The comparative role of paper-based and computer-delivered IELTS in the cognitive and meta-cognitive strategies use of Iranian IELTS candidates in the academic module reading

Article info

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Abstract

The present study examined the comparability of Paper-Based (PB) and Computer-Delivered (CD) IELTS in the academic module reading section, focusing on Iranian IELTS candidates' cognitive and metacognitive strategies. The study intended to determine if the delivery mode had any impact on the use of these strategies. To this aim, 200 upper-intermediate learners were randomly selected and divided into two groups to participate in the study under the two aforementioned test conditions. They completed a test-taking strategy survey under both test conditions. Moreover, five participants from each test condition group took part in think-aloud protocols. The quantitative data were analyzed by means of Independent-sample t-test and Multivariate Analysis of Variance (MANOVA) to test the research hypotheses. Content analysis of the think-aloud protocols was also conducted to identify the strategies employed by the IELTS candidates in both PB and CD formats. The results revealed that the PB group had a significantly higher mean than the CD group on the cognitive and metacognitive processes used in academic IELTS. However, the think-aloud protocols indicated that, in many cases, these differences were minimal, with cognitive and metacognitive processes being similarly employed across both formats. Moreover, significant differences were observed between the PB and CD groups in their reading test-taking strategies. The implications of these findings for test preparation and design are discussed.

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1. Introduction

Nowadays, advances in Information and Communication Technology (ICT) have provided educational settings with a new paradigm for knowledge delivery in adult education. Online learning and testing supported by e-learning tools have also gained attention and are placed within this paradigm (Larsson et al., 2019). According to Brown et al. (2012), E-learning is a broad term encompassing a wide range of applications and procedures that all depend on computer technology to facilitate learning.

As ICT has become significant in different aspects of education, technology-oriented assessment is attracting a lot of educationists, covering a wide range of contexts from primary schools to higher education levels (Newman et al., 2010). Similarly, many English as Foreign Language (EFL) centers worldwide have turned to virtual teaching, learning, and testing processes (Lan, 2020). Hence, virtual teaching/learning models relying on different computer-based (CB) educational platforms such as Learning Management Systems (LMSs), Google Meet, Zoom Meetings, Skype, and Sky Room have been introduced to the language teaching centers (Hidayati et al., 2021). With the advent of the COVID-19 pandemic, almost all educational and language teaching centers have paid special attention to computer-based educational models (Maican & Cocoradă, 2021).

In the same vein, testing organizations worldwide have employed computers in the testing and assessment domains; more specifically, computers are used in different areas to assess L2 achievement through Computer Adaptive Test (CAT) methods. Hence, testing centers have enhanced their activities in terms of assessing L2 learners' language proficiency, testing language skills, and assessing language components. For instance, the International English Language Testing System (IELTS), which was mainly a paper-based test, is presently administered in two new modes of test delivery named *IELTS indicator* and *Computer-Delivered* (CD) *IELTS,* both of which require the test takers to sit for the test in front of their computers (Chan et al., 2018).

The effect of the computer-based delivery mode of high-stakes tests on the candidates' performance and their scores have been reported by some scholars (e.g., Chan et al., 2018; Rokhaniyah & Putra, 2021). Weir et al. (2007) investigated differences between the CD and PB testing of IELTS writing. Similarly, Chan et al. (2018) found that

academic writing assessed through the computer-based method was more attractive to learners, especially those more interested in technology. Furthermore, Rokhaniyah and Putra (2021) reported that a well-designed web-based online IELTS academic reading exam can also improve the reading scores of the candidates. With respect to the significance of the delivery mode and its effect on the learners' performance in the test, the present study investigated the comparability of a paper-based (PB) and Computer-Delivered (CD) IELTS as two delivery modes in the academic module reading. Hence, the comparative role of paper-based and computer-delivered IELTS in the cognitive and meta-cognitive strategies use of Iranian IELTS candidates in the academic module reading were taken into account in the present study.

2. Review of the Related Literature

Second language reading ability is one source of gaining information and knowledge and as some studies argue, good comprehension of the second language texts can contribute to more effective language learning (e.g., Cho & Rhodes, 2010; Conrad & Donaldson, 2012; Rosenshine, 2017; Zhang et al., 2020). This is because the learner will be exposed to more inputs by reading and comprehending the texts in the second language (Khansir & Gholami Dashti, 2014). Moreover, mastering L2 reading comprehension skills can play a significant role in EFL learners' enjoyment, studying at university, and keeping oneself updated through reading the daily press and news (Samiei & Ebadi, 2021). In this regard, the mastery of reading skill in the EFL context is considered apriori (Poushaneh & Berenj Foroush Azar, 2020; Tobia & Bonifacci, 2020). Likewise, as Brevik (2019) argues, both explicit reading strategy teaching and the everyday application of methods by students will aid in developing students' reading comprehension. So, in many academic contexts teaching reading comprehension strategies along with reading test-taking strategies are included in the curriculum as a significant part of second language instruction (Magnusson et al.,2019; Richards, 2008). That is why a significant section of all the high-stakes tests and academic entrance exams worldwide is devoted to assessing reading (Du & Ma, 2021; Grabe & Jiang, 2013; Hopfenbeck, 2017; Huddleston & Rockwell, 2015; Lim, 2020).

Reading is an active and productive activity in which the reader questions the text

and immediately applies a variety of accessible information (previous knowledge and contextual signals) to create its meaning (Jung, 2017; Lin et al., 2019). Researchers may learn a lot about how people think about what they are reading by studying the tactics readers use (Gopal & Singh, 2020). As a result, reading methods also include the attentive procedures readers use to enhance their understanding of a particular reading content (Birch, 2002). Reading strategies have been shown to be important for improving reading abilities in previous studies on L1 and L2 readers of various competency levels across multiple learning situations (Amiri & Maftoon, 2010; Lee, 2015; Mokhtari et al., 2008).

Second language learners might employ different cognitive and meta-cognitive strategies both in the process of developing L2 reading and in answering reading comprehension tests (Daguay-James & Bulusan, 2020; Elekaei et al., 2020; Ghaith, 2020; Motlagh, 2021). In this respect, Motlagh (2021) reported that advanced learners of English used metacognitive strategies more frequently compared to their high-intermediate counterparts, and Ghaith (2020) gave a positive account of the role of meta-cognitive strategies in the success of EFL learners in the reading tests. Likewise, Singh et al. (2021) explored ESL learners' reading test-taking strategies and found that they used both cognitive and metacognitive strategies in this respect. Zulmaini (2021), who investigated training of test-taking strategies for the reading section of the Test of English as a Foreign Language (TOEFL), acknowledged that in the process of learning, students employ planning, monitoring, socio-affective, and comprehending strategies, while in the exam sessions, they mainly rely on retrieval, test-wise strategies. Some studies have also found that cognitive intrinsic motivation affects EFL learners' reading comprehension test-taking strategies (Cartwright et al., 2020; Delgado & Salmerón, 2021).

Considering the increasing importance of the IELTS exam, especially in developing countries like Iran, being successful in this exam and obtaining the ideal result is of utmost importance. Having passed the general courses in language schools and the IELTS training program, some candidates are unsuccessful in achieving acceptable proficiency levels. There could be some possible reasons like the lack of practice and test-wise, not having a good command of using the strategies, and some other reasons. Nevertheless, the problem could be more noticeable in reading, where IELTS candidates

need to employ special test-taking strategies to answer the complicated items, especially in the academic module. The reading section of IELTS is a challenging task that includes different sub-skills such as speed reading, skimming, scanning, phrase identification, text organization, deciphering meaning, and time management (Rasti, 2009).

On the other hand, the reading abilities that EFL students would need to succeed at foreign postsecondary institutions have received much attention (Ferris & Tagg, 1996). Even though such studies have proven very beneficial to EFL instructors, few have strayed from the norm when it comes to teaching or assessing reading and writing abilities (Baker, 2015; Buslon & Alieto, 2019; Kim & Craig, 2012; Kozulin & Grab, 2002). However, the impact of technology-based teaching or tech-based assessment has gained priority in English Language Teaching (ELT) research. For instance, Farha and Rohani (2019) highlighted that EFL learners in Asian countries, including Iran, have difficulty in the reading section of IELTS, especially in the academic module. Moreover, it has been indicated that concerning the difficulty of the IELTS sections and the time allotted to them, the listening comprehension section has a 70% difficulty, the writing section has a 68% difficulty level, and the reading comprehension section has a 77% difficulty level (Abboud & Hussein, 2011). The difficulty level of the texts in the test might affect learners' performance and final test scores.

Some research results on second-language acquisition point to a favorable correlation between second-language proficiency and learners' adoption of strategies (Moeini, 2020). Hence, the unfamiliarity of test takers with test-taking strategies, which can promote test-takers' scores, in addition to the techniques commonly advised by IELTS cramming course teachers, can be another issue regarding performance in the IELTS exam (Dastpak et al., 2021). Test takers might be cognitively and meta-cognitively involved in the test process and, accordingly, select specific strategies to answer questions, especially in the reading section of academic IELTS, which tests candidates' knowledge with respect to argumentative, analytical, and recreational tasks (Rezaei et al., 2016) which, in turn, require high mental engagement and rely on cognitive and meta-cognitive processes and strategies (Kalyuga & Singh, 2016; Rokhaniyah & Putra, 2021; Sheorey & Mokhtari, 2001). Hence, with respect to the delivery mode of the test, test-takers might employ specific cognitive or metacognitive strategies to solve their problems

of answering the reading section of academic IELTS.

The present study aimed to compare the role of paper-based and computer-delivered IELTS in academic module reading, specifically focusing on the mental processes test takers may experience. Prior studies have investigated the general disparities in performance between paper-based and computer-delivered tests (Du & Ma, 2021). However, there is a significant lack of knowledge regarding the influence of these distinct delivery modes on the cognitive and meta-cognitive strategies employed by test takers, specifically among Iranian IELTS candidates. The significance of this disparity lies in the fact that cognitive and meta-cognitive methods play a major role in enhancing reading comprehension and overall performance in tests.

The rationale for conducting this study arises from the growing prevalence of computer-delivered testing and the necessity to understand its consequences for the cognitive processes and strategies of test takers. Considering the significant importance of the IELTS exam, understanding how various formats can influence the behavior of test-takers can provide valuable information to educators, test developers, and policymakers, enabling them to enhance test design and preparation methods.

The findings of the current study have the potential to reveal distinct cognitive and meta-cognitive processes used by individuals taking tests in various formats. This can lead to a more profound understanding of the underlying mechanisms that impact test taking conducts of the test takers. This understanding can enhance the fairness of testing processes and facilitate the creation of focused tactics to assist learners in achieving their best performance, irrespective of the test type. Accordingly, the current study aimed to find the cognitive and meta-cognitive processes Iranian IELTS candidates underwent while sitting for the reading test section of IELTS as a high-stake testing method. Additionally, it sought to determine the extent to which paper-based and computer-delivered IELTS affected the selection of test-taking strategies among test takers in academic IELTS reading. In this regard, the present study attempted to find answers to the following questions:

1. To what extent do paper-based and computer-delivered IELTS affect the cognitive and meta-cognitive processes reported by test takers in academic IELTS reading?

2. To what extent do paper-based and computer-delivered IELTS affect the self-report selection of test-taking strategies among test takers in academic IELTS reading?

3. Methodology

3.1. Design

The present study employed a non-experimental survey-based sequential exploratory mixed methods design. Tests and questionnaires were used to collect the quantitative data, and think-aloud protocols were used to provide the researchers with the qualitative data.

3.2. Participants

The study involved 200 Iranian IELTS candidates aged between 18 and 30, selected from an initial pool of 350 candidates. All participants demonstrated upper-intermediate language proficiency, determined through a standardized language proficiency test. Candidates with extreme scores (too high or too low) were excluded to ensure a homogenous proficiency level within the sample. From the eligible candidates, 200 were randomly assigned to one of two groups: 100 participants took the paper-based reading test, while the other 100 took the computer-delivered reading test. This random assignment ensured that both groups were comparable in terms of language proficiency and other relevant characteristics. Each group completed the same reading passages and questions in the test to maintain consistency in the assessment. In the qualitative phase of the study, five randomly selected candidates from each group carried out think-aloud protocols (TAPs) which provided the researchers with insights into the cognitive and meta-cognitive processes the test takers experienced while answering each specific item of the test.

3.3. Instrumentation

Quick Oxford Placement Test (QPT), a standard academic IELTS reading, a survey of test-taking strategies (Bicak, 2013), and think-aloud protocols were used to collect the data. These instruments are described in the following sections.

Quick Oxford Placement Test

The QPT, including 60 multiple-choice questions, was used to verify the individuals'

homogeneity. Based on Cronbach's alpha, the test has a high level of reliability ($\alpha=.91$) (Berthold, 2011, p. 674). Construct validity of the test has also been confirmed (Motallebzadeh & Nematizadeh, 2011; Wistner et al., 2009).

Academic IELTS Reading

An academic reading test with three texts followed by different items was selected from *Cambridge Practice Tests for IELTS: Volume 17* (Cambridge University Press, 2021). The same test was uploaded by the system in the CD format. Both of these tests were the same in content and items and were administered as the Mock test of academic reading. Although the IELTS partners do not provide retired IELTS forms for research reasons, these volumes include content prepared by Cambridge ESOL, the IELTS partner responsible for test development, in accordance with their regular IELTS test production processes. Hence, it accurately represents what you will see in the real thing (Huang, 2013). The test selected included all the ten reading items that usually appear in the academic reading of IELTS.

Test-taking Strategies Survey

The test-taking techniques utilized in this research consisted of 20 questions, which were divided into four subscales: item analysis strategies (7 items), time management strategies (4 items), choice prediction strategies (3 items), and after-test strategies (3 items) (See Appendix A). The subscales had internal consistency coefficients ranging from 0.39 to 0.78, which varied according on the amount of items. Moreover, the "construct validity of this scale has been proved by Exploratory Factor Analysis (EFA)" (Biçak, 2013, p. 279). The study participants were asked to select from Never=1 to Always=5 on the Likert scale. All the study participants in both PB and CD IELTS groups received this questionnaire prior to the reading test.

Think-aloud Protocols (TAPs)

In line with Nielsen and Landauer's (1993) mathematical model of determining the number and type of participants for Think-aloud Protocols (TAPs), five participants were randomly selected from each group (PB and CD IELTS). These participants were first briefed on the think-aloud protocol methodology. The briefing session lasted approximately 30 minutes and included a detailed explanation of the think-aloud process, a demonstration, and a short practice session where participants could familiarize themselves with

verbalizing their thoughts while answering reading test questions.

During the actual test-taking session, participants were monitored by the researchers to ensure they adhered to the think-aloud protocol. This monitoring helped maintain consistency and ensured that participants verbalized their thought processes effectively. The participants were asked to record their voices while answering the reading tests, which provided the researchers with insights into the cognitive and meta-cognitive processes they experienced while answering each specific item. Participation in this phase of the study was voluntary and based on the interviewees' consent. This approach ensured that the collected data accurately reflected the participants' natural test-taking strategies and cognitive processes.

3.4. Procedure

The first phase of this study involved selecting the study participants. Out of the 350 randomly selected IELTS candidates, 200 homogeneous EFL learners were selected based on the results of a standard version of the Quick Placement Test (QPT). The selected participants were randomly assigned to paper-based IELTS (n=100) and computer-delivered IELTS (n=100).

The second phase of the study, the data collection process, spanned three months based on the participation rate of candidates in the mock tests of the institution. During this period, 15 to 20 candidates were tested in each exam session. The procedure involved administering surveys; participants first completed the reading test-taking strategies survey which was administered before the participants took the reading test to ensure that the test itself did not influence their responses. The survey took approximately 20 minutes to complete. After completing the survey, participants took the academic IELTS reading task, presented in their respective delivery modes (paper-based or computer-delivered). The reading test followed the standard IELTS format and lasted 60 minutes.

During the reading test, the selected participants (five from each group) performed think-aloud protocols. Their voices were recorded as they verbalized their thoughts while answering the reading questions. This provided insights into the cognitive and meta-cognitive processes they employed. Throughout the entire procedure, participants' adherence to the protocol was monitored by the researchers to ensure consistency and

reliability in the data collection. Participation in this phase was voluntary and conducted with the interviewees' consent.

3.5. Data Analysis

To analyze the quantitative data, SPSS version 25 was employed, and descriptive statistics was used to analyze the data related to the proficiency test. Multivariate Analysis of Variances (MANOVA) was run to compare the PBI and CDI groups' means on four components of reading test taking strategies. Likewise, content analysis was employed to analyze the qualitative data pertaining to think-aloud protocols and interviews with the test takers. The relationship between participants' reading comprehension and test-taking strategies was examined through correlation coefficients. The construct validity of the test-taking strategies survey was, however, estimated through factor analysis. Likewise, the results of think aloud protocols were analyzed based on content analysis to gain information into the IELTS candidates' strategies in taking the two IELTS formats.

4. Results

Quantitative Data Analysis

Testing normality assumptions revealed that all skewness and kurtosis indices were within the range of ±2. Hence, the data were considered normal. Moreover, the KR-21 reliability index for the overall academic reading IELTS was .86, confirming that the test enjoyed an acceptable reliability. The Cronbach's alpha for the sub-sections was .956. The overall reading strategy questionnaire enjoyed a reliability of .925. The reliability indices for its three components were cognitive ($\alpha = .878$), metacognitive ($\alpha = .883$), and social ($\alpha = .742$). The reliability indices for the overall reading test-taking strategy questionnaire were .889. The reliability indices for its components were time management ($\alpha = .781$), item analysis ($\alpha = .741$), distractor selection ($\alpha = .817$), and after-test ($\alpha = .463$).

The first research question was an attempt to examine the extent to which paper-based and CD IELTS affect the cognitive and metacognitive processes reported by test takers in academic IELTS reading. The following directional hypothesis was formulated to answer this question: "Compared to CD IELTS, paper-based IELTS significantly affects the cognitive processes reported by test takers in academic IELTS reading". To test the

hypothesis, an independent-samples t-test was run to compare the PBI and CDI groups' means on cognitive processes. As displayed in Table 1, the PBI groups (M = 3.75, SD = .754) had a higher mean than the CDI group (M = 2.71, SD = .591) on cognitive processes.

Table 1

Descriptive Statistics Cognitive Processes by Groups

	Group	N	Mean	Std. Deviation	Std. Error Mean
Cognitive	PBI	100	3.75	.754	.075
	CDI	100	2.71	.591	.059

The results of the independent-samples t-test are shown in Table 2. Prior to examining the findings, it is important to acknowledge that the assumption of homogeneity of variances was not retained in cognitive processes. As displayed in Table 2, the results of Levene's test of homogeneity of variances were significant (F = 6.10, p < .05). Thus, the two groups did not enjoy homogenous variances in the cognitive processes. That was why the second row of Table 2, i.e., "Equal variances not assumed," was reported.

The results of the independent samples t-test (t (187.29) = 6.10, p < .05, r = .407 representing a moderate effect size; 95 % CI [.856, 1.23]) indicated that the PBI group had a significantly higher mean than the CDI group on the cognitive processes used in academic IELTS reading. Thus, it can be concluded that, compared to computer-delivered IELTS, paper-based IELTS significantly affected the cognitive processes reported by test takers in academic IELTS reading.

Table 2

Independent-Samples t-test Cognitive Processes by Groups

	Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	6.108	.014	10.912	198	.000	1.045	.096	.856	1.234
Equal variances not assumed			10.912	187.299	.000	1.045	.096	.856	1.234

In an attempt to find the extent to which paper-based and CD IELTS affected the metacognitive processes reported by test takers in academic IELTS reading, an independent-samples t-test was run to compare the PBI and CDI groups' means on metacognitive processes. Table 3 displays the results of the descriptive statistics for the two groups on metacognitive processes. The results indicated that the PBI groups (M = 3.73, SD = .684) had a higher mean than the CDI group (M = 2.76, SD = .431) on metacognitive processes.

Table 3
Descriptive Statistics Metacognitive Processes by Groups

Group	N	Mean	Std. Deviation	Std. Error Mean
PBI	100	3.73	.684	.068
CDI	100	2.76	.431	.043

As displayed in Table 4, the results of the independent samples t-test (t (167.02) = 12.01, p < .05, r = .681 representing a large effect size; 95 % CI [.812, 1.13]) indicated that the PBI group had a significantly higher mean than the CDI group on the metacognitive processes used in the academic reading IELTS. Thus, it can be claimed that compared to CD IELTS, paper-based IELTS significantly affected the metacognitive processes reported by test takers in academic IELTS reading.

Table 4

Independent-Samples t-test Metacognitive Processes by Groups

	Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	9.531	.002	12.013	198	.000	.971	.081	.812	1.131
Equal variances not assumed			12.013	167.025	.000	.971	.081	.812	1.131

The second research question addressed the extent to which paper-based and CD IELTS affected the self-report selection of test-taking strategies among test takers in academic IELTS reading. Multivariate Analysis of Variances (MANOVA) was run to compare the PBI and CDI groups' means on four components of reading test-taking

strategies. Before discussing the results, the assumptions of homogeneity of variances and homogeneity of covariance matrices will be reported. Table 5 shows the results of Levene's tests of homogeneity of variances. The results indicated that the assumption of homogeneity of variances was retained on item analysis (F (1, 198) = 2.41, $p > .05$) and distractor selection (F (1, 198) = .04, $p > .05$); however, it was violated on time management (F (1, 198) = 21.85, $p < .05$), and after test (F (1, 198) = 4.90, $p > .05$). Since the present sample sizes were equal, the violation of this assumption was ignored.

Table 5

Levene's Test of Homogeneity of Variances Reading Test Taking Strategies by Groups

		Levene Statistic	df1	df2	Sig.
Time Management	Based on Mean	29.887	1	198	.000
	Based on Median	21.858	1	198	.000
	Based on the Median and with adjusted df	21.858	1	179.040	.000
	Based on trimmed mean	28.858	1	198	.000
Item Analysis	Based on Mean	5.388	1	198	.021
	Based on Median	2.415	1	198	.122
	Based on the Median and with adjusted df	2.415	1	168.087	.122
	Based on trimmed mean	4.343	1	198	.038
After Test	Based on Mean	5.612	1	198	.019
	Based on Median	4.901	1	198	.028
	Based on the Median and with adjusted df	4.901	1	187.300	.028
	Based on trimmed mean	5.557	1	198	.019
Distraction Selection	Based on Mean	.057	1	198	.812
	Based on Median	.040	1	198	.841
	Based on the Median and with adjusted df	.040	1	191.199	.841
	Based on trimmed mean	.099	1	198	.754

Table 6 shows the results of the Box's test. The results (Box's M = 135.79, $p < .001$) indicated that the assumption of homogeneity of covariance matrices was violated. Since the present sample sizes were equal, the results of the Box's test were ignored.

Table 6

Box's Test Reading Test-Taking Strategies by Groups

Box's M	135.795
F	13.284
df1	10
df2	187429.482
Sig.	.001

Table 7 shows the main results of MANOVA. The results (F (4, 191) = 56.51, $p <$

.05, partial eta squared = .535 representing a large effect size) indicated that there were significant differences between the PBI and CDI groups' means on reading test-taking strategies. Thus, it can be argued that compared to CD IELTS, paper-based IELTS affected the selection of more test-taking strategies among test takers in academic IELTS reading.

Table 7

Multivariate Tests Reading Test Taking Strategies by Groups

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.982	2619.431	4	195	.000	.982
	Wilks' Lambda	.018	2619.431	4	195	.000	.982
	Hotelling's Trace	53.732	2619.431	4	195	.000	.982
	Roy's Largest Root	53.732	2619.431	4	195	.000	.982
Group	Pillai's Trace	.535	56.014	4	195	.000	.535
	Wilks' Lambda	.465	56.014	4	195	.000	.535
	Hotelling's Trace	1.149	56.014	4	195	.000	.535
	Roy's Largest Root	1.149	56.014	4	195	.000	.535

Table 8 shows the descriptive statistics for the two groups on the four components of reading test-taking strategies. Based on these results and the Between-Subjects Effects shown in Table 8, it can be concluded that:

A: The PBI group (M = 3.36) significantly outperformed the CDI group (M = 2.42) on time management (F (1, 198) = 99.31, p < .05, partial eta squared = .334 representing a large effect size).

B: The PBI group (M = 3.33) significantly outperformed the CDI group (M = 2.52) on item analysis (F (1, 198) = 120.53, p < .05, partial eta squared = .378 representing a large effect size).

C: The PBI group (M = 3.41) significantly outperformed the CDI group (M = 2.62) on after-test (F (1, 198) = 81.56, p < .05, partial eta squared = .292 representing a large effect size).

D: The PBI group (M = 3.50) significantly outperformed the CDI group (M = 2.51) on distraction selection (F (1, 198) = 119.89, p < .05, partial eta squared = .377 representing a large effect size).

Table 8

Descriptive Statistics Sub-Section of Academic Reading IELTS by Groups

Dependent Variable	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Time Management	PBI	3.367	.067	3.235	3.500
	CDI	2.423	.067	2.290	2.555
Item Analysis	PBI	3.333	.052	3.230	3.436
	CDI	2.520	.052	2.417	2.623
After Test	PBI	3.410	.061	3.289	3.531
	CDI	2.627	.061	2.506	2.748
Distraction Selection	PBI	3.500	.064	3.375	3.625
	CDI	2.515	.064	2.390	2.640

Qualitative Data Analysis

The *think-aloud protocols (TAPs),* as qualitative data set, were used to confirm the quantitative findings of the research questions in the present study. Hence, the qualitative data collected through TAPs represented the cognitive and metacognitive processes test takers experienced while answering the test items. Five randomly selected participants taking part in the test from each group (PB and CD IELTS) were briefed in terms of think-aloud protocols, and then they were asked to record their voices while answering reading tests.

To analyze the TAPs, the recorded verbalizations were transcribed verbatim and then coded using a grounded theory approach. The unit of analysis was each distinct thought process or strategy verbalized by the participants. These units were identified and categorized into cognitive and meta-cognitive strategies based on established frameworks (Bicak, 2013; Boo, 1997; Huang, 2013). The coding process involved several steps:

1. Initial Coding: Transcripts were read multiple times, and initial codes were assigned to data segments representing specific cognitive and meta-cognitive processes.

2. Axial Coding: The initial codes were then organized into broader categories to identify patterns and relationships between different strategies used by participants.

3. Selective Coding: Finally, core categories were developed that encapsulated the main cognitive and meta-cognitive strategies employed by the test takers.

The qualitative analysis revealed that paper-based IELTS test takers made more use of cognitive processes than the computer-delivered IELTS test takers. Consistent with the quantitative data analysis, the TAPs indicated that the PBI group reported more tangible cognitive strategies compared to the CDI group. Evidence of think-aloud extracts with respect to the main cognitive and meta-cognitive strategies employed by the test takers are shown in two sub-sections as follows through examples.

A. Cognitive Strategies

1. Using Pneumonic Devices

Pneumonic devices are best shown through developing keywords out of the initial layers of important words in a sentence or text to recall the information conveyed by the message or even the message itself. It is a cognitive strategy identified by Boo (1997) and Huang (2013). Evidence of think-aloud extracts for this strategy are as follows:

> *"I should focus on creating keywords to remember important information from the text before answering the test items".* Or, "*I should try to keep in mind the main parts of the text while I am reading the exam texts before answering the test items*."

It is worth mentioning that all five participants in the PBI group and just two participants in the CD IELTS group employed this strategy.

2. Using Already Known Concepts

As another cognitive strategy involving the use of memorized information and the ideas gained through known concepts to answer the reading test questions or deciphering the intended meaning of the test (Bicak, 2013), using already known concepts, was among the strategies employed by the test-takers. Evidence of think-aloud extracts for this strategy are as follows:

> "*When studying for examinations, recalling material by connecting it to what I already know is very helpful".* Or, *"I should apply what I've memorized to the questions in the test in case the items are about the realities I am aware of".* Or, *"I do not read the text, as I am familiar with the context. So, I answer the questions based on my own information.*"

Four participants in the PBI group and three participants in the CDI group utilized this

approach. These findings underscore the differences in cognitive strategies used by participants in different test delivery modes, providing a deeper understanding of the impact of test format on cognitive and meta-cognitive processes.

3. Time Management Strategies

Concerning time management strategies, which require cognitive and behavioral processes (Ma et al., 2020; Rapp et al., 2013), the majority of the TPAs of the PBI test-takers showed the time arrangement before starting the test, focusing on the scoring formula to spend time on a specific item, and trying to complete the test fast. Evidence of think-aloud extracts for this strategy are shown in the following examples:

> "*Before beginning the exam, I need to allocate enough time for each section and question*". Or, *"When answering a question, I should not waste my time on difficult items*". Or, "*I should complete the test soon.*" Or, "*I should rely on the scoring formula to save time*".

Three of the students in the PBI group and three CD test taker participants focused on the time management strategies discussed above.

4. Using Hints in Questions

In terms of utilizing the hints provided in questions when responding to other questions as a cognitive strategy (Bicak, 2013), four of the PBI test takers used this strategy and hence experiencing this process, while only two of the CDI group referred to it. Evidence of think-aloud extracts for this strategy are shown in the following examples:

> "*I should use the information given in previous or following questions to answer another question*". Or, "*I need to compare the questions addressing one single topic together*". Or, "*It is better to utilize all the provided information in different items while responding to a single question related to them.*"

5. Using Keywords

Focusing on the keywords and phrases to better comprehend the questions while reading, as a cognitive strategy (Wahyono, 2019), was just employed by the PBI test takers. Evidence of think-aloud extracts for this strategy are shown in the following examples:

> "*I need to look at the keywords in the questions and match them with the keywords I read in the text to understand the items better*". Or, "*I should consider the*

connections between the keywords mentioned in the stem of the question and their answers".

6. *Distracter Selection*

With respect to distracter selection, which as a test-taking strategy requires cognitive processes (Bicak, 2013), the majority of the test takers in PBI (n=4) and CDI (n=4) groups used distractor selection and elimination strategies such as "eliminating options that seem wrong", "guessing", "eliminating the option which seem different from the others", and "frequent refereeing to the text". Evidence of think-aloud extracts for this strategy are shown in the following examples:

"*I always do my best to eliminate the options that seem wrong*". Or, "*I should omit the options which use the words "only", "just", "not" as I guess they are deliberately formed this way to trap me*". Or, "*I can eliminate the option which seems different from the others*". Or, *"I had better put aside the options which frequently refer to the text".*

B. Meta-cognitive Strategies

Regarding the meta-cognitive strategies observed during academic IELTS reading, findings from the qualitative analysis of TAPs corroborated the results of the quantitative phase. During the TAPs, participants verbalized their thought processes while tackling the reading test items, providing real-time insights into their meta-cognitive strategies.

1. *Skipping Difficult Questions*

The analysis of the TAPs revealed that most test takers in both groups (n=4, in each) employed the meta-cognitive strategy of skipping questions they couldn't answer, which was consistent with Wahyono's (2019) planning meta-cognitive strategy development in test-taking. Evidence of think-aloud extracts for this strategy are shown in the following examples:

"Let's eliminate the items for which I am convinced that I do not know the answers." Or, *"When a question seems to be too complicated, I should skip it". Or, "I prefer to skip at least two or three questions which need a lot of care and attention to answer".*

2. *Postponing Complicated Items*

The analysis of the TAPs revealed that the majority of test takers in both groups (n=4) in

each group) used the meta-cognitive strategy of postponing the questions they were not able to answer immediately which has been categorized as a planning meta-cognitive test-taking strategy (Hemmye, 2004; Motlagh, 2021). Evidence of think-aloud extracts for this strategy are shown in the following examples:

"*Let's mark some questions to be answered later.*" Or, *"I do not need to respond to some questions I am not able to answer at the moment for later consideration"*. Or, "First, I *should mark the vague questions and once I finish answering the questions of the text, I get back to the marked items and try to answer them later".*

3. Post-test Reflections

Post-test meta-cognitive strategies which fall within the domain of monitoring and behavioral strategies (Ghaith, 2020) were also verbalized in the TAPs of the candidates. The majority of the participants in the PBI group (n=5) and most of the the participants in the CDI group (n=3) used similar post-test reflections, including contemplating their test scores, envisioning their progress toward goals based on the results, and reflecting on challenges encountered during the test. Evidence of think-aloud extracts for this strategy are shown in the following examples:

"Why were some questions so difficult to answer." Or, "I think about my likely test score". Or, "I am happy that the test was finished, as I'm sure I will gain a high score".

4. Uncertainty Management

Four individuals from each group employed similar meta-cognitive strategy of uncertainty management when addressing uncertain questions if time permitted. This aligns with Pintrich's (2002) concept of uncertainty management which is also labeled as a monitoring strategy. Evidence of think-aloud extracts for this strategy are shown in the following examples:

"*I have enough time. So, I'll check the answers of some questions I am not certain about, at the end, once more*". Or, *""I'll review my responses to the questions addressing main idea and title, once more at the end of the test, in case time permits me."*

This thorough examination of both real-time think-aloud protocols offers valuable insights into the meta-cognitive strategies employed by test takers during the IELTS

reading test.

5. Discussion

In terms of academic IELTS cognitive processes, the performance of the paper-based (PBI) group surpassed that of the computer-delivered (CDI) group, indicating the impact of the delivery mode on cognitive engagement. However, analysis of think-aloud protocols revealed that both PBI and CDI groups employed similar cognitive strategies, such as creating keywords and utilizing memorized concepts, albeit with varying frequencies which is consietent with the work some other researchers (Bicak, 2013; Boo, 1997; Huang, 2013). Moreover, like the findings of Ma et al. (2020) and Rapp et al. (2013), while PBI test-takers demonstrated proactive time management strategies, focusing on item scoring formulas, CDI participants tended to review their actions during the test, suggesting nuanced differences in cognitive approach. Both groups exhibited similar distractor selection strategies, indicating a common cognitive process in tackling test items as Bicak (2013) also argued.

Reading comprehension, as an active cognitive process, relies on connecting text with prior knowledge to construct meaning (Cartwright et al., 2020; Wahyono, 2019). The findings indicate that cognitive strategies played a pivotal role in enhancing reading comprehension, aligning with previous studies (Fotovatian & Shokrpour, 2014). Notably, despite variations in delivery mode, both groups employed different cognitive techniques to navigate the reading tasks, corroborating earlier research findings (Elekaei et al., 2020; Ghafournia & Afghari, 2013; Wahyono, 2019).

In addition, with respect to the meta-cognitive processes, both PBI and CDI groups exhibited similar strategies, including post-test reflection and goal envisioning, indicating consistent meta-cognitive engagement regardless of delivery mode. These findings support prior research emphasizing the role of meta-cognitive strategies in enhancing reading comprehension (Baker & Beall, 2014; Boulware-Gooden et al., 2007; Ghaith, 2020; Hemmye, 2004; Motlagh, 2021; Pintrich, 2002).

Despite these similarities, significant differences were observed in reading test-taking tactics between the PBI and CDI groups, including time management, item analysis, and distractor selection. For instance, quantitative data revealed variations in

critical reading test-taking methods across delivery modalities, contrary to existing literature (Assiri, 2011; Chick, 2013; Wu et al., 2017; Zulmaini, 2021). While these differences may not always manifest in test results, they underscore the importance of considering delivery mode in test design to mitigate potential disparities in test-taking strategies and outcomes.

It can be argued that both cognitive and meta-cognitive strategies play crucial roles in academic IELTS reading comprehension, with nuanced differences observed between paper-based and computer-delivered formats. Understanding these differences can inform practitioners to optimize test-takers' performance across delivery modalities.

6. Conclusion

This study examined how test delivery methods affected the cognitive and meta-cognitive strategies involved in answering academic IELTS reading comprehension. The findings revealed that although candidates employed similar reading strategies in both computer-delivered (CD) and paper-based (PB) IELTS formats, the candidates tested through PB format used such strategies more than their counterparts in the CD group. This implies that even though there are similarities in the use of strategies, the way the test is administered may affect the tendency to use certain test-taking strategies. One reason for this could be the familiarity of the Iranian candidates of IELTS with paper and pencil tests and paper-based tests, while they are not well familiar with the CD tests. During their schooling education, Iranian students are tested through essay-type or multiple-choice items printed on papers. Accordingly, they have developed certain strategies apt to the test format they are accustomed to. When a CD test like CD IELTS is given to the candidates, the strategies they have already developed might not be completely useful.

Furthermore, as the study findings revealed, the PBI group significantly outperformed the CDI group on time management, item analysis, after-test, and distraction selection strategies, as cognitive strategies. Due to the likely stress and anxiety digital devices might impose on the test takers, CDI group might have been affected by a lot of stress while answering the reading test. Hence, they might not have managed their time well. Likewise, they might have lost their concentration while analyzing the items and finding their answers. This is consistent with previous research

on the possible disadvantages of digital devices in educational settings (Baron, 2015; Delgado & Salmeron, 2021; Salmeron & Delgado, 2019; Wolf, 2018). Moreover, when participants are pressed for time and they are engaged in tasks on a screen, they might lose their attention and not be able to use proper cognitive strategies such as using the clues in the questions to find the proper answer.

With respect to meta-cognitive strategies, the study findings revealed that compared to the CDI group, PBI group used more cases meta-cognitive strategies, while for other meta-cognitive strategies such as skipping difficult questions, postponing complicated items, and uncertainty management, both groups were similar. It means that test delivery mode might just partially influence the meta-cognitive test taking strategies of the testees. These findings align with prior reported research results conducted by Ackerman and Lauterman (2012), but reject Clinton's (2019) findings which highlighted the significance of considering the design and delivery of tests to promote appropriate meta-cognitive processes while taking tests. In fact, the present study findings showed that test-delivery mode did not leave huge impacts on the selecting meta-cognitive strategies in test taking.

To sum up, the results highlight that test developers and educators should consider how the method of delivery affects cognitive and meta-cognitive processes in academic reading comprehension. Customized interventions targeting the improvement of reading methods can effectively address the possible difficulties related to digital test administration and enhance overall performance on tests.

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Appendix A
Reading Test-taking Strategies Survey

Dear Candidate:

The aim of this study is to determine test taking strategies in reading. With this regard, 20 items are provided in this form. After reading each statement, please mark the expression which corresponds to your answer. Please, try to give the most relevant information to let us help you and your friends more in this tiresome process. Thank you in advance for your contributions and wish you luck in your exams.

Student ID Number:

Gender**:**   Female [ ]   Male [ ]

Never=1,   Sometimes=2,   Usually=3,   Often=4,   Always=5

No.	Strategies	1	2	3	4	5
1	I arrange the time for each part and each question before I start the test. TM					
2	I change my strategy depending on formula scoring or number-right scoring. TM					
3	I do not spend extra time on a question. TM					
4	I try to answer the questions as quickly as possible. TM					
5	I eliminate the questions whose answers I definitely do not know. IA					
6	I make use of the clues in questions while answering another one. IA					
7	I go over what I have done while answering the questions. IA					

8	I try to use all the information given while answering the questions. IA					
9	I spend time to answer a question and mark it to answer later on. IA					
10	I try to answer the questions which I am not sure of or I did not answer if I have time. IA					
11	I underline the important words and sentences while reading the questions. IA					
12	I firstly eliminate the options which I surely consider false while answering the questions. DS					
13	I go back and read the question or paragraph to find the correct answer if necessary.DS					
14	I read all options and choose the best one while answering questions. DS					
15	I eliminate the option which seems different from the others. DS					
16	I pay attention to whether I circled more than 3 same options one after another on the answer sheet or not. DS					
17	I try to find the answer by guessing when I reduce the alternatives into two. DS					
18	I decide if the score I got from the test sufficient for my target. AT					
19	I reward myself if I get a score that fits my target AT					
20	I question the reasons why I couldn't answer some of the questions. AT					

Note: TM: Time management; IA: Item Analysis; AT: After Test; DS: Distracter Selection

1. Time management is both a behavioral and a cognitive skill.

2. Item Analysis is considered a metacognitive skill if it requires planning and mental scripting about items

3. Item Analysis is considered a cognitive skill if it requires thinking, reading, remembering and reasoning

4. Distracter selection is a cognitive skill.

5. After Test strategies are considered as behavioral and metacognitive skills

Bicak, B. (2013). Scale for test preparation and test taking strategies. *Educational Sciences: Theory and Practice, 13*(1), 279-289.