

Comparing information and communication technology performance and reading achievements of high school Brazilian students

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Considering the necessity of technology literacy acquisition and reading comprehension skills to use ICT resources, this study aimed at assessing ICT performance, reading comprehension achievement, and the possible relations among them. The subjects were sixty-three K10 and K11 students of public Brazilian schools near São Paulo. The Technology Performance Scale (TPS) and the Cloze Test with options were applied in groups, by school and grade. The TPS showed an average student ICT performance. The best performance referred to learning and creative task development linked to the concept and productivity tools factor. The average achievement in reading comprehension was 28,76 ($SD=6,72$). There was positive correlation between reading comprehension and TPS total and factor score to K11 female students. It's important to consider that the ICT performance was statistically different between the grades as the comprehension between genres.

Keywords: technology literacy; technology performance; psychometric

1. Technology and learning

The inclusion of digital media in daily life, both as a strategy for teaching-learning and a resource for gaining access to information, determines a need for teachers and students to develop skills to use Information and Communication Technologies (ICT) [1,2,3,among others]. The educational use of ICT requires high-level cognitive abilities from the user (specially attention, memory e reasoning), for it is necessary to identify, characterize and understand technical information on the media in order to apply them in different situations, for specific tasks and objectives [4]. Scholars usually refer to *technology literacy* as a technical and functional competence used to develop and apply ICT resources, which depends on language [5,6]. This is due to the fact that communication is the center of the learning process in the classroom, weather it is a virtual or presence-based course [7].

In the realm of reading specifically, there can be a textual and/or hipertextual base [8], thus the relevance of the analysis of users' reading skills in relation to ICT resources, through decoding (recognition and attribution of meaning to words) and comprehension (interpretation of meaning of written language) as proposed by Flanagan e cols [9]. Besides that, it is expected that the processes of learning-teaching basic reading, writing and logical mathematical abilities adapt to the new digital media [3].

Researchers and specialists in reading of printed material now recognize the need to identify the steps to be taken in order that an individual is able to advance from initial learning of reading to the use of such skills as a basic learning instrument [10]. This involves the reader's active participation, by interacting with the text, selecting, processing and interpreting information, besides being able to recall, summarize and expand information, thus integrating it to preexistent knowledge [11,12,13].

2. Technology and Literacy performance

The nature of reading comprehension competence is undergoing a process of redefinition, which results from the use of electronic multimedia [14]. Since the 1990s, the concept of *literacy* has been expanded. Not only calculus, reading and writing skills, but also the abilities associated with the use of different media and technologies are being considered for such definition. Electronic reading requires

new modes of conceptualization [15]. In printed texts the page, which is comprised of stable contents, predetermines physical space, and is controlled solely by the author. In an electronic context, space is dynamic, virtual, fluid and transient, allowing for text mutability. One cannot consider electronic text superior to the printed version, but for its characteristics, it is a singular option for creating and communication messages [16].

As a consequence, fundamental changes are taking place in the creation of texts, whose models are dynamic and creative, in reading strategies and in the formation of new readers [17]. They need to accomplish the task of reading through electronic media. Since young people communicate more often through these media than by using traditional media [18] there is a need for further research on how the comprehension process of electronic messages and texts takes place. Furthermore, it is necessary to identify a baseline on the relation between reading comprehension of printed texts and the use of ICT resources for further comparison with reading through digital media.

The studies made on reading comprehension of electronic texts have revealed that it is essential that the reader be, at least able to identify the typical structure of the media in which the text is being conveyed. Moreover, in order to effectively understand, the reader must distinguish the textual structure of different media, recognize and identify the various linguistic and graphic elements of the text, author's intention and perceive the omission of contents [19], which necessarily requires proficient use of the digital apparatus that supports information in combination to reading comprehension skills.

In a recent investigation on this theme, Joly, Capovilla, Neri, Bighetti e Nicolau [19] have found there are differences in reading comprehension performance for printed and electronic texts. The participants were 80 freshman psychology students. 79% of which were female. 69,1% studied at night. The age varied between 17 to 56 years of age ($M=24,05$, $DP=7,13$). 59,3% of the students were younger than 22 years old and 30,9% were more than 25.

It was observed that, according to the ranking proposed by Bormuth, participants showed a level of frustration in comprehension (score < 44% of total expected) for the printed text, which revealed little success in the task [20]. The independent comprehension level (score > 58% of total expected) was observed for digital texts, which indicates reader autonomy for this type of text.

The analysis of the effect of gender (male x female) and age (lower than 25 x 25 or older) on the reading comprehension test performance, for both printed and digital texts, showed significant comprehension differences, both for printed and digital texts, as a function of participant gender ($p<0,03$) e and age ($p<0,05$). Women have demonstrated better performance than men in the two types of text. It was also observed that the participants who were under 25 displayed a better comprehension of the digital text [19].

In Brazil, studies that attempt to measure the performance in ICT as well as those about digital comprehension are still very rare [2,5,21,22,23]. There is a shortage of quantitative data and information about technological literacy in the Brazilian school system.

The study of Martins [23] conducted with 463 students, using Scale of Performance in Use of Information and Communication Technologies (*Escala de Desempenho em Tecnologias da Informação e Comunicação – EDETEC*) [24] aimed at evaluating the performance of students graduating from High School, and beginning university, in the use of technologies in their daily activities. Among them 53,1% are female and 46,9% male, with ages varying between 15 and 60 ($M=22,00$; $SD=6,90$). The majority were private school students (84,9%), 47,1% in high school and 52,9% in the freshman year of college.

The results were that 25.5% of the participants displayed advanced, 52% intermediate and 13.6% elementary performance. Among the participants, 9,1% demonstrated no ability in the use of ICT. In the group being investigated, 68% declared that they use the Internet, very frequently, as an aid for academic activities. In the subgroup of up to 18 years of age, this percentage increases to 72%, which is a good indicator, equivalent to international standards.

However, except for the use of Internet as a study-aid, the study identified that the majority of the instrument items related directly to the act of studying using ICT did not display significant scores, in comparison to others. According to the study, this result suggests that students have a dichotomous relationship with the available resources (in which they are proficient) and systematized learning actions.

The average scores in the various items of the scale was 85,62 ($DP=36,59$) for a maximum score of 168, which places the group above arithmetic average of the instrument, thus suggesting that, in general, the students see themselves as frequent users of CIT resources. The average for items which comprise factor 1 was 32,84 ($DP=13,86$), for items related to factor 2, 22, 21 ($DP=13,29$) and factor 3 30,57 ($DP=12,70$).

The averages for factor *basic communication tools* (F1) and problem solving tools (F3) revealed superior performance and a good mastery of the skills that require the use of the most common technological resources. The average in the *concepts and productivity tools* factor (F2) indicates low frequency of actions.

In relation to the effect of gender and type of academic institution (private or public), the study revealed a difference in relation to total scores. When the type of school was considered, ($t [461]=2,57$; $p < 0,01$), private school students ($M=87,38$; $DP=35,72$) showed superior performance in comparison to public school students ($M=75,74$; $DP=34,47$). There were also differences when gender was considered, ($t [461]=-4,44$; $p < 0,00$). Male participants displayed better performance ($M=93,49$; $DP=35,34$) than female ($M=78,67$; $DP=36,34$) [23].

Even though they are two significant components of the learning-teaching process, the revision of Brazilian literature has shown that there are no studies about the performance on information and communication technologies in the educational context and its possible relation to reading comprehension performance. Thus, considering the need for *technology literacy* acquisition and the relevance of reading comprehension for the learning processes, the objective of the present study was to measure ICT performance and reading comprehension (*Cloze test* with option).

3. Method

3.1 Participants

63 students between 15 and 18 years of age ($M=15,84$; $SD= 0,83$) regularly attending K10 (50,8%) and K11 (49,2%) in Brazilian public schools near the city of Sao Paulo, São Paulo, Brazil. The participants were 58,7% male and 41,3% female.

3.2 Instruments

Escala de Desempenho em Tecnologias da Informação e Comunicação (*Scale of Performance in Use of Information and Communication Technologies*) – EDETEC [24]

Its objective is to identify performance characteristics, in relation to instrument mastery, as well as the effective use of technological resources, in relation to adequacy of application in daily life, as well as a learning item, under the perspective of technological literacy. It is composed of 56 Likert-type items with four alternatives (0 = never, 1 = sometimes, 2 = very often, 3 = always), divided in three factors.

Basic communication tools (17 items, 12, 19, 21, 33, 34, 35, 36, 37, 40, 41, 42, 44, 47, 48, 51, 52, 54) are linked to the abilities to use technology for elementary tasks such as obtaining information, network interaction and cooperative learning. Factor 1(F1) contains, for example, “*I get e-mails*”, and “*I know how to connect my equipment to Internet*”. Factor 2 (F2) is called *productivity concepts and tools* (20 items, 04, 07, 08, 11, 17, 20, 22, 23, 26, 27, 29, 30, 31, 32, 38, 43, 45, 46, 55, 56), which refer to productive use of the instruments aiming at improving learning of contents, creative development of tasks and conveying ideas, such as “*I use my computer to produce videos*” and “*I use extra resources in my mobile phone (camera, recorder among others)*”. Factor 3 (F3) is linked to *Problem solving tools* (19 items 01, 02, 03, 05, 06, 09, 10, 13, 14, 15, 16, 18, 24, 25, 28, 39, 49, 50, 53) and involves the advanced use of technological resources in order to solve routine problems and to make decisions, such as “*knowing how to identify the best technological resource in order to solve a problem*”.

Maximum score is 168 points, with 51, 60 e 57 respectively for factors 1, 2 and 3. This is an instrument that can be applied either individual or collectively, in printed or electronic format, with an average duration of 20 minutes.

This scale has shown evidence of construct validity obtained by an exploratory study conducted by Joly and Martins [25], displaying good internal consistency ($\alpha=0,96$). Internal precision, verified by the split-halves method, was 0,87 and revealed homogeneity among items. Factorial analysis indicated the presence of three factors responsible for 47,48% of the variance.

Teste Cloze com opção - EM (Cloze Test with option – HS) [26]

It is comprised of an editorial text with 300 words, to which the Cloze Oriented System (COS) was applied. Its comprehension analysis criterion requires the omission of one in each five words with multiple-choice alternatives. There is only one correct option, and the other four are comprised of one word in the same grammatical category of the word that has been omitted, two words related to the grammatical category of the word that has been omitted, and one word that is of a different grammatical category. The omitted words were substituted by blanks, all of the same size. The subjects must choose among the 5 alternatives, the correct word to fill the blank and complete the sentence. [27]. Only the alternatives that exactly match the original text were considered correct. Any answers left blank were computed as error and each right answer received 1 point. The performance of the subjects was registered by counting right and wrong answers. The precision of the instrument is 0,90, which was obtained by using the Alfa Cronbach test.

3.3 Procedure

The evaluation was conducted collectively, by grade and period, and participants took the test in the classroom. An instructor oversaw the activity in order to provide any directions needed in completing the instrument. The average time was 30 minutes for each test. The instructions and questions were printed and the answers were registered with pen and paper.

4. Results and Discussion

EDETEC revealed that participants show an average performance of 52,46 points ($SD=37,68$) equivalent to the use of 31,23% of the resources evaluated. The use of ICT applied to *basic communication tools* ($M=19,62$; $SD=14,50$) and *problem-solving tools* ($M=18,80$; $SD=13,49$) displayed the highest average frequency of use. The factor *productivity concepts and tools* was identified as the least frequently used ($M=14,21$; $SD=11,56$). The results corroborate the study of Martins, in which EDETEC [23] was also used.

The items with highest average response frequency were “*I know how to edit texts using a computer*” ($f=1,95$; $SD=1,07$), “*I access sites*” ($f=1,89$; $SD=1,26$) and “*I know how to print texts using the computer*” ($f=1,84$; $SD=1,25$), which are in the scale category of basic tools and communication (factor 1). Such factor evaluates the use of technology for simple tasks, as the ones pointed out as most frequently conducted by the participants in the study.

As pointed out by Penuel, Korbak e Cole [4], actions that directly support learning, creative development of tasks and presentation of ideas, whose items are categorized as factor 2, are less used, maybe because they demand higher cognitive abilities (selection, categorization, and comparison of information, for example). Another hypothesis in relation to the frequency observed by factor may be linked to the lack or difficulty in obtaining Internet access and more sophisticated technological equipment such as Palm, DVD, among others, as is the case with the majority of items in F2.

Despite the technological progress in the context of Brazilian education, and its indisputable importance, digital exclusion still persists. The need to train teachers and students, so that they achieve technological literacy, was also clear in this study. Nowadays, ICT performance is closely linked to personal development and individual proficiency in the use of technological recourses, either for teaching, learning, obtaining information and communicating, by constantly adapting to technological innovation [6].

We have also observed, by using ANCOVA, the influence of grade ($p < 0,02$) and gender ($p < 0,04$), independently of age, on ICT performance, which corroborates the study of Martins [23]. Tukey *post hoc test*, used based on data of *t student*, revealed that the total average scores for usage were higher for K11 ($t[59]=-3,05$; $p<0,003$) male students ($t[59]=-2,06$; $p<0,044$), and by factor for K10 female students.

For reading comprehension, average performance was 28,76 points ($SD=6,72$) right answers from a maximum of 40 points, demonstrating that participants understood 72% of the text. Such an indicator categorizes them as autonomous readers [20]. Co-varied analysis showed the influence of gender on performance ($t[59]=3,63$; $p<0,001$), independently of grade or age, with females achieving an average score ($M=32,12$; $SD=4,49$) that was higher than males ($M=26,41$; $SD=7,07$). This result also corroborates other research with participants of the same age range [19,28,29], as well as the literature in the area [30].

As for the relation between ICT performance and reading comprehension, when participant gender and age were considered, a significant and positive correlation was found for female participants attending K11 in comprehension both for total score ($r = 0,73$; $p<0,001$) and for EDETEC factors (F1 [$r=0,76$; $p<0,001$]; F2 [$r=0,58$; $p<0,011$]; F3 [$r=0,69$; $p<0,003$]). It is important to point out that the evolution in ICT performance from K10 to K11 must have influenced the correlations observed, since reading comprehension performance did not show significant difference between grades. It is also worth pointing out that performance differences among grades are more recurring in the literature. But comparisons by gender, with significant differences in relation to ICT use for females, require further investigation.

And finally, we must emphasize that, despite the limitations of the present study in relation to number of participants and the lack of related literature, it has shown a correlation between reading comprehension and ICT performance. We have also verified the efficiency of the Cloze Oriented System for evaluating reading comprehension and evidence of convergent-discriminator validity of the psychometric instrument based in this evaluation system. We suggest that new studies be conducted in order to discriminate ICT performance in relation to digital reading.

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