



The Impact of Linguistic vs. Content Schemata on Improving ESP Students' Reading Comprehension

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Abstract

Reading is a complex process in which meaning is developed through the reader's engagement with the text. This study was specifically concerned with the effect of linguistic versus content schemata on the reading comprehension of ESP students. To accomplish the objectives, 60 ESP learners studying Public Relations classes at Applied Science University participated in the Nelson English Language Proficiency Test (NELPT). The reading component of NELPT was employed. The participants were between 20 and 35 years of age. The participants were subdivided into one control and two experimental groups, each group comprising 20 students. A pre-test on reading was given to all three groups. The Nelson English Language Proficiency Test (NELPT) reading component was employed. The experimental groups received supplemental instruction on reading comprehension, focusing on content and linguistic techniques delivered through a virtual learning environment. The control group received only standard classroom instruction in the university classroom. Finally, a post-test (NELPT) was administered to all three groups to identify the effect of linguistic and content schemata on the reading comprehension of ESP students compared to that of the control group. Findings indicated that both linguistic (mean diff. = 4.42, $p = 0.000$) and content schemata (mean diff. = 2.28, $p = 0.010$) learning could help ESP learners enhance their reading comprehension. Linguistic schemata proved more effective than content schemata learning (mean diff. = 2.13, $p = 0.020$) in improving ESP students' reading comprehension. This study provides useful information for students, teachers, and material providers engaged in ESP courses.

Keywords: content schemata, ESP, linguistic schemata, reading comprehension achievement

1. Introduction

The complex process of reading comprehension holds great importance in language acquisition. It is particularly crucial within English for Specific Purposes (ESP) where learners need to understand specialized texts relevant to their area of study or work (Carrell, 1998; Hamed et al., 2020). Reading is

a multifaceted, interactive process involving bidirectional communication between the reader and the text (Anderson, 1999; Rumelhart, 1977a). Comprehension involves more than a simple decoding of words and phrases. It is the result of the interplay between bottom-up linguistic processing and top-down context-oriented processing. In other words, readers approach the text in a cyclical fashion rather than a sequential one. They move back and forth between the lowest linguistic level to the highest (Kusumarasdyati, 2023, Muhammadpour & Khalili Sabet, 2024). This shift of emphasis was mostly influenced by the emergence of the schema theory that emphasized effective and productive reading requires both top-down and bottom-up techniques operating cooperatively (Rumelhart 1977a, 1980; Sanford & Garrod 1981; Van Dijk & Kintsch 1983). Reading comprehension is treated as the procedure of adopting and authenticating conceptual schemata for the text and building a meaningful image of passage using them (Rumelhart, 1977b).

Schema theory has significantly shaped the understanding of reading comprehension as an interactive process (Rumelhart, 1977b, 1980; Sanford & Garrod, 1981; Van Dijk & Kintsch, 1983). It underscores the importance of adopting and validating conceptual schemata, comprising linguistic (knowledge of language structures) and content (background knowledge of the subject matter), for effective text comprehension.

Research reveals that ESP students often struggle to understand technical English textbooks (Irudayasamy et al., 2020; Muhammadpour & Khalili Sabet, 2024). Activating linguistic and content schemata may enhance their reading comprehension abilities. This study examines the potential impact of such activation and urges educators to integrate purpose-built learning schemata into reading-oriented lessons to promote better comprehension in their classrooms (Muhammadpour & Khalili Sabet, 2024).

2. Literature Review

2.1. Reading Comprehension

Reading comprehension is generally considered the most significant of the four language skills in the context of second language learning, particularly in English as a second or foreign language (Carrell et al., 1988; Richards & Renandya, 2002; Yan & Kim, 2023). This essential skill involves a multifaceted array of cognitive functions and processes that contribute to the formation of a mental representation of written text (Abusamra et al., 2020). Educators have employed reading in classrooms both as a tool for linguistic development and as a method for reinforcing and expanding students' content area knowledge (Rudman, 1993; Smallwood, 2004). As a result, enhancing reading comprehension in second language contexts is crucial for learners' overall language proficiency and academic success.

The comprehension of reading as a skill has undergone substantial transformation throughout history. In its early conception, reading was seen as a passive ability grounded in decoding grammar and vocabulary within the Audiolingualism paradigm (Silberstein, 1987). According to this "bottom-up processing" model, readers were perceived as passive receivers of information, attempting to encode the intended meaning by recognizing letters and words as meaningful units (Rivers, 1968). Essentially, the reader's role was reduced to that of a transporter of information from the written page, devoid of any active collaboration between the reader and the writer. In this view, the meaning of a text was expected to surface spontaneously as the reader decoded linguistic units, such as vocabulary, grammar, and syntax, based on their existing knowledge (Aebersold & Field, 1997). This perspective on reading comprehension, however, has been substantially revised and expanded upon in subsequent research and theorizing.

In the 1970s, the "psycholinguistic model" arose, challenging the passive understanding of reading comprehension and introducing a dynamic, interactive approach (Goodman, 1967, 1985; Smith, 1971). This "top-down processing" model emphasized the importance of readers actively employing their prior knowledge and schemata to predict and interpret text (Kintsch, 1998; Kintsch & Van Dijk, 1978). According to this perspective, proficient readers engage in a "psycholinguistic guessing game" where they read selectively, analyze written signs, capitalize on redundancy, develop hypotheses about the upcoming content, and rely on their background knowledge of the world and content schemata to forecast the discourse. Finally, they confirm, verify, or refute these predictions as they progress through the text. As readers actively engage with the text, they grasp broader chunks of meaning and integrate this new information with their prior knowledge. This involves a 'top-down' processing in the cognitive system, where the readers make predictions using their higher-level schemata and actively seek textual evidence that fits with their initial predictions (Kintsch, 1998; Kintsch & Van Dijk, 1978). In essence, reading comprehension is viewed as the outcome of the interplay between the literal, propositional representation of a text in working memory and the related schema derived from one's background knowledge.

Contemporary research has coalesced around an "interactive" model that combines both bottom-up and top-down processes, acknowledging that proficient readers employ multiple processing levels, ranging from basic decoding to advanced comprehension strategies, to construct meaning (Rumelhart, 1980; Rumelhart, 1977; Stanovich, 1980). It is now widely accepted that second language (L2) reading is a reciprocal process in which skilled readers continuously utilize elements at all levels, from grapho-phonetic to schematic (Eskey & Grabe, 1988; Carrell, 1988, 1989; Rayner & Pollatsek, 1989). Contemporary perspectives on reading have moved beyond conceptualizing reading as a pure print-free psycholinguistic exercise of making guesses. Instead, reading proficiency is now understood as an interactive process involving both bottom-up and top-down processing mechanisms, where pre-existing knowledge and prediction significantly enhance the processing of textual input (Eskey & Grabe, 1988; Carrell, 1988, 1989; Rayner & Pollatsek, 1989). This interactive process manifests itself across three distinct levels: first, the reciprocal engagement of lower- and higher-level skills; second, the concurrent operation of bottom-up and top-down processing; and third, the interplay between the background knowledge presupposed by the text and the reader's existing knowledge structures (Rumelhart, 1980). Furthermore, as readers acquire additional information on a given subject, their schema is subject to modification and refinement via growth, reorganization, and correcting inaccuracies. This reflects a continual learning and adaptation process (Kintsch, 2009).

It can be concluded that schema contributes significantly to reading comprehension. Readers often utilize a bottom-up approach initially to establish a basic understanding of the text, subsequently engaging in a top-down process for a deeper interpretation. Predictions about the text's content are then validated, retrieved, or refuted through additional analysis of the information. This interactive model of reading, integrating both bottom-up and top-down strategies, makes use of their strengths while avoiding their limitations. It is currently considered the most comprehensive framework for describing reading comprehension.

2.2. Types of Schemata

Introduced by Bartlett (1932) within the field of psychology, the concept of "schema" originally referred to the active organization of prior experiences. Cognitive scientists have adopted this term to

describe how individuals process, organize, and store information. Schemas, or schemata, are cognitive frameworks that enable the arrangement of information within long-term memory (Widdowson, 1983). They encapsulate the experiences, conceptual knowledge, attitudes, values, skills, and strategic approaches individuals bring to a textual situation (Vacca & Vacca, 1999). A schema functions as a cognitive template that facilitates the matching and comprehension of new information (Rumelhart & Ortony, 1977). As defined by Rumelhart (1980), a schema is a data structure representing generic concepts held within memory.

Schema Theory, a critical aspect of cognitive science, investigates the acquisition, processing, and retrieval of knowledge. A core principle of this theory states that written text does not inherently suggest meaning. Rather, the text acts as a guide, directing readers to access or construct meaning through the utilization of their pre-existing knowledge base (Brown, 2001). This pre-existing knowledge constitutes the reader's background knowledge, and these pre-existing knowledge structures are referred to as schemata. Effective comprehension hinges upon the capacity to integrate textual material with one's knowledge, as "every act of comprehension involves one's knowledge of the world" (Anderson, 1977, p. 369).

According to Rumelhart (1982), schemata are fundamental to our cognitive processes, acting like the building blocks of understanding. These complex mental networks allow us to make sense of new information, events, and situations. Urquhart & Weir (1998) identify several types of schemata based on their content, including formal, content, cultural, and linguistic. Each of these types helps us interpret and understand information in different ways.

A reader's linguistic schema, encompassing their pre-existing knowledge of vocabulary, grammar, and syntactic structures, serves as a basic element in text comprehension. Linguistic schema, which contributes to the learners' language proficiency, is a significant determinant of understanding, particularly for novice learners. The effectiveness of any reading strategy is contingent upon a strong linguistic schema without which successful comprehension seems impossible. As Carrel (1984) demonstrated, a richer linguistic schema facilitates greater information extraction from a text and positively correlates with enhanced reading proficiency. This is supported by Eskey (1988, p. 94), who posits that skilled readers utilize both decoding and interpreting skills, with decoding skills becoming more automatic yet no less important as their reading skill develops. Thus, effective text comprehension is predicated on strong decoding abilities (Eskey, 1988).

Formal schema encompasses an individual's understanding of diverse text types and genres. This schema acknowledges that various genres employ distinctive grammatical structures, vocabularies, text organization, language structures, and levels of formality (Carrell & Eisterhold, 1983; Urquhart & Weir, 1998). Essentially, formal schema pertains to the structures inherent to different genres. These schemata are conceived as internalized, abstract, encoded, and coherent patterns of meta-linguistic discourse, guiding text comprehension. Readers activate their schematic representations of various text forms, such as essays, fiction, poems, journalistic articles, and scholarly papers, to facilitate a deeper understanding of the content. Empirical studies indicate that familiarity with text genres enhances reading comprehension, as the text type itself provides contextual cues regarding its subject matter (Urquhart & Weir, 1998).

Content schema, as defined by Carrell & Eisterhold (1983), refers to an individual's pre-existing knowledge regarding the subject matter and content domain of a given text. It encompasses conceptual understanding and information pertaining to typical occurrences within a specific topic and the

interrelationships between these events that form a cohesive whole. Content schema is posited as crucial for comprehension the lack of which can impede understanding. This is echoed by Aebbersold and Field (1997), who assert that “if the topic is outside students’ experience or base of knowledge, they are adrift to an unknown sea” (p. 41). The set of typical events and entities associated with a specific occasion remains open to interpretation in the content schema. For example, an individual's content schema for going to a restaurant may include information concerning services provided, menu options, and the process of ordering meals and paying the bill. Together, these schemas significantly contribute to reading comprehension by facilitating the processes of decoding, interpretation, and meaning-making of texts, drawing on an individual's existing knowledge of language, text genres, and subject matter.

Language includes not only vocabulary, grammar, and syntactic structures, but also serves as a vehicle for conveying diverse cultural aspects. Owing to its inherent culture-specific characteristics, content schema is often subcategorized to encompass cultural schema. Within the framework of schema theory, learners actively develop and iteratively revise schemata as they engage with new information. This process entails the comprehension of the text's subject matter as well as the identification of cultural elements essential for accurate interpretation. Content schema constitutes a part of an individual's cultural orientation, and given the pervasive nature of culture across all facets of life, it substantially influences all dimensions of reading. Readers construct various schemata, often rooted in their respective cultural backgrounds. Recognizing the pivotal role of cultural schema in English as a Second Language (ESL) pedagogy, educators commonly formulate reading strategies designed to cultivate or activate learners' schemata. Research conducted by Johnson (1981) and Carrell (1981) has demonstrated that an individual's implicit cultural knowledge, presupposed by a given text, interacts with their culturally-informed background knowledge of the content. Consequently, texts rooted within one's own cultural framework are more readily processed and comprehended than texts more rhetorically similar which are based on a less familiar or more distant culture.

2.3. Schemata Activation and Language Instruction

The inability of language learners to activate appropriate schemata, rather than lacking them, significantly impacts ESL reading comprehension (Carrell, 1983; Williams, 1987). Effective L2 reading instruction must consider the relevance of content, as a reader's familiarity with the text's subject matter greatly influences their comprehension. ESL/EFL teachers should provide students with content incorporating pertinent cultural information to reduce reading complexities (Carrell, 1983, 1987).

For educators, the significance of background knowledge has three primary implications: first, a recognition of the knowledge underpinning a given text; second, the facilitation of active engagement with pre-existing knowledge during the reading process; and third, the cultivation of problem-solving and interpretive strategies that empower students to utilize their knowledge effectively. Therefore, by instructing students to activate and employ their background knowledge, teachers assist them in becoming competent readers.

All these considerations underscore the importance of integrating content schema into pedagogical practice. Williams (1987) proposed a three-phase approach for fostering reading comprehension: first, a pre-reading phase focused on constructing background knowledge through the utilization of visual aids, games, or multimedia resources; second, a reading phase wherein students read the text, thereby reinforcing their existing background knowledge; and third, a post-reading phase designed to integrate acquired knowledge into a new schema structure. Furthermore, Krashen (1993)

proposed two strategies for schema activation: the first, termed Free Voluntary Reading, encourages students to select and read texts of personal interests, free from concerns for evaluation and accountability; his second suggestion entails students engaging with texts in their first language to facilitate the activation of a knowledge base conducive to second language comprehension. Extensive reading has also been advocated as a beneficial strategy (Bamford & Day, 1997; Day & Bamford, 1998, 2002); however, irrespective of its inherent motivating effects, several challenges in its curricular implementation have been identified, including the requisite educator training, the availability of adequate resources, and the allocation of dedicated reading time within the curriculum (Grabe, 2002).

2.4. Schema Theory and Reading Comprehension

Extensive research on schema theory has demonstrated its profound influence on understanding reading comprehension in native and second languages. This research highlights that a reader's comprehension of a text largely depends on their possession of relevant schemata, which include content, formal, and linguistic schemas. A lack of appropriate schemata can lead to miscomprehension or poor reading comprehension (Carrell, 1981, 1983, 1988b). Thus, activating relevant schemata before reading and utilizing them during the reading process enhances overall understanding.

Several studies further emphasize the role of background knowledge in reading comprehension. Koh (1986) attempted to display the effects of familiar context on students' reading comprehension. The results indicated that comprehension improves when readers possess relevant background knowledge of the text's subject matter.

Winfield and Barnes-Felfeli (1982) conducted a study on a class of twenty intermediate-level ESL students, containing two groups: one consisting of Hispanic learners and the other encompassing Hebrew, Arabic, Navajo, Greek, and other non-native English speakers. While all participants underwent the same pre-reading activities, they exhibited varying degrees of background knowledge. Whereas the non-Hispanic students demonstrated relatively consistent performance across both texts, the Hispanic students showed a significantly better performance. Based on these findings, the researchers concluded that familiarity with textual content augments reading fluency, thereby leading to better comprehension among learners possessing prior knowledge of the topic.

Hinkel (2012) investigated the influence of cultural differences on EFL reading comprehension. The findings of this research indicated that cultural differences, coupled with a limited understanding of cultural nuances, can hinder EFL reading comprehension.

Weng (2012) further corroborated these findings by demonstrating that participants performed better on texts that were culturally and topically familiar than on those that were culturally and topically unfamiliar. Weng proposed that pre-reading interventions or vocabulary instruction could serve to increase background knowledge in EFL learners, consequently improving comprehension.

Hosseini and Mahmoodi (2015) found that topical background knowledge exerts a positive influence on students' reading comprehension performance.

Smith et al. (2021), through a critical review, indicated that higher levels of background knowledge impact comprehension based on text characteristics, the quality of the situation model constructed by the reader, and the presence of reader misconceptions. Furthermore, background knowledge also has a differential impact on stronger and weaker readers; weaker readers derive greater

benefit from high-cohesion texts and are able to partially compensate for deficiencies in reading skills by possessing a high degree of prior knowledge.

McCarthy et al. (2023) investigated the relationship between prior knowledge types—including topical vocabulary, basic/factual knowledge, and integrated/conceptual knowledge—and scores on Scenario-Based Assessments (SBAs). Their findings revealed that all three knowledge measures predicted comprehension beyond reading skill, thereby underscoring the necessity of evaluating both the nature and the impact of students' pre-existing knowledge on learning outcomes.

Filderman et al. (2022), through a meta-analysis of comprehension interventions for struggling readers in Grades 3-12, supported the effectiveness of interventions that incorporate background knowledge and strategy instruction to enhance comprehension in upper elementary grades and beyond.

Kiili et al. (2024) examined the relative contributions of prior topic knowledge and basic reading skills to students' performance in both identification and justification tasks. Their findings demonstrated that word recognition and reading comprehension were predictors of performance on identification tasks, whereas prior knowledge and reading comprehension were predictive of performance on justification tasks.

McNeil (2011) investigated the combined effects of background knowledge and reading comprehension strategies, specifically self-questioning, on reading performance. The results revealed that both background knowledge and self-questioning accounted for a significant portion of the variance in reading comprehension scores, with self-questioning emerging as a stronger predictor than background knowledge alone.

Levine and Haus (2008) demonstrated that background knowledge has a significant influence on reading comprehension across diverse question types when textual material is presented at an "instructional" reading level. The results of their investigation highlighted the possibility that background knowledge may constitute a more critical factor than language proficiency in comprehending such material.

This study intends to investigate whether activating linguistic and content schemata has any effect on fostering ESP students' reading comprehension. While it has been shown that both content and linguistics schemata are essential for a perfect comprehension of written texts in a reader's mother language (L1) or second language (L2), it is still a field that has been commonly overlooked by both researchers and language instructors in ESP courses in Iran.

3. Research Questions

The main goal of this study was to explore the effectiveness of activating linguistic and content schemata in fostering ESP students' reading comprehension. Accordingly, the following research questions were formulated:

1. Does linguistic schemata learning have any significant effect on improving ESP students' reading comprehension?
2. Does content schemata learning have any significant effect on improving ESP students' reading comprehension?

3. Is there any statistically significant difference between the effects of linguistic schemata learning vs. content schemata learning on ESP students' reading comprehension?

4. Method

4.1. Research Design

This research used a quasi-experimental method to evaluate the impact of an intervention on the target population. Quasi-experimental research shares similarities with the traditional experimental design, but they specifically lack the element of random assignment to treatment or control. One-way ANOVA was used in which there were one independent variable with two layers, namely, content and linguistic schemata, and one dependent variable, reading comprehension. This study required a pre-test-post-test research design to be applied to allow the researchers to inspect differences in the performance of two experimental groups before and after the experimental manipulation.

4.2. Participants

To accomplish the present research, 60 undergraduate male and female students majoring in Public Relations at Tehran Applied Science University participated in the study. They were between 20 to 35. The participants were assigned to one control group and two experimental groups.

4.3. Instruments

Two instruments were employed in this study: The Nelson proficiency test and a researcher-made reading comprehension test of public relations. They are explained in detail in the following two subsections.

3.3.1. Nelson Proficiency Test

To ensure the homogeneity of the students in terms of their language proficiency, the mean and the standard deviation of Nelson scores of the two experimental groups were calculated. The Nelson proficiency test consists of three parts: cloze tests, structure, and vocabulary, all in the multiple-choice question form. Altogether, there are 50 items and it takes 45 minutes to answer the test. The reliability of the Nelson test is 0.89 estimated through K-R21, an acceptable index of reliability.

4.3.2. Researcher-Made Reading Comprehension Test of Public Relations

To measure the reading ability level of the participants of the two groups before and after the treatment, the researchers made a technical public relations reading comprehension test. This test consists of five parts followed by 30 questions including 10 multiple-choice questions (Cronbach's $\alpha = 0.88$), 10 four-option multiple-choice cloze tests (Cronbach's $\alpha = 0.87$), 5 matching (Cronbach's $\alpha = 0.86$), 5 true/false (Cronbach's $\alpha = 0.90$). The test was used as the pre-test and post-test of the study. The total grade for this test was 30 and 40 minutes was allotted for this test. To reduce the test effect, the researchers changed the order of items and choices and reworded some words of the item stems or choices of the post-test. Two experts in public relations read the test carefully and provided the researchers with some tips to remove some malfunctioned or ambiguous items and add some more. Lastly, they verified the final refined test.

4.4. Procedure

The study was completed in the following steps: Firstly, three classes of ESP learners consisting of 20 male and female students ($N = 60$) were chosen. The researcher used an experimental research model including pre- and post-test instruments. Secondly, the Nelson test of language proficiency was administered to prove their homogeneity. The reliability of the Nelson test is 0.89 estimated through K-R21, an acceptable index of reliability. The reading comprehension test was administered to all chosen groups as a pre-test. Thirdly, students underwent a ten-session exposure to language learning (treatment). One experimental group received content pre-teaching whereas the other group received linguistic schemata pre-teaching. While the experimental groups underwent the training sessions, the control group received no treatment. They were taught according to the set rules of the conventional classroom but the other groups went through teaching content and linguistic schemata. In one class, the instructor worked on the content and the related text first, but in the other one, the instructor taught the new vocabulary and grammar in advance. All three groups took part in the post-test. The results were analyzed by SPSS software.

4.5. Procedure

One-way ANOVA was adopted to analyze the data in this study. According to Mackey and Gass (2005), one-way ANOVA prepares information on whether or not the three (or more) groups differ (three groups in the current study, but it does not provide any information as to the place or the source of difference. To specify the location of the difference when the F value is significant, a post-hoc analysis (i.e., Scheffe test) is executed. Thus, the researcher of this study applied one-way ANOVA since there were three groups (linguistic group, content group, and control group) and we wanted to see whether or not the three groups differ. In fact, there were one independent variable with two layers, namely, content and linguistic schemata, and one dependent variable, reading comprehension.

5. Results

5.1. Testing Assumptions

The four necessary assumptions to be met before the use of parametric tests include assumptions of interval data, independence of subjects, normality, and homogeneity of variances. The first assumption is met since the present data were measured on an interval scale. Bachman (2005, p. 236) declares that the assumption of independence of subjects is met when the performance of any given individual is independent of the performance of other students.

The third assumption deals with the normality of the data which is checked using the One-Sample Kolmogorov-Smirnov Test. The normality results, shown in Table 1, indicated that the probability values associated with the three sets of proficiency scores were greater than 0.05. Consequently, it was concluded that the normality assumption for proficiency scores in three groups was not violated.

Table 1

One-Sample Kolmogorov-Smirnov Test of Normality for Proficiency Scores in the Three Groups

Group	N	Kolmogorov-Smirnov Z	Sig.
Linguistic	20	0.563	0.909
Content	20	0.367	0.999
Control	20	0.643	0.803

Table 2 demonstrates that the three sets of public relations reading scores on the pre-test met the normality assumption ($p > 0.05$).

Table 2

One-Sample Kolmogorov-Smirnov Test of Normality for Public Relations Reading Post-test Scores in the Three Groups

Group	N	Kolmogorov-Smirnov Z	Sig.
Linguistic	20	0.631	0.821
Content	20	0.653	0.788
Control	20	0.573	0.864

The normality results, appearing in Table 3, showed that the probability values associated with the three sets of public relations reading scores on the post-test were above 05. As a result, the normality assumption for reading scores on the post-test was not violated.

Table 3

One-Sample Kolmogorov-Smirnov Test of Normality for Public Relations Reading Post-test Scores in the Three Groups

Group	N	Kolmogorov-Smirnov Z	Sig.
Linguistic	20	1.096	0.181
Content	20	0.590	0.878
Control	20	0.624	0.831

The last assumption – homogeneity of variances – will be discussed when presented in the results of the inferential statistics.

5.2. Statistics for Nelson Proficiency Test

As mentioned before, the Nelson test was administered to the three groups to ensure the homogeneity of the participants in terms of language proficiency. One-way ANOVA was conducted to compare the proficiency scores in three groups. Before discussing the results of ANOVA, the descriptive statistics of participants' scores on the Nelson proficiency test were computed (Table 4). According to Table 4, the students in the linguistic group ($M = 11.62$, $SD = 1.95$) did not show a better performance in comparison to the content schemata group ($M = 10.86$, $SD = 1.71$) and the control group ($M = 11.23$, $SD = 1.67$) on the Nelson proficiency test.

Table 4

Descriptive Statistics for Proficiency Scores in the Three Groups

Group	N	Mean	SD
Linguistic	20	11.625	1.959
Content	20	10.862	1.711
Control	20	11.237	1.677

The assumption of homogeneity of variance was checked through Levene's Test. The results revealed that the homogeneity of variance for the proficiency scores was met because the probabilities associated with Levene's F-values (0.39) exceeded 0.05.

The results of ANOVA employed to compare the scores of these three groups on the proficiency test are laid out in Table 5. ANOVA results (Table 5), could not detect any statistically significant difference in participants' proficiency scores among the three groups at the $p < 0.05$ level, $F(2, 57) = 0.91$, $p = 0.40$, $p > 0.05$, in which the p-value (0.41) was above 0.05, and the F-value (0.91) was lower than the F-critical (4.98); thus, it was concluded that the students in three intact groups (linguistic, content schemata, and control) were homogeneous, all in an elementary level of English language proficiency.

Table 5

ANOVA for Comparing Three Groups' Proficiency Scores

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	5.815	2	2.907	0.910	0.408
Within Groups	182.056	57	3.194		
Total	187.871	59			

5.3. Investigating the Research Questions

The first research question of this study was raised to find out whether linguistic schemata learning has any significant effect on improving ESP students' reading comprehension. The second research question of this study asked if content schemata-learning has any significant effect on improving ESP students' reading comprehension. Finally, the third question was formulated to see if there is any statistically significant difference between the effects of linguistic schemata learning vs. content schemata learning on ESP students' reading comprehension. To answer these research questions One-way ANOVA was conducted for both pre-test and post-test of reading comprehension.

5.3.1. Pre-test Results

The descriptive statistics of participants' scores on the public relations reading pre-test were calculated and outlined in Table 6 before presenting the results of ANOVA for the pre-test. As can be seen in Table 6, the reading means are not very different among the linguistic group ($M = 17.35$, $SD = 2.82$), content schemata group ($M = 16.58$, $SD = 2.41$), and control group ($M = 16.95$, $SD = 2.53$) on the pre-test.

Table 6

Descriptive Statistics for Public Relations Reading Pre-test Scores in the Three Groups

Group	N	Mean	SD
Linguistic	20	17.350	2.820
Content	20	16.587	2.418
Control	20	16.950	2.537

Levene's Test was used to test the assumption of homogeneity of variance. Table 7 The results indicated that the homogeneity of variance for the pre-test scores was not violated since the Sig. for Levene's Test (0.70) was greater than 0.05. Table 7 reflects the results of ANOVA used to compare the scores in three groups on the pre-test of reading comprehension. According to Table 7, ANOVA revealed no statistically significant difference in reading scores among three groups on the pre-test at

the $p < 0.05$ level, $F(2, 57) = 0.43$, $p = 0.65$, $p > 0.05$, in which our F-value, 0.43 was less than the F-critical (4.98).

Table 7

ANOVA for Comparing Three Groups' Public Relations Reading Scores (Pre-test)

	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	5.819	2	2.909	0.431	0.652
Within Groups	384.659	57	6.748		
Total	390.478	59			

5.3.2. Post-test Results

The descriptive statistics for the scores on the post-test of public relations reading are shown in Table 8. As Table 8 shows, on the post-test of reading, the largest mean is for the linguistic group ($M = 22.67$, $SD = 2.22$), followed by the content group ($M = 20.54$, $SD = 2.36$), and then the control group ($M = 17.25$, $SD = 2.53$).

Table 8

Descriptive Statistics for Public Relations Reading Post-test Scores in the Three Groups

Group	N	Mean	SD
Linguistic	20	22.675	2.218
Content	20	20.537	2.365
Control	20	17.250	2.528

The assumption of homogeneity of variance was tested using Levene's Test. The results showed that the homogeneity of variance for the reading post-test scores was met ($p = 0.63$, $p > 0.05$). The results of ANOVA performed to compare the scores of three groups on the post-test public relations reading are provided in Table 9 below. ANOVA (Table 9) detected a statistically significant difference in reading scores among the three groups at the $p < 0.05$ level, $F(2, 57) = 17.37$, $p = 0.000$, $p < 0.05$. The p-value (0.000) was less than 0.05, and also F-value, 17.37 was more than the F-critical (4.98).

Table 9

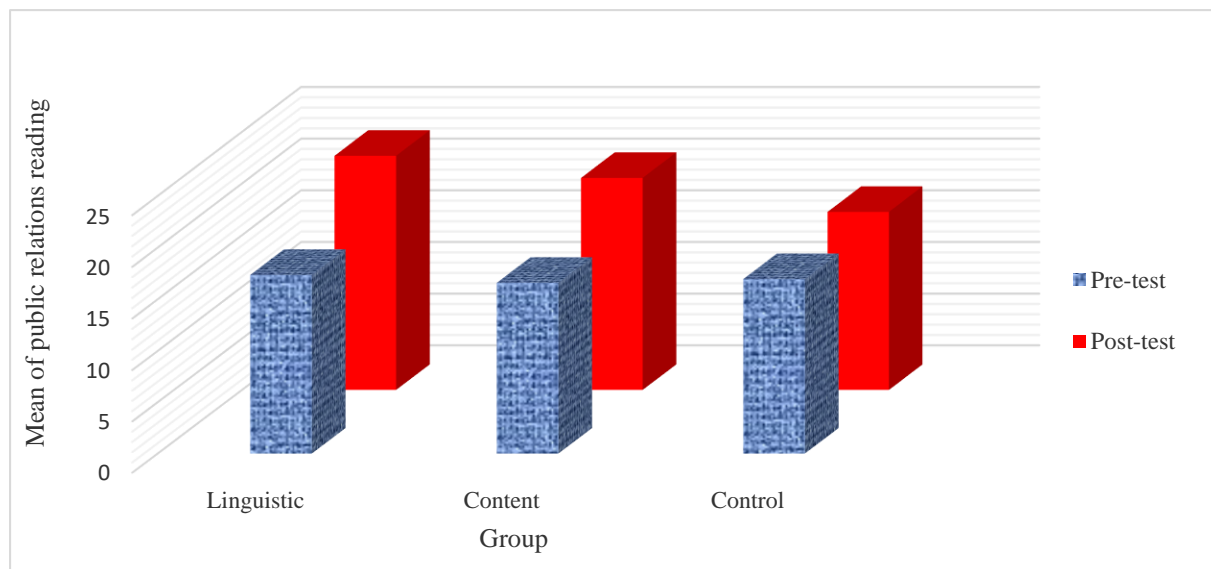
ANOVA for Comparing Three Groups' Public Relations Reading Scores (Post-test)

	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	195.881	2	97.941	17.375	0.000
Within Groups	321.297	57	5.637		
Total	517.178	59			

The graphical representation of the results is demonstrated in Figure 1 below. As obvious in Figure 1, the means on the pre-test of public relations reading comprehension are almost the same in the three groups, nonetheless on the post-test the participants in the linguistic group had the best performance, followed by the content schemata, and then the control group.

Figure 1

Bar Graph for Public Relations Reading Scores in the Three Groups on the Pre-Test and Post-Test



ANOVA just tells us that there exists a significant difference among the public relations reading measures among the students in the three groups, but it does not indicate where this difference lies. Thus post hoc Scheffe test was conducted to find the exact location of the difference among the three groups. Table 10 below demonstrates the results of the Scheffe test.

Post hoc Scheffe tests (see Table 10) indicated that there was a statistically significant difference in reading scores of the linguistic group ($M = 16.67$, $SD = 2.21$) and control group ($M = 12.25$, $SD = 2.52$) with the mean difference of 4.42, $p = 0.000$, $p < 0.05$, in which p-value, 0.000 was below.05; therefore, we could claim that linguistic-learning develops ESP students' reading comprehension.

The results of Post hoc Scheffe tests, as appeared in Table 10 above, revealed that there was a statistically significant difference in reading scores of the content schemata group ($M = 14.53$, $SD = 2.36$) and control group ($M = 12.25$, $SD = 2.52$) with the mean difference of 2.28, $p = 0.01$, $p < 0.05$; hence, it was proved that content schemata-learning improves ESP students' reading comprehension.

Besides, Table 10 above shows that there was a statistically significant difference in public relations reading scores of the linguistic group ($M = 16.67$, $SD = 2.21$) and content schemata group ($M = 14.53$, $SD = 2.36$) with a mean difference of 2.13, $p = 0.02$, $p < 0.05$, in which p-value, 0.02 was less 0.05; accordingly, we could assert that linguistic-learning is more effective than content schemata learning in improving ESP students' reading comprehension.

Table 10

Scheffe Post-hoc Tests for Multiple Comparisons of Three Groups' Public Relations Reading Scores (Post-test)

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Linguistic	Content	2.137*	0.750	0.023	0.250	4.024
	Control	4.425*	0.750	0.000	2.537	6.312
Content	Control	2.280*	0.750	0.014	0.400	4.174

6. Discussion

The findings of this study substantiate the effectiveness of linguistic and content schemata learning in improving students' comprehension and retention of the subject matter. The study results indicated that conventional instructional methods may not be as effective in developing reading skills as those incorporating linguistic schemata teaching. The substantial mean difference of 4.42 points underscores the positive influence of linguistic-focused learning on students' reading abilities, aligning with findings from Eskey (1988) that emphasize the importance of linguistic schemata, including vocabulary, grammar, and sentence structure, for effective decoding. Chastain (1988) emphasizes the necessity of activating background and linguistic knowledge in the learning process to convey meaning. Readers must go beyond the printed text to grasp the author's intended meaning.

The findings also revealed a significant difference in reading comprehension scores between the content schemata group ($M = 14.53$, $SD = 2.36$) and the control group ($M = 12.25$, $SD = 2.52$), with a mean difference of 2.28 ($p = 0.01$). This significant difference provides strong evidence to reject the null hypothesis that content schemata learning has no significant effect on ESP students' reading comprehension. These results align with established theories on the role of background knowledge in reading comprehension (Carrell, 1981, 1983; Coady, 1979; Hinkel, 2012; Hosseini and Mahmoodi, 2015; Johnson, 1981; Koh, 1986; McCarthy, et al., 2023; Weng, 2012). Brown (2001) highlights the active role of the reader, asserting that comprehension goes beyond the visual cues on the page and relies heavily on the reader's existing knowledge. The significant difference observed in this study demonstrates that activating relevant content schemata through targeted instruction can effectively enhance reading comprehension. This finding supports the notion that students may possess adequate background knowledge, but without proper activation and engagement, their comprehension abilities remain hindered. Therefore, these results suggest that incorporating content schemata-based learning strategies can be a valuable tool in improving ESP students' reading comprehension abilities. Bottom of Form

The results of the study also revealed that linguistic schemata-based instruction, focusing on language-specific skills such as vocabulary, grammar, and sentence structure, proves to be more effective in enhancing ESP students' reading comprehension than content schemata-based instruction, which focuses on activating background knowledge related to the text's subject matter. This finding is congruent with established theoretical frameworks concerning reading comprehension, particularly concerning less proficient readers. Many studies have illuminated the compensatory impact of background knowledge and reading ability, demonstrating that less skilled readers possessing strong topical knowledge can partially offset limitations in general comprehension skills (Adams et al., 1995;

Holmes, 1983). This phenomenon can be further justified by the findings of Kiili et al. (2024), who concluded that word recognition and reading comprehension were statistically significant predictors of identification performance, while prior knowledge and reading comprehension were statistically significant predictors of justification performance.

Additionally, the observed effect can be explained in light of the reading passage level, as posited by Levine and Haus (2008), who found that background knowledge constitutes a significant factor influencing reading comprehension when textual material is at the “instructional” reading level. In such instances, background knowledge may be a more salient determinant than language proficiency in comprehending the text. Elsewhere, two studies of offline text comprehension (Rupley & Willson, 1996; Willson & Rupley, 1997) found quantitative evidence that suggested background knowledge of a topic begins to diminish in importance at about fourth grade when strategy knowledge begins to play a more important role in reading informational text.

This study further corroborates the notion that while content schemata are undoubtedly important for understanding text, strong linguistic skills provide a solid foundation for decoding and processing information, ultimately leading to enhanced comprehension. Strong background knowledge can mitigate poor reading ability, and vice versa. High-knowledge readers can compensate for low reading skills. This effect is most pronounced when readers possess robust background knowledge, enabling them to retrieve information effectively, even if their understanding of the relationships between propositions is limited. Overall, these findings confirm that linguistic learning and content schemata-learning play a crucial role in enhancing reading comprehension among ESP students, suggesting that integrating these schemata teaching into ESP curricula could substantially improve student outcomes. Based on the findings of this study, it is recommended that students improve their reading comprehension with the aid of learning the elements of schemata properly. In addition, teachers could also use schemata teaching as a complementary teaching technique to assist students in ameliorating their comprehension level of texts. This research prompts educators to reconsider their instructional methods, emphasizing linguistic components that bridge gaps in understanding specialized content.

Skillful readers are good at decoding and interpreting texts, their decoding skills grow more automatic but no less significant as their reading skill progresses. Less skillful readers, on the other hand, show less automatic decoding skills, relying more on linguistic rather than content schemata (Eskey, 1988, p. 94). Language not only contains vocabulary, grammar, and sentence structures, but it also transfers different levels of culture. Studies verified that content schemata show conception and recalling more than formal schemata do for text structure. Therefore, it could be concluded that linguistic learning and schemata learning complement each other, and they play a pivotal role in students’ comprehension of a text.

7. Conclusions and Implications

The findings of this study confirm the application of linguistic learning and schemata learning techniques in improving students’ comprehension of text. Indeed, the experimental groups demonstrated better performance in reading comprehension than the group using the conventional approach. In the present study, it was argued that linguistic and content pre-teaching and schemata pre-teaching are important ingredients for improving reading comprehension, and they are essential parts of second or foreign language learning. Language learners need a wide array of target language linguistic and content

knowledge to be able to understand a passage in a second or foreign language successfully. Despite being carried out with a small number of participants, the results of this study indicate that the subjects of the experimental groups obtained higher scores on reading comprehension than those of the control group. This tends to highlight the effectiveness of an approach that integrates the linguistic and content pre-teaching technique as a tool in teaching reading comprehension activities in a foreign language.

To sum up, learning reading skills is a big challenge for foreign language students, but they can overcome it by being exposed to linguistic and content pre-teaching techniques. Learners should then be trained in areas they struggle. To this end, teachers should address the needs of the learners and think of the most appropriate way to introduce the techniques. EFL and ESP teachers should make learners practice a wide range of linguistic-learning and content schemata learning techniques. This would enable learners to handle reading comprehension pitfalls they may encounter both in and out of classroom context. Teachers and syllabus designers need to develop lesson plans that would include linguistic learning and content schemata learning techniques which would provide extra language exposure so that students would take great strides toward boosting their language development by pumping up their reading competence increasingly.

In summary, these findings provide valuable insights into the effectiveness of linguistic learning and content schemata approaches in improving reading comprehension among ESP students, indicating a promising direction for future educational practices and research. Future research could explore the long-term effects of such instructional methods on students' performance not only in reading skills but also in other subskills of reading such as reading accuracy and fluency. The effect of such a method on other language skills, as well as their applicability across various disciplines within ESP could be detected. Future research could also explore the specific types of content schemata that are most effective for different genres and disciplines within the ESP context. Further research is necessary to determine the long-term persistence of the training effect to investigate how long students who benefitted from linguistic-learning and content schemata learning techniques retain their advantage over those who have not received these learning techniques. The study could also be replicated with multimedia tools such as mobile phones, tablets, Moodle, and so on.

6. Discussion

Incorporating mobile technologies and gadgets into English language teaching and learning has been a focus for researchers, policy makers, and curriculum designers in recent years. Mobile application designers have produced educational applications aimed at providing education outside of the classroom, and one specific skill that has garnered attention from researchers is reading comprehension, particularly among engineering students. It is a critical skill that plays a significant role in their future careers and academic pursuits.

To answer the first research question, participants were asked if they were interested in using mobile applications to enhance their reading comprehension achievement. Jeong's (2017) research found that most participants claimed that learning English through mobile applications was more engaging than traditional methods. Moreover, mobile applications were more effective and motivating for the students, making them interested in studying English. Khrisat and Mahmoud (2013) and Muhammed (2014) reported similar findings on students' interest in using mobile phones and applications in EFL classrooms in the Saudi Arabian context.

Lee's (2014) study revealed that the majority of students prefer studying conventional printed course books, but learning English on gadgets improves their learning when used independently or combined with a teacher's instruction. However, Loan's (2009) study results were in contrast with Lee's, stating that modern technological devices have become a "Time Eating Machine," and the act of reading has become a closed book.

To address the second research question, Azadi and Azad (2017) reported that the experimental group significantly outperformed the control group on the post-test in both reading rate and comprehension while using mobile applications for reading. Hazaea and Alzubi's (2016) study found a direct relationship between the use of mobile WhatsApp, online and offline dictionaries and resources, and memos, and participants' reading comprehension achievements. Keezhatta and Omar (2019) emphasized that MALL materials and systems enhance reading comprehension achievement among EFL students. In addition, Moon et al. (2017) found that student-centered reading comprehension activities on the iPad can lead to better student achievement in reading comprehension.

The study by Loewen et al. (2019) had similar results to the present study, indicating significant progress on L2 measures and a positive correlation between the amount of time spent on Duolingo application and learning gains. However, the findings of Ng et al.'s (2020) study were in contrast to the current study, showing that students spending more time on their smartphones learning the language did not display better performance compared to the ones spending less time.

Regarding gender differences in adoption and use of technology, Poushter's (2016) study found no clear understanding, while Cai et al.'s (2017) meta-analysis of 50 studies concluded that males still hold more favorable attitudes toward technology use than females. Yang's (2012) study found no significant differences between male and female participants' attitudes on MALL, while Viberg and Gronlund's (2013) study found that female students are more positive towards the use of mobile gadgets in language learning. Additionally, Tsai (2016) highlighted significant differences among various English proficiency levels' reading preferences between printed texts or electronic ones in male and female groups.

In summary, mobile technologies and gadgets have been integrated into English language teaching and learning environments. Reading comprehension is a critical skill that has gained attention from researchers, with studies showing that mobile applications are more engaging, effective, and motivating for students. MALL materials and systems have a positive impact on reading comprehension achievement, providing a motivating learning environment for students. However, further research is needed to understand gender differences in the adoption and use of technology.

7. Conclusion and Implications

This study delves into the impact of mobile applications on enhancing the reading comprehension skills of Iranian EFL engineering students. The researcher utilized a placement test and two mobile apps to investigate the matter, involving 70 freshman and sophomore engineering students from Semnan University, Semnan, Iran. The findings revealed that the use of mobile apps has a positive influence on the participants' reading comprehension achievement, and they expressed great interest in utilizing such tools for educational purposes. The study also discovered a significant correlation between the time spent using mobile apps and reading comprehension achievement.

The outcomes of this research are of great value to curriculum designers and policymakers in the higher education sector, who can use the information to develop appropriate content for English language course books and allocate adequate class time to facilitate the instructional use of technology. University professors and teachers can also benefit from this study by encouraging students to engage more in the learning process inside and outside the classroom with the aid of technology, particularly mobile applications. The use of technology-based learning fosters communication between teachers and students, and even between students, helping them solve educational problems collaboratively.

Moreover, students can utilize various English language educational applications to enhance their language skills, including listening, speaking, reading, and writing, as well as sub-skills such as vocabulary, grammar, and pronunciation, at any time and from anywhere. It is claimed that there is a link between different language skills, and improvement in one skill can lead to enhanced performance in others, unintentionally. Lastly, using innovative technologies in the EFL setting facilitates access to original resources and professional knowledge, particularly among engineering majors, for both teachers and students.

As with any study, it's important to acknowledge the limitations of our research. Firstly, we lacked a control group and all participants were categorized into one experimental group. Secondly, there was a lack of teaching sessions, with participants working independently without guidance. They only had the opportunity to ask questions during consulting sessions. The third limitation relates to our sample population, consisting solely of undergraduate students in two engineering majors: chemical engineering and materials science and metallurgy engineering. Lastly, our study focused on mobile reading comprehension applications designed solely for the Android platform. Participants who owned different mobile platforms were required to install the applications on their tablets or laptops using Android simulation software. While we recognize these limitations, we have taken steps to ensure the validity of our findings and hope that our research provides useful insights into the use of mobile applications for reading comprehension.

This study was limited to freshman and sophomore students with the objective of enhancing their reading comprehension skills, which will be beneficial for their future language proficiency, career prospects, and knowledge enrichment. In order to obtain more reliable results, it will be helpful to conduct broader studies across different majors with a larger number of participants using various educational applications. Our tone is professional and objective. The description is concise and informative, containing 115 words.

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Authors' Contributions

All authors have conducted the study, collected data, analyzed and interpreted the data, and written up the manuscript.

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The authors declare that there is no conflict of interest.

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