized into five parts (Engage, Explore, Explain, Extend and Evaluate) (Shahrokni, 2018). These five phases extracted from Nearpod are visible in Figure 1.
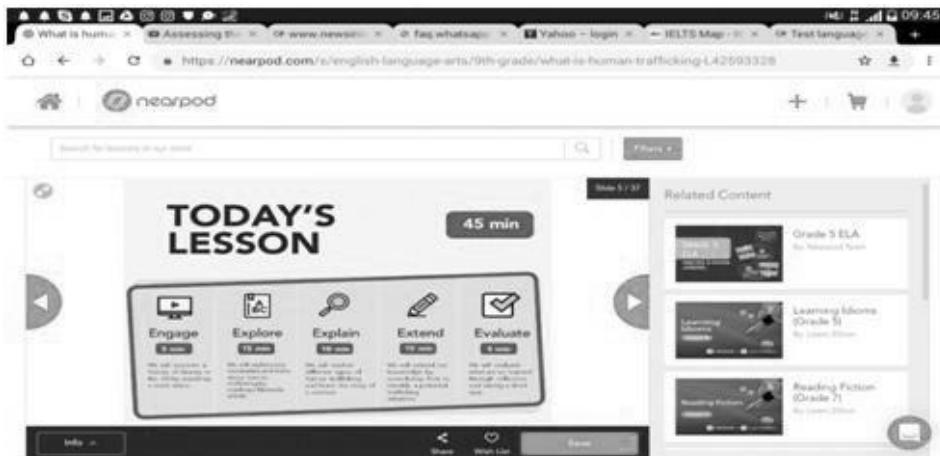

Figure 1: The five phases of 5E-based online activities in Nearpod (Nearpod, 2022)

Engage phase: It contained examining some statistics on the given topic, testing prior knowledge which contained 1 question requesting students to manifest their personal information, going on a field trip (a 3-dimensional photo of the topic and a relevant question), watching a short video followed by some questions and findings parts in which students concluded by answering some questions. *Explore phase*: It contained introducing new related vocabularies, matching these words with their definitions, reading an article on the given topic to know more followed by some relevant questions, moving to think-pair-share in which there are 3 questions and students have to select one of them and discussing it in the discussion section of Easyclass. *Explain phase*: It contained an open-ended question which is a request to explain the definition of the given topic or a related question, a slide explaining the answer to the previous question by Nearpod, another open-ended question, and again an open-ended question. *Elaborate/Extend phase*: It contained a relevant question, a slide presenting more data, another related question, and again a slide presenting more data. All these questions and slides aided learners to extend their knowledge via learning about the presented topic in the question and its relevant slides. *Evaluate phase*: It contained a quiz containing a quiz and a poll. The quiz and the poll created a chance for the learner to reflect on what was about to be evaluated.

Critical Thinking and Creativity Checklists

The second author developed two self-assessment checklists containing self-initiative items particular for the above-mentioned student level, benefiting from EFL learners' prior experiences with self-assessments. Critical thinking and creativity checklists (Appendix A) were validated by two experienced TEFL experts in self-assessment to confirm if the items measure the construct under the study. The checklists were used by participants as an instrument to have an assessment of their skill growth. Each checklist was prepared based on a definition that could coordinate the

definition of skills presented in the Partnership for 21st Century Learning (2015). Some adaptations were done from the Partnership framework for 21st Century Learning (2015) so that it could be appropriate for the context of the study. The adaptations are as the following: a) after the checklist was piloted by 15 participants to prove its appropriateness for the current study context, every sentence was rephrased to the extent to be fit for participants' comprehension. b) The researcher endeavored to replace more keywords relevant to themes and also sub-skills of the constructs that she desired to measure.

To measure the critical thinking and creativity skills of the participants, critical thinking and creativity checklists were given to the students both as pre-test and post-test. This scale contained 7 items dealing with critical thinking and creativity underlying components: critical thinking (4 items), and creativity (4 items). This checklist was considered as a self-report scale that is in a Likert 3-choice response type, containing three options as 1 (still not), 2 (starting), and 3 (now, yes). Cronbach's alpha was used to check its reliability. The Cronbach's Alpha indices for the two checklists containing Critical thinking and creativity were .83 and .76, respectively which is satisfactory (Pallant & Manual, 2010).

Students' Self-Reflections

Self-Reflections (Appendix B) were the next tools specifically targeted at collecting data on the 5E-based activities as treatment and were completed twice at the end of classes 3 and 12. It had 6 questions to gain insight into English learners' experiences during the study. To find out about students' perception of the efficacy of treatment in a more detailed manner after reviewing the literature comprehensively, six questions were devised. Since these questions were devised self-initiatively, three TEFL university instructors were asked to review the items for the sake of validating the instrument to make sure they were worded appropriately and concisely.

Participants' answers to the questions went through inductive thematic analysis. In the next phase, the reliability index related to the

coding procedure of the two experts who coded the data was calculated by applying Holsti's (1969) coefficient of reliability. The value was revealed to be 0.83, which showed a satisfactory index in coding agreement. It had a narrative format (Pallant & Manual, 2010). Schön (1983) also highlighted the significance to concentrate on self-reflection. Students were required to record their handwritten replies to the questions in a narrative manner.

Informal Interviews of Students

Four unstructured and open-ended interview questions (Appendix C) were developed and 12 approximately 15-minute interviews in audio format were run to examine experimental participants' perception of various components of the treatment and their effects on their creativity and critical thinking (indirectly). These questions were prepared based on the themes and sub-skills of the construct the researcher intended to measure. For example, reasoning effectively, solving problems, thinking innovatively, cooperating creatively with classmates, and implementing creativity and innovation were considered as the main sub-skills of the constructs based on Partnership for 21st Century Learning (2015). Open-ended interview questions were employed to extract and explore participants' responses, which were developed to unfold rich data so that themes, as well as constructs, could be illuminated regarding the phenomenon under this study.

Thematic analysis procedures were applied to analyze the interview outcomes as explained by Auerbach and Silverstein (2003). According to Auerbach and Silverstein (2003), there are six steps for content analyses. These steps are as follows: to get familiar with data, figure out initial codes, seek for themes among codes, review and study the themes, define and also label them, and create the final report. All the following measures to the six steps were used to analyze the qualitative data. To code the qualitative data, inductive coding was carried out. To do so, the researchers read through the data and allowed codes to emerge as a bottom-up analytic strategy.

Furthermore, two university professors in applied linguistics with 25 years of experience in teaching and also the experience of thematic analysis

helped the researcher. Next, agreements and disagreements between the researcher and the research assistants' coding were calculated by applying Holsti's (1969) coefficient of reliability which manifests the number of agreements per total number of coding. The calculated value was 0.92, which proved a satisfactory agreement. This number indicated that the research assistant's coding outcomes were consistent with those of the researchers' coding (Pallant & Manual, 2010).

First Researcher's Pre-and Post-Self–Reflection and Interview

The teacher (the first researcher) completed a self-reflection (Appendix D) before and after the treatment so that the teacher's knowledge and perception of the current treatment would be gained. The aim was to gain the teacher's perspectives on the theoretical framework of the study: critical thinking and creativity which are subheadings of 21st-century learning skills (4Cs: Critical thinking, Creativity, Communication, and Collaboration) and the 5E Model. Before and after the treatment, the teacher kept a record of her handwritten responses to the two questions provided through the reflection.

There were 4 questions for the teacher in her interview sheet (Appendix E) to which she responded and they were conducted in English language. It took approximately about 10 minutes. The teacher's interview zoomed on the research questions presented in the study and also presented content from the critical thinking and creativity checklists. As recommended by Creswell (2014), the researcher pursued the interview and raised questions to start the discussion, and then she followed the interview with some relevant open-ended questions to have much more data in detail. Data were collected in audio format and notes were drafted in the field notes.

Field-Notes

The teacher's observations, interviews, and also, her reflections were manifested in her field notes. The goal behind observational notes was to describe the process and the manner of implementing the lesson plan. The

teacher had to record interactions between students and teacher and the teacher's facilitation techniques applied; if there were any. The researcher could also add reflective notes relevant to teacher-student interaction while 5E-based online activities were conducted.

In addition, the teacher wrote reflective notes which were entirely depicted in field notes throughout this study. The reflective drafts were applied for a few goals. First of all, the teacher identified and reflected her perceptions and assumptions on those notes before data was collected. Furthermore, the teacher kept recorded self-reflective data while the study was in progress. Finally, the teacher visited again the previously recorded assumptions depicted in the notes due to data analysis.

Data Analysis

The research questions of the present study aimed at exploring the extent to which 5E-based online activities develop the English language students' critical thinking and creativity. Therefore, the collected data in the study including students' interviews, students' self-reflection, the teacher's interview, teacher's reflections, and teacher's field notes were analyzed drawing on grounded theory to yield the prospective emergent theories. To do so, the stipulated steps associated with grounded theory consisting of 1) Open coding, 2) Axial coding, and 3) Selective coding were followed. Moreover, to seek confirmation for the development of the two selected skills among 21st-century cognitive learning skills, the results of the critical thinking and creativity checklists given to the learners in the experimental group before and after the treatment were also analyzed descriptively.

The collected data was analyzed to identify the initial themes contributing to critical thinking and creativity each individually during open coding. In the present study, after identifying the themes and sub-categories in the open coding stage, and main categories in the axial coding stage, the core category relating to the contribution of 5E-based online activities to the development of the English students' every due skill was developed in the

selective coding stage. The main categories were joined together and the core category of factors in 5E-based online activities contributing to critical thinking and creativity distinctly emerged.

To make sure of the reliability of the thematic analysis procedure, the study benefited from two Ph.D. holder raters in TEFL who had 20 years of experience to ensure inter-rater reliability. After the analysis, agreements and also disagreements between the two ratings were calculated by applying Holsti's (1969) reliability coefficient. Holsti's (1969) reliability coefficient depicts the number of agreements per total number of thematic decisions. To further augment the reliability, the intra-rater reliability was also run.

RESULTS

Qualitative Data

In the current study, critical thinking was defined as the ability to reason effectively, use systems thinking, make judgments and decisions, and solve problems, and creativity was characterized as the ability to exercise idea creation techniques, create ideas, analyze and refine ideas, work creatively with others, and implement ideas (Partnership for 21st Century Learning, 2015). To find the extent 5E-based online activities develop the English language students' critical thinking and creativity, the collected data from students' interviews, students' self-reflection, teacher's interview, teacher's self-reflections, and teacher's field notes were analyzed drawing on grounded theory to yield the prospective emergent theories.

Many of the responses described students' critical thinking experience as being beneficial for learners in making judgments and decisions, enhancing their problem-solving skills, doing effective reasoning, and using systems thinking while they were doing 5E-based activities. Pieces of the observations and reflections in this study as excerpts will be presented in the following paragraph:

"*Using different, but topic-related materials such as pictures and videos in the assignment made the instruction interesting and encouraged*

me to answer relevant questions" (Salmani, self-reflection, May 20, 2020). This shows that he started reflecting critically about his learning experiences, so it is in line with the current study result as assisting learners in making judgments and decisions."*When I did my assignments containing different topic-related activities, I became more active in class and wanted to know more and more, not only about grammar and vocabulary but also about the content*" (Hosseini, self-reflection, May 20, 2020). This reveals that she started analyzing how pieces of a whole have interaction with each other, so it supports the study finding as assisting learners in using systems thinking. "*Asking us questions before reading made it more interesting for us since we started thinking about the issue*" (Ershadi-Manesh, interview, May 29, 2020). This shows that she started being interested to ask and answer significant questions, so it is in line with the study finding as helping learners to enhance their problem-solving skills.

On the other side, many of the responses described students' creative and innovative experiences as being beneficial for learners in encouraging creative thinking, working creatively with others, and implementing innovations. To support the mentioned claim, some excerpts will be given as samples:

"*As I could notice, learners usually shaped logical argumentative patterns which they took from previous arguments to new argumentative settings*" (Teacher's field notes, May 22, 2020). Students started elaborating, refining, analyzing, and evaluating their opinions to enhance creative attempts, so it supports the current study outcome as encouraging creative thinking. "*The 5E-based assignment normally encouraged us to be innovative with new ideas. It asked us to elaborate about some mind-boggling questions, and start reasoning*" (Fadaee, interview, May 29, 2020). Hence, students started acting on innovative opinions, and implementing innovations as the study results claimed.

After extracting the sub-categories from the initial themes during the open coding stage, the main categories emerged during the axial coding. It was during the selective coding stage when the core category depicting the

main theory grounded in the data resulted.

The following Table 1 reveals the resulting core categories for each of the due skills; respectively, critical thinking and creativity.

Table 1: Results of the axial coding phase for the extent 5E-based online activities develop critical thinking and creativity

Skills	Sub-categories	Main Categories
Critical Thinking	●Analyzing and evaluating main alternative perspectives/ Reflecting critically about learning experiences and also processes/ Effective analysis and evaluation of evidence, arguments, claims and beliefs	Assisting learners in making judgments and decisions
	●Cultivating students' interest to ask and answer significant questions/ Encouraging a sense for scientific inquiry development	Helping learners to enhance their problem-solving skills
	●Encouraging learners to use various types of reasoning/ Improving appropriate reasoning for a given situation	Encouraging learners to do effective reasoning
	●Analyzing how pieces of a whole have interaction with each other/ Encouraging learners to see how overall outcomes can be seen in complex systems	Assisting learners in using systems thinking
Creativity	●Using a variety of idea creation techniques/ Elaborating, refining, analyzing and evaluating their opinions to enhance creative attempts	Encouraging creative thinking
	●Bringing up new ideas and sharing them with others/ Being responsive and open to original and different aspects; incorporating others' reactions into one's work	Encouraging learners to work creatively with others
	●Acting on innovative opinions/ Making a tangible and beneficial try to their own and others' learning experiences	Implementing innovations

Upon constant reviewing of the sub-categories, the researcher came up with four and three, main categories which contributed to the emergent theory for the way 5E-based online activities helped to develop the English students' critical thinking and creativity, respectively.

Quantitative Data

Apart from what was mentioned above, to compare the 4C level of the learners in the experimental group, the critical thinking and creativity checklists were administered to the participants before and after the treatment. Each summary of the results is presented in Table 2 below:

Table 2: Summary of the results for critical thinking and creativity skills checklists before and after the treatment

Skills	How is it going?	Still not	Starting to	Now, yes
Critical thinking	Before Treatment	87 (72.21%)	22 (18.26%)	11 (9.13%)
	After Treatment	14 (11.62%)	33 (27.39%)	73 (60.59%)
Creativity	Before Treatment	92 (76.36%)	20 (16.6%)	8 (6.64%)
	After Treatment	10 (8.30%)	21 (17.43%)	89 (73.87%)

As presented in Table 2, a pre-post treatment comparison of the checklist results for critical thinking (Not yet: 72.21% to 11.62%, Starting to: 18.26% to 27.39%, Yes: 9.13% to 60.59%) indicates that learners' critical thinking skills have shown development. Similarly, a pre-post treatment comparison of the checklist results for creativity (Not yet: 76.36% to 8.30%, Starting to: 16.6% to 17.43%, Yes: 6.64% to 73.87%) reveals that learners' creativity skills have improved based on descriptive results.

DISCUSSION

This mixed-method grounded theory study aimed at identifying the effect of 5E-based online activities on English language students' critical thinking and creativity skills. Analysis of the findings related to teacher and also students' interviews as well as their self-assessments and self-reflections ended up in major findings. Interpreting both the numerical information and the verbalized comments proved that English language students' critical thinking and creativity skills among 21st-century cognitive learning skills were positively developed and improved. It seemed reasonable to assume that the 5E-based online treatment paved the way for augmenting critical thinking and creativity among IELTS learners.

In line with the results of the current study, some other papers presented further support to confirm the positive effect of applying the 5E Learning Cycle Model in education compared with other instruction modes. This study was found to be consistent with the one done by Boddy et al. (2003). Students found the trail of a unit study that was rooted in the 5E Model very mind-boggling. It also proved to be very effective to raise a higher level of thinking ability among students. Moreover, other studies were done by Runisah, Herman, and Dahlan (2017) and also by Lu, Yang, Shi, Xue, and Wang (2020) with the same findings. The same results have been achieved in the present study since the 5E-based online activities were proved to make students start reasoning effectively. They started to have progress in problem-solving ability.

The study findings revealed that 5E-based online activities were beneficial for English language students to start analyzing and evaluating main alternative perspectives which led to reflecting critically on their learning experiences. Also, the 5E-based treatment aided them in the effective analysis and evaluation of evidence, arguments, claims, and beliefs. Furthermore, the study result showed that the relevance among five different stages of the treatment cultivated students' interest to ask and answer significant questions, and consequently, encouraged a sense of

scientific inquiry development among the students. As a result, learners started using various types of reasoning for a given situation and analyzing how pieces of a whole interact with each other in complex systems. All of these outcomes are defined as sub-skills of critical thinking and problem-solving (Partnership for 21st Century Learning, 2015).

Non-routine problem-solving skill is among the 21st-century skills. All of the students were successful in concluding since their answers seemed completely logical. Whatever they did, their replies sounded true. It showed they had nice information analysis while they were watching films or reading articles. They were able to identify and raise significant questions so that they ended up with better solutions. The mentioned ability is another sub-skill of critical thinking. All the above-noted statements based on the teacher's self-reflection revealed the fact that the students started to reason effectively and have gone through the various stages which are entirely the sub-skills of critical thinking and problem solving (Partnership for 21st Century Learning, 2015).

Evans (2004) conducted a study to figure out how to raise students' motivation and enhance their creativity and their curiosity. He planned a unit about gases based on the 5E Model resulted in students' active participation in the lesson. While the 5E-based unit was treated, they participated responsibly as well as creatively and also had fun. Evans's study is incongruent with this study. It was supported that the 5E-based online activities made students creative and motivated effectively so that they took their learning responsibility and turned into engaged, independent, and motivated learners.

Additionally, the study resulted revealed that 5E-based online activities were beneficial for English language students to start using a variety of idea creation techniques which led to elaborating, refining, analyzing, and evaluating their opinions to enhance their creative attempts. While the students in the experimental group were doing the activities in different phases of 5E-based treatment, they brought up their new ideas and started sharing them with others in the activity that demanded them to

discuss the topic in Easyclass. The students were responsive and open to original and different aspects in the "discussion section" of Easyclass and tried to incorporate others' reactions into their work while acting on innovative opinions. It supported the fact that they were capable of demonstrating both originality and also inventiveness in work and figuring out the real-world restrictions to adopting novel opinions which are sub-skills of creativity (Partnership for 21st Century Learning, 2015).

The outcomes of this study, however, should be applied cautiously since there existed limitations to the current investigation that are worth citing because they put forward implications for further studies. First, future research papers are invited to seek survey platforms that are not online to achieve much better generalizable results since it was an instrument allowing participants to skip questions and this fact could potentially result in random errors of measurement and it possibly could prevent generalizability of the results, although it was tried to impede this limitation by increasing the number of participants from 20 to 30 in each experimental and control group.

In addition, this study was restricted to only one IELTS language school in Karaj and the length of allocated time to conduct the research was limited to 12 classes. Hence, later studies seek larger samples, especially for validation studies and general surveys of 5E-based treatment effectiveness on English language teaching and learning.

CONCLUSION AND IMPLICATIONS

The current study presented empirical evidence for the role of 5E-based online activities in Iranian EFL learners' critical thinking and creativity skills which were targeted by 21st-century learning skills. The investigated findings demonstrated that 5E-based online activities were valid enough for explaining the creativity and critical thinking among the required skills for the 21st century. The results of the open coding, axial coding and selective coding provided sufficient shreds of evidence to verify the categories of the

phenomena under the study. Furthermore, the quantitative descriptive data analyses of the checklists indicated that the 5E-based online activities led to the development of the students' critical thinking and creativity skills. This was compared with the outcomes of a wider range of studies in other settings. To a large extent, they converged at very similar patterns which insinuated that proposed activities were confirmed in multiple studies.

Furthermore, the interrelationship between the 5E Learning Cycle Model on one side and critical thinking and creativity promotion on the other side found support in Partnership for 21st Century Skills (2007) in which it is much more accurate to measure 21st-century learning skill mastery directly in the learners. Therefore, it is essential to create an educational application or website matching the Partnership for 21st Century Learning framework considered for 21st-century skills so that practitioners, syllabus designers, and teachers can benefit from ready-made activities based on 5Es. This application can assist the new generation of students to be employed in modern markets and meet their demands. This tool would be able to measure each learner's degree of proficiency in each area of critical thinking and creativity.

The findings also shed light on the relationship between 5E-based online activities and EFL learners'4Cs (Critical Thinking, Creativity, Communication, and Collaboration) which were titled 21st-century learning skills since the aim of this study was to deal with the two cognitive critical thinking and creativity skills based on the definition which was given by Partnership for 21st-Century Learning (2015). It has been shown that the 5E-based treatment is teachable and these two super cognitive skills can be promoted and consequently, assessed as effectively as possible by L2 teachers. Recently, different resources provide their users with wonderful and ample activities, techniques, and equipment and all educational academies can utilize them (Arnold, Puchta & Rinvolucri, 2007). These activities can be administered within the main teaching syllabi so that learners are given a domain to feel how the learning activities and efforts may end up in their eventual success.

Regarding the practical implications of the study, the results indicated that 5E-based treatment can exert a positive effect on L2 learners. It suggests that the useful potentials of the 5E-based treatment can be exploited in language education in EFL contexts the same as in Iran, where English is taught to foreign language learners as the second language throughout the school period; hence, such treatment could be employed to promote 21st-century skills; particularly, critical thinking and creativity skills so that students can move beyond these basic skills and embrace these skills (Kivunja, 2015). According to Saxena (2015), each of these 4Cs titled super skills can aid language learners to develop their essential qualities to succeed in college, careers, and also citizenship.

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Appendices
Appendix A: Critical Thinking and Creativity Checklists

Critical Thinking

How is it going?		Still not	Starting to	Now, yes
Effective Reasoning	I can make various forms of decisions (based on both facts and also personal experiences).			
Benefit from System Thinking	I can realize how various items influence on each other as well as how they work together.			
The ability to Judge and Decide	I can realize other individuals' points of view. I can connect between different information. I can have reflection on learning experiences and arrive to conclusion.			
Problem Solving Ability	I am able to solve problems on a regular basis and recent ways. I can raise appropriate questions to figure out others points of view.			

Creativity

How is it going?		Still not	Starting to	Now, yes
Enjoy Creative Thinking	I can apply strategies to make new opinions (such as brainstorming and drawing). I can have creative innovative opinions and improve them.			
Work as Creative as possible with people	I am not able to communicate new opinions to other individuals. I am also open to opinions from other individuals.			
Consider Each Failure as a Learning Chance	I know that when I can't do something correctly, a chance is created to learn. I figure out that sometimes creativity entails learning from mistakes which can take a long time.			
Have Innovative Implementation	I have the potential to invite creative opinions to life via changing my opinions into products which could assist others.			

Appendix B: Learners' Self-Reflection

1. What is your name?
2. What did you as a student learn from going through this sort of experience? Do you desire to do this once more? Why or why not?
3. How well did you get along and work with your partner?
4. What creative risks did you take while you were going through this experience?
5. Which phase (prior knowledge, discussion section, film, article, vocabularies in Nearpod, field trip or lets evaluate and poll) in theonline activities you received was the best for you and why?
6. Which phase (prior knowledge, discussion section, film, article, vocabularies in Nearpod, field trip or lets evaluate and poll) in the activities you received did you hate? Why?

Appendix C: Learners' **Interview**

Questions:

1. Could you tell me more about the activities (assignments) you did during the term? What was your general idea about them in the process of English learning? How much can they be efficient in IELTS learning (Not at all, a little, 50%, so much, completely)? Why?
2. What did you admire or hate about those activities in English learning?
3. Have you learned anything from the activities you have received so far?
4. What percentage did you think they helped you in process of your English learning? What about IELTS learning?

Probing questions:

- Could you let me know a little more about…?
- Could you bring an example about…?
- What was the reason you decided to…?
- Can you explain more about…?

Appendix D: Teacher/ Researcher's **Self-Reflection**

1. If you wanted to define critical thinking and creativity relevant to learning in 21st century, how would you currently do it?
2. How do you currently define 5E-based online activities?

Appendix E: Teacher's **Interview Questions**

1. Could you describe 5E-based online activities which have been run in the online class so   far?
2. What did take your attention about English learners during the   course?
3. How do you describe each of the two 21st cognitive learning skills: critical thinking and creativity which were done by students?
4. What is your anticipation about any possible challenges if 5E-based online activities are going to be implemented further?

Probing questions:

- Could you let me know a little more about…?
- Could you bring an example…?
- What was the reason you decided to…?
- Could you explain more about…?