

# Reading Comprehension and Deafness: the Impact of E-learning in an Italian EFL Context

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## Abstract

Foreign language learning holds a number of challenges that vary according to a wide number of variables. Deaf learners face the additional challenge of not being able to fully rely on the acoustic channel as a source of linguistic input. This paper presents the results of a one-sample pretest/posttest study aimed at evaluating the effectiveness of a deaf centred e-learning environment (DELE), compared to the traditional pen and paper approach, in three reading comprehension tasks. Eight Italian prelingually and profoundly deaf students were asked to complete a multiple choice, a cloze and a true/false task. A series of t-tests revealed an overall statistically significant decrease in the number of wrong answers and no answers provided, as well as a reduced average item response time, when using DELE. These results seem to suggest that a more visually oriented learning environment, specifically designed for deaf learners, may prove to be more effective than traditional paper-based materials.

*Keywords:* E-learning, Deafness, EFL, Reading

Received June 10, 2016; Accepted December 15, 2016.

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## Introduction

A considerable knowledge of the English language, being English the world's lingua franca today, has increasingly proven to be of significant importance for an individual to interact with others on a global scale. Much effort has gone into the development of teaching materials and techniques to ensure that the acquisition of English by non-native speakers is as accessible as possible.

The issue of accessibility, however, becomes critical when considering special educational needs, such as those pertaining to the community of deaf people, who are unable to fully rely on the acoustic channel as a source of input for language (Berent, Kelly, Albertini & Toscano, 2013; Berent, Kelly, & Schueler-Choukairi 2012; Berent 2009).

Within a society that is regulated by principles of inclusive learning, a series of measures should be effectively implemented to adapt teaching materials and techniques to deaf learners' needs. Such measures cannot be disjoined from reliable research results, which, in turn, need to rely on sufficient funding in order to be carried out. A number of projects have been designed in this perspective, building on the enhancement of visual components of language that e-leaning systems are able to offer. Two of these are the Dedalos project, developed at the Institute of Informatics and telecommunications, Net Media Lab, in Greece (Drigas, Kouremenos, & Vrettaros, 2008), and the European project SignMedia, developed at the center for Sign Language and Deaf Communication, developed at the Alpen Adria Universität Klagenfurt, in Austria (Gansinger & Dotter, 2012). The main focus of these projects is to provide learners with a more suitable learning environment to reach their learning goals.

Several studies based on comparisons between deaf and hearing readers have highlighted a series of challenges that deaf readers face, making the traditional use of text limiting in accessing information from a text. Assuming that word recognition is based on phonological awareness abilities, one of the main arguments put forward in maintaining that deaf readers would be more challenged than hearing readers in approaching a text relies on the fact that deaf readers may have reduced access to the phonological coding of words. Such studies have reported contrasting results and are still at the centre of related research studies (Banner & Wang,

2011; Kyle & Harris, 2010; Gaustad, 2004; Marschark, 2003; Marschark, Sarchet, Convertino, Borgna, Morrison & Remelt, 2011; Parault & Williams, 2010).

### What is DELE?

A significant amount of research has gone into the development of an online e-learning platform named DELE (Deaf-centred E-Learning Environment)<sup>1</sup>, which was built at the CNR in Rome, Italy. The main principles guiding this project have been: ease of access for the deaf learner in terms of a technology enhanced experience of the written text, visualisation procedures centred on the fact that deaf learners are more accustomed to gathering information visually rather than orally, and the application of embodiment principles through the use of metaphors and enriched with storytelling techniques.

Reading is usually a process that takes place silently and autonomously after listening and speaking have been acquired. This is not the case for deaf learners, since they are unable to rely on the acoustic channel as a source of linguistics input, and for this reason DELE gives them a better opportunity to become more efficient readers by introducing real texts together with a range of pedagogical instruments.

The pedagogical path in DELE is represented by a story centred around an authentic text, taken from everyday readings (leaflets, newspapers, forms, etc.) or from a textbook or literary work, as exemplified in the present study, based on the use of Lewis Carroll's Alice in Wonderland incipit (Bhatia, 1983; De Monte, Tomasuolo, Capuano, & Roccaforte, 2011).

Foreign language teaching to learners without any hearing impairment frequently adopts text simplification, in order to provide learners with a more accessible text according to the competency level that has been reached. However, working with deaf learners requires different strategies. DELE substitutes simplification with facilitation, which refers to the practice of

<sup>1</sup> The platform was built within the three year project FIRB-VISEL "E-Learning, sordità, lingua scritta: un ponte di lettere e segni per la società della conoscenza", funded by the Italian Ministry of Education, University and Research, which involved the following institutions: Istituto di Scienze e Tecnologie della Cognizione of the CNR (National Research Centre) of Rome (Dr. Elena Pizzuto); Sapienza University of Rome, Department of Archival, Philological, Linguistic and Geographical Sciences (Prof. Paola Giunchi) and Pictorial Computing Laboratory (Prof. Stefano Levialdi); University for Foreigners of Siena (Prof. Massimo Palermo); Istituto Statale Sordi di Roma (Dr. Ivano Spano).

leaving the text intact in its original form, supplementing it with tools that are able to guide the learner towards a better and deeper understanding. Such tools can be images, written definitions, and also an in-built video messaging service whereby the deaf learner is able to ask the tutor a question in sign language. This way, the deeper understanding of the text is carried out simultaneously with the reading comprehension tasks, so that the deaf learner feels guided and sustained in reading a text in a foreign language.

This study represents the first attempt to evaluate the effectiveness of DELE in a foreign language acquisition environment. Its first results were presented in a poster format at the 2014 TESOL convention that was held in Rome<sup>2</sup>.

As can be seen in Figure 1, in DELE the body, the setting, the visually image schemas, the multimodal and multimedia tool of e-learning can all help in the achievement of a learning goal. For instance, in DELE we used the metaphor of a bridge to represent words that act as connectors: the bridge is something that unifies, but it is also something that allows access. An animation explains the correct position of the connector in a sentence. Symbols, arrows, image schemas and diagrams help in the explanation and can be used again in the activities and exercises.

According to the principles of embodied cognition, (Gardenfors, 2007; Johnson, 2007), the idea is to encourage the manipulation of the written language by deaf learners: moving, exchanging, highlighting, taking notes with the post it function, and so on. Deaf Signing users are provided with help by videos in LIS (Italian Sign Language) in a certain form or function, connectors in our example, is not translated but explained through visual expressions, gestures, and examples. In an attempt to provide an alternative source of input for the phonic environment that hearing speakers are accustomed to, as opposed to deaf people, the platform is nurtured by a strong visual input: a lot of examples appear in sequence like cuts from a newspaper or from a different genres books, as a sort of visual full immersion. In a multimedia laboratory, learners can translate their doubts or their mistakes into a sensorial experience in which the right answer is translated into a harmonious representation, and the wrong answer instead is represented like a

<sup>2</sup> TESOL Italy's 39th National Convention, 14-15 November 2014, Rome, Italy.

crash or a snatch or something that is visually disharmonic. In the laboratory, users/learners can exchange thoughts, doubts and comments, thus fostering an environment of peer learning.

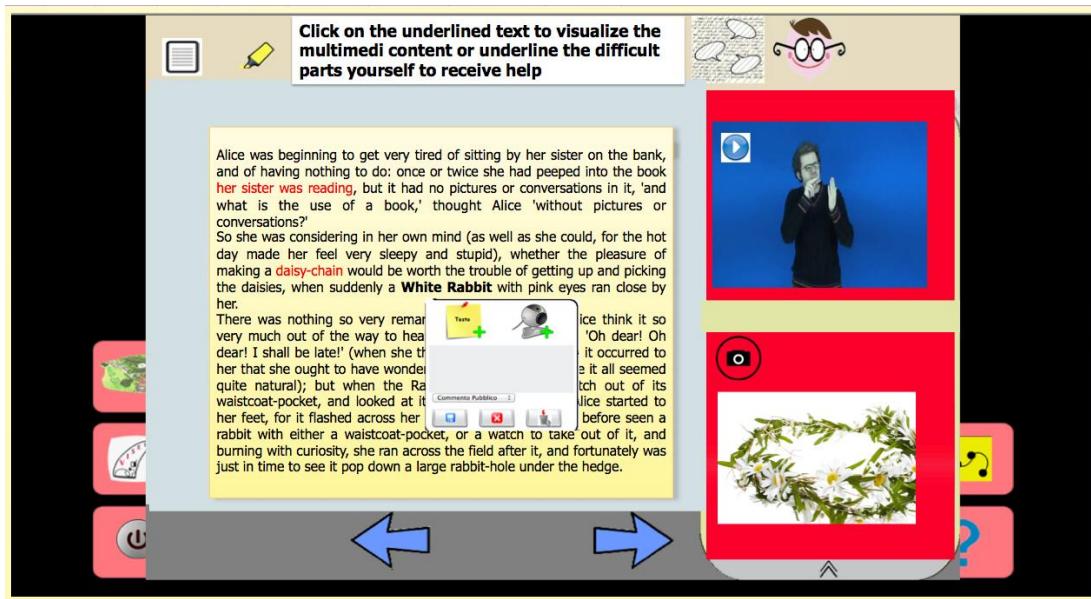


Figure 1. The reading activity in DELE.

## The Experimental Design

### Research Questions

The aim of the present study is to evaluate the effectiveness of using DELE for EFL reading comprehension activities. The research questions addressed are:

1. Is there sufficiently significant evidence to suggest that the use of DELE in reading comprehension tasks is able to lower the number of wrong answers and no answers given by the participants?
2. Is there sufficiently significant evidence to suggest that the use of DELE in reading comprehension tasks is able to influence item response time?

## Procedure

In both cases, a series of one-tailed paired samples t-tests were run. In symbolic terms, the hypothesis statement can be read as  $\mu_d > 0$ , where  $\mu_d$  corresponds to the mean differences in data distribution between tasks undertaken with DELE and tasks undertaken with traditional tools. The significance value used will be that of 0.05. All t-tests were run with the software package SPSS Statistics 23.

## Participants and Tasks

Eight prelingually and profoundly deaf students were asked to complete three comprehension tasks related to the very beginning of Alice's Adventures in Wonderland by Lewis Carroll. The learners were selected from the second year of a lower secondary school class, so as to form a homogeneous group in relation to age and type of deafness.

Each learner carried out each task via two different modalities: half of the text, in fact, was presented using traditional paper and pencil tools (activities taken from Torchia, F., & Scornito, B. 2011), whereas the other half was presented through DELE.

The instructions were the same each time, and were related to the three comprehension tasks. However, in DELE the curiosity of the participants was sparked by the symbols, the hyperlinks, and they were therefore led to click on them spontaneously in order to see what materials and activities would appear. The materials created to improve text comprehension were organized in multimedia files appearing on the side of the screen, and allowing access to video, animations, images, flowcharts, videos in sign language, and linguistic and grammatical sheets; all of this was created by relying heavily on the visual channel thus reducing verbal language as much as possible.

The cloze task did not present substantial differences when presented through DELE or traditionally via pen and paper, and was aimed at stimulating processes of lexical, semantic and grammatical inference, whereas the multiple choice and true/false tasks, aimed at assessing lexical competency and the broad comprehension of the text, were presented more dynamically, relying on the interactive and multimedia components of the medium.

The dependent variables considered for each item were error production, incomplete answers and response time.

## Results

For each task, pretest and posttest data were compared in order to establish whether observed differences in the distribution of performance data before and after the intervention.

Three series of paired samples t-tests were performed in relation to the three dependent variables contained in the research questions, reaching a total of nine paired samples t-tests, plus an additional two t-tests that were run to provide an overview of wrong answers and no answers provided, regardless of the task.

Setting the significance level at .05, though with varying degrees of confidence, all of the values obtained differences occurred just by chance is much low than the pre-established significance threshold level.

## Descriptive Analysis

As can be seen in Figure 2, a lower amount of wrong answers and no answers provided is solidly visibly when comparing pretest and posttest data, resulting in instances of unanswered items in relation to the true/false task.

A closer look at the degree of decrease in the amount of wrong answers and no answers across tasks shows some consistent differences. The bigger differences between pretest and posttest mean data can be observed in relation to the number of unanswered items: a simple subtraction of pretest and posttest values for the multiple choice, cloze, and true/false tasks revealed a difference of respectively 2.55, 2.37 and 2.50, as opposed to the difference observed for wrong answers provided, which is respectively 1.25, 1.37 and 1.37. This may suggest that the use of DELE is more influential in decreasing the number of items left unanswered rather than the number of items with a correct answer. This result may be an indication of the fact that a difference in the medium has a greater influence on the instrumental easification of the act of performing the task, together with an enhancement of the intrinsic interest within the learner, rather than on the actual linguistic and communicative competences that are being tested.

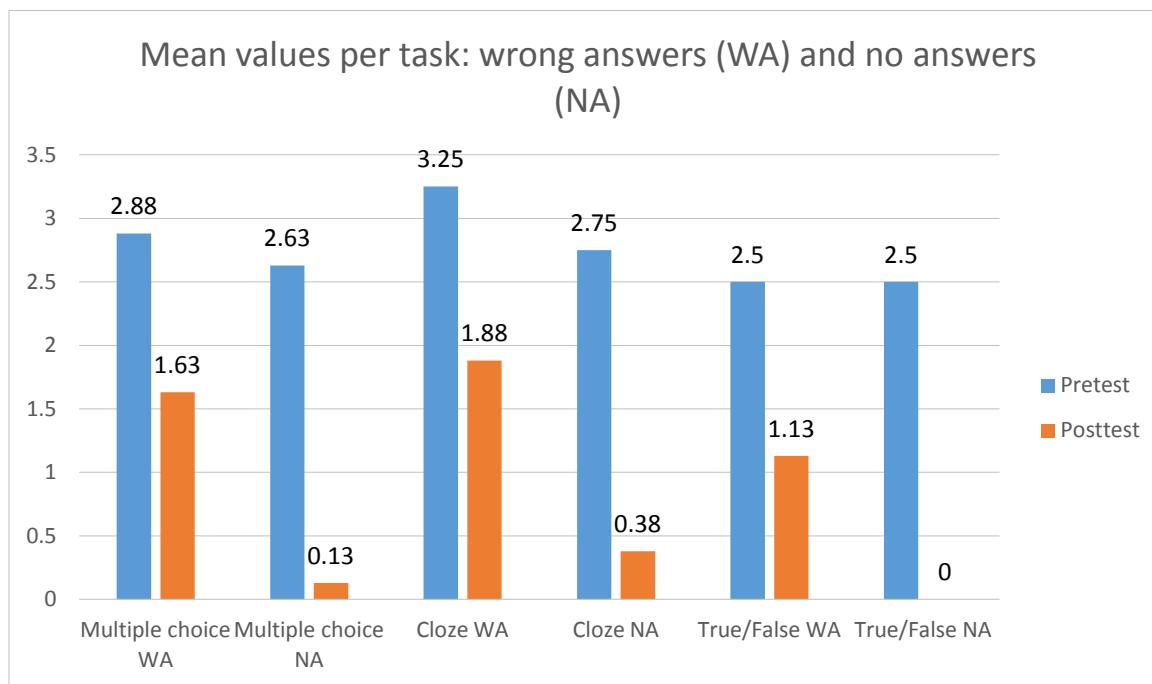


Figure 2. Mean values per task: wrong answers (WA) and no answers (NA).

In relation to the observation of the standard deviation, the first thing that can be observed in Table 3 is not only the overall decrease in the average number of wrong answers and no answers provided by the participants when using DELE, but also a decrease in the overall standard deviation from the mean in almost all cases.

Table 1  
*Mean (m) and standard deviation (s) answer values per task*

		pretest		posttest	
		m	s	m	s
MULTIPLE CHOICE	wrong answers	2.88	.835	1.63	.744
	no answers	2.63	.744	.13	.354
CLOZE	wrong answers	3.25	1.669	1.88	1.126
	no answers	2.75	1.282	.38	.518
TRUE/FALSE	wrong answers	2.50	.756	1.13	.835
	no answers	2.50	.756	.00	.000

This means that, not only the amount of wrong answers and no answers provided is lower when using DELE, but the mean results obtained in the posttest are characterised by a distribution that is more even and uniform compared to that observed in the pretest values. This would indicate that the behaviour of students using DELE varied less than their behaviour using pen and paper. Of course, some differences can be traced when comparing each task. The highest degree of uniformity can be seen in relation to the unanswered items: there was a drop in the multiple choice, cloze and true/false tasks by 52.41%, 59.59% and 100% respectively. In relation to the amount of wrong answers provided, the drop in standard deviation was not as substantial: the analysis reported on a drop of 10.89% and 32.53% for the multiple choice and cloze tests, but an increase in standard deviation of 10.44% for the true/false task. This would indicate that the influence of the medium in relation to the true/false task was less relevant and produced a less uniform result in the posttest phase of the study.

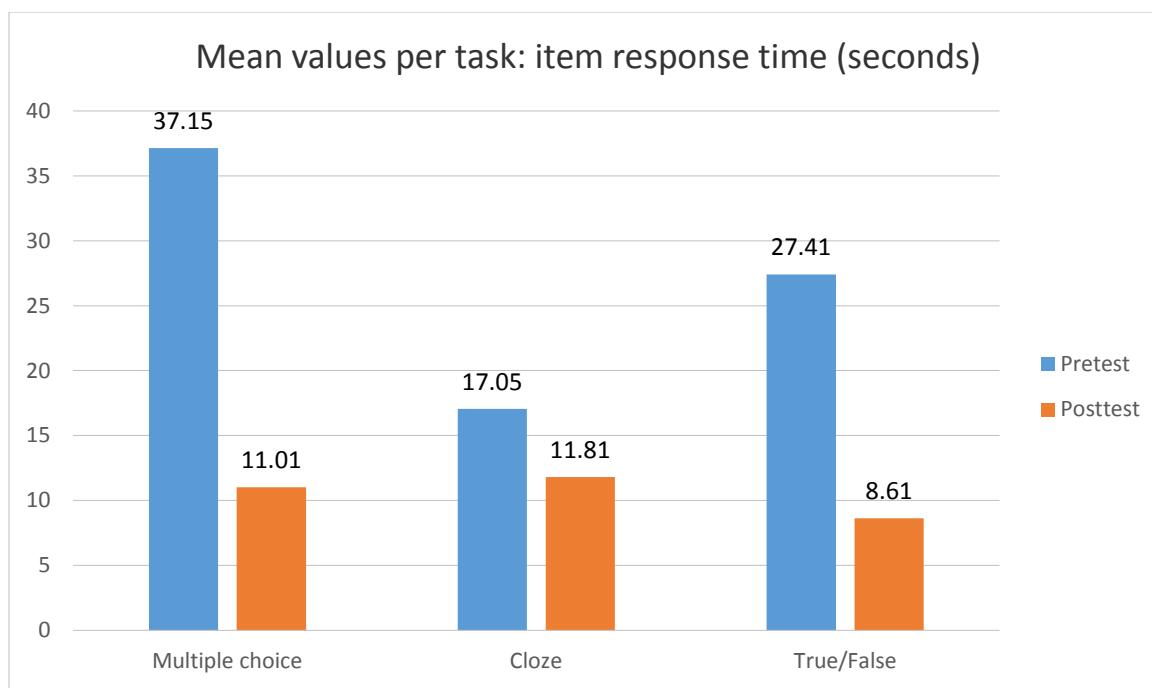


Figure 3. Mean values per task: item response time (seconds)

In relation to item response time, Figure 3 shows the mean values relating to each task. Again, it is possible to observe how the values decrease in all tasks, though to different extents:

the bigger differences are noticeable in the multiple choice task, then in the true/false and lastly in the cloze task.

Table 2

*Mean (m) and standard deviation (s) values for overall pretest and posttest response time per task (seconds)*

Task	Pretest		Posttest	
	m	s	m	s
MULTIPLE CHOICE	37.15	33.14	11.01	3.18
CLOZE	17.05	5.79	11.81	2.41
TRUE / FALSE	27.41	26.04	8.61	3.06

The mean response time value per task becomes almost half for the cloze and about a third for the multiple choice and true/false tasks in posttest data, but also, once again, the distribution of the data in posttest results is much more uniform and closer to the mean value, thus indicating more solid means.

Figures 4 and 5 show how the time needed for each participant to be able to provide an answer to a certain item is always lower when using DELE, with an exception of two items in the cloze test. In some cases, there are occurrences of no answers provided, when using the traditional approach, and in other the response time is sometimes halved cases when using DELE. The most substantial differences in response time can be observed in relation to the multiple choice and the true/false tasks: in these cases, in fact, the average decrease in the amount of seconds required to provide an answer for a specific item is 10.16 and 10.42 respectively; on the other hand, the decrease observed for the cloze test was 5.63 seconds only.

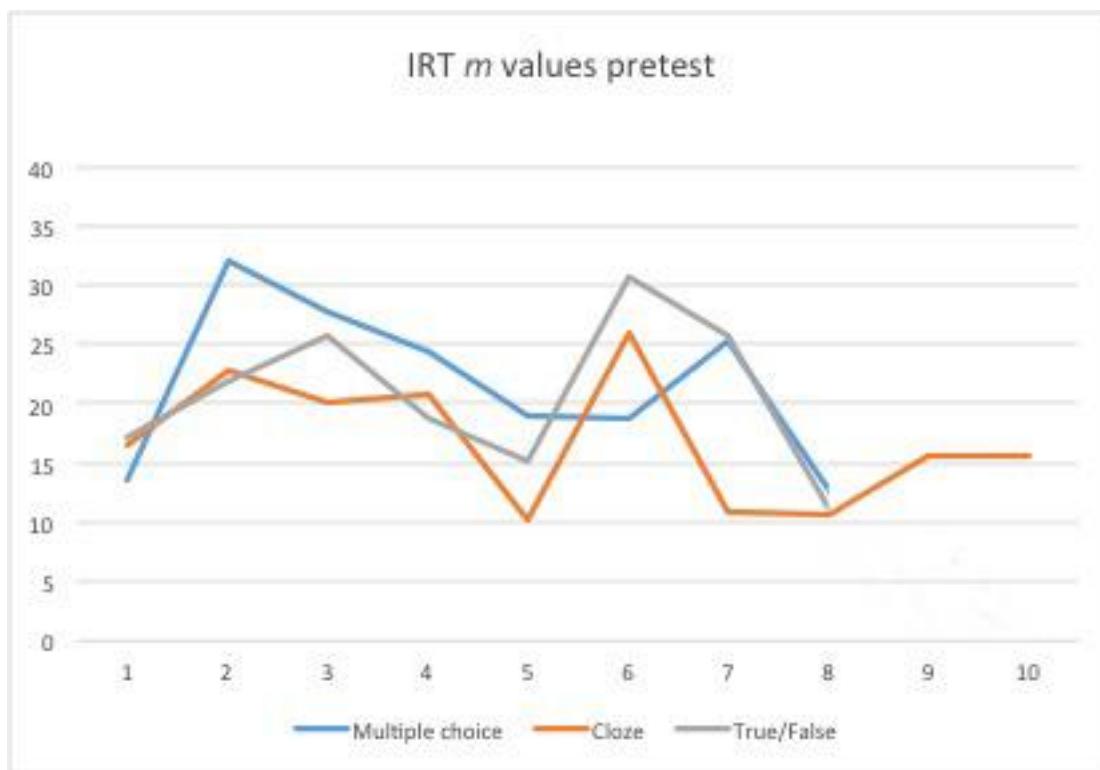


Figure 4. Item response time mean values (pretest)

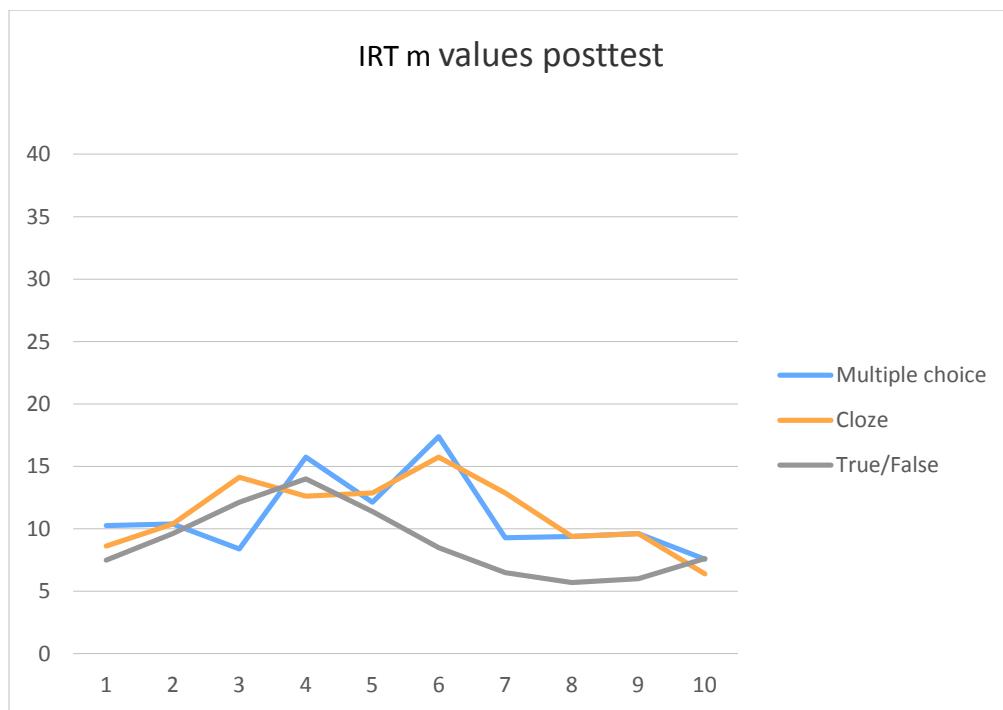


Figure 5. Item response time mean values (posttest)

In regards to the standard deviation values, and excluding the three instances of no answers provided in the pretest phase, in figures 6 and 7 a lower dispersion of posttest data can be observed in 20 cases out of 27, confirming the tendency to have more consistent and uniform mean results in posttest data. This could suggest that improvement occurred across the board, in a homogeneous manner.

However, the overall average decrease in the standard deviation values varies considerably: it decreases by 2.92 in the multiple choice task, by 4.54 in the cloze task and by 7.27 in the true/false task. As a result, we cannot say that overall the results are a lot more consistent and uniform, even though there is an indication that they may be so.

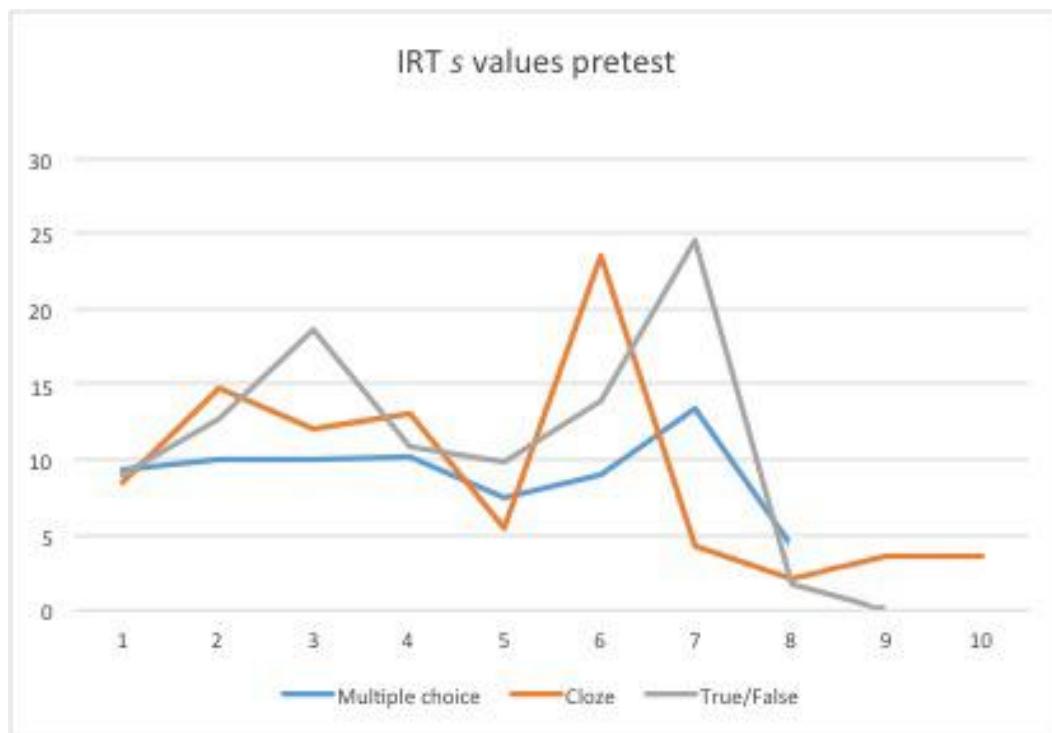


Figure 6. Item response time standard deviation values (pretest)

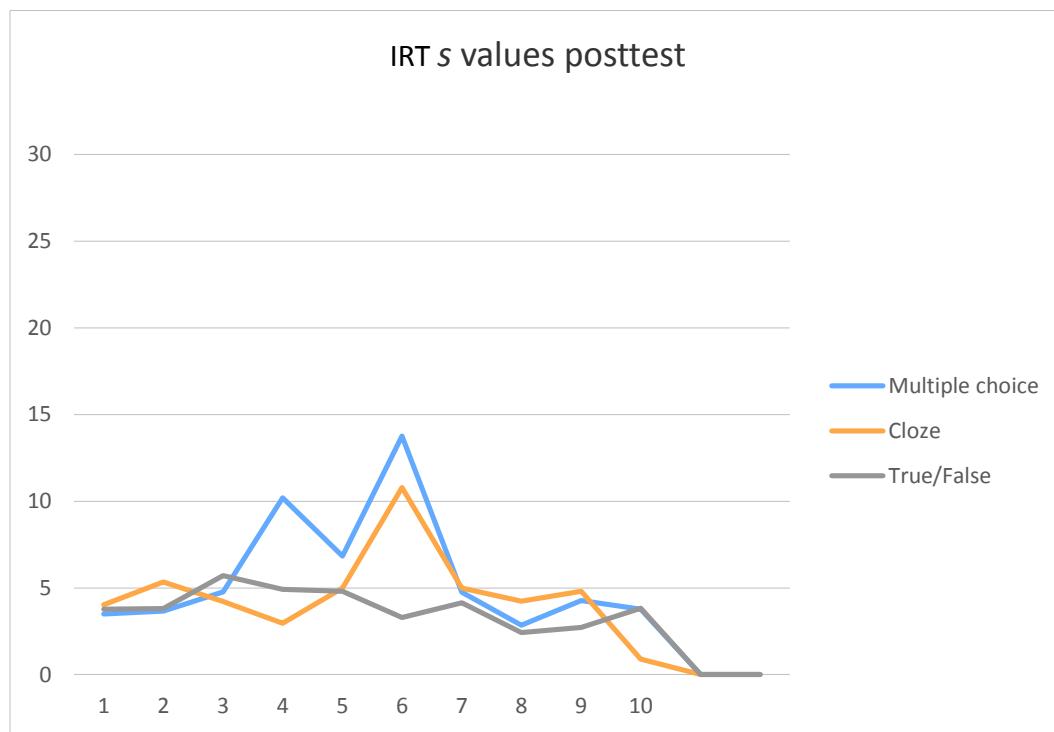


Figure 7. Item response time standard deviation values (posttest)

The following sections report on findings obtained after running a series of three t-tests per task. An additional two t-tests were run in order to provide an overview of the parameters that were taken into consideration, namely wrong answers, no answers provided and item response time.

### Multiple Choice

The t-test revealed that the learner produced a higher amount of wrong answers using the tradition pen and paper method ( $m = 2.88$ ,  $s = .835$ ) compared to using DELE ( $m = 1.63$ ,  $s = .744$ ),  $t(7) = 3.416$ ,  $p \leq .05$ .

In regards to the amount of items for which no answer was provided, these were higher in the pretest ( $m = 2.63$ ,  $s = .744$ ) compared to the posttest ( $m = 0.13$ ,  $s = .354$ ),  $t(7) = 7.638$ ,  $p \leq .05$ .

When analysing item response time, if using traditional methods learners took a higher amount of seconds to provide an answer to each item ( $m = 37.15$ ,  $s = 33.144$ ), compared to when using DELE ( $m = 11.01$ ,  $s = 3.189$ ),  $t(9) = 2.391$ ,  $p \leq .05$ .

### **Cloze**

Overall similar patterns in the results emerged for the cloze test. The t-tests indicated that, again, the learners produced less errors in the pretest ( $m = 3.25$ ,  $s = 1.669$ ) compared to the posttest ( $m = 1.88$ ,  $s = 1.126$ ),  $t(7) = 2.986$ ,  $p \leq .05$ .

The amount of items left unanswered in the pretest ( $m = 2.75$ ,  $s = 1.282$ ) was higher than in the posttest ( $m = .38$ ,  $s = .518$ ),  $t(7) = 4.461$ ,  $p \leq .05$ .

In regards to item response time, learners used more time in responding when using pen and paper ( $m = 17.05$ ,  $s = 5.794$ ) compared to when using DELE ( $m = 11.81$ ,  $s = 2.415$ ),  $t(8) = 2.949$ ,  $p \leq .05$ .

### **True/False**

The results obtained for the true/false follow a similar pattern, but with varying degrees of significance. The amount of errors in the pretest ( $m = 2.50$ ,  $s = .756$ ) diminished in the posttest ( $m = 1.13$ ,  $s = .835$ ),  $t(7) = 4.245$ ,  $p \leq .05$ . This was observed also in relation to the amount of abandoned items, which were higher in the pretest ( $m = 2.50$ ,  $s = .756$ ) compared to the posttest, where they were completely absent ( $m = .00$ ,  $s = 0.00$ ),  $t(7) = 9.354$ ,  $p \leq .05$ .

There was also a difference in item response time, which was very much higher in the pretest ( $m = 27.41$ ,  $s = 26.047$ ) compared to the posttest ( $m = 8.61$ ,  $s = 3.061$ ),  $t(9) = 2.210$ ,  $p \leq .05$ .

### **Task Overview**

An additional two t-tests were performed in order to get an overview of the pretest and posttest data distribution in relation to amount of wrong answers and no answers provided, regardless of the kind of task they relate to. This revealed a difference in the degree of influence

that the change of the medium in undertaking the task had on the production of wrong answers or no answers.

In fact, the difference between the overall amount of wrong answers in the pretest data ( $m = 8.63$ ,  $s = 1.506$ ) and in the posttest data ( $m = 4.13$ ,  $s = 1.126$ ),  $t(7) = 6.874$ ,  $p \leq .05$ , was nearly half of the difference between the overall amount of no answers in the pretest data ( $m = 7.88$ ,  $s = 1.506$ ) and in the posttest data ( $m = .38$ ,  $s = .518$ ),  $t(7) = 11.966$ ,  $p \leq .05$ .

**Significance values.** All t-tests that were run led to p values that were lower than .05, thus allowing the rejection of the null hypothesis. At a closer look, however, not all significance values distance themselves from the significance threshold to the same degree.

Across all tasks, significance values are more solid when pertaining to the unanswered items: the multiple choice and the true/false tasks display a value of .000, where the cloze task displays a slightly weaker result. In regards to the wrong answers, in table 7 we see that the higher value can be traced in the cloze test ( $p = .010$ ).

As a result, the cloze test seems to provide weaker significance values compared the other two tasks, in relation to wrong answers and no answers provided.

Table 3

*Significance values in the mean differences of the type of answers provided according to task*

	pretest - posttest	Sig. (2-tailed)	Sig. (1-tailed)
MULTIPLE CHOICE	wrong answers	.011	.005
	no answers	.000	.000
CLOZE	wrong answers	.020	.010
	no answers	.003	.001
TRUE/FALSE	wrong answers	.004	.002
	no answers	.000	.000

In regards to item response time, the pretest – posttest significance values for each task, as shown in table 8, there is an indication of a clear difference between the multiple choice and true/false tasks on one side, and the cloze task on the other. The first two, in fact, have a one-tailed significance value of .020 and .027 respectively, whereas the significance value connected to the cloze test, that is .009, is much further away from the significance threshold. Therefore, in this case, the improvement seen in lowering the mean item response time is more significant in relation to the cloze test compared to the other tasks.

Table 4

*Mean, standard deviation and significance values according to response time per task*

		<i>m</i>	<i>s</i>	Sig. (two-tailed)	Sig. (one-tailed)
MULTIPL E CHOICE	Pretest	37.15	33.14	.041	.020
	Posttest	11.01	3.18		
CLOZE	Pretest	17.05	5.79	.018	.009
	Posttest	11.81	2.41		
TRUE/FA LSE	Pretest	27.41	26.04	.054	.027
	Posttest	8.61	3.06		

### Discussion and Conclusion

The fact that the study indicated a statistically significant decrease in error production and unfinished tasks when using DELE may be motivated by various factors. The low amount of errors can be attributed to a better comprehension of the text through the various deaf user friendly features that characterise DELE. When provided with tools that enable a more comprehensive understanding of the text, even and perhaps especially when the text is written in a foreign language, the performance of deaf learners in activities of this kind can be enhanced.

The lower amount of unfinished tasks can also be due to the positive impact that a visually oriented learning environment can have on the deaf learner. The pretest data showed that most unfinished items were at the end of the task: this may suggest the fact that the learners

simply did not have enough time to complete them because most of the time was spent focusing on the items for which they did provide an answer, regardless of whether it was correct or incorrect.

The observation of how the standard deviation values change in the posttest data compared to the pretest data indicated that results are generally more uniform and compact, but this uniformity is not displayed consistently across the three tasks, therefore more data would be needed.

There may be an effect of task on the enhancement of reading comprehension through DELE: item response time decreases to a smaller extent in the cloze task compared to the other ones. Furthermore, in relation to the significance values, when considering wrong answers and no answers provided, the values pertaining to the cloze task are the least significant, whereas when considering item response time, the cloze task values are the most significant: this provides additional reasons to investigate this aspect of the study.

Further research will be aimed at considering larger and different sample groups, keeping a close eye on the randomization of participants in order to ensure that meta-variables are not influencing the results.

Furthermore, a number of threats to the internal validity of the study can be addressed with different research designs. For example, a one sample pretest/posttest design can sometimes produce a practice effect, thus playing a role in the data indicating better performance in the posttest. It can also sensitise participants, because it may alert them in relation to the aim of the study that is being conducted. In this second case, participants may feel that they are expected to perform better when using the new, unfamiliar tool that is being proposed to them, which may positively affect their attention. This could be solved by implementing a research design with a number of groups, allowing the alternation between the use of DELE and the use of traditional approaches, so as to minimize the practice and sensitising effects.

A closer look on pre-existing conditions related to competency levels in the target language can also be included in further studies: in this particular study, it was known that all participants had taken part in EFL classes in the previous 6 to 7 years of schooling, so the competency level was assumed but not tested.

Though encouraging, the results rely on a small homogeneous sample of students: several challenges were faced in the attempt to select students that were similar according to age and type of deafness and rehabilitation process followed. As a result, the data analysis focuses on just a few of the many variables that can be taken into consideration for studies of this kind. Future research will be aimed at partially replicating the investigation of the effectiveness of DELE in an EFL context for deaf learners, considering a larger scale. This will allow to detect with better approximation causal links between the variables considered, as well as being able to further investigate the potential of DELE in other aspects of its use.

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### Acknowledgment

The authors wish to thank Prof. Paola Giunchi, for suggesting a joint collaboration between the authors, Prof. Stefania Spina, who provided support in the initial phase of the statistical analysis, and both Prof. Giunchi and Spina for reading the final draft of article.

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