Learning Effectiveness and Contribution of an Instructor in Learning with Technological Methods

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יעילות הלמידה ותרומתו של המדריך בלמידה בשיטות טכנולוגיות

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Abstract

This study addresses the effectiveness of learning via educational software. The study focuses on instruction provided as part of the training of technicians and examines the effectiveness of instruction provided via educational software in terms of learning outcomes via Bloom's revised taxonomy, Te'eni's affective-cognitive model of organizational communication, and the STEM model. We divided learners randomly into three groups who studied the same topic: one group studied with the educational software only, the second with the educational software together with an instructor, and the third with an instructor who used a presentation. The learners took a test and four months later they took another test to examine the effectiveness of the instruction over time. The research results show that recall levels and performance levels on the tests were almost identical in all groups, but in the categories of understanding and applying the study material the addition of an instructor strongly contributed to achievements: Those who received instruction via educational software achieved the best results in the category of understanding, while those who studied with an instructor who used a presentation achieved the best results with regard to application of the material studied. The findings of this study can highlight the effectiveness of using educational software in learning processes in all educational systems.

Keywords: Learning products, educational software, technological training, instructor.

Literary review

In recent decades, gradually more technologies are emerging, which the effect of changing the manner of teaching in class and transforming teachers into mediators (Nachmias & Mioduser, 2001; Waldman, 2007). Digital teaching tools are gradually being integrated as major work tools in the various educational systems and are being utilized in schools, colleges, and universities, as well as in military instruction (Nachmias & Mioduser, 2001). The online learning environment has unique aspects and emphases that relate to students' pedagogical and personal conduct. This learning is important particularly for generation Z, born beginning from 2000 directly into technological progress, as a major part of their lives is conducted on social networks (such as Twitter, Instagram, WhatsApp, and Snapchat). Hence, using an online environment is completely natural for this generation that is almost unfamiliar with any reality that does not include technologically generated conduct. Therefore, it is only to be expected that learning activities as well take place in learners' natural environment, i.e., in an online environment (Rotem & Peled, 2008).

The Covid-19 crisis has deeply affected learning institutions around the globe and has shaken things up to a considerable degree. The pandemic forced elementary schools, high schools, and higher learning institutions to shut down temporarily. Various schools, colleges, and universities halted all in-person instruction (Ben-Amram & Davidovitch, 2021). Educational institutions struggled to cope with the challenging situation and these circumstances made them realize that it is necessary to plan for extreme scenarios, such as not being able to teach in person due to security concerns or a global pandemic. There was need for an urgent response throughout all educational systems, including academic institutions. Therefore, in addition to claims in favor of online learning, such as accessibility at any time and anywhere and flexibility when performing the instruction (Davidovitch & Eckhaus, 2020) another claim was that online learning is used as an essential response in times of crisis such war or global pandemic. The combination of face-to-face encounters and lectures using technological tools may generate a combined interactive form of learning and enhance students' learning potential.

Methodology

The purpose of the study was to examine the effectiveness of technology-enhanced instruction versus face-to-face instruction in the short range (immediately after the instruction) and in the medium range (up to four months). A timeframe of four months was set since the Air Force schedules instruction programs on the same topic at four-month intervals. Effectiveness was determined by tests that examined the first three cognitive dimensions of Bloom's revised taxonomy and based on questionnaires examining the effectiveness of instruction and the motivation of trainees according to the STEM model (Davidovich & Shiler, 2016) and the affective-cognitive model of organizational communication (Te'eni, 2001). The uniqueness of the study compared to other studies is that the effectiveness of the training was tested both over time and at several different levels of knowledge.

The research participants were 84 Air Force technicians aged 19-22 in all genders serve for about a year in the Air Force as F16 aircraft technicians, in order to strengthen the internal validity, the technicians were randomly distributed among the different groups. Our main goal was to compare the effectiveness of different learning conditions, we designed an experiment in which we were able to detect causal relationships. We applied a between-subjects (or between-groups) research design: different participants were tested in each condition, such that each participant was only exposed to a single learning mode. In other words, our independent variable was the learning condition, which we directly manipulated. The dependent variables that were expected to vary as a result of the manipulation of the independent variable were various measures of learning effectiveness.

Experimental manipulation: We divided the participants randomly into three groups of 28 technician each. Each group of technicians learned the topic of safety in F16 aircraft in one of three methods:

- Educational software – unguided learning in the computer room.
- Educational software together with guided learning (face-to-face, by an instructor).
- Face-to-face guided learning (by an instructor, with the assistance of a presentation).

The experimental manipulation related to the learning method only. The same educational software on safety measures in the F16 plane was used by groups 1-2, and the same instructor guided groups 2-3. The experiment was held for the three groups simultaneously in order to prevent information leaks between the groups. The instruction was carried out at the technicians' military base by a regular instructor at the base in the existing classrooms with which the technicians were familiar. This enhanced the internal validity, as we reduced the chance that any unfamiliar external variable in the respondents' environment could disrupt the experimental process.

Dependent variables: Learning effectiveness was measured identically in the three groups by tests and questionnaires that examined the first three stages of Bloom's revised taxonomy, based on questionnaires that examined the effectiveness of the instruction and the motivation of the trainees by the STEM model (Davidovich & Shiler, 2016) and by the ability to apply communication strategies described in the affective-cognitive model of organizational communication (Te'eni, 2001).

We tested the differences between the groups via a Mann-Whitney U-test, a non-parametric method appropriate for the perceptions variables that we measured by Likert scales which are ordinal-level (Jamieson, 2004; Kuzon et al., 1996) and for relatively small sample sizes (Norman, 2010). In addition to testing the reliability of the questionnaires was performed by Cronbach's alpha test after no reverse questions were found, the Friedman test was proposed to test the differences between the test results and those tested at different times (paired variables).

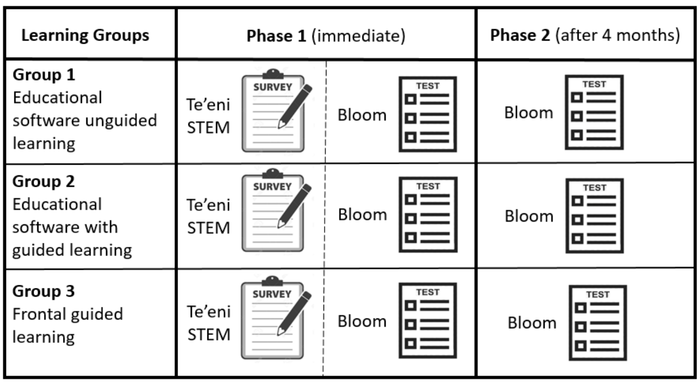

Figure 1. Experimental design

Findings

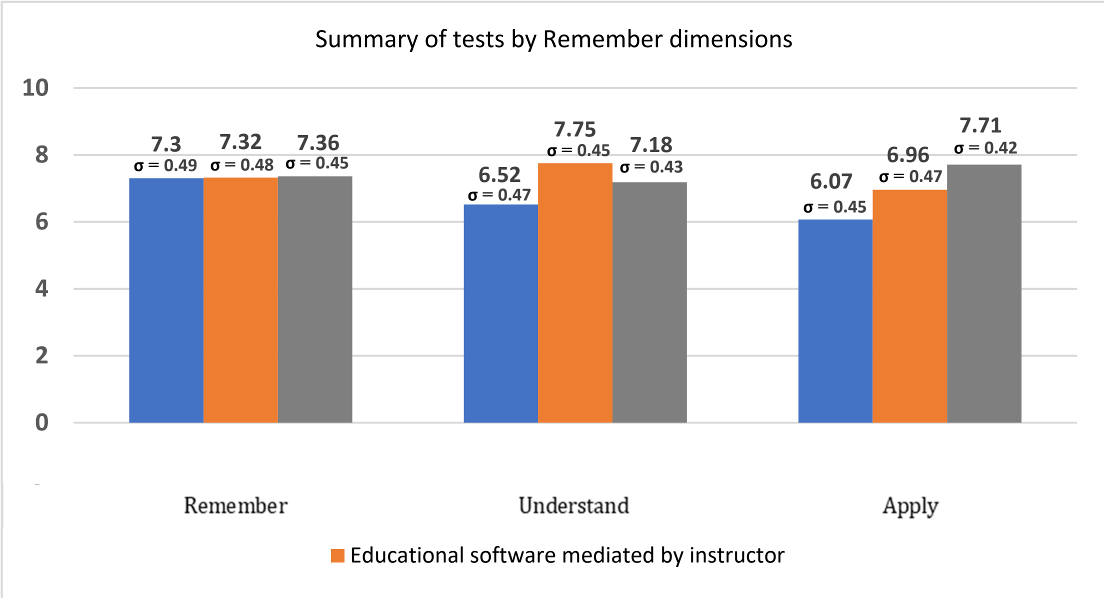

Figure 2. Summary of test results by the dimensions in Bloom's revised taxonomy

It is evident from Figure 2 that the scores on the test questions concerning the "remember" dimension are almost identical in the three methods. Concerning the "understand" dimension there is a clear advantage for including an instructor with the educational software. In contrast, in the "apply" dimension there seems to be an advantage to frontal learning with an instructor who uses a presentation.

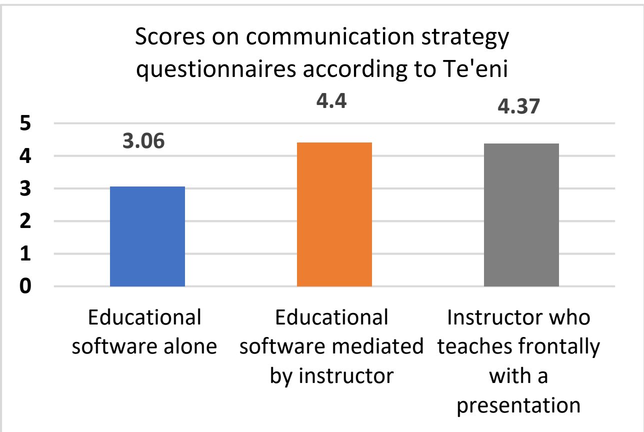

Figure 3. Scores on the questionnaire that examined the ability to use

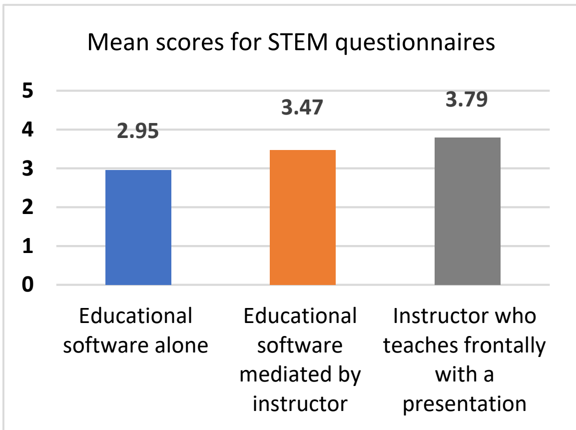

Figure 4. Means of questionnaire scores according to the STEM model

According to Te'eni's affective-cognitive model of organizational communication and the STEM model, it is evident from Figures 4 and 5 that the ability to use efficient and beneficial strategies is low when using educational software alone, and that the overall score when an instructor is present, whether mediating when studying with educational software or teaching frontally with a presentation, is significantly different than when studying with educational software alone.

It is evident from Figure 5 according to the STEM model that the highest scores were in the group taught by an instructor with a presentation.

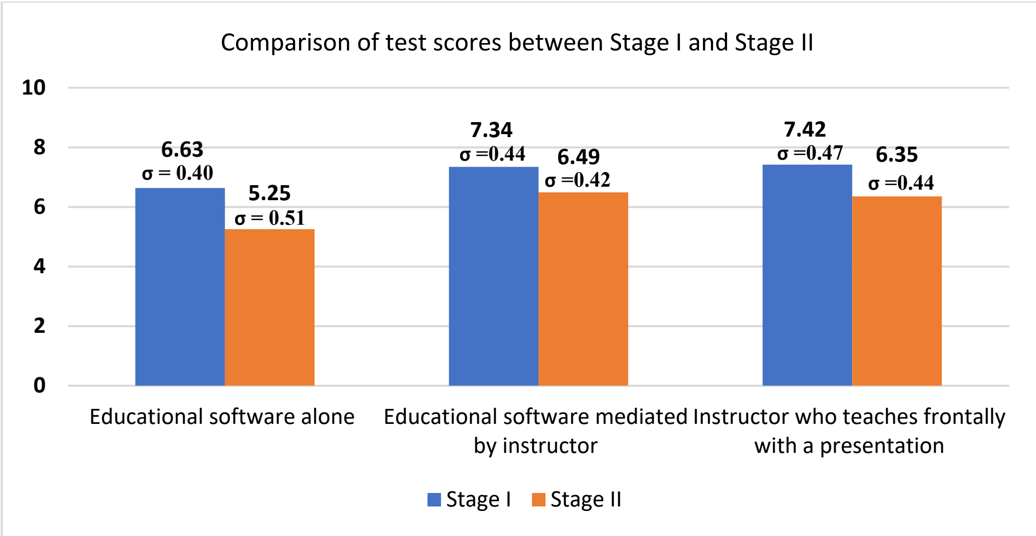

Figure 5. Comparison between the general test scores in Stage I vs. Stage II

The purpose of Stage II was to examine the decline in test results for each type of instruction over time and to assess the effectiveness of the instruction not only in the short term but rather also in the medium term after four months.

As expected, in all tests a decline was evident in the results after four months. The decline in the general level was highest when only educational software had been used. The second highest decline was in the group who had studied with an instructor teaching frontally with a presentation, and the lowest was for the combination of an instructor who mediated educational software. When examining the decline by the dimensions in Bloom's revised model for the dimensions of "remember" and "understand", the greatest decline was when only educational software was used.

Conclusions and Recommendations

The current study explored the effectiveness of technology-enhanced learning in the short and medium term by using several tools: Bloom's taxonomy, the STEM model (Davidovich & Shiler, 2016), and the affective-cognitive model of organizational communication (Te'eni, 2001). The study found that educational software is an inferior method when used as a single learning tool. The inclusion of a human instructor who mediates the educational software to the students is very valuable for most parameters measured. In addition, face-to-face learning with an instructor who uses a presentation was found to have many advantages. The instructor can contribute significantly to instruction with educational software both on the level of learning achievements as evident from the test results and with regard to the subjective sense of the learning experience and the different perceptions of learning as evident from the questionnaire results. Therefore, organizations must adapt the instruction to their specific goals. When it is necessary to teach retrieval of knowledge from long term memory, the software as a tool is not only beneficial but rather also efficient and economical, but when the instruction is more complex and there is need to arouse motivation and to allow participation by the trainees and a connection to the instruction goal, an instructor should be included in the learning process. Educational software is a static tool with a low capacity for topical development, and in a dynamic and changing world it is necessary to update the software frequently or to consider other tools such as utilizing a skills classroom. In this classroom the software is not a standalone tool; after learning with the software trainees apply what they have learned in practice in a sterile classroom with the necessary physical means and accompanied by an instructor. In this way, theoretical instruction (the educational software) is combined with practical instruction (the skills classroom).

A possible explanation of the data is that the instructor's mediation enables deeper comprehension of the material and the addition of further layers that aim beyond remembering the data (which cannot be mediated). According to the Media Naturalness Theory, a higher level of naturalness is facilitated in frontal (face-to-face) instruction, and since such instruction requires of learners less cognitive effort the quality of the learning is better (Weiser et al., 2016). In addition, according to the Media Richness Theory, richer media suits complex and ambiguous messages on the understand and apply dimensions and therefore it is not possible to make do with educational software alone in order to establish knowledge on these dimensions rather the learning should be enhance via face-to-face communication with an instructor (Daft & Lengel, 1984). In addition, the presence of an instructor enables two-way communication that is characterized by a higher level of trainee participation. This is because the instructor creates involvement and interest by asking questions. This communication, which in many cases predicts trainees' success, enables better comprehension of the material studied (Weiser et al., 2016).

The inclusion of a instructor who mediates the educational software to students is highly valued. Most criteria through which a instructor's mediation is measured have a major contribution to training through educational software, even on the level of learning achievements, as evident from the test results in Bloom's taxonomy and even in the subjective sense of the learning experience and the different perspectives of learning reflected in the results of the questionnaires. Our conclusion is that the academic institutions should utilize teaching methods tailored to the specific learning objectives of the training. When the training wishes only to convey information, educational software is an effective and cost-saving tool. Yet, when the training requires a high level of understanding, training becomes more complex, and motivation must be stimulated, facilitating trainees' participation as well as forming a connection with the training objectives, it is important to integrate a instructor in the learning process. We highly recommend examining the educational software every few months in order to ensure that it is still relevant to the training material. Otherwise, it should be updated.

The study stresses the added value of a human instructor within technology- enhanced instruction. The practical implications of the study for decision makers in organizations are to adapt instruction for relevant populations and occupations based on the instruction's goals with regard to different cognitive levels. Organizations must invest resources in training programs for instructors, so the latter will be able to accompany learners effectively. Organizations and instructors need to understand the importance of instructors' availability to answer questions and guide, while learners are using educational software. Training programs for these instructors should include an emphasis on the use of communication strategies such as contextualization.

In addition, the study raises the question of the effectiveness of static educational software, which is the most common at present, and poses considerable questions concerning its relevance. For educational software to be beneficial for learning processes and perceived positively by their users, they must be evolving, dynamic, updated, and adapted to the learners. It is time that those assimilating educational software demand that developers apply elements of smart technology in order to generate individual adaptation to learners with regard to their needs, abilities, study pace, and so on. The time has definitely come to transition to smart educational software.

In the current study we focused only on the first three dimensions of Bloom's revised taxonomy – remember, understand, and apply. It would be very interesting to replicate our study in order to examine the effects of different learning conditions on the next three and highest dimensions of Bloom's taxonomy. Such studies would provide important insights on the effect of learning conditions on learners' ability to analyze, evaluate, and create. Analyzing and evaluating are information-based thinking skills, and creativity is a problem-solving skill. Instructional design principles for the 21st century need to put emphasize on these high-level thinking skills (Sahin, 2009).

This case study of learning through educational software when training technicians was conducted on a high-standard group. We recommend conducting future studies on the impact of educational software in other groups in order to understand its effectiveness, especially due to the increasing use of technology for learning following the Covid-19 pandemic.

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