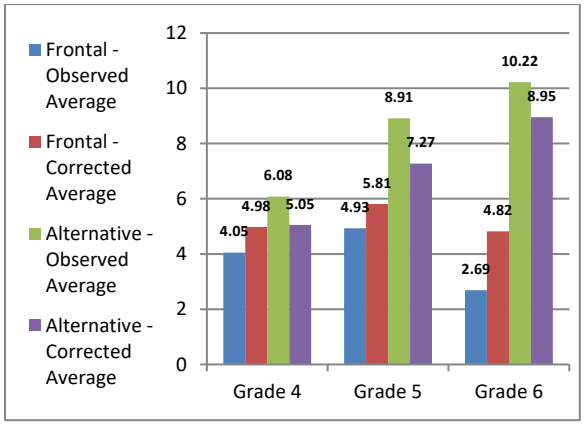

Figure 1. Average progress according to method and grade

By contrast, in the alternative classes, not one of the 5% who began weak remained so by the end of the year. Similarly, 35.2% of the average students progressed to strong, and the 49.3% of students who began as strong maintained their strong standing

Analysis of the distribution within the groups showed that with the alternative method, most of the students who began the year as average progressed to strong (76.9%), while in the frontal method most average students remained average (53.7%). Note that strong students at the beginning of the year maintained their strong standing, regardless of the method of teaching.

The most striking finding is that most of the students in the frontal method remained in their original level, while most students in the alternative method progressed to a higher level. This corroborates the third hypothesis.

Two-year follow-up. MoE test scores showed that two years later, the students in the alternative method retained their lead over those from the frontal method. The average scores of the three classes of 6th graders who had undergone frontal instruction (they had been in 4th grade during the study) were 61.7, 61.8, and 62.5. This is substantially lower than the scores of those who had studied in the alternative method (68, 77.4, 84.3).

In addition, the percentage of failures in the district test was compared with the percentage of failures collated from the computer results two years earlier, for each of the teaching methods. Of the frontal-method students, 32% failed in the computer and 39% failed the district test, while only 14% of alternative students failed in the computer and 16% failed the district test. These results of the district test echo the computer results of two years earlier, even though different instruments were used.

The significant positive effect that alternative teaching has on student achievement in mathematics over the frontal method was preserved even when the number of computer classes in which the student participated during the school year served as a controlled variable. Significant differences were found between the two teaching methods regarding progress on the computer and progress in solving exercises.

Furthermore, we saw a correlation between teaching method and age: the older the students, the greater the gap in achievement on the computer. This gap was sustained for at least two years, as shown by the results of MoE district test, where the success rate of students who studied with computer-assisted learning and alternative classroom teaching methods was 84%, compared to 61% for those who did not.

Hypothesis IV. The fourth hypothesis was that a significant difference would be found in the mathematical achievements between male and female students who learn in each of the ways. The hypothesis was tested with the the number of computer lessons that the student took part in as the statistically controlled variable. The independent variables were teaching method (alternative, frontal) and gender (male, female). The results of the study is presented in Table 2, which displays the results of a co-variance analysis.

Table 2. Difference in scores of students' achievement based on teaching method and gender – progress scores, adjusted scores, standard deviation and f values.

Teaching method	Frontal		Alternative		f-values
Gender	M	F	M	F	
Progress on the computer	3.79 **(2.39)**	3.98 **(2.07)**	8.38 **(4.37)**	8.26 **(3.96)**	.05
Adjusted mean	**5.43**	**5.47**	**6.81**	**6.69**	
Progress in solving problems	-6.48 **(23.48)**	-3.89 **(16.18)**	3.80 **(19.07)**	2.45 **(14.34)**	1.50
Adjusted mean	**-2.28**	**2.79**	**2.66**	**1.32**	
Progress in solving word problems	3.42 **(3.18)**	3.16 **(3.40)**	6.86 **(4.70)**	7.81 **(4.95)**	*3.60
Adjusted mean	**5.60**	**5.15**	**4.77**	**5.73**	

Observation of Table 2 indicates that there is a clear interactive effect between teaching method and gender with respect progress in computer level or progress in solving problems. Female students who learned with the alternative method progressed in the area of solving word problems more than boys who

learned in the same method. In fact, their progress in this area was greater than in any other variable tested between the boys and girls who learned with alternative method. The fourth hypothesis was therefore confirmed, although only partially.

Within the framework of the statistical analysis, we also tested for a triple interaction (teaching method, age, gender) but found sucn an interaction to be not statistically significant.

However, we did find a correlation between teaching method and age: the higher the age of the students, the greater was the gap between achievement in computer level, with an advantage to students taught with the alternative method in their homeroom.

7. Discussion

The hypothesis that there is a connection between the teaching method used in the classes and student performance in mathematics has a solid basis [see for example, [12, 13, 14, 15], and it is fairly established that diversified teaching methods that veer from the traditional frontal method can activate and involve all students in the heterogeneous class and allow the introduction of teaching technologies tailored to the needs of students.

It should be noted that, in all cases, the number of computer classes attended by each student was taken into account. This variable was statistically controlled in the covariance analysis. Advanced comparisons showed that, on the average, students in frontal classrooms attended about half the number of computer classes than those in alternative classrooms. In any case, however, the findings show a gap in achievement favoring students who studied with the alternative teaching method, regardless of the number of computer classes in which the students participated.

The study also shows that the method affects different age groups (grades 4-6) differently, that is, the gap in achievement increases with age. It appears that students studying in the alternative method improve over the years while students studying in the frontal method weaken over the years.

The study also compared the progress of various levels of students (weak, average, strong) within each class based on the teaching method and found that a significant percentage of weak and average students who studied in the alternative teaching method advanced to a higher level within their class. In contrast, most of the frontal-method students remained at the level in which they began the academic year. In other words, weak and average students in the alternative teaching method are able to reduce the initial gap between them and their classmates, while students in the frontal method fail to close the gap and are left behind.

7.1. Reasons underlying the different results

Although the basic conditions for teaching mathematics were similar in the two schools, the achievement levels in the alternative method were higher. This raises the question: What takes place in the classroom in each method that affects achievement as observed?

One aspect is how the teachers relate to their students. Teachers who practice alternate methods relate to their students individually and match teaching method and study material to each one's unique needs and personal capabilities. Students take responsibility for their own learning and progress at their own pace and ability. Conversely, teachers using the frontal method consider the class to be a single unit. The method is suitable for the average student: however, strong students quickly lose interest while weak students are unable to follow the subject matter, do not fully participate, and fall by the wayside.

Another aspect concerns the connection between classroom teaching and learning in the computer room. Computer-assisted learning is individual learning. The alternative method suits the computer room and this affects classroom learning since difficulties that arise in the computer room can be later resolved by the teacher in the classroom and vice versa. This ensures continuity between the classroom and the computer room and increased effectiveness.

By contrast, frontal teaching is disconnected from the learning process in the computer room. Difficulties that arise during the work in the computer room are not resolved in the classroom, therefore students experiencing difficulties are unable to keep up in the classroom nor progress in the computer room; their loss is double. Teachers that use frontal teaching ignore any diversity revealed in the computer room, do not exploit the possibilities offered by the computer, and continue to teach for the average student, resulting, again, in bored high-achievers and confused weak students.

Furthermore, teachers who use alternative teaching consider computer learning to be integral, whereas frontal teachers do not attach importance to the computer's impact on the learning process and miss out on the computer's huge potential for learning.

In this context, it is worth noting that, over time, a school develops a teaching and learning culture that draws on its prevailing educational approaches and becomes integrated into its ethos [17, 18]. This can explain the differences that occur between schools despite equal conditions in the learning environment. Schools that adhere to frontal teaching methods are less likely to adopt alternate tools – guidance, training, appropriate textbooks and various teaching aids – tailored to the needs of the students.

7.2. Differences in student achievement

The processes that students are exposed to in each of the teaching methods are what underlie the disparity in achievement. In the alternative method, the student is the heart of the learning process, takes responsibility, and is actively involved. They receive appropriate assistance in the classroom in response to difficulties they encounter in the computer room and at a level consistent with their personal ability. When they return to the computer room, they are in control of the material and can progress. Students in the frontal method do not receive adequate response to the problems they encounter. The learning process from the computer room has no continuation, and in the absence of support and reinforcement, the process stops and progress is arrested.

These findings corroborate the findings of Hativa [19, 20], according to which computer-assisted learning contributes to an increase in the gap between weak and advanced students and promotes good students in disadvantaged schools. In fact, it seems that good students do not need much help from the teacher; their natural curiosity leads to progress regardless of how they learn. Weak students, however, need personalized, focused assistance from the teacher. Because they do not receive this assistance in the frontal teaching method, their progress is halted. However, in the alternative method, they receive the personalized assistance to allow them to progress according to their ability.

Word problems. While the study found gaps in student achievement (based on teaching method) with respect to the indices of computer work and solving numerical exercises, there was no difference of achievements with respect to word problems. A possible explanation lies in the structure of the computer-assisted math curriculum. The computer presents a fixed number of word problems with a defined hierarchy. Questions in a particular topic are based on a fixed text with numbers that change from question to question. Progress is contingent on correctly solving the earlier questions in the sequence. The questions are ranked sequentially from second grade to eighth grade.

During computer practice, students are introduced to ten problems. The student must correctly solve at least six questions on the first try to move to a higher level; otherwise, the computer displays questions of similar structure with different numbers. In the second round, the requirements diminish and the threshold for success is lower, but in any case, the student must obtain the required level of success for ten word problems to advance to a higher practice level. In the other areas, the computer presents between five to ten exercises only, although the student must achieve the required level of success to advance to a higher level. However, because of the different format, to advance a level in word problems, students must participate in a greater number of classes than required for the other areas. Thus, the effect of the number of computer classes in which the student participated on the progress in word problems is clear.

In this connection, one should note that the method for word problems in the computer-assisted math curriculum has not yet been finalized because of the complexity involved in ranking the difficulty of word problems, which requires, besides the mathematical sophistication of the problem, evaluation of the content regarding semantic, linguistic, logical, and other elements.

7.3. Differences in achievement in mathematics based on teaching method and gender

Within the framework of this study, the differences in achievements in mathematics between male and female students were studied as a factor of the teaching method used. It was found that in the case of solving word problems, girls who were taught using the alternative teaching method achieved higher scores than boys taught using the same method. The findings listed above are the basis for the discussion below, which focuses on the differences between male and female with respect to different teaching methods, which is one of the more interesting findings in this study. This finding is similar to that reported by Hertz-Lazarowitz, Calderon and Ivory, who found that teaching reading and writing in small learning groups positively affected mainly girl students, who did not only progress faster in the subject of Hebrew, but also in mathematics and sciences, and reached greater achievements than boys taught in the same method or that girls taught using the frontal method. It seems that in small groups, girls feel more self-confident and are not deterred from actively participating in the learning event. They talk more in this framework and ask more questions, and thus they learn and progress more. On the other hand, in classes were the frontal method was used, the sampling tended to favor the boys [15].

The study also suggests that the alternative teaching method offers an advantage to weak or average students, while the frontal method does not encourage their advancement: weak students who are taught in this method remain weak and average students remain average. It seems that only advanced students retain their high rankings no matter what the teaching method. This can be explained by the fact that the alternative method retains a sequential between the teaching process in the classroom and the teaching activities in the computer room, whereas with the frontal method, there is a disconnection between what goes on in the classroom and the computer room.

8. Conclusions

The study shows that the alternative method of teaching promotes improvement in weaker and average students whereas with the frontal method the weak and average students remain weak and average, respectively. This gap continues over the years. This is explained by the fact that alternative teaching maintains continuity between the classroom learning process and learning activity in the computer room whereas frontal teaching does not. The findings indicate the importance of integrating flexible teaching styles into mathematics teaching.

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