

**BAR-ILAN UNIVERSITY**

**The Effectiveness and Cost Effectiveness of Integrating ICT  
in Science Classes at the Fifth Grade in Arabic-Speaking  
Schools in Israel**

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## **Abstract**

In recent decades there has been a transition from an industrial society to a knowledge society. The driving forces of society and the economy have changed from natural resources and industrial capacity to knowledge resources. Against this background, both the goals of the education system and the ways to achieve these goals have changed. In particular, teaching is shifting from a traditional approach of imparting knowledge and practice to an innovative approach of fostering understanding and thinking in an online environment in order to give students the skills appropriate for the 21st century. In accordance with the change in the perception of education, many countries around the world use information technology in teaching both as a tool for improving student achievement and as an end in itself - to make students digitally literate. Indeed, many countries around the world are investing heavily in information and communication technology (ICT) programs in schools. Israel has also joined this trend and invests considerable resources in integrating ICT into teaching. However, there are few studies examining the effectiveness of ICT programs in relation to their cost. In various countries, findings regarding the cost-effectiveness of ICT programs have been mixed, and in Israel, the research on calculating the cost-effectiveness ratio of the ICT program at the elementary school level is still emergent.

The current study analyzes the effectiveness of an ICT program implemented in fifth-grade science classes in Arab sector schools in terms of motivation, cooperation, self-efficacy and achievement. In addition, this study analyzes the cost-effectiveness ratio of the ICT program. A cost-effectiveness study is one that examines the ratio between the cost of a particular educational program and its effectiveness according to predefined indices, so that it can be compared to other programs to the extent that each shekel of investment affects the predefined indices.

The first research question is: How effective is the ICT program implemented in certain fifth grade science classes in the Arab sector in terms of motivation, cooperation, self-efficacy and achievement? This question can be subdivided as follows: (1) To what extent, if any, will there be differences between the level of motivation of fifth-grade students in the ICT program and those in a non-online program in a school in the Arab sector? (2) To what extent, if any, will there be differences between the level of cooperation of students in the ICT program and those

in a non-online program in a school in the Arab sector? (3) To what extent, if any, will there be differences between the level of self-efficacy of students in the ICT program and their peers studying in a non-online program in a school in the Arab sector? (4) To what extent, if any, will there be differences between the degree of improved achievements of students in the ICT program and their peers in a regular fifth-grade program in a school in the Arab sector? The second research question is: What is the cost-effectiveness ratio of learning in the ICT program compared to the traditional program for fifth-grade students in the Arab sector in Israel? This question can be posed operationally: (1) To what extent, if any, will the cost-effectiveness ratio of integrating the ICT program in the fifth grade in the Arab sector be optimal compared to a traditional science program?

The research hypotheses are as follows: (1) The level of motivation of the students in the ICT program will be higher than for their peers in the non-online program. (2) The level of self-efficacy of the students in the ICT program will be higher than for their peers in the non-online program. (3) The level of improvement in achievement among the students in the ICT program will be higher than for their peers in the non-online program. (4) The level of cooperation among the students in the ICT program will be higher than for their peers in the non-online program. (5) The cost-effectiveness ratio of implementing the ICT program in the fifth grade in the Arab sector will be optimal compared to the traditional program in the sciences.

The research method was quasi-experimental: measurement before and after the implementation of the ICT program, in both the experiment (ICT) group and a control group in which the ICT program was not implemented. Allocation to the experimental and control groups was not coincidental because it was the schools that chose which program to participate in, and it was not possible (ethically or organizationally) to force upon a school which program to choose for this research. In the study, the pre- and post-level measurements between the experiment and control groups were compared using the Differences in Differences method. Cost-effectiveness was calculated using the CBCSE Cost Tool Kit for educational programs.

Research Tools: For this study, both quantitative and qualitative data were collected. The quantitative tools were a motivation questionnaire, a self-efficacy questionnaire, a science achievement test, and a cost-effectiveness analysis model. The motivation

questionnaire was the PAGO (Achievement Goal Orientations). The self-efficacy questionnaire was developed by Chen & Gully (1997) and translated into Hebrew by Grant-Flomin (1998) and then into Arabic. A structured achievement test was developed specifically for this study. The qualitative tool was a structured observation using a checklist to examine the cooperation among the students.

The sample included 145 fifth graders sampled from two primary schools in the central region studying in the Arab school system in Israel. The experiment group consists of 88 students, with the remaining 57 students in the control group.

Regarding Hypothesis 1, no significant difference was found between the experiment and control groups in the change in level of motivation ( $R = 0.029$ ,  $R^2 = 0.001$ , Table 3) and thus the hypothesis was not confirmed.

Regarding Hypothesis 2, no significant difference was found between the experiment and control groups in the change in level of self-efficacy ( $R^2 = 0.014$ ,  $R = 0.119$ , see Table 5), and thus the hypothesis was not confirmed.

Regarding Hypothesis 3, the level of achievement among the students in the experiment group rose by ten points on average, whereas in the control group the grades rose on average by only one point ( $R^2 = 0.084$ ,  $R = 0.290$ , see Table 7).

Regarding Hypothesis 4, the level of cooperation among students in the experiment group was found to be higher than among the student in the control group.

Regarding Hypothesis 5, analysis of the cost-effectiveness model calculations was based on the six components (INGREDIENTS METHOD) and revealed that an investment of NIS 441.47 per student per year yielded a relative increase of 9.35 points on average. In other words, an investment of NIS 47.22 per computer per student per year is expected to result in an increase of one point on average in grades, relative to an increase in the grade without the program.

These findings point to the effectiveness of ICT in improving students' achievements in science and in their level of cooperation, but not in their motivation or sense of self-efficacy. The calculation of cost-effectiveness enables us to evaluate the effectiveness of the ICT program in science in relation to other programs whose cost is known, in terms of an improvement in the score for each shekel invested in the program.

This study has theoretical contributions and practical contributions. The research findings on the partial effectiveness of the ICT program contribute to the theoretical understanding of the impact of ICT in teaching. The study shows that the ICT program is very effective in improving collaborative learning and improving achievements, but less effective in students' motivation and self-efficacy. The study emphasizes that the effectiveness of the ICT program is not self-evident and depends very much on the program itself and how it is implemented by the teachers. The study also emphasizes the importance of receiving personal feedback from the teacher, in addition to the feedback received from the student, in developing students' self-efficacy.

In addition, the study contributed to the development of indicators for calculating the cost effectiveness of the ICT program by implementing a combination of two different tools: the six components of Levin and McEwan (Levin, McEwan, Belfid, Bowden & Shand, 2018) Cost, and the CBCSE Cost Tool Kit for cost-effectiveness calculation. In doing so, the study showed that the combination of these tools is effective and appropriate for cost-effectiveness assessment of educational programs.

The practical importance of the research is that it helps policymakers make optimal decisions, especially given the fact that in the education system, which has a limited budget, programs compete for funding. Due to this competition over budgets, it is no longer possible to relate to the effectiveness of the program alone. Rather, it is necessary to examine the effectiveness of the ICT program in relation to the overall costs of the program in a way that will enable comparison with other programs. The study helped calculate the cost-effectiveness of the ICT program as an accurate amount of investment per point of improvement on average student achievement (NIS 47.22), helping policymakers evaluate this program in relation to other programs designed to improve students' achievements.

The study also has implications for Israeli policy because it helps assess the effectiveness of the ICT program in relation to its cost, and thus enables us to examine whether the plan is justified from a budgetary point of view and in what aspects. At the international level, the research contributes by extending the implementation of the cost-effectiveness model (Cohen & Nachmias, 2009) to the field of basic

education, and thus constitutes one of the first studies in education that also relates to the cost dimension when assessing the effectiveness of educational programs.

The study contributes to education in the Arab sector, where the cost component is of paramount importance in view of the limited budgetary allocations made to the Arab education system in Israel (Abu-Asbah, 2007).