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AUTHOR Dori, Y. J.; And Others
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ABSTRACT

Teaching the Cell topic in junior high schools involves a host of problems. The study reported in this paper investigated the effect of various teaching methods on Israeli students' achievements, acquiring laboratory skills, and the dimensions of learning activities. The Cell topic was taught to an experimental group using the Jigsaw method and cooperative learning strategies and to a control group using the customary frontal method. Research instruments included the achievement test on the cell topic and observations before and during the learning activity. Results indicate that students who studied by the Jigsaw method had higher achievement in the test than students in the control group and high achievements were obtained with students with medium academic ability. In classes that improved greatly in academic achievements, the cooperative learning activity increased and positive attitudes towards the Jigsaw method were found. This study recommends developing additional study units in biology for junior high schools as a way to improve academic achievements as well as laboratory skills. Contains 12 references. (Author/JRH)

# The Effect of Teaching the Cell Topic Using the Jigsaw Method on Students' Achievement and Learning Activity

Y.J. Dori, O. Yeroslavski and R. Lazarowitz
Department of Education in Technology and Science
Technion, Israel Institute of Technolgy
Haifa, Israel

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Y. J. Dori, O. Yeroslavski and R. Lazarowitz
*Department of Education in Technology and Science*
*Technion, Israel Institute of Technology, Haifa, Israel*

## ABSTRACT

Teaching the Cell topic in junior high school involves a host of problems, as indicated by a number of studies and by teachers who teach the topic. This research studies the effect of various teaching methods on students' achievements, acquiring laboratory skills and the dimensions of learning activity. The achievements and laboratory skills were also analyzed by the students' academic levels, the cognitive level of the questions in the tests and the various knowledge domains.

Both groups studies the Cell topic. The teaching method of the experimental group was cooperative learning using the Jigsaw method, while the control group studied by the customary frontal method. A study unit on the cell topic has been developed for the sake of the research. It includes a theoretic element and a laboratory skill element.

In the Jigsaw method, the Cell topic was divided into five sub-topics that are independent with respect to the order of study. In the first phase of the research, the class was divided into groups that were heterogeneous with respect to sex, learning capability and special social problems. Each student in each group was assigned one of five sub-topics. In the second phase, the students formed new "expert groups," whose task was to study together the same sub-topic and prepare it for the third phase. In the third phase, the students returned to the original heterogeneous groups. There, each student taught the topic prepared in the expert group, and had to study the other four sub-topics from his/her peer students.

The research findings show that students who studied by the Jigsaw method had better achievements in the test on the Cell topic than students in the control group. High achievements were obtained by students with medium academic ability, who improved their scores in particular in the questions at the high level. In the classes that improved greatly in academic achievements, the cooperative learning activity increased and positive attitudes towards the Jigsaw method were found. The research indicates that the Jigsaw method should be used in teaching biology in general and the Cell topic in particular.



*68th Annual National Association for Research in Science Teaching Conference*, San Francisco, CA, April, 1995.

## Introduction

Cooperative learning has been defined over the last two decades, as a classroom learning environment in which students work together in small, mixed-ability groups on academic tasks, seeking assistance primarily from each other and making decisions by consensus (Johnson, Johnson, Maruyama, Nelson & Skon, 1981; Okebukola, 1986; Watson, 1991). According to Slavin (1984) and Watson (1991) the success of cooperative learning techniques has an additive effect if three main components are used: grouping of students, group tasks and incentive structures, and heterogeneous arrangement of students within groups. A number of researchers (Humphreys, Johnson & Johnson, 1982; Lazarowitz, Baird, Hertz-Lazarowitz & Jenkins, 1985; Lazarowitz & Karasenty, 1990; and Lonning, 1993) have shown that teaching in small groups can improve students' academic achievements.

The cell topic is studied in junior high school in Israel. It is important to teach this topic as early as possible within the study of biology since it is a prerequisite for understanding the structure and function of all organisms, including humans. Teaching the cell topic involves a host of problems (Dreyfus & Jungwirth, 1988, 1989; Dreyfus, 1989). Teachers often indicate that the cell topic is difficult to comprehend due to its abstract and complex nature.

## Research objective and methodology

The research aims at investigating the effect of teaching the cell topic using various teaching methods on students' achievements and on three dimensions of learning activity. The research sample included 2 ninth grade groups. The teaching method of the experimental group was cooperative learning, using the Jigsaw method (Aronson, Stephan, Sikes, Blaney & Snapp, 1978), while the control group studied by the customary frontal approach. A study unit on the cell topic, which has been developed as a part of this study, includes a theoretic element and a laboratory skill element.

In the Jigsaw method, the cell topic is divided into the following five sub-topics: (1) cell membrane, (2) mitochondria and ribosomes, (3) cell nucleus, (4) chloroplasts, and (5) cell wall and vacuole. These sub-topics are independent of each other with respect to the order of study.

The class is divided into groups that are heterogeneous with respect to sex, learning capability and discipline problems. Each student in each group is assigned one of the five sub-topics. Then, the students form new "expert groups," whose task is to study together the same sub-topic and prepare it for peer tutoring. The students then return to the original heterogeneous groups, and each student teaches the topic prepared in the expert group, and learns the other four sub-topics from the peers.



*68th Annual National Association for Research in Science Teaching Conference*, San Francisco, CA, April, 1995.

## Research design and instruments

The research was conducted during the academic year 1992-3 and included 112 junior high school students studying in four eighth grade classes. Two classes with 56 student formed the experimental group, who studied according to the Jigsaw method. The other 56 students in two classes constituted the control group. This group studied the same material in a regular, frontal class setting, in which the teacher is the major source of information. All four classes studied the same subject matter during the research period. The students in each class were divided into two academic levels, based on a prior knowledge test.

The study material included a set of five booklets, a separate one for each of the sub-topics. The validation of the study unit was done by two cell biology experts and five experienced biology teachers. Each booklet included 30 questions, 24 of which were categorized as basic questions, requiring knowledge and understanding, and the rest were at a high-level, requiring application and analysis.

The research instruments included achievement test on the cell topic and observations before and during the learning activity. The achievement test was administered to both groups before and after the experiment. The test included 40 questions, 30 of which were multiple choice and the rest required matching between terms and symbols. 8 questions were devoted to each sub-topic, 6 of which were at the basic level and the rest required application and analysis. The $\alpha$-Kronbach of the test was found to be 0.79. The observations of learning activities were based on an instrument developed by Sharan and Hertz-Lazarowitz (1978), which includes student-student interaction, teacher-student interaction, and group interaction.

## Research findings

The research objective was to find out whether the use of different teaching strategies affects students' academic achievement in the cell topic and learning activity. The independent variable was the teaching strategy and the dependent variable (with respect to the first part) was the mean score of the achievement test. The results are listed in Table 1.

The results indicate that the students who studied the cell topic using the Jigsaw method scored significantly higher than those students who studied using the conventional frontal method. This significant difference between the two groups was obtained even though the mean pre-test score of the control group was higher than that of the experimental group. High achievements were obtained by students with medium academic ability, who improved their scores in particular in the questions at the low level.



*68th Annual National Association for Research in Science Teaching Conference*, San Francisco, CA, April, 1995.

Table 1. *Mean scores, standard deviations and t-test on achievement in the cell topic by learning mode*

| | Experimental Group | | Control Group | | t | P |
|---|---|---|---|---|---|---|
| | N | $\bar{X}$ (SD) | N | $\bar{X}$ (SD) | | |
| Pre-test | 56 | 8.85 (9.47) | 56 | 12.51 (11.46) | | |
| Post-test | 54 | 79.95 (10.84) | 52 | 73.88 (14.23) | | |
| Net gain | 54 | 70.91 (13.67) | 52 | 61.28 (13.42) | 3.62 | 0.001 |

With respect to the second part of research objective, the independent variable was the teaching strategy and the dependent variable was the learning activity. The classes' learning activities were observed by two observers and classified by three dimensions: cooperative, individual, competitive and other. The results are summarized in Table 2 by the number of cases each activity was observed and by percentage frequency. In the experimental group, which improved greatly in academic achievements, the cooperative learning activity increased during the treatment, while the competitive activity disappeared and the individual learning activity decreased. Overall, the number of observed cooperative behavior cases within the experimental group increased by a factor of 6, while the total number of the rest of the cases decreased by a factor of 3. In the control group no major changes occurred, as expected, since no change was made in the teaching methodology

The experimental group responded to an open feedback questionnaire aimed at assessing students' attitudes toward the Jigsaw method. In the responses students expressed willingness to use this method for learning additional topics in biology and to recommend learning the cell topic using this method, to their friends.

Table 2. *Frequency of learning activity dimensions before and during the treatment*

| Dimension | before treatment | | | | during treatment | | | |
|---|---|---|---|---|---|---|---|---|
| | Experimental Group | | Control Group | | Experimental Group | | Control Group | |
| | N | % | N | % | N | % | N | % |
| Cooperative | 21 | 25 | 18 | 17 | 128 | 87 | 12 | 15 |
| Individual | 30 | 36 | 36 | 33 | 7 | 5 | 35 | 42 |
| Competitive | 13 | 16 | 20 | 19 | 0 | 0 | 15 | 18 |
| Other | 19 | 23 | 33 | 31 | 12 | 8 | 21 | 25 |

## Summary

The research findings show that students who studied by the Jigsaw method had higher achievements in the test on the cell topic than students in the control group. High achievements were obtained by students with medium academic ability, who improved their scores in particular in the questions at the low level. In the classes that improved greatly in academic achievements, the cooperative learning activity increased, and positive attitudes towards the Jigsaw method were found. Teachers and students indicated that the Jigsaw method is advantageous in teaching biology in general and the cell topic in particular. The research indicates that developing additional study units in biology for junior high school is recommended as a way to improve academic achievements as well as laboratory skills. More studies should be carried out to examine the effect of collaborative teaching on academic achievements and laboratory skills.

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