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**A Program Based on Problem Space Theory for
Assessing EFL Critical Reading and Writing of
Secondary Stage Students**

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Abstract

The study sought to investigate the effect of a suggested program based on Problem Space Theory for assessment to develop critical reading and writing skills of EFL second secondary stage students. The sample consists of 30 students and three raters from Al Abaseya and Al Basateen Preparatory / Secondary Institutes for Girls, Al Azhar Al Sharif institutes, Cairo Governorate. The researcher applied one group quasi-experimental design. A blueprint, prepared by the researcher, is given to the students as an introduction to the suggested program. Quantitative data is obtained from the pre- posttest and the test is assessed by the integrated critical reading and writing checklist prepared by the researcher. The qualitative data is obtained from the student interest inventory, a questionnaire for the participant teachers, observation card and unstructured interview with the participant teachers. Triangulation of the qualitative analysis emphasized the conclusion of the posttest scores. That is, there is a statistically significant difference between the mean scores of the research group in the pre and post-test administration of the overall and the sub-skills of the critical reading and writing skills in favor of the posttest scores. After testing the validity of the hypotheses, the findings revealed the effectiveness of the suggested program on developing the critical reading and writing skills of the EFL second secondary students.

Keywords: Problem Space Theory, critical reading, critical writing, Assessment as learning

1. Introduction

Nowadays, it is necessary to focus on how to achieve better-education and higher-quality of learning. Egypt is going through a major transition in education that brings about greater change in the Egyptian society to build a better economy. New reforms are intended to modernize the country's education system and to improve the quality of pre-university education via Edu 2.0 to rank the international standards.

Web 2.0 describes the current state of the internet, which has more user-generated content. It refers to the 21st-century Internet applications such as Facebook, Twitter, and various platforms, through which information is shared and delivered. Therefore, there must be a direct interference from the behalf of the educational organizations to control students' use to the internet pre-university stage. Educational platforms, such as Discovery and EKB, are set by the educational organizations through Edu 2.0 for the students from primary stage to secondary stage. Between 2018 and 2030, Edu 2.0 focuses on developing a competency-based curriculum in line with 21st century skills. In (World Economic Forum, 2015, p. 23), a new vision for education is defined through the skills needed in the 21st century.

Therefore, there is a global need for students to develop a broader set of skills during the years of formal education to be global students. In primary stage, knowledge, skills, attitudes and values are integrated in the curricula to help the student to acquire new competencies. As a result, teachers have to rethink their methods of teaching and assessment to face these new skills. Care et al., (2018, p. 21- 23) raised a question about how these skills can be assessed. Care mentioned that writing skills are assessed through writing tests, however, the 21st century skills challenge the current assessment approaches. Challenges

in assessment lie in the need to understand the nature of these skills to cope with knowledge, attitudes and values that are included in the all new curricula.

It is essential that assessment design should mirror the authentic demands of the targeted skill. The rationale for twenty-first century skills education is to develop the students' capacity to generalize, to adapt and to apply skills in different contexts in life. Then, how can assessment capture these applications? Therefore, it is important to understand the requirements of assessment.

Aghazadeh, S. (2019, pp. 9, 12 &16) pointed out that assessment designs must be authentic and deal with real-world problems to report the actual targeted skills. To achieve this, students' ability should be developed over time to know how far they are able to apply successfully relevant knowledge, skills and attitudes in real-life scenarios. To reach an acceptable reliable assessment, checklists and rubrics (holistic or analytic) should be used to score students' responses in assessing the 21st century skills and sub skills. However, designing valid and reliable rubrics with a clear progression is not an easy task for teachers as it requires expertise. Therefore, there are a lot of ready-made rubrics that have been approved by international organizations for assessment such as Polya's rubric of solving problems (1985).

Rubrics as scoring tools are characterized by being stable, fair and consistent. In this study, Polya's rubric of solving problem is employed to assess secondary stage students 'critical reading and writing skills on the base of Problem Space Theory. This rubric focuses on the process rather than the solution. There are four main descriptors of the problem solving that the students have to understand to be able to reach a solution. The problem is well defined or ill-defined according to the students' background and their reflection on analyzing the problem. To solve a problem, students must be able to identify the problem,

analyze it and identify possible solutions. Style and mechanism descriptor is added to the rubric by the researcher as it cannot be ignored in writing paragraphs. Therefore, the present study attempted to find out an alternative approach to assess critical reading and writing skills by employing Polya's stages and problem solving rubric.

Cromwell (2018) pointed out that in Newell and Simon (1972) problem space theory, all creative problem solving takes place within a problem space, which includes an initial (current) state, the goal state, and all possible states between them. A problem exists when individuals have goals they want to obtain. The actions that people take in order to move from one state to another are known as operators. People navigate their way through the possibilities of problem spaces. However, problem spaces can be very large so the key issue is that domain knowledge helps them to decide what to do. But for novel solvers, Newell and Simon proposed that operator selection is guided by cognitive shortcuts, known as heuristics. The solver needs to identify, devise a plan and evaluate his solutions to the problem to select the best one. This idea of searching in a problem space happens in reading and writing critically.

The GSI Teaching & Resource Center (2016, p. 5) stated that when the students read critically, they read actively with the aims of identifying and questioning certain assumptions. Critical reading is not a process of a superficial reading, but it is an interaction and engagement between the reader and the text. Critical reading of a text enables students to make their own argument, judgments and interpretations of the ideas claimed by the others. Therefore, when reading critically, it is important not only to take in the words on the page, but also interpret and reflect upon what has already been read.

On the other hand, critical writing depends on critical reading when writing involves reflection on written texts. In order to write analysis of a subject, careful reading of the sources should be done critically. In “Skills for Learning” (March 2018), critical writing is an essential part of writing an assignment. When students write their assignments they are writing with a definite purpose, that purpose is to answer the questions that have been set and to write critically to solve a current problem. When students read and write critically about a current problem, they consequently follow the steps involved in the Problem Space Theory and assessed by Polya’s rubric.

2. Literature review and related studies

1.1. Problem Space Theory

Woerner & Hendricks (2022) stated that problem Space referred to the entire range of components that existed in the process of finding a solution to a problem. There are three main stages of the problem space: it starts with “defining the problem,” then proceeds to the intermediate stage of “identifying and testing possible solutions” and ends with the final stage of “choosing and implementing a solution”. Besides, it includes all of the smaller steps that exist between these identified stages. Each real problem demands a solution, and if it is searched properly in the problem space, then outlines which steps are needed to take to move from the initial state to the goal state. All the details about the solution form a solution space.

1.2. The Importance of Problem Space Theory

Woerner (2022) concluded that problem space identifies the problem and develops steps to find out the solution. This importance seems in different fields such as law, sport, and industry, and especially in education. It helps to find

solutions to problems the individuals encounter in their real lives. Heuristics, Algorithms, Insight and Trial-and-error methods are common practices in problem space theory. In spite of being a scientific theory in mathematics, the problem space theory is proved to be as a cognitive theory in different fields of life and many researches and studies are interested in studying it.

1.3.Critical Reading

WOODBECK (2014, pp. 4, 12-16) defined critical reading through actions and assessed it by Polya's Rubric. Critical reading was defined as moving beyond a surface-level of understanding a text to a deeper understanding by going back to prior knowledge of comprehension, judging what the author's purpose might be and considering what was said and what was left unsaid. The students' critical reading was assessed by Polya's Rubric according to their understanding to the topic. Besides, the report imposed different levels of questions (implicit and explicit). The answers to these questions led to analyze, synthesize, evaluate and judge the reading text critically.

1.4.The Importance of Critical Reading

Looking critically at reading means analyzing and evaluating what we read; working out what was good and what was not, and why. In this regard, Tasnimi (2017, p. 1) pointed out that understanding the argument in a text was essential to critical evaluation because anything could not be evaluated without understanding it. Strengths and weaknesses, the limitations in the author's argument and evidence should be identified and any assumptions that author might have made should be challenged.

1.5.Using Problem Space Theory for Assessing Sub Skills of Critical Reading

Greenstein (2021) stated that the spectrum of 21st century assessments included rubrics, checklists, observations and formal/ informal questions. Through literature review and related studies, there is a common agreement that Polya's rubric of problem solving was a mainstream view in psychology and education. It was used to measure 21st century skills such as critical thinking and problem solving. The following studies demonstrated using the problem space theory in assessing critical reading and writing skills by using Polya's rubric as a tool for assessment. High order questions based on Polya's rubric asked students through the following sub skills: Understand the problem, Devise and Carry out a plan and Reflect and Look back. The kind of these questions helped students to solve word problems independently when framed as a general problem-solving technique. With practice, students learnt how to analyze a problem and think of several possible solutions.

Mijušković (2014, p. 252) used rubrics for assessing students sub- skills of reading comprehension. In this article, it was mentioned that rubrics made the learning targets clear for the students to develop the outcomes. Students who were practiced for reading comprehension would be able to complete complex tasks such as analyzing the required skills which could be assessed by the teachers. In addition to that, rubrics in reading comprehension helped the students to deliver the required instructions. Instructions were important in the educational process because they personalized universal strategies that met the needs of students. They made the assessment process accurate, fair and consistent. The rater then was able to judge in a fair manner by going back to

the key aspects of the rubrics. Therefore, students were able to identify the assessment criteria that complete the reading task.

Sabet, K. et al (2017, p.99) investigated the effect of teaching critical thinking through problem solving on reading comprehension of EFL intermediate learners. The participants of the study were 40 intermediate students studying English in an institute in Ardabil, Iran. They were assigned into control and experimental groups. The sample TOEFL reading comprehension was conducted as pre-posttest. The students in the experimental group were taught reading comprehension through the sub skills of problem solving instruction and the students in control group were taught through the traditional method of teaching. Findings of the post-test revealed that teaching problem solving had affected the reading comprehension performance of the experimental group and brought about better understanding of the text. This study put more emphasis on Critical Thinking tasks to enable students to make decisions and solve problems effectively in their real lives.

2.5 critical Writing

Critical writing was about developing one's academic voice within a subject area.

Developing critical writing skills involved reflecting, researching, note-making and reading, as well as writing. As an academic writer, it was expected to engage critically with other authors in the subject area. This involved agreeing and disagreeing with their arguments and evaluating their ideas and theories. It was important to include all relevant evidence, ideas and theories, not just those that support one's point of view.

1.6.The Importance of Critical Writing

Yamin & Purwati (2020, p. 142) mentioned that critical thinking in writing was needed to enable learners to build a sense of crisis towards any topic. This

capacity was required to create a framework based on reflecting, exploring, and solving some practical problems in their learning, work, and daily lives.

1.7.Using Problem Space Theory for Assessing Sub-Skills of Critical Writing

Hensberry & Jacobbe (2012, p. 59) proved that the students' problem-solving skills had increased after using Polya's (1985) heuristic when they were asked to write their thought processes through the use of a structured diary. Participants in this study were seven African-American students enrolled in a voluntary summer school enrichment program at an elementary school) in the south-eastern United States. Analysis of students' responses indicated that most students showed improvement in their solution strategies. The result was that having students write about their thinking by imposing questions and using Polya's rubric for assessment was beneficial for developing their problem-solving skills in critical writing.

A scoring rubric was developed based on Polya's model and Schoenfeld's framework for assessing problem solving. Dindyal & Tay, (2014, pp. 686 - 688) designed a 'practical' worksheet to guide the students through the problem solving process. To assess the students' work, the scoring rubric focused on the main components of the problem-solving processes. The rubric was designed to encourage students to go through Polya's stages when they were faced with a problem to use heuristics to explore the problem and to devise a plan. Both teachers and researchers used the scoring rubric to mark the students' responses to the daily problems or problem for homework. The result was that most of the students quickly responded to the emphasis underlined by the scoring rubric. Therefore, markers understood that using rubric as an assessment encouraged the students to formulate significant or hard problems in reading and writing.

Studies in the field of critical thinking and critical writing were notably rare in the Turkish EFL context. Therefore, Ataç (2015, pp. 620 – 626) mainly aimed to integrate these concepts into the field of foreign language learning and teaching. Participants in this study consisted of 49 first year ELT students enrolled at Faculty of Education. They were enrolled in the Advanced Reading and Writing Course during two semesters. The qualitative data was collected from analyzing the students' written work, observation and open-ended questions. The researcher used a critical writing rubric to analyze the essays. Results indicated that the students showed success in understanding their audience, content and organization in writing essays.

3. Statement of the Problem

Regular methods of assessment do not inform about the students' real levels in critical reading and writing skills. They only inform about their marks. However, the 21st century skills cannot be assessed in regular ways. Assessment must be inseparable part of teaching-learning process to assess the students' critical reading and writing skills. Students do not know the requirements of every skill to learn and teachers do not know these requirements to teach. Accordingly, the present study tries to find an answer to the following main question:

How can critical reading and writing be assessed through a program based on problem space theory?

:The main question is answered through the following sub-questions

1. What are the integrated critical reading and writing skills that secondary stage students should possess?

2. What are the features of the suggested program based on problem space theory that develop the critical reading and writing of EFL secondary stage students?
3. What is the effectiveness of the suggested program based on problem space theory in developing the critical reading of EFL second secondary stage students?
4. What is the effectiveness of the proposed program based on problem space theory in developing the critical writing of EFL secondary stage students?
5. To what extent is the research group students satisfied with the proposed program based on problem space theory to develop their critical reading and writing skills?

4. Hypotheses of the Study

:The current research tried to verify the following hypotheses

1. There is a statistically significant difference at the level (0.01) between the mean scores of the research group pre posttest administration of their overall critical reading skills in favor of the post scores.
2. There is a statistically significant difference at the level (0.01) between the mean scores of the research group students in the pre-posttest administration of the critical reading sub-skills in favor of the post scores.
3. There is a statistically significant difference at the level (0.01) between the mean scores of the research group in the pre-posttest administration of the overall critical writing skills in favor of the post scores.
4. There is a statistically significant difference at the level (0.01) between the mean scores of the research group in the pre-posttest administration of the critical writing sub-skills in favor of the post administration test.

5. The students of the research group are generally satisfied with the suggested program based on problem solving theory to develop their critical reading and writing skills.

5. Aims of the Study

- Designing a program to improve the critical reading and writing of the second secondary stage students.
- Using an alternative method of assessment that suits assessing the 21st skills.

6. Significance of the Study

This study is significant for many reasons:

- For students: to develop their critical reading and writing skills by using Polya's rubric for assessment and using a template to write a paragraph about solving problems related to real scenarios in life.
 - For teachers: to reconsider their way of assessment to cope with the 21st century skills to assess the students' problem solving and critical reading and writing skills that cannot be assessed in the regular way of assessment.
- For educational organizations: to add self-assessment and high thinking order questions to the middle and high schools.

7. Delimitations of the Study

This study is conducted in El Abaseya Institute for Girls with second secondary stage students as one tactic group. The institute belongs to Al Azhar Al Sharif. The study includes (n=40) aged between 16 and 18 years old. They have studied English for 9 years since the beginning of their academic study as EFL students at school. Three instructors are the raters and the participants in the study from El Abaseya Institute and Al Basateen Institute.

8. Definition of Terms

➤ Problem space theory

Problem space theory is part of the social science category of problem-solving strategies. It does not offer details of a solution but instead focuses on steps and goals involved in working through a problem. Problem space theory outlines what is needed to attain a solution. Newell and Simon (1972) proposed that for every problem there is a problem space which is defined by three components.

SHANILOU (2015) defined problem space theory as the following:

“The problem space consists of two states. We have the initial state, which is our state that we are currently in and the goal state which is where we are aiming to get to, or the solution. The problem space is the gap between these two states. Problem solving consists of the search for the path in this problem space that get us to the goal state. This all takes place in our **working memory** which has a limited capacity and requires help.”

The researcher defines **Problem Space Theory** as a mental representation of a problem that helps a person to follow the right track in solving the problem. It is a cognitive theory that consists of the initial situation, the space of resolution or the intermediary action of persons in which the problem is analyzed, and the final state (goal state). Solution of the problem depends on the cognitive side and the background knowledge of the problem solver.

➤ Critical Reading

(Singh, 2021, p.1) defined critical reading as it is the ability to read a text without accepting everything it says for grant. It means that the reader should question what an author wants to say in a topic. Looking critically at a reading text means to analyze, evaluate and interpret what is read. Mastering critical

reading takes time and practice. With hard work, students can gain their skills and become critical readers.

The researcher defines critical reading as an approach in pedagogy that emphasizes helping students to understand logically of what they read. In this context, critical reading involves questioning and analyzing a text, rather than assuming everything as facts. This skill enables students to go beyond the printed words by imposing questions in different levels of thinking in order to achieve deep learning such as defining the problem, analyzing it and finding a solution to the problem. With this end, critical reading is an important priority to critical writing.

➤ **Critical Writing**

In “Skills for Learning” (March 2018), critical writing is an essential part of writing an assignment with a definite purpose. It is about developing one’s opinion within a subject area. Developing critical writing skills involves reflecting, researching and note taking. It involves more discussion, analysis and evaluation. Students need to make sure that their writings involve critical analysis of the work of others. Critical writing can be improved through some very simple questions before writing assignments.

The researcher defines critical writing as it is a kind of writing that a student tries after deep reading of a text or deep thinking of a problem. When they write critically, they do not only write a conclusion to a topic but also try to find a solution to a problem after analyzing it. Reason and background knowledge play a huge part in the writing process. Analyzing events, predicting future situations, explaining facts and evidence and commenting on what happen are integral skills of critical writing.

➤ **Assessment as Learning**

According to Yambi & Caluyua. (2020, pp. 1-2), assessment refers to a related series of measures by gathering and interpreting information about student level of attainment according to the learning goals. Assessment as learning occurs when students are their own assessors. Students monitor their own learning, ask questions and use a range of strategies to decide what they know and can do, and how to use assessment for new learning. Assessment is also used to identify individual student weaknesses and strengths so that educators can provide special educational support.

The kind of assessment in this study happens through pre-designed integrated critical reading and writing rubric. It is considered as a contract between the educators and the students. It helps the students to get deeper understanding to their assignments through different levels of frequencies that are characterized by their objectiveness, fairness and stability.

9. **Design of the study**

The study employed one group quasi-experimental design. The quantitative part was performed in a pre and post-tests of one group. The qualitative part was performed in Student interest inventory, Teacher's questionnaire, Observation card and Unstructured interview.

10. **The Participants**

2, (n=30) female students 1/2021 At the beginning of the school year 2021 from Al Abaseya preparatory and secondary school for Girls were taken as one group for the study. They were EFL second secondary stage students. Their ages ranged between 16 and 18 years. They have been studying English for 8 years

since their first primary school. Three teachers were participants; one rater teacher; whose teaching experience exceeds 20 years, adopted the program. The other two raters, one had the same experience as the participant teacher and the other's experience was between 15 and 20 years in teaching. All the raters were taught at the beginning of the school year how to use the rubric for assessment. The experiment took place in Al Abaseya preparatory and secondary school for Girls. As for the raters, the rater teacher was from Al Abaseya Institute while the other two raters were from Al Basateen Prep/Secondary Institute and were teaching the same level. Both institutes belong to Al Azhar Al Sharif, Cairo Governorate.

11. Variables of the Study

Independent variable: A suggested program based on Problem Space Theory

Dependent variable: Critical reading and writing of EFL 2nd secondary stage students

12. Instruments

12.1. Pre and post-tests

It was a qualitative instrument that examined the participants before and after manipulation. This test was accepted and modified by the jury member to make sure that it was suitable in form and content to second secondary stage students. The final version was accepted by the advisor after making some modifications.

Description of the Test

The pre and post-test consists of

- A reading text about a real problem that happened in life. It was followed by 6 questions:

The answer of questions 1 and 2 identified the problem. The aim of these questions was to know if the students were able to give a well-defined or an ill-defined problem.

Questions 3 and 4 analyzed the problem. These questions measured the students' ability to analyze the problem and the steps they had to follow to reach a workable solution. Question 5 measured the students' ability to choose the best solution to the problem. The last question let the students think what would happen if the problem was not solved.

- Writing a paragraph about solving a problem was the second part of the test.

The students were asked to write three paragraphs about a real problem in life. The critical writing was based on the descriptors of the Problem Space Theory and was assessed by Polya' problem solving rubric. The questions were taken from the integrated checklist prepared by the researcher, based on Polya's stages of problem solving rubric and the revised Bloom's taxonomy.

Validity and Reliability of the Test

The Internal Consistency of the Test

To ensure the internal consistency of the main skills and sub-skills of the test, the correlation coefficients were computed between the score of each sub-skill and the total score of the test, and the following table shows the correlation coefficients

Table (1) Values of the correlation coefficients between the score of each component of the critical reading and writing test and the overall test score

Item	Correlation
1	0.61**
2	0.58**
3	0.64**
4	0.66**

5	0.61**
6	0.60**
7	0.65**
8	0.69**
9	0.71**
10	0.74**

** Significance level at 0.01, when $t \geq 0.46$ where $n = 30$.

:Stability of the Overall Test

The overall test stability was computed by **Alpha-Cronbach coefficient**. Cronbach's alpha coefficient was calculated for the test and its value was 0.86, which was an acceptable high value and generally indicated the accuracy and reliability of the test as a means of measurement.

Reliability of the Test

The test was re-applied two weeks after its application, and the correlation coefficient was calculated between the degrees of the two applications. It was found that the correlation coefficient was equal to (0.96), which was a high value that indicated a very strong correlation and confirmed the accuracy and reliability of the test as a means of measurement.

12.2. The Suggested Program

The suggested program was mainly designed from the students' curriculum to develop the students' critical reading and writing skills to solve problems through Polya's rubric as a pedagogical tool. Problem space theory was the common ground for teaching, learning and assessment, based on the literature review and the related studies.

12.3. Student Interest Inventory

An interest inventory was a qualitative testing instrument designed to measure the level of a students' interests in a variety of activities. It informed

direct observation of self-reporting interest in educational activities to show how far rubrics were important for the learning process for the following purposes:

- Calculating the internal consistency

The internal consistency of the interest inventory phrases was calculated by calculating the correlation coefficients between the score of each phrase and the total score of the inventory, after deleting the effect of the single item from the total score. The following table showed the correlation coefficients:

Table (2) Values of the correlation coefficients between the score of each item and the total

Item	score of the student interest inventory	
	Correlation	
1	0.66	**
2	0.60	**
3	0.59	**
4	0.58	**
5	0.70	**
6	0.62	**
7	0.65	**
8	0.65	**
9	0.61	**
10	0.66	**
11	0.64	**
12	0.69	**
13	0.60	**
14	0.71	**

**Significance level is at 0.01, where n = 20, t ≥ 0.55

- Calculating the reliability of the interest inventory

The alpha-Cronbach coefficient was used for calculating the reliability of the interest inventory. The scale and its value were (0.91), which was a high value and generally indicated the accuracy and reliability of the interest inventory as a means of measurement.

12.4. Teachers' Questionnaire

Teachers' questionnaire gave information about the participant teachers; the grades they teach, years of experience and if they used rubrics before in assessment or not.

This questionnaire showed teacher perspectives; the participant teacher and the two raters, after using rubrics for assessment. They were asked to complete it with 4 frequencies: strongly agree (SA), agree (A), disagree (D) and strongly disagree (SD). They showed their perspectives in 10 points through 4 criteria: **Assessment as learning, Feedback, Consistency and Fairness and Efficiency**

12.5. Observation Card

Observation card was prepared by the researcher depending on the critical reading and writing sub-skills to be noticed inside the class. Levels of frequencies are as the following:

Not achieved To some extent, Achieved,

12.6. Unstructured Interview

Evans (2022, p. 84) defined unstructured interview as an interview in which questions were not prearranged. It was prepared in advance in relation to a topic that the researcher wished to cover. It tended to be more informal and free flowing than a structured interview, much like an everyday conversation. The nature of this conversation was spontaneous as the questions develop during the course of the interview, which were based on the participants' responses.

13. Assessment Instruments of the Study

13.1. Polya's Problem-Solving Rubric

Teachers were provided with rubrics as printouts to assess the students' work. This study adopted the analytic rubric of Polya's problem solving for assessment that was suitable for the second secondary stage students with 4 frequencies

(Always 4– Frequently 3 – Sometimes 2 and Never1). As for the descriptors, according to the problem space theory, they included: **defining** the problem, **devising** a plan, **reflecting** on the best solution and **using a language** that includes the structure of the sentences, punctuation and spelling.

13.2. The Integrated Critical Reading and Writing Checklist

As for the critical reading, the students answer questions through 3 stages according to Problem Space Theory: The initial (current) state, ‘Operators’ and The goal state where the students should reflect on the solutions and choose the best one.

As for the critical writing, the students follow a template to write three paragraphs, based on Problem Space Theory.

13.3. A blank Student Self-Assessment Rubric

Student self-assessment activated students as owners of their own learning and placed the student at the center of the learning process. This rubric was identical to the main problem solving integrated rubric. It consisted of a blank sheet for the students to decide the frequency that matches their answers according to the main common sub skills of critical reading and writing.

14. Results of the Study

14.1. Quantitative Results of the Study

14.1.1. Testing the Validity of the First Null Hypothesis:

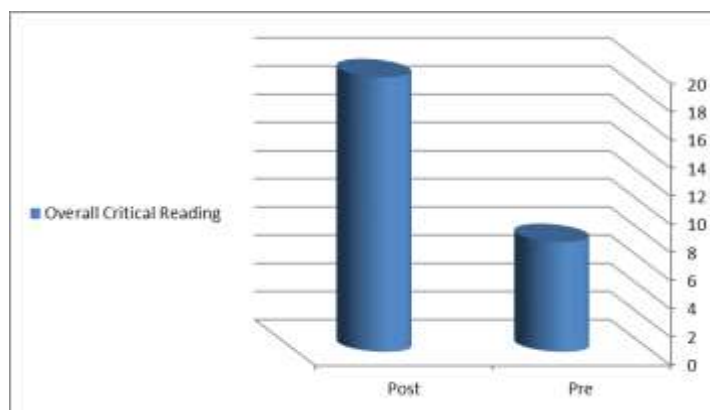
The first null hypothesis stated that: “**There is no statistically significant difference between the mean scores of the research group in the overall pre-posttest critical reading administration.**” To verify the validity of this hypothesis, a paired sample t-test was used to detect the significance of the differences between the overall pre and post-test administrations of critical reading skill. The following table shows this:

Table (3) Results of the t-test indicate the difference between the mean scores of the research group in the pre-posttest administration of the overall critical reading skill, where (n = 30), (degrees of freedom = 29).

performance	mean		Std. Deviation		t - test value	Sig.	Effect size (η^2)
	pre	post	pre	post			
Overall Critical Reading	7.8	19.5	2.87	2.52	25.42	0.000	0.96

According to the table, the null hypothesis is rejected and the alternative hypothesis which stated: “There is a statistically significant difference at the level (0.01) between the mean scores of the research group pre post-tests administration of their overall critical reading skills in favor of the post scores.” is accepted.

Figure (1) shows the difference between the mean scores of the research group students in the overall pre-posttest administration of the critical reading



14.1.2. Testing the Validity of the Second Null Hypothesis

The second null hypothesis stated: “**There is no statistically significant difference between the mean scores of the research group students in the sub-skills of the pre-post critical reading test.**” To verify the validity of this hypothesis, a paired sample t-test was used to detect the differences between the

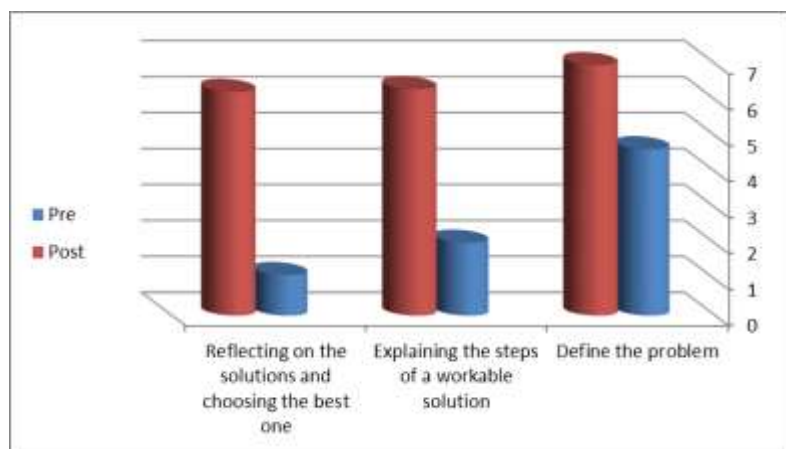
pre-posttest administration of the critical reading sub-skills, and the following table illustrates this:

Table (4) Results of the t-test to indicate the difference between the mean scores of the research group students in the pre-post administration of the critical reading sub-skills, where (n = 30), (degrees of freedom = 29).

Skill	mean		Std. Deviation		t- test value	Sig.	Effect size (η^2)
	pre	post	pre	post			
Define the problem	4.63	6.97	1.33	1.00	6.86	0.000	0.62
Explaining the steps of a workable solution	2.03	6.3	1.73	1.24	12.006	0.000	0.83
Reflecting on the solutions and choosing the best one	1.13	6.23	1.55	1.13	19.634	0.000	0.93

Thus, according to Table (4), the null hypothesis is rejected and the alternative hypothesis which stated: **“There is a statistically significant difference at the level (0.01) between the mean scores of the research group students in the pre and post-test administration of the critical reading sub-skills in favor of the post scores.”** is accepted.

shows the difference between the mean scores of the research Figure (2) .group in the pre-post administration of the critical reading sub-skills



14.1.3. Test the validity of the third null hypothesis:

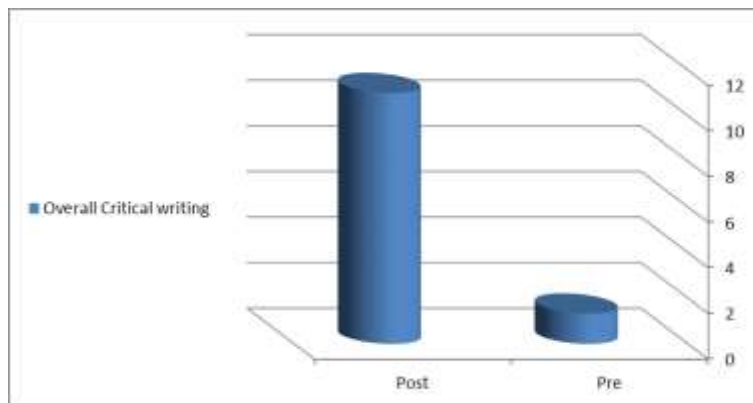
The third null hypothesis stated: “There is no statistically significant difference between the mean scores of the research group in the overall pre and posttest of critical writing.” To verify the validity of this hypothesis, a paired sample t-test was used to detect the significance of the differences between the overall pre and post-test administrations of the critical writing. The following Table shows this:

Table (5) Results of the t-test to indicate the difference between the mean scores of the research group students in the pre and post-test administration of the overall critical writing test; where (n = 30), (degrees of freedom = 29).

performance	mean		Std. Deviation		t - test value	Sig.	Effect size (η^2)
	pre	post	pre	post			
Overall Critical writing	1.33	11	2.55	1.86	19.834	0.000	0.93

Thus, according to Table (5), the null hypothesis is rejected and the alternative hypothesis which stated: “**There is a statistically significant difference at the level (0.01) between the mean scores of the research group in the pre-posttest administration of the overall critical writing skills in favor of the post scores.**” is accepted.

Figure (3) shows the difference between the mean scores of the research group students in the pre-posttest administration of the overall critical writing skills as a total score



14.1.4. Testing the Validity of the Fourth Null Hypothesis:

The fourth null hypothesis stated: “There is no statistically significant difference between the mean scores of the research group in the pre-posttest critical writing sub-skills.” To verify the validity of this hypothesis, a paired sample t-test was used to detect the differences between the pre- posttest administration of the critical writing sub-skills, and the following table shows this:

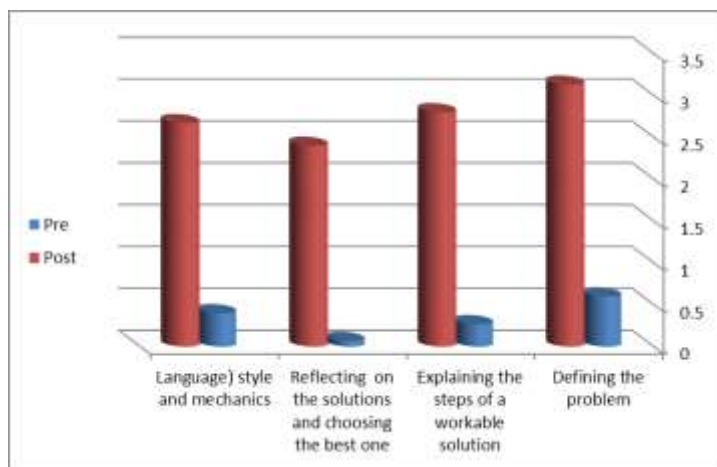
Table (6) Results of the t-test indicate that there is a difference between the mean scores of the research group in the pre-posttest administration of the sub-skills critical writing, where (n = 30), (degrees of freedom = 29).

Skill	mean		Std. Deviation		t- test value	Sig.	Effect size (η^2)
	pre	post	pre	post			
Defining the problem	0.6	3.13	0.89	1.01	12.917	0.000	0.85
Explaining the steps of a workable solution	0.27	2.8	0.64	0.71	14.258	0.000	0.88

Reflecting on the solutions and choosing the best one	0.07	2.4	0.25	1.07	12.854	0.000	0.85
Language (style and mechanics)	0.4	2.67	0.81	0.66	15	0.000	0.89

Thus, according to Table (6), the null hypothesis is rejected and the alternative hypothesis which stated: “There is a statistically significant difference at the level (0.01) between the mean scores of the research group in the pre-posttest administration of the critical writing sub-skills in favor of the post administration test.” is accepted.

Figure (4) shows the difference between the mean scores of the research group in the pre-posttest administration of the critical writing sub-skills



14.2. Qualitative Results of the Study

Testing the Validity of the Fifth Null Hypothesis

The fifth null hypothesis stated “**There is no general satisfaction among the students of the research group about the use of the suggested program based on the problem solving theory to develop critical reading and writing**

skills”. To verify the validity of this hypothesis, an interest inventory was applied on the research group after using the proposed program based on the theory of problem solving in teaching.

Table (7) Results of satisfaction measurement after using of the suggested program based on the theory of problem space in developing the critical reading and writing, where n = 30

item	SA		A		DA		SDA		Mean	Percent (R II)	General direction of the
	N	%	N	%	N	%	N	%			
1	16	53.3	13	43.3	1	3.3	0	0	3.5	0.87	ST Agree
2	18	60.0	12	40.0	0	0	0	0	3.6	0.90	ST. Agree
3	6	20.0	22	73.3	0	0	2	6.7	3.07	0.76	Agree
	Reduce Anxiety								3.38	0.84	ST. Agree
4	10	33.3	18	60.0	2	6.7	0	0.0	3.27	0.82	ST. Agree
5	17	56.7	13	43.3	0	0.0	0	0.0	3.57	0.89	ST. Agree
	Give confidence								3.41	0.85	ST. Agree
6	20	66.7	8	26.7	26.7	1	3.3	1	3.57	0.89	ST. Agree
7	12	40.0	18	60.0	0	0	0	0	3.4	0.85	ST. Agree
8	12	40.0	18	60.0	0	0	0	0	3.33	0.83	ST. Agree
9	10	33.3	20	66.7	0	0	0	0	3.33	0.83	ST. Agree
	Give feedback								3.4	0.85	ST. Agree
10	16	53.3	12	40.0	2	6.7	0	0.0	3.47	0.87	ST. Agree
11	17	56.7	13	43.3	0	0	0	0	3.57	0.89	ST. Agree
12	16	53.3	13	43.3	1	3.3	0	0.0	3.5	0.88	ST. Agree
13	19	63.3	10	33.3	1	3.3	0	0	3.6	0.90	ST. Agree

14	16	53.3	13	43.3	1	3.3	0	0	3.5	0.88	ST. Agree
Achieve Autonomy									3.53	0.88	ST. Agree
Satisfaction survey as a whole									3.44	0.86	ST. Agree

Table (7) indicates that the general trend of all dimensions of the inventory as a whole is strongly agree, the null hypothesis is rejected and the alternative hypothesis which stated “The research group students are generally satisfied with the suggested program based on the theory of problem solving to develop their critical reading and writing skills.” is accepted. Thus, this answered the question that stated: To what extent is the research group students satisfied with the proposed program based on problem space theory to develop their critical reading and writing skills?

15. Discussion and recommendations

The study showed that the blended program was effective in developing EFL creative journal writing among first-year secondary school students (scientific stream) and results revealed significant differences in favor of the posttest.

The study showed that the program was effective in developing the critical reading and writing skills of EFL second secondary stage students based on the problem space theory.

The quantitative results of the study, stated by the pre-posttests, demonstrated that there is a statistically significant difference between the mean scores of the research group on the pre-posttests in terms of the development of the participants' critical reading and writing skills and sub-skills in favor of the posttest. This was proved through the hypotheses of the study that justified the effectiveness of using the suggested program based on problem space theory on developing the critical reading and writing skills of EFL second secondary stage

students. The following section summarises the findings and contributions made.

The qualitative results were obtained from analyzing the qualitative data: Student interest inventory, Teachers' questionnaire, Observation card and unstructured interview to support the quantitative results.

The integrated critical reading and writing checklist, set by the researcher based on Polya's rubric answered the **first sub question** that stated '**What are the integrated critical reading and writing skills that secondary stage**' This checklist defined the main integrated sub-skills **students should possess** of critical reading and writing and the method of assessment for teachers. Besides, it is the base of the students' self-assessment that helped them to develop their critical reading and writing sub skills.

Results confirmed the reliability of the suggested program, designed by the researcher, and its suitability to be generalized on second secondary stage students; as it included:

- Thirteen modules in the first term and five modules in the second term stemmed from the SB or the second secondary stage and concerned with problems from real life.
- The critical reading questions addressed the higher thinking order based on the revised Bloom's Taxonomy that let the students to define, think, analyze and evaluate the best solution.
- The critical writing template was based on TOEFL format for writing essays.

- Both of the critical reading and writing were assessed by the integrated reading and writing checklist, prepared by the researcher and adapted from Polya's solving problem rubric; the main tool of problem space theory.
- All the components of the suggested program were shown to the research group as an introduction to the program.

Therefore, the aim of the suggested program was to develop the students' critical reading and writing skills by following Polya's rubric, not only as a kind of assessment, but also as a tool for teaching and learning. These features answered the **second sub question** that stated '**What are the features of the suggested program based on problem space theory that develops the critical reading and writing of EFL secondary stage students?**'

The quantitative analysis of the sub skills of the critical reading was at Significance level (0.01). This indicated that the pre and post-test administration of the critical reading at a significance level of (0.01) was in favour of the post-test administration. Besides, the value of the effect size expressed in the Eta square of the proposed program for the overall critical reading equaled (0.96), which was greater than (0.232). This means that the effect size was great and this indicated that using the suggested program based on problem space theory had a very significant impact on the development of the overall critical reading degree of the research group. This analysis answered the **third sub question** that stated "**What is the effectiveness of the suggested program based on problem space theory in developing the critical reading of EFL second secondary stage students?**"

The value of the effect size in the Eta square of using the proposed program for critical writing as a total score equaled (0.93) which was greater than (0,232). This means that the effect size was great and indicated that using the

suggested program based on the theory of problem space in teaching had a very significant impact on the development of the overall critical writing skills in the research group. Besides, the significance level in critical writing sub-skills was less than (0.01) and this indicated that there was a difference between the pre-posttest administrations of the critical writing sub-skills at the significance level (0.01) in favor of the post-test administration in the highest average. That answered the **fourth sub question** that stated: **“What is the effectiveness of the proposed program based on problem space theory in developing the critical writing of EFL secondary stage students?”**

However, the quantitative results were supported by the qualitative analysis of the following data sources.

Analysis of the Student interest inventory indicated that all the items of the inventory and the inventory as a whole came with an arithmetic mean between (3.25 to less than or equal to 4). This indicates that the general trend of all items of the inventory and the inventory as a whole was strongly agree. This analysis answered the **fifth sub question** that stated **‘To what extent is the research group students satisfied with the proposed program based on problem space theory to develop their critical reading and writing skills?’**

16. Conclusion

From the short discussion above, key findings emerged **after analysing the previous quantitative and the qualitative results as the following:**

- Using the suggested program based on problem space theory in assessment was effective in developing the students’ critical reading and writing skills.
- Using Polya’s tool included in the suggested program and followed the steps of the problem space theory was effective in teaching and learning.

- The integrated critical reading and writing checklist included in the program was accepted by the teachers as a fair consistent explicit method of assessment.
- Using student self-assessment was accepted by the students as a method of realizing their weaknesses and strengths in critical reading and writing and to follow their development in learning. They gave themselves the marks that they deserved, and knew whoever assessed their work, they would get the same marks.
- Critical reading questions; based on higher thinking order of the revised Bloom's taxonomy, had developed the students' critical thinking in reading. Critical writing, based on a template that followed the steps of Polya's rubric, had greatly developed the students' writing. Here is a comparison between the suggested program and the SB in critical reading and writing questions in solving problems.

17. Recommendations

Out of results of the study, it is recommended

For teachers

- Teachers should reconsider their methods of teaching and assessing the 21st century skills that are needed in life and in workplace.
- Teachers should be practiced to set questions based on the higher thinking order of the revised Bloom's taxonomy.
- Students should be practiced on self-assessment from very young age.

For decision makers

- Questions on reading in the SB and WB should be reconsidered as; in spite of developing the curricula, they are still low thinking order questions.
- Templates should be included in writing paragraphs of every lesson.

- Assessment by using rubrics should be included in all curricula in every skill; reading, writing, listening, speaking and culture skills.

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