The Relationship between Iraqi EFL Preparatory Students' Cognitive Load and Reading Comprehension

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Abstract:

Cognitive load has been central to language learning research. Cognitive Load Theory (CLT) has recently become 'The Next Big Thing' in teaching and the most important thing for teachers to know. Reading comprehension has been extensively researched, and it is still of current interest as it is one of the most complex cognitive activities in which human beings engage. Developing reading comprehension abilities will help students master the other three skills: speaking, listening, and writing.

This study aims at: Firstly, finding out Iraqi EFL preparatory students' cognitive load and reading comprehension. Secondly, identifying the correlation between Iraqi EFL preparatory students' cognitive load and reading comprehension. The current study is a descriptive correlational one. For the academic year 2022–2023, a sample of 345 randomly selected students from Al-Karkh 2nd preparatory schools in Baghdad are chosen. Two instruments are used to achieve the aims of this study: the Cognitive Load Subjective Rating Scale (Pass, 1992; Leppink et al., 2013) and the Reading Comprehension Test (Coleman, 2020).

The findings reveal that the students have a high level of cognitive load and a high level of reading comprehension. Furthermore, the findings also reveal that participants' intrinsic and extraneous cognitive loads are negatively correlated with reading comprehension, whereas their germane cognitive load is positively correlated.

Keywords: Cognitive Load, Cognitive Load Theory, Reading Comprehension.

I. Introduction:

The Cognitive Load Theory, developed and put forth by Sweller (1994), is one of the most recent theories which attempts to explain how the human brain works and how to manipulate instructional materials to facilitate learners' language learning. According to this theory, some types of loads can be placed on our working memory, and this overloading impedes learning (Clark et al., 2005). It focuses on the cognitive demands placed on the student, which are taken into account in terms of working memory.

Students may struggle to remember everything when learning numerous things at once, such as several subjects or language topics, because the cognitive load on their

working memory may intensify. They might be unable to manipulate simultaneous task requirements, generalize and transfer new knowledge using cognitive resources (Sweller et al., 2019).

English is taught intensively in Iraq as a foreign language. Students who learn English should necessarily master the four basic language skills of the target language: speaking, writing, listening, and reading. Among those four skills, reading is vital to language comprehension. Reading is a complex, interactive, flexible, and understandable skill that requires considerable effort, a significant amount of time, and a lot of resources to master.

Reading comprehension, according to Indrayani (2014), is the process of understanding the writer's message accurately through simultaneous meaning construction and extraction based on the reader's background knowledge as well as interaction and involvement with the text.

In line with the aims of the present study, the following research question is presented:
Is there any correlation between Iraqi EFL preparatory students' cognitive load and their reading comprehension?

II. Literature Review

2.1 Cognitive Load

CL is defined as the demands placed on a person's working memory by a task. The amount of cognitive load is influenced by task demands and an individual's aptitude. cognition is associated with comprehension and the storage of information in working memory or long-term memory for later retrieval (Ali & Sundus, 2022) . As a result, the idea of "cognitive load" is a theoretical one that describes the interaction between information structures and learner cognitive abilities (Kalyuga, 2009).

According to Paas & van Merrinboer (1994), cognitive load is regarded as a complex multidimensional construct made up of:

* Causative elements relating to the task, the learner, and their interaction components;

* Assessment factors including mental load, mental effort, and performance.

The content of the language that is central to determine the cognitive state of an individual (Dhea, 2022); presentation, organization, complexity, and difficulty of a task all contribute to mental load, which is the set of cognitive resources required to complete this task. On the other hand, mental effort refers to the cognitive resources that are allocated to a task (Paas et al., 2003).

Sweller & Chandler (1991) have developed an educational theory that contributes to providing insight into the cognitive processes involved in learning. It discusses the concept of cognitive load in terms of the working memory resources necessary to complete a certain task in a specific situational setting (Kalyuga & Plass, 2018).

This theory suggests that our working memory is subject to certain types of overloads

that can impede learning. It is called Cognitive Load Theory (CLT) (Clark et al., 2005).

2.2 Cognitive Load Theory:

CLT is a learning and instruction theory introduced first by Sweller in the 1980s, and it has undergone significant development and expansion for more than three decades. It is also regarded a psychological theory that examines the connections between psychological concepts and learning, i.e., the theory primarily addresses how cognitive constructs are organized, what occurs when we learn, and how instructional designers may design educational materials to support learning (Moreno & Park, 2010).

The core of CLT is limited working memory capacity (Sweller et al., 2004). When working memory capacity is exceeded by the amount of mental load, overload and disruption in mental processes occur. The goal of cognitive load theory is to ensure that the cognitive load is kept within working memory's capacities while performing a task or multiple tasks.

2.3 Types of Cognitive Load

CLT has identified three types of cognitive load that require WM resources. These types have been referred to as 'good' (germane), 'bad' (extraneous), or just there (intrinsic)' (de Jong, 2010, p. 125). These categories of CL are additive which means that they all together constitute the total amount of CL (Sweller 2010).

a. Intrinsic Load

It is CL that is created by the inherent difficulty of a subject. The difficulty and the learner's prior knowledge both have an impact on intrinsic CL. It means that a subject that is challenging for a novice learner may be simple for an expert. For instance, a child in the first year of school would likely have a high intrinsic load for the task of learning to write the alphabet, whereas a child in the second or third year of school would have a considerably lower intrinsic load for the same task (Brunken, Plass & Leutner, 2003).

Examples of the intrinsic CL involve in learning a language are provided by Pollock & Sweller (2002). They assume that, without consulting any other entries, each new word can be learned independently; Spanish words for "bird" are given as an example. Due to the minimal level of element interactivity in the information, the term can be learned independently of the Spanish word for "cat". Because just a small number of items must be processed in WM at any given time, it also places a minimal intrinsic CL on the brain.

b. Extraneous Load

Extraneous load is defined as unnecessary information processing which is caused by the instructional design itself. It results from the way instructional design presents the knowledge and activities that the learner must be engaged with in order to achieve learning goals. Although it is imposed by the material, but can be avoided by employing a different instructional design (Cierniak, Scheiter & Gerjets, 2009).

A reduction in extraneous load can be achieved by using a more efficient instructional design. For instance, combining relevant graphical information with written explanations is a more effective technique of reducing extraneous load and enhance learning performance. More working memory resources might be made available for germane load associated

with learning and transferring by minimizing extraneous load (Pass & Van Gog, 2006).

Recent researches indicate that learning environment may also be an important factor to consider at the level of extraneous load associated with a given task (e.g., distraction in the classroom). The environment in which tasks are performed by the learners affects CL. Another important factor is the learner's intrusive thoughts about failure and doing well in that task (Choi, van Merriënboer & Paas, 2014).

c. Germane Load

Germaine load is connected to learning-related activities like automating and acquiring schema, and it directly affects learning. Instructions should be changed to eliminate extraneous cognitive load, free WM resources for germane cognitive load, and encourage students to use the free WM capacity to construct schemas in order to enhance learning, (Van Merreienboer & Sweller, 2005).

Germane load is defined as the working memory resources needed to handle the element interactivity of intrinsic cognitive load. In addition to intrinsic and extraneous load, element interactivity is expected to be the main source of WM load underlying germane load. However, unlike intrinsic and extraneous load, germane load only depends on intrinsic cognitive load and is not an independent source of CL.

According to the notion of CL, intrinsic load, extraneous load, and germane load are additive. The three types are added together to form the overall load. Increases in germane load may be feasible even in the presence of significant extraneous load if intrinsic load is low. The use of an effective instructional design can decrease extraneous load, which leads to free capacity for an increase in germane CL (Paas, Renkl, & Sweller, 2003).

2.4 Reading Comprehension

RC is a language ability that has long been regarded as being crucial for all students to learn since it allows them to better absorb the variety of information available in printed sources (Boardman, 2007).

Scott (2010) claims that RC is a difficult task requiring multiple levels of processing. The capacity to deal with new words in text is one of the most important components of comprehension. RC problems take up significant mental resources that could be used for more in-depth degrees of text processing in readers. To forecast the meaning of new words, context clues alone are insufficient.

According to Rivers (2000, p. 70), RC is "a problem-solving behavior that actively includes the reader in the process of deriving and assigning meaning... drawing on contextual information... readers decode print semantically and syntactically." According to Russell (2013, p. 7), "the reader needs to create an efficient strategy for solving problems during reading." This definition is in keeping with Brown's statement (2007, p. 379), which states that the act of reading necessitates deliberate reflection and thought. In other words, a reader must be critical and thoughtful in order to effectively comprehend a text. It is "the act of obtaining words or input through hearing or reading." Comprehension is the result of being able to take in information, analyze it, and formulate a coherent, precise understanding of the input.

2.5 Reading Comprehension Models

While reading a text, there are mental processes occurring inside the readers' mind. In general, there are three main models of these processes: bottom-up model, top-down model, and interactive model. These three models are categorized as metaphorical models by Grabe (2011). The metaphorical model offers a symbolic view of a number of reading comprehension processes.

a. Bottom-Up Model

In order to do bottom-up processing, readers must be able to identify linguistic cluse including letters, morphemes, syllables, words, phrases, grammatical cues, and discourse markers. Readers impose their linguistic data-processing methods on the text (Brown, 2001). Language signal recognition is regarded as a lower-level reading process. To understand what is being read, readers must understand the meaning of the texts starting with the simplest components. In this model, students infer meaning from context by recognizing each word, which acts as the basis for the entire reading process (Anderson, 2003).

This model suggests that readers quickly become proficient readers. Proficient readers are those who can recognize words well, and their proficiency as readers is enhanced by their ability to decode words (Pressley, 2000). Together with common letter chunks, prefixes, suffixes, and the original words can all be quickly comprehended by skilled readers. As a result, this ability can allow the brain to access more memory resources for reading comprehension. Contrarily, novice readers put more effort to identify text, which consumes less of the brain's processing capacity for comprehension of what they are reading (Ahmadi & pourhossein, 2012).

Top-Down Model

In Top-Down Model, readers begin with the largest elements before moving on to smaller ones in order to improve their comprehension of what they are reading (Anderson, 2003). In order to comprehend the reading texts, readers must utilize their background knowledge to predict and make inferences (Brown, 2001).

Eskey (2005) asserts that TDM, which is constructed "from brain to text," focuses on the whole reading process. According to this model, readers make some expectations about the reading context based on their prior knowledge and then use the word information they learn from vocabulary decoding to confirm and modify those predictions.

According to Smith (2004), a reader actively participates in the process of transforming print into meaning by using reading skills, knowledge of a relevant subject, and understanding of a language to confirm or refute his or her assumptions. According to Ahmadi & Pourhossein (2012), the top-down model emphasizes reading skills including anticipating, summarizing, and predicting from texts.

c. Interactive Model

The components of both the bottom-up and top-down models are combined in this model. According to Alyousef (2005), the interactive model emphasizes automaticity or reading fluency and refers to reading as an "interactive" process between a reader and a text. According to this model, the reader engages with the text to expand its meaning and

draws on a variety of types of knowledge, including linguistic or universal knowledge (achieved through bottom-up processing) and schematic knowledge (achieved through top-down processing). The readers must take into account the key language cues in the texts in order to understand them, and they must draw on their prior knowledge to create a clear mental image of what they are reading.

2.6 Reding Comprehension from a Cognitive View

The cognitive aspects of reading are typically the main focus of reading research. (Lonigan et al., 2009). Decoding skill and verbal capacity are the two key cognitive factors that support reading comprehension. This notion derives from the basic reading theory by Hoover and Gough (1990), which argue that in order to comprehend a text, a reader must be able to read individual words (phonological decoding competence) and comprehend their meaning (verbal ability) (Alloway, 2010).

The integration of several cognitive processes is necessary for RC (Kendeou & Trevors, 2012). The act of processing and connecting individual idea units in order to understand a text as a whole requires the reader to create a mental image of the text in their memory. This image of the text combines the text with relevant background knowledge and links them together using semantic relationships (e.g., referential, causal, and spatial relations). The reader discovers semantic relations using passive and purposeful inferential procedures (Broek, 2005).

The cognitive processes involved in reading comprehension can be divided into two groups:

* **Lower-level processes** that translate written code into meaningful language units; and

*** Higher-level processes** that put these language units together to form a meaningful and coherent mental representation.

Regarding higher level processes, the crucial role of *inference making* has been shown; it enables a reader to link one part of the text to other parts and to background knowledge; the role of *executive function processes* has also been shown, such as the capacity to organize and reflect on information within the borders of a reader's working memory capacity (Sesma et al., 2009); and finally, the role of *attention-allocation skills*, such as selective attention and comprehension monitoring, which enable a reader to focus on relevant aspects of the text (Oakhill et al., 2005).

Regarding lower-level processes, there is a universal agreement that decoding, reading fluency, and vocabulary knowledge are major contributors to text comprehension at this level of processing (Fuchs, Hosp, & Jenkins, 2001).

Lower-level cognitive processes like decoding lexical items or comprehending sentences' propositions are often automatic and use a negligible number of cognitive resources. Automating these processes frees up more cognitive resources for reading comprehension's higher-level processes (Perfetti & Hart, 2002).

From early childhood to adulthood, higher-level processes undergo significant developmental changes and become automated more slowly (Luna et al., 2004). These processes, which require more cognitive effort, attempt to integrate the text information with relevant prior knowledge in order to allow the reader to absorb the text, contributing

to the construction of a cohesive situational model of comprehension. (McNamara & Magliano, 2009).

III. Methodology

3.1 Population and Sample

The population of this study is the students in the 5th preparatory school in Baghdad City's General Directorates of Education, Al-Karkh 2nd, for the academic year 2022–2023. The sample for the study is (345) students, selected randomly from the total population of different schools.

3.2 Instruments

The following instruments have been used in the current study in order to collect the required data:

a. Cognitive Load Questionnaire;
b. Reading Comprehension Test

In this study, subjective scales are used in order to measure CL. These scales have been developed and adapted by the researcher from Leppink's (2013) multiple-item scales and based on the original scale of Pass (1992) to capture sources of intrinsic and extraneous cognitive load experienced by students while performing a reading comprehension task designed by the researcher for measuring CL.

Participants have to respond to eighteen (18) items on a nine-item Likert-scale questionnaire labeled from 1 (*not at all the case)* to 9 (*completely the case)*. Higher scores indicate a greater cognitive load. High intrinsic and extraneous cognitive loads are considered negative since they negatively affect learning outcomes, while a high germane cognitive load is considered positive since it improves learning through generative processing (Mayer, 2014). The exact wording is adjusted from the original instrument to fit the content and the student population of this study.

The second instrument is a reading comprehension test. It is used in order to measure students' reading comprehension level. An objective test which is multiple choices and short answer questions are used. The test is adapted from:
https://www.readworks.org/article/Machines-Get-Smarter/8a58609e-8267-42c4-96fc-78bc26e00fe5#!articleTab:content/questionsetsSection:24908/

The test contains (10) items, seven (7) which are multiple choice with four alternatives. The alternatives include one correct answer and three wrong answers. The last three (3) items of the test are short answer questions.

3.3. Reliability

The concept of reliability in a test score means the extent to which it is free from errors that limit the measurement (Shatha & Shaima, 2009). In other words, it is a measure of the reproducibility of the test (Elaf, 2019). Test scores are reliable if the test measures a specific characteristic in a consistent manner under varying conditions that may lead to measurement errors. It means that if an instrument is used again on the same sample under the same conditions, it will produce the same findings. Reliability in this sense means

consistency or accuracy of measurement (Allam, 2000, p. 131). Cronbach's alpha method for internal consistency is used to determine the reliability of the instruments.

The Alpha Cronbach procedure is used to evaluate how well each item on the scale correlates with its congruent components. Thorndike & Hagen (1969) indicate that assessing reliability according to this method depends on the internal consistency of individuals' responses to each item of the scale. An instrument is reliable if it has a reliability of (0.60) or above (See Table 3.1).

Table 3.1

Reliability Coefficients Using Cronbach's Alpha Equation

Instruments	**Reliability Coefficient**
Cognitive Load	**0.77**
Reading Comprehension	**0.70**

The instruments' coefficients are 0.77 and 0.70, which show acceptable reliability when compared to the standard value (0.60).

Regarding the reliability of the subjective three items of RCT, it has been measured by using Inter-Rater Reliability (IRR) method. The measurement of IRR offers a way to express the level of agreement between two raters who independently rate a set of subjects' features (Hallgren, 2012). The simple way to measure Inter-Rater Reliability is to calculate the percentage of items that the judges agree on, this is known as Percent Agreement which always ranges between 0 (0%) and 1 (100%) in which (0) indicates no agreement between raters and (1) indicates perfect agreement between raters (see table 3.2).

Table 3.2

Inter-Rater Reliability Using Percent Agreement for Two Raters

Item	**Agreement between Raters**	**Percentage Agreement between Raters**
8	**1**	**67%**
9	**1**	
10	**0**	

IV. Results

4.1 Results Related to the First Aim

The first aim of this study is to find out Iraqi EFL preparatory students' cognitive load and reading comprehension. This aim has been met by applying the research instruments to the study's sample of 345 students. Each instrument's arithmetic mean and standard deviation are determined, and a t-test for one sample is used to determine the significance of the difference between each instrument's arithmetic and theoretical means. The following results are displayed for each instrument:

4.1.1 Cognitive Load Questionnaire

The responses from the sample are calculated for the total CL and for each type of CL. The sample arithmetic mean of the total CL scale is (106.71), the standard deviation is (27.45) and the theoretical mean is (90). For intrinsic load, the arithmetic mean is (53.684), the standard deviation is (17.659), and the theoretical mean is (45). For extraneous load, the arithmetic mean is (35.092), the standard deviation is (10.118), and the theoretical mean is (30). The germane load's arithmetic mean is (17.933), its standard deviation is (7.112), and its theoretical mean is (15). The significance of the difference between the arithmetic means for the scale as a whole and for each load type and the theoretical mean is assessed using the t-test for one sample (see table 4.1).

Table 4.1

Arithmetic Mean, Standard Deviation, and T-Test Values of Cognitive Load

Load Type	Sample	Arithmetic Mean	Theoretical Mean	Standard Deviation	T-Test Values		Sign.
					Computed	Critical	
Total Cognitive Load	٣٤٥	١٠٦,٧١	٩٠	٢٧,٤5	١١,٣٠٨	١,٩٦٠ (٠,٠٥) (٣٤٤)	Sig.
Intrinsic Load		٥٣,٦٨	٤٥	١٧,٦6	٩,١٣٤		Sig.
Extraneous Load		٣٥,٠٩	٣٠	١٠,١2	٩,٣٤٩		Sig.
Germane Load		١٧,٩٣	١٥	٧,١١	٧,٦٦١		Sig.

According to the above table, the sample has a high level of total cognitive load and for each of its three types. The computed t-values (11.308 and 9.349) are found to be greater than the critical t-value of (1.960) at the level of significance (0.05) and the degree of freedom (344).

4.1.2 Reading Comprehension Test

The test's arithmetic mean (10.42), standard deviation (2.52), and theoretical mean (10). The study sample's test responses are sorted, and for one sample, a T-test is used to determine the significance of the difference between the theoretical and arithmetic means. The difference is discovered to be statistically insignificant (see Table 4.2).

Table 4.2

Arithmetic Mean, Standard Deviation, and T-Test Values of Reading Comprehension Test

Sample	Arithmetic Mean	Theoretical Mean	Standard Deviation	T-Test Values		Sign.
				Computed	Critical	
٣٤٥	10.42	١٠	2.52	3.11	١,٩٦ (٠,٠٥) (٣٤٤)	Sig.

The table above reveals that the study sample has a high level of reading comprehension, as the computed t-value is found to be (3.11), which is higher than the critical value (1.96) at the level of significance (0.05) and a degree of freedom (344).

4.2 Results Related to the Second Aim

In order to achieve this aim, the Pearson correlation coefficient is used to analyze students' responses to the CL questionnaire and RCT. A t-test is used to identify the significance of the correlation between the two variables (see Table 4.3).

Table 4.3

The Correlation between Iraqi EFL Preparatory Students' Cognitive Load and Reading Comprehension

Cognitive Load	Sample	Correlation Coefficient	T-test		Sign. (0.05)
			Computed	Critical	
Intrinsic	345	-0.34	6.740	١,٩٦	Sign.
Extraneous		-0.36	7.238		Sign.
Germane		0.35	6.807		Sign.

The previous table reveals the following:

- The correlation coefficient value between intrinsic load and RC is (-0.342), which means that the correlation is negative, that is, the higher the level of intrinsic load in the sample of the study, the lower their RC level. The calculated t-test value is (6.740), which at the level

of significance (0.05) and the degree of freedom is higher than the critical value (1.96) (344). The correlation is therefore statistically significant.

- The correlation coefficient value between extraneous load and RC is (-0.364), which means that the correlation is negative, that is, the higher the level of extraneous load in the sample of the study, the lower their RC level. The calculated t-test value is (7.238), which at the level of significance (0.05) and the degree of freedom (344), is higher than the critical value (1.96). The correlation is therefore statistically significant.
- The correlation between germane load and RC is (0.345), indicating a positive correlation, meaning that the higher the study sample's level of germane load, the higher their level of RC. The calculated t-test value is (6.807), which at the level of significance (0.05) and the degree of freedom is higher than the critical value (1.96). (344). The correlation is therefore statistically significant.

V. Discussion of Results

This study reveals that Iraqi EFL preparatory students have a high level of cognitive load and a high level of RC. Additionally, Iraqi EFL students' intrinsic and extraneous loads are negatively correlated with their RC, while their germane load is positively correlated with their RC. When students' intrinsic and extraneous loads are high, their level of RC will be low. A high level of germane load, on the other hand, results in a high RC level.

VI. Conclusions

1- Iraqi EFL preparatory students have a high level of CL.

2- Iraqi EFL preparatory students' intrinsic and extraneous loads are negatively correlated with RC. Students who have a high level of these load types perform poorly in reading comprehension tasks, which would lead to a low level of reading comprehension. On the other hand, grammar load is positively correlated with reading comprehension. Students who have a high level of this load type perform well in reading comprehension tasks as they make use of their background knowledge and schemas in order to comprehend a text.

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العلاقة بين العبء المعرفي والاستيعاب القرائي لدى طلبة المدارس الاعدادية العراقيين دارسي اللغة الإنجليزية لغةُ أجنبيةُ

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مرشحة ماجستير قسم اللغة الانجليزية كلية التربية ابن رشد للعلوم الانسانية جامعة بغداد / بغداد ،العراق

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الملخص:

كان العبء المعرفي أساسيًا لبحوث تعلم اللغة. أصبحت نظرية العبء المعرفي مؤخراً "المشروع الكبير القادم" في التدريس و اهم شيء يجب على المعلمون معرفته.

تم اجراء ابحاث مكثفة على الاستيعاب القرائي ولايزال موضع الاهتمام الحالي كونه احد اكثر الانشطة المعرفية تعقيدا والتي ينخرط فيها الانسان. ان تطوير مهارات الاستيعاب القرائي سيساعد الطلاب على اتقان المهارات الثلاثة الاخرى وهي: التحدث و الاصغاء و الكتابة.

تهدف هذه الدراسة الى: اولا، معرفة العبء المعرفي لطلاب المرحلة الإعدادية العراقيين دارسي اللغة الإنجليزية كلغة أجنبية، والاستيعاب القرائي. ثانياً، ايجاد العلاقة المتبادلة بين العبء المعرفي لطلاب المرحلة الإعدادية العراقيين دارسي اللغة الإنجليزية كلغة أجنبية، والاستيعاب القرائي.

الدراسة الحالية هي دراسة ارتباطية وصفية. تم اختيار عينة عشوائية تتكون من (٣٤٥) طالباً و طالبة من المرحلة الاعدادية في مدارس محافظة بغداد/ مديرية الكرخ الثانية للعام الدراسي ٢٠٢٢/٢٠٢٣. تم استخدام اداتان لتحقيق أهداف هذه الدراسة: مقياس التصنيف الذاتي للعبء المعرفي (باس ، ١٩٩٢) و (ليبينك ، ٢٠١٣) ، واختبار الاستيعاب القرائي (كولمان ، ٢٠٢٠).

تكشف النتائج أن الطلبة لديهم مستوى عالٍ من العبء المعرفي بالإضافة إلى الاستيعاب القراءئي. علاوة على ذلك ، تكشف النتائج أيضًا أن العبء المعرفي الداخلي والخارجي للطلبة يرتبطان سلبًا بالاستيعاب القراءئي، بينما يرتبط العبء المعرفي الوثيق ارتباطًا إيجابيًا.