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Foreign Language Vocabulary Acquisition and Retention in Print Text vs. Digital Media Environments

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Abstract: In the context of very current trends in digital language education generally supported by governments and educational institutions, it seems necessary to evaluate the efficiency of these tools from various points of psycholinguistics and applied linguistics, mostly when it comes to learning a foreign/second language (L2). Therefore, this paper aims to evaluate vocabulary retention in L2 when using print text in contrast with digital media. The research was conducted among 122 participants who were university students and were divided into two groups to learn 60 new phrasal verbs; one group of them using a standard print text, the other using the same text displayed and annotated on their digital devices. There were two memory tests after four weeks of studying the four sets of phrasal verbs, i.e., 15 verbs a week, and another test after another month to evaluate students' memory retention of the given vocabulary in time. The results clearly show a slight but clear discrepancy in these two groups in favor of the group using the print text in both tests performed. The findings of this study suggest that students can retain L2 vocabulary better in conditions where they have access to printed vocabulary and if they can make notes, highlight or write their translation in their native language. However, these findings should be verified from other perspectives as well to obtain more reliable data.

Keywords: vocabulary retention; SLA; foreign language learning

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1. Introduction

The massive use of the Internet and digital media in the last decade has created a lot of new concepts in applied linguistics related to the use of computers in FLL (Foreign Language Learning) and L2 (foreign/second language) acquisition, such as eLearning, eLearning 4.0, and hybrid learning, and various other kinds of digital learning.

Moving from paper-based to screen-related learning activities is becoming more and more common every year, especially among the young population [1]. Recent world context derived from the COVID-19 pandemic created the perfect conditions for a mass migration of face-to-face to online courses, compelling students to adapt to new ways to access content for their classes, including language students [2]. English students specifically had mixed opinions about the learning methods used and their efficacy to enhance their vocabulary and comprehension of a foreign language [3–6]. Unable to meet face-to-face and using online technology for their study of English as a second language, students are still left unanswered on account of what seems to be a lack of evidence regarding the effectiveness of different methodologies in foreign language verbal acquisition, specially printed and online text. Therefore, it seems relevant and necessary to verify what discrepancy there could be regarding vocabulary acquisition and retention in L2 when using digital media in contrast with the use of print text.

Furthermore, recent studies show that when students learn a second language, online classes can shape the way students learn with both advantages and disadvantages. Klímová,

Pikhart, Cierniak-Emerych, and Dziuba [7] point out in their study that although in online classes students have some advantages (such as reviewing the learning material more often and learning in the comfort of their homes), the lack of social contact and consequently any possibility to develop speaking skills appear to be the main negative aspects for the students. Nenakhova [8] presented similar opinions on Russian students, mentioning the ability to study at home as an advantage and the absence of communication as one of the main disadvantages. In addition, Danchikov, Prodanova, Kovalenko, and Bondarenko [9] discuss that the use of online learning technologies places high demands on these professionals, as learning new skills and methods was and continues to be necessary for them to manage the learning process successfully. With so little time for the teachers to adapt, it becomes even more essential to evaluate existing methodologies and their effectiveness for classroom and online learning.

Some research indicates that certain elements can moderate L2 vocabulary results. Chiu and Liu [10] (2013) investigated the general effectiveness of L2 computer-assisted vocabulary instruction, with an analysis of the features of treatment duration, educational level, the use of games, and the role of teachers in the CALL (Computer Assisted Language Learning) studies. The results showed that computer-assisted language learning in L2 vocabulary acquisition has positive effects with a medium effect size, especially within less than one month. Zhang and Zou [11] investigated 41 articles about the multimedia technology used by students for L2 acquisition. The study identified that multimedia input (the instructional message presented through multimedia) may influence the effectiveness of L2 education. They mention the potential of multimedia to stimulate multiple cognitive channels and learning attention, type of activities, and the information conveyed. In addition, Bancha and Tongtep [12] compared the learning management system (LMS) vocabulary exercises and vocabulary online games in facilitating better vocabulary acquisition. The results showed that both options can facilitate vocabulary memorization and retention with no statistical difference between them.

Willies and Ohashi [13] confirm a well-known fact that when it comes to vocabulary expansion in L2, the frequency at which the students will be exposed to the words can enhance learning and retention. A rich and structured lexical environment is essential for providing opportunities to encounter new words and to provide sufficient opportunities for periodically repeated encounters with lexical items to stop them from being forgotten. Unfortunately, textbooks may not provide these opportunities, and it leaves a gap that technology seems to be trying to fill. In addition, Kohnke, Zou, and Zhang [14] explored this matter in the effectiveness of a custom-designed mobile app for developing students' discipline-specific vocabulary range and retention. The result provided credible evidence of the facilitative effect of the mobile app on academic students. However, Lee [15] points out that the frequent practice of informal digital learning of English does not necessarily guarantee L2 vocabulary gains, but the quality of these activities (combining form and meaning-focused language learning) could improve vocabulary acquisition. In addition, many authors admit that digital applications should not be seen as protagonists of the learning process, but rather as support procedures, [8,16–18], in addition to traditional methods such as printed materials.

Research shows that printed materials provide benefits that cannot be matched by digital media [19]. Some of the advantages include better reading comprehension [20], confidence and immersion in the content of the text, and lower levels of fatigue for reading printed text when compared with reading from a device screen [21]. Furthermore, printed text seems to be the most preferred choice among students worldwide, especially among academic students [22,23]. Pfost, Dörfler, and Artelt [24] investigated the effects of different reading sources, including print-based materials and online reading activities, on secondary school students' literacy development. The students had to answer reading tests and questionnaires about their habits, and their answers showed that traditional book reading was beneficial to their literacy skills, whereas online reading activities had a negative impact on both their reading comprehension and lexical competence. On the contrary, Porion,

Aparicio, Megalakaki, Robert, and Baccino [25] found no statistical difference between print and digital reading on text comprehension of readers regarding surface, semantic, and inference understanding.

Research studies also reveal contradictory results regarding students' vocabulary retention in L2 for different environments. Kilickaya and Krajka [26] compared the usefulness of online vocabulary teaching and the traditional methods used in upper-intermediate academic English classes. While the control group practiced vocabulary through notebooks and cards, the experimental group practiced the same vocabulary items in the passages through an online dictionary lookup system. The authors claim that the learners in the experimental group outperformed the control group and that the experimental group students remember better the words studied online, evidenced using a follow-up post-test given three months later. However, other studies seem to differ in the students' results in paper and print. Chiu and Liu [10] investigated printed dictionaries, pocket electronic dictionaries, and online type-in dictionaries on English vocabulary retention at a junior high school. Results indicate that although electronic dictionaries temporarily attract junior high school students' attention, printed dictionaries help them retain target words more effectively.

Overall, the literature shows that multiple aspects changed during the last few years regarding second language education, and different sources of information, including mobile apps, online platforms, and digital gadgets for better word retention in L2. However, it still seems to lack important information about the efficacy of different methodologies used in verbal L2 acquisition. The recent pandemic scenario seemed to give important insights into students' points of view on their education, including the benefits and the downsides of online classes, with divergent results in the literature about what is the best way to improve verbal acquisition in online and printed materials in L2 acquisition and leaving a clear space in these different methodologies.

Despite the urgency of the topic, there are not many experimental studies currently discussing the influence of digital media vs. print media on our memory, vocabulary retention, information comprehension, and text processing. Naturally, there are virtually no systematic reviews and metanalyses dealing with the topic and comparing the impact of these two modalities at all, nor are there any that deal with at least some aspects of human language acquisition, both L1 and L2. There have been several studies that somehow hint that there could be a discrepancy when opting for one of these modalities, but their advantages and disadvantages are still hidden with the very strong support of the digital ones. Therefore, this study aims to elucidate the difference in L2 vocabulary acquisition of two groups of students, one receiving only online activities (digital media) and the other only paper activities (print media), and measure the differences in vocabulary retention between the two groups.

Research Question

What are the differences in foreign language acquisition and retention when utilizing digital and printed texts?

2. Methods

To assess the first and second research questions the following methodology was applied. An intervention was conducted to evaluate the impact of print text vs. digital media on vocabulary acquisition and retention in university students. The first research question that dealt with vocabulary retention was evaluated just after the intervention by testing the participants of the intervention, however, the second one dealt with the longer time period, therefore, the evaluation was conducted after another month, or to be specific, after four weeks after the first test.

2.1. Participants

Altogether 122 students of the Faculty of Informatics and Management of the University of Hradec Kralove participated in the experiment and all participants were students of Applied Informatics and Economics & Management and aged between 20 and 24 years, both males and females with a higher number of males (66 males and 56 females). This gender discrepancy is caused by the fact that more males generally study these study programs related to ICT. The participants were randomly divided into two groups with the idea of ensuring gender balance in both experimental and control groups. All the participants were Czech citizens with Czech as their first language. Their L2, which they had studied from basic school through high school, was English. The level of English ranged from B2 to C1 according to the Common European Reference Framework for languages (CERF) and it was tested at the beginning of the second semester of 2022 using a standardized Oxford Placement Test to create a homogeneous group of participants. After the test, all students with lower results were not selected to participate in the experiment, and there were none with better results than C1.

2.2. Procedure and Material

The participants had a regular 90-min class of English per week during the second semester of 2022, which lasted for 13 weeks, from 7 February to 9 May 2022. The course focuses on English for ICT and business or finance. However, there was space to implement some general English into these classes as well. Therefore, the experiment focusing on L2 vocabulary acquisition and retention could easily be a part of their regular classes. To evaluate whether there is any difference between the retention of new words in an electronic environment, i.e., digital media, and in a traditional one, i.e., print text, the students were divided into two experimental groups and each of these groups was divided further into two new groups just to create smaller subgroups.

The tested vocabulary knowledge and its retention were based on learning and remembering specific phrasal verbs that were carefully chosen so that the participants of the experiment did not know them, and it was not possible to understand their meaning as they clearly differ from the student's first language, which was Czech. To determine what phrasal verbs to choose, an initial test was performed at the beginning of the semester to see what phrasal verbs they did not understand. The reason for the choice of this specific L2 vocabulary, i.e., phrasal verbs, was that, firstly, students' knowledge of general English, based on the initial test results, was relatively high, and secondly, phrasal verbs (e.g., bear out or account for) are one of the most difficult aspects for Czech learners, as well as for other learners of the English language [27,28]. Therefore, it was ensured that the participants did not have prior knowledge of these lexical items or were limited to those that are the same or very similar in their L1 and L2

The students in the first experimental group (further on only the "print group") were provided with a printed text of 15 phrasal verbs for four weeks (i.e., 60 phrasal verbs altogether). The phrasal verbs were used in their practical context in sentences and the tutor went through all of them, 15 sentences each week, i.e., each phrasal verb was illustrated by one sentence, at the beginning of each lesson (from 14 February till 11 March). The students could use their pens, pencils, and highlighters to underline and annotate the list of verbs. Each instruction lasted 15 min and the students were told by the teacher how to understand and use these phrasal verbs in other contexts as well.

The students in the second experimental group (further on only the "digital group") were given the same amount and in the same format the phrasal verbs but only electronically, via their mobile phones or laptops as a pdf. attachment downable from MS Teams. They were told not to print them out and bring them to their classes just on their mobile phones or laptops. They could use any annotations, highlight functions, or notes but written on their mobile phones or laptops only. It was relatively easy to ensure that the students do not use any print material as they are students of ICT, and it is generally very unusual to print any texts or study materials for any of their subjects either. Only two

students were observed having printed the texts as they brought the printouts to the classes and the test class as well and, therefore, they could not be included in the survey. None of the participants knew that the study dealt with print vs. digital media. Therefore, they could not know what the purpose of the study was, and it was feasible for the researchers to find out who used their print materials; since there were only two students who used these annotated printouts during their classes and they brought them to the test session as well, the researchers could easily identify them and then leave them out of the study.

To ensure an identical approach for these two groups, the researchers conducted the same intervention in both groups, the only difference was the format of the presentation of the phrasal verbs, i.e., print or digital. A script for the classes was prepared to be followed so that both groups of students had identical instructions and conditions. Moreover, there was just one teacher in all four subgroups to make the classes and instructions as identical as possible. Identical timing was also ensured in all groups, i.e., exactly 15 min each week. In the fifth week of the semester, students' knowledge of all 60 phrasal verbs was tested in class and students had to fill in the missing phrasal verbs based on the context of the sentences they had been learning for the previous four weeks. The test contained 60 sentences, i.e., 60 phrasal verbs, thus, a score of 100% equaled 60 points. All participants were motivated to learn the phrasal verbs as passing the test in the fifth week was a part of their credit requirement for the given subject and they were informed about the test at the beginning of this experiment. Therefore, they devoted their regular time to revising before the test based on their subjective evaluation and experience.

Moreover, to test the retention after a certain period of time, both groups were given the same test without informing them in advance after another four weeks. The test was identical for both groups again, but the sentences were mixed up in a different order compared to the previous test, however, the test sentences were identical. The idea of this control test was to see if there is any time discrepancy in these two groups after a given period of time.

All the respondents agreed with participating in the experiment and they provided the written consent with it which they expressed by their enrolment in the course. They were provided with the information at the beginning of the semester, and they could change the course at the beginning of the intervention during the first or second week of the semester. The research was approved by the Ethics Committee of the University of Hradec Kralove (no. 2/2021). GDPR was fully followed, i.e., no personal details about the participants were collected. The only information collected was the name of the student and the results of the test as these results were a standard credit requirement for the subject assignment. However, for the purpose of this study, only the results of the two tests were recorded without any name or any other personal identification.

3. Results

The first test was conducted after four weeks of intervention with the teacher. All participants were given a regular paper and pen test with all sixty sentences they had studied with the tutor during the first weeks of the semester. Their only task was to fill in an appropriate phrasal verb in blank spaces. The time for the test was 15 min, which seemed sufficient as all participants finished by that time. The maximum score was 60 points (100%) as there were 60 sentences and thus 60 phrasal verbs; for convenience, it was necessary to recalculate in percentages, but the results are more obvious in the absolute values, i.e., the total number referring to the correct phrasal verbs.

In this experiment, the group of participants who used a traditional print text is referred to as a "print group", whereas the group that used their mobile devices to display and annotate their pdf text is referred to as a "digital group". As it is visible in Table 1, the number of respondents differs by two students, as it was observed that two participants in the digital groups used their own printouts during the lessons and they also brought them to the test to review before the lesson. Therefore, they were left out of the experiment. It is obvious that when just comparing the mean and median, the results differ with

50.95 vs. 54.53 and 55 vs. 59, respectively. Even in the minimal value, there is a clear difference, 11 vs. 24, in favor of the print group. The maximal value of 60 was reached in both groups.

Table 1. Results of the first test.

	Digital Group First Test	**Print Group First Test**
No. of resp.	64	66
Mean	50.95	54.53
Median	55	59
Min. value	11	24
Max. value	60	60

After four weeks of the first test, another test was performed but without informing the students about the test. The idea of this subsequent test was to provide more data on longer-time retention of the acquired words, specifically four weeks after the official test, i.e., four weeks after the students intentionally studied for their credit test. The students did not know about this second test and none of them had revised for the test, they only used their memory from the time when they studied for the first test. The results of this control test are presented in Table 2. The number of respondents remained identical to the first test, minus two students from the digital group for the same reason as the previous test. The mean was 44.74 for the digital group, while 52.57 for the print group. The same trend is visible in median values as the digital group reached 47.5 while the print group was 56. The minimal value in the digital group was as low as three but in the print group, it remained still relatively high at twenty-one. There was no drop in maximal value in the print group, i.e., still 60, but the maximal value in the digital group dropped to 57.

Table 2. Results of the control test.

	Digital Group Control Test	**Print Group Control Test**
No. of resp.	64	66
Mean	44.74	52.57
Median	47.5	56
Min. value	3	21
Max. value	57	60

When comparing the results of the first test and control test in the digital group, it is possible to see that the first test was nearly 51 while the second test dropped by nearly six points to 44.74. The same trend is visible in median values, and the drop was from 55 to 47.5. The drop in minimal value from eleven to three seems also very clear, while the drop in maximal value from 60 to 57 is not important. All these results are presented in Table 3.

Table 3. Comparison of the first and control test results in the digital group.

	Digital Group First Test	**Digital Group Control Test**
No. of resp.	64	64
Mean	50.95	44.74
Median	55	47.5
Min. value	11	3
Max. value	60	57

Regarding the results of the print group and their first and second test, the results seem better. With 64 participants the mean value of the first test was 54.53 and the drop in

the second test was just by two points, which is more than satisfactory. In median values, the drop was by three points only, from 59 to 56. Also, the minimal values changed only slightly from 24 to 21, and the maximal value stayed without any change at 60. All these results are presented in Table 4.

Table 4. Comparison of the first and control test results in the print group.

	Print Group First Test	Print Group Control Test
No. of resp.	66	66
Mean	54.53	52.57
Median	59	56
Min. value	24	21
Max. value	60	60

The differences between the digital and print groups in the first and control tests can be seen in Figure 1.

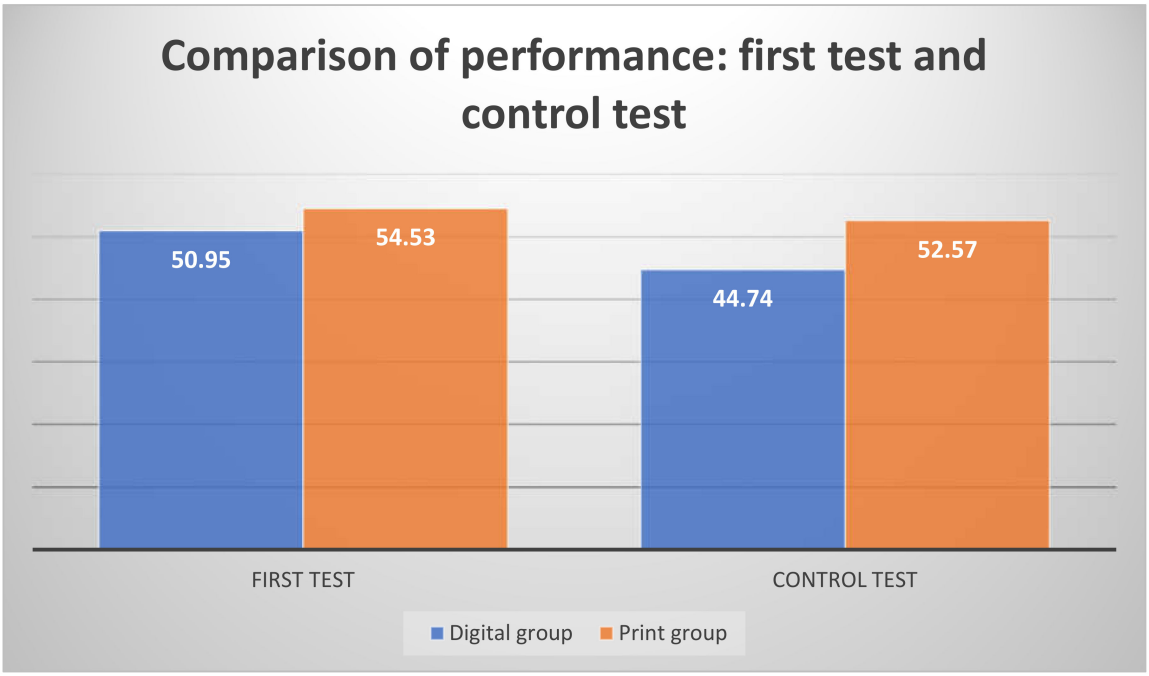

Figure 1. Graphic representation of the differences between the digital and print group in the first and control tests.

With these results, it is possible to see that the print group obtained better results both in the first test and mostly in the second test which checked vocabulary retention after a longer period. It can be assumed that the print media allow for higher retention both in the shorter and longer run. The difference is not dramatic but seems important and would need further verification on a larger scale.

4. Discussion

The findings of this study suggest that students can retain L2 vocabulary better in conditions where they have access to printed vocabulary and if they can make notes, highlight, or write their translation in their native language. This finding corroborates with further research on this topic (e.g., [10,16,17,29]. For example, Baron, Calixte, and Havewala [29] (2017) in their study of 429 university students from the US, Japan, Germany, Slovakia, and India, stated that students preferred printed text to digital text. The main reasons involved the ease of annotation and the paper's tactile properties, while among the

drawbacks there was a lack of convenience and expenditure of environmental or monetary resources. In addition, they said they had been able to concentrate more when reading the print text. Similarly, even a larger study conducted by Mizrachi et al. [23] across 30 countries worldwide confirms that students prefer reading print text since the print format is better for the granular recollection of information and in-depth understanding. However, this does not mean that digital texts should not be used, but that teachers should incorporate them in L2 vocabulary acquisition, thinking of such strategies in a way that could enhance vocabulary learning in a meaningful way. It could also be interesting to think of strategies that would engage learners in the content itself without getting them distracted by the multimodal effects of digital media [30].

The results of this study also show that students' knowledge of the newly acquired vocabulary decreases with time, be it learned online or traditionally. Therefore, repetition and multiple exposures to vocabulary items are important. However, it must be emphasized that these vocabulary items must be learned in the context to make such learning meaningful. Furthermore, teachers should also react to students' individual learning needs and styles to detect what way of learning new words might suit their students best. As the aim of the research was not to look for a mechanism responsible for memory retention in relation to the media provided, it would be extremely useful to investigate these mechanisms also because of various practical implications they could have, e.g., when compiling textbooks for foreign language learning. These days FLL textbooks contain a lot of various internet links that might be proved less efficient in vocabulary acquisition in comparison with the old-fashioned note-taking strategies.

One hypothesis for the results found in the study is that the method utilized in this study enhanced the student's memorization of phrasal words by offering the opportunity for them to use the context in the memorization. The use of context hints is well known for the memorization of target words and can highly improve students' ability to acquire new vocabulary [31–33] (Kaivanpanah, Akbarian, & Salimi, 2021; Saricoban, & Basibek, 2012; Rodriguez & Sadowki, 2000). To highlight directly on paper and take notes immediately, adding clues that can relate the words to other stimuli, could have the effect of enhancing students' memorization, and therefore their recall later. Umejima, Ibaraki, Yamazaki, and Sakai [34] investigated memory retrieval by comparing three groups of Japanese students who had to write down scheduled appointments on a calendar using a paper notebook (note), an electronic tablet (tablet), or a smartphone (phone). After the retention period for an hour which included an interference task, they tested recognition memory of those appointments with visually presented questions in a retrieval task and scanned with functional magnetic resonance imaging. The authors found that the verbalized memory retrieval processes for the note group were much higher and the accuracy for answering questions about the appointments suggested that the use of a paper notebook promoted the acquisition of rich encoding information and spatial information from real paper and that this information could be utilized as effective retrieval clues.

There are many practical recommendations that could arise from this experimental study, such as finding the balance between digital textbooks and print ones or prioritizing the former ones as they could provide better results in L2 vocabulary retention. Generally, this research also aims at reconsidering the implementation of various digital tools and platforms, including mobile apps, into foreign language learning, or any other kind of learning. Moreover, it is also important to consider various generational discrepancies when utilizing these tools, such as the technologically savvy Gen X versus the older generation of learners. However, more research is necessary to verify the results on a much larger scale and with diverse groups of students.

The fact that digital tools are generally recommended and virtually used all over the world for L2 acquisition merely intuitively and without any systematic research verification seems inappropriate and not sufficient as this use has a major impact on the way L2 is acquired. These findings are trying to shed more light on the topic and bring much more attention from scholars to the topic, one that needs our undivided attention.

This research has, of course, some limitations. As the group of respondents was sufficient to create a statistically representative sample, it would still be necessary to verify the findings on a larger scale or even geographically on a more global scale and including various age groups as it is possible that iGen results will be different from Gen Z and those from Gen Y. The age parameter was not taken into account in this research but could present a very important aspect that needs further verification as it is generally accepted that the younger generation of computer users' memory and the way they process digitally presented information are very much different from the previous generations. Moreover, the experiments could be conducted with different sets of vocabulary or even collocations as this experiment dealt with relatively specific vocabulary only. In addition, a much longer retention span timewise should be tested to obtain more accurate results.

5. Conclusions

It is clear that this pilot study with a rather small research sample is just a basic introduction to the topic of digital media vs. print text in relation to L2 acquisition and it could be an impetus for further studies that could verify these preliminary findings on a much larger scale. Moreover, looking for mechanisms that could be related to the discrepancy we identified could be also important for the development of psycholinguistics and applied linguistics.

These findings could be important, not only from the psycholinguistic perspective and learning psychology and theory, but they could also provide very clear implications for practical aspects of FLL from the beginning of L2 acquisition, through high school and university to a much later age, even to L2 acquisition in seniors. As the modern aspects of digital technology are omnipresent, there is still not a sufficient analysis of them from this perspective, and their massive implementation everywhere and to everyone needs a very serious and systematic justification before it is done so.

These findings could thus be an impetus for further development of this area and could bring more relevant research that could be later implemented into the practice of FLL and teaching. Nowadays, the trend in education is very much to be in favor of digital learning in its various forms and aspects; on the other hand, however, it has not been verified sufficiently how much this trend can contribute to better FLL and practice.

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