SECOND LANGUAGE LEARNING WITH TECHNOLOGY: TESTING PREDICTIONS OF 1990S WITH META-ANALYTICAL DATA

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Abstract - This paper describes testing a hypothesis about the most critical precursors for successful second language learning with computers from mid 1990s using a large set of meta-analytical data and finds evidence in its support. Specifically, combinations of at least two instructional qualities from the array of 'student-student interaction', 'student-content interaction' and 'cognitive support for learning' produced the weighted average effect size of $g^+ = 0.49$, significantly different from instructional conditions that lacked such qualities.

Index Terms - Computer-Assisted Second Language Learning, Meta-Analysis, Communication, Automaticity, Lexical Skills. A tribute to Elizabeth Gatbonton (1941 – 2017)…

I. INTRODUCTION

In the mid nineties, when personal computers were just entering the field of education and 'smart' technologies were still the mark of the future insights and developments, Norman Segalowitz and Elizabeth Gatbonton published a paper, entitled 'Automaticity and Lexical Skills in Second Language Fluency: implications for Computer Assisted Language Learning' (1995) in which they try to understand and help realize their readership what kind of educational use of computers would be the most beneficial for students who are learning second language. Being dedicated scholars in cognitive psychology and language arts teaching, respectively, they combined their respective expertise in an attempt to outline the most promising instructional practices with the computers that would serve as key factors in successful second language learning.

Specifically, they claimed that there are three major qualities of the developing field of computer-assisted language learning that, if provided with the adequate attention and efforts from cognitive psychologists, software developers, instructional designers and language art teachers, would reveal their true potential for dramatically improving quality and outcomes of the second language learning. Segalowits & Gatbonton [1] named: (1) Genuine communication in environments approaching authentic ones; (2) Conditions facilitating skills transfer; and (3) Opportunities for the vast practice to promote automaticity of lexical skills. In the concluding remarks of the paper they wrote: "For a computer program to enhance lexical skill development it must promote student/computer dialogue within a carefully constructed framework. The framework should be one that respects certain psychological criteria for the student's communication to be genuine, provides conditions for promoting transfer appropriate learning, and has built into it the kind of inherent repetition that automatizes lexical skills …" (p. 146). More than two decades later, it's probably the time to see to what extent and in what principle components the expectations of 1990s were met in educational practices. Though a large body of research literature lately appeared to provide an overview of new developments, successful practices and noteworthy challenges in the field of Computer Assisted Language Learning, (e.g., [2], [3], among many others), none would provide the opportunity to address it more closely than a relevant meta-analysis.

II. RESEARCH OBJECTIVES

The current paper offers a brief overview of the selected findings of a large-scale meta-analysis of effectiveness of technology integration in postsecondary education [4], reanalyzed to test the set of hypotheses stated by Segalowitz and Gatbonton (1995). We asked the following research questions:

1) How effective computer-based second language instructional practices are in comparison with teaching second language without (or with lighter use of) technology?
2) Does the level of 'student-student' interactions matter in facilitating successful second language learning and to what extent?
3) Do educational technology designed and used for 'cognitive support' help to achieve better outcomes in second language learning and to what extent?
4) Is the degree of 'student-content' interaction instrumental in successful second language learning and to what extent?
5) What is the combined effect of educational technology characterized as high in 'cognitive support', 'student-student' and 'student-content' interactions qualities on learning outcomes of second language learners?

III. METHOD

Schmid et al. (2014)

The vast collection of studies in Schmid et al. (2014) served the data source for our review. That large-scale meta-analysis addressed effectiveness of technology integration in postsecondary education and counted in total 879 achievement effect sizes derived from 674 individual primary research studies that encompassed over 58,500 students. Its major research question reflected effectiveness of the experimental instructional conditions that largely relied on computer-based educational technology in comparison with technology-free (or lighter in technology use) 'control' instructional conditions. Educational technology was broadly defined according to the framework suggested by [5] to include the whole "…variety of modalities, tools, and strategies for learning…" (p. 19). Search strategies, inclusion criteria, data collection, review procedures, statistical analyses, and complete study findings are presented in detail in the report published in Computers and Education [4]. Here it would suffice to mention the main methodological characteristics of that meta-analysis of origins for the current study.

(1) The research included in the meta-analysis covered period from 1990 to 2010 and represented published and so-called "grey literature" sources alike.
(2) Only randomized true experiments and high-quality quasi-experiments were admitted.
(3) Sufficient description of study detail (primarily instruction-related) was provided in the reviewed reports to enable coding of methodological, substantive and demographic study characteristics.
(4) Reported statistical data allowed for the confident effect size extraction to assess comparative effectiveness of technology more saturated instructional conditions in terms of student achievement outcomes.
(5) Overall, the reliability of coding major study characteristics was reliable with Cohen's kappa ranging from 0.74 (for the abstract screening) to 0.84 (for coding study features).

A d-type standardized mean difference effect size (Cohen's d), was used as the common metric that then was transformed into Hedges' g [6] to provide correction for small sample sizes. The random effects model [7] was the main analytical approach for data aggregation, followed by the mixed effects model moderator variable analyses. was used to test the difference in levels of moderator variables. All analyses, including sensitivity and publication bias analysis, were performed in Comprehensive Meta-Analysis™ 2.2.048 (Borenstein, Hedges, Higgins, & Rothstein, 2008).

Current study

Out of the entire collection of studies in Schmid et al., (2014), only those that reported technology-supported instructional strategies for second language learning and their achievement outcomes were selected to inform research questions of the current review. Individual effect sizes were weighted and aggregated according to the principles of the random effects analytical model.

The results of the original coding for their respective study features were used in subsequent moderator variable analyses (mixed model).

Though there is no equivalence between concepts outlined by Segalowitz and Gatbanton and moderator variables coded for instructional practices summarized in Schmid et al., the latter may serve as the first-level crude approximation of the former. These tentative connections could be depicted as follows.

- Technology-reliant instructional interventions that enabled and promoted interactions among student throughout their learning experiences were coded in the meta-analysis as higher in 'student-student' interactions and communications. They are not to be necessarily perceived as the principle of genuine dialogue between learners of second language in authentic situations. However, with no doubt they are higher in such potential than their control counterparts judged to be lower in that quality (or lacking it at all).
- Technological tools and applications for learning whose major functionality was coded in the meta-analysis as 'cognitive support' may or may not qualify as the means for proper skill transfer, as described by Segalowitz and Gtbanton, but they are instrumental in students better understanding what really matters for both conceptual knowledge gained through educational process and its practical application outside of the classroom. As such, we consider educational technology use for cognitive support for learning some reasonable approximation of the methods for effective skill transfer.
- Finally, the degree of learners' interactions with the content of the instruction, though may not always provide sufficient for automatizing lexical skills amount of practice, but it reflects the overall rate of accessing learning materials.

So coded three moderator variables were analyzed in an attempt to explore variability that surrounded the overall weighted average effect size of technology more saturated instructional conditions in comparison with technology-free or technology-lean instruction for second language learning.

IV. RESULTS

Schmid et al. (2104) reported the overall effect of technology on achievements at $g^+ = 0.27$, low (in terms of Cohen's classification of effects in social sciences), but statistically significant. When studies in all other subject matters were removed, the collection of second language studies counted 71 independent effect sizes, ranging in magnitude from –0.74 to 2.42 with the overall weighted average of $g^+ = 0.44$ (the random effects model). Table 1 provides summary statistics for the effect of educational technology on achievements in second language classrooms.

Table 1
Overall average weighted effect size (random effects model) for technology in second language learning and heterogeneity statistics (fixed effect model)

Population Estimates	k	g+	SE	Lower 95th	Upper 95th
Random Effects Model	71	0.443**	0.06	0.32	0.53
Fixed Effect Model	71	0.372**	0.03	0.31	0.43
** p< .01					
Heterogeneity Analysis	$Q_T = 292.28$ (df = 70), $p < .001$, $I^2 = 76.05$				

Table 2
Results of the Moderator Variable Analyses (mixed effect)

Levels of Moderator Variables	Number of Effects (k)	Category Average ES (g+)	Lower 95th CI	Upper 95th CI	$Q_{Between}$
Two or three factors are higher in the experimental Condition	49	0.487	0.33	0.64	
Two or three factors are equal or higher in the control condition	14	0.140	-0.15	0.43	
Between Groups: df = 1					4.33, p = .037

None of the coded moderator variables of interest alone showed significant difference between their levels (higher vs. lower) in achievement outcomes, neither the analyses detected any significant difference in effect sizes between studies published before an after 2000. However, when 'student-student' and 'student-content' interactions and 'cognitive support' factors were combined in various proportions, we observed that the presence of at least two of these factors in the same study led to increase in achievement outcomes (Table 2).

DISCUSSION

Authentic student communication, transfer appropriate learning and inherent repetitions for automaticity development were named by Segalowitz and Gatbonton (1995) as preconditions for successful computer-assisted second language learning with computer. We tested that prediction in a follow-up meta-analysis of effectiveness of technology integration (Shmid et al., 2014), on a sub-collection of second language studies coded for presence and salience of instructional qualities analogous to those hypothesized by Segalowitz and Gatbonton. The overall effect of computer use for second [language instruction was 0.44 (noticeably higher then for the entire collection across subject matters), indicating that the treatment works. However, no difference was detected between studies of 1990s and 2000s, despite some rather dramatic advancement in computer-based educational technologies (including 'smart' mobile devices and application) between these two time periods. In other words, technological progress is not necessarily matched by the ability of educators to make full use of the benefits of multi-functionality it brings. With respect to the study main objective of putting in test the forecast of 1990s, neither of the three qualities of computer-assisted second language instruction, addressed in the moderator variable analyses, came out to be significant. However, when at least two of them characterized experimental instructional intervention in the same study at the levels higher than in the corresponding control instructional condition, the difference in effect sizes was significant – student learning outcomes did improve. Thus, the original hypothesis received both indirect – neither factor alone made a difference in student achievements – and direct – their specific combinations did improve learning – empirical confirmation. The claim grounded in these patterns of results cannot be unequivocal, since coded and analyzed study features did not necessarily reflect the exactly same qualities of computer-based instruction depicted in Segalowitz & Gatbonton (1995). However, these characteristics are still of undeniable interest for educational research and practice, even after two decades. The applied value of the three

precursors of successful second language learning with computers should be further empirically studied with the refined operational definitions carefully designed experiments, while teachers may want to experiment on their own by implementing practices that would include combinations of two or all three of the tested components to benefit students' learning.

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