REUVEN LAZAROWITZ, RACHEL HERTZ-LAZAROWITZ, MAHMOOD KHALIL, SALIT RON

DESIGNING COOPERATIVE LEARNING IN THE SCIENCE CLASSROOM: INTEGRATING THE PEER TUTORING SMALL INVESTIGATION GROUP (PTSIG) WITHIN THE MODEL OF THE SIX MIRRORS OF THE CLASSROOM MODEL

Abstract

The model of the six mirrors of the classroom and its use in teaching biology in a cooperative learning mode were implemented in high school classrooms. In this study we present:

a) The model of the six mirrors of the classroom (MSMC).

b) Cooperative learning settings: 1. The Group Investigation; 2. The Jigsaw Method; and 3. Peer Tutoring in Small Investigative Groups (PTSIG).

c) Two biology topics: 1. Microorganism; 2. Evolution.

The MSMC examines the processes of a) organization, b) learning tasks, c) teacher instructional behaviors, d) teachers' communicative behaviors, e) students' academic performance, and (f) students' social behaviors. Each mirror is described in terms of five levels of complexity from simple to complex. Both subjects were taught in Cooperative Leaning Methods: The Jigsaw Method, Group Investigation (GI) rooted in Dewey's (1927) philosophy, and Peer Tutoring in small Investigative Groups which is a combination of the Jigsaw method and Group Investigation.

Two biology subjects were instructed through the MSCM and PTSIG: 1) Microorganisms, learning unit written in Arabic and Hebrew for 9th grade students in the STS approach structured around two biological principles: a) the unity of the life, b) the relationship between structure and function. 2) Evolution, learning unit for 12th grade students, included topics on Lamarck's, Darwin's and neutral theories, punctuated equilibrium, genetics diversity, natural selection, specialization and phylogenesis. The paper will include the subjects, research procedure and results.

Key words: Six mirrors of the classroom, cooperative learning, microorganisms, evolution

Introduction

In this study we present:

a) The model of the six mirrors of the classroom (MSMC), developed by Hertz-Lazarowitz (1992).

b) Three methods of cooperative learning: 1. The Group Investigations (Sharan & Hertz-Lazarowitz, 1980, 1986); 2. The Jigsaw method (Aronson et al, 1978); and 3. Peer Tutoring in Small Investigative Groups (PTSIG developed by Lazarowitz & Karsenty, 1990).

c) Two biology topics: 1. Microorganism (Khalil & Lazarowitz, 2002); 2. Evolution (Ron & Lazarowitz, 1997), taught at the secondary school level, within the model of the six mirrors of the classroom (MSMC).

The Six mirrors of the classroom

The model examines classroom processes and includes six mirrors of the classroom: *(1) organization, (2) learning tasks, (3) teacher instructional behaviours, (4) teacher communicative behaviours, (5) students' academic performance, and (6) student social behaviours.* Each mirror is described in terms of five levels of complexity from simple to complex.

The model served as a conceptual framework which guided classroom observation, in behavioural categories: On task, off task behaviors, level of students' cooperation in the interaction, and helping and social events which occur in learning. Teachers were trained to design their classroom environment, and move from traditional whole classroom instruction to more active and then cooperative learning. The model and its measures assisted the research by testing the effects of cooperative learning on students' academic and societal outcomes. The conceptual dynamics among the six mirrors enabled us to formulate predictions and to analyze a variety of variables. For example, quality of on-task cooperation as expressed by content, frequency of in-group communication, and level of reasoning, predicted academic and societal outcomes**.** *The six mirrors of the traditional classrooms:* The traditional classroom is usually the whole classroom direct teaching (Also called Frontal or Expository teaching). The observations indicated that physical organization (Mirror 1) of the traditional classroom is usually perceived as fixed with little or no movements of students around the room. The Learning tasks (Mirror 2) were presented to the whole class and then, each student tackled the learning task alone. The teacher communicated with the class as a whole with a high frequency of lecturing, disciplining, and commenting on negative events in the class (Mirrors 3 and 4).

Research results of the implementation of the MSMC

Classroom structure and dynamics were obtained using video tapes and observers' coding. Findings indicated that there were differences between traditional classrooms, where expository teaching was dominant, as compared to active and cooperative classrooms, with considerable student interaction.

Students' behaviours (Mirrors 5 and 6) were mostly solitary on-task and off-task activities. Interactive behaviours, which included on-task and off-task and helping activities, were observed for about 25 percent of the time. Interactions among students were not initiated by the teacher and in fact, constituted mostly brief clandestine types of activities.

Developmental observations showed that from first to twelfth grade, students maintained a stable interactive "on task behaviour" (about 15%), but increased their "off task" interactive behaviours. For teachers, an increase in social off-task interactions was considered a negative outcome, indicating growing discipline problems and disturbances of the teacher's classroom management.

The six mirrors of the cooperative learning classroom

In contrast to traditional classrooms, teachers designed their Cooperative Learning classrooms so that the physical setting (Mirror1) included 4-5 subsystems (groups), multiple resources for learning, and considerable movement and contact

among the groups. Learning tasks (Mirror 2), were divided horizontally, as in a Jigsaw structure, or vertically and integrated, as in the Group Investigation method. In the jigsaw method, students are assigned to groups of about 4-6 members, with all groups working on the same topic. In each group, each member studies a different section of the topic, and then members from all groups who studied the same section meet in "expert groups" to discuss their section. Students then return to their groups and teach their group members about their section. In Group Investigation, students in the class form groups of 2-6 members, each group chooses a subtopic from the general topic assigned to the class, and produces a group report. Subsequently, each group shares its findings with the entire class in the form of presentations and class discussions. These Cooperative Learning tasks, which involved peer learning and peer teaching, were designed to increase interdependence and personal as well as collective responsibility.

The pattern of teacher's communication and instructional behaviours (Mirror 3 and 4) included communication with the whole class for a short period of time, then with each of the groups as well as with individuals who needed help. The teacher observed a given group at a time and helped advance the group's discussion to a higher level. Most of the time teachers were helping, explaining, and giving feedback to students. Little disciplining took place and only a few negative comments were heard in the class.

In this context, students engaged quite frequently in interactive, cooperative and helping behaviours. It was observed that within lively and stimulating group discussions, peer learning was at a high cognitive level. These descriptions of class activities and dynamics exemplify how the "anatomy of cooperation" model of the six mirrors enabled the observation and investigation of academic outcome.

The Jigsaw Method (Aronson et al, 1978)

In The Jigsaw method, the class is divided into small groups of heterogeneous five students who can treat each other as resources. The learning goals and materials are structured by the teacher and are divided into independent sub-units which can be learned separately so that one sub-unit does not depend on the mastery of others.

The jigsaw is composed from two cooperative structures; the jigsaw (5 students A to E) and the experts group (5 students with the same part 5a, 5b, 5c, etc.). In the expert group students master their part and prepare for peer-tutoring, then they return to the jigsaw group to tutor their teammates and prepare for a test. The original jigsaw was further extended to jigsaw II, experts-jigsaw and in jigsaw-investigative group.

Group Investigation (GI) (Sharan & Hertz-Lazarowitz, 1980, 1986)

Group investigation is rooted in Dewey's (1927) philosophy. GI integrates four basic features: investigation, interaction, interpretation and intrinsic motivation. These features are combined in six stages of the model: 1. The class determines subtopics and organizes into research groups; 2. Groups plan their investigation; 3. Groups carry out their investigation; 4. Groups plan their presentations; 5. Groups make their presentation; 6. Teacher and students evaluate their projects. In GI the investigation process is presented in each stage; groups select topics for

investigation by their interest and curiosity. Thus in the GI classroom groups work on *different*, but *related* topics of investigation. They use a variety of resources to generate questions, gather information in the investigation and become active in constructing their knowledge. The teacher is a facilitator, a mentor and a collaborator in the student's inquiry process (Sharan & Hertz-Lazarowitz, 1980, 1986; Hertz-Lazarowitz & Calderon, 1994).

Peer Tutoring in small Investigative Groups (PTSIG)

The method was developed by Lazarowitz and Karsenty (1990) as a combination of the Jigsaw method and Group Investigation (GI). The PTSIG was experimented on in a secondary school. The method includes the following structures: The Jigsaw structure for peer-tutoring, and the GI structure for the expert counter group. The teacher as a curricula developer, designs the biology related learning tasks for each sub-unit, as an inquiry-investigative sequence of activities. Therefore, students work, especially in their expert group, on complex and rich learning tasks. In their expert-group students read, make observations on the objects studied and generate questions for laboratory investigative experiments. The tasks include open questions and biological problems which could be solved only by using microscopes, preparing slides or performing experiments with other group members. After they finish their learning tasks in the expert group, they return to their Jigsaw group for peer tutoring. Usually, the different sub-topics which were investigated, are presented and discussed within the original Jigsaw group in order to acquire a general understanding and knowledge of the topics.

The evaluation is based on students' academic products in their expert groups, and their grades in a test on all the units. The students prepare for the final test with further reading. The teacher occasionally leads the discussion with the whole class to organize and conceptualize significant biological concepts. Topics such as the cells, animal physiology, photosynthesis in higher plants, and evolution are topics which can be naturally divided into five independent sub-units and can be learned in a jigsaw investigative method. Teachers-researchers in Israel, have implemented PTSGI, developed curricula to be used in high-school biology classrooms.

The positive academic and social outcomes of Cooperative Learning are presented in many writings (Gillis & Ashman, 2003; Hertz-Lazarowitz, 1992, 2005; Hertz-Lazarowitz & Zelniker, 1995; Lazarowitz & Hertz-Lazarowitz, 1998; Lazarowitz, 2007; Slavin, 1995; Slavin, Hurley & Chamberlain, 2003).

Two biology subjects instructed through the MSCM.

1. Microorganisms

This learning unit was written in Arabic and Hebrew for 9th grade Israeli and Arab students in the STS approach, by Khalil and Lazarowitz, 2002. The learning unit was structured around two biological principles: a) the unity of the life, and b) the relationship between structure and function. The following topics were included in the learning unit: microorganisms and their structure, the physiological processes, microorganisms' role in the food web, carbon and nitrogen cycles, food industry, environment and the level of health society. The problems raised in the unit were concerned with health issues, environment, microorganisms and drainage

canalization between neighbourhood villages, allowing students to investigate achievement in the cognitive and affective domains (attitudes toward environment preservation, and understanding and peace between people who live close to each other). The unit helped students to master practical skills in the laboratory work, and problem solving skills. The learning tasks included individual and small group instructional settings in classrooms and laboratory work. Students read scientific essays, watched videos, played group games, went on group trips to observe nature, visited food industries and searched for information from different sources, internet and libraries. The learning unit raised students' motivation by being practical, connected with daily life and dealing with societal issues. In this manner the relationship between science, technology, environment and society was emphasized.

The outcomes on the cognitive and affective domains were obtained analyzing students' portfolios written while studying in the classroom, in the laboratory and during their home work. The results show that students improved academic achievement, developed positive attitudes toward the environment, and understood the issues related to preservation of nature and its relation to peace (Khalil & Lazarowitz, 2002; Khalil, Lazarowitz & Hertz-Lazarowitz, 2009).

2. Evolution

In the study conducted by Ron and Lazarowitz (1997) with 12th grade students, the topic of evolution was taught in an instructional mode of cooperative learning groups. The topics were; Lamarck's, Darwin's and neutral theories, punctuated equilibrium, genetics diversity, natural selection, specialization and phylogenesis. The results showed that students' academic achievement were higher compared with the control group. The explanation was based on the fact that cooperative learning facilitates students' verbal interaction and construction of the knowledge based on group interaction and cooperation (Ron & Lazarowitz, 1997).

The biology teaching and learning in the classrooms and laboratory work offers many opportunities for the evaluation and grading procedures, beside the use of the classical test following the instruction of a unit (Lazarowitz, 2000; Lazarowitz & Tamir, 1994).

In implementing these methods, a complex and rich teaching and learning processes are taking place in the classroom. The teacher has to become an engineer of the learning tasks, and a designer of the physical setting of learning, as the teacher has to orchestrate instructional and communicative behaviours to produce quality learning that will maximize the social- academic performance of the students.

References

Abrami, P. C., Poulsen, C. & Chambers, B. (2004): Teacher Motivation to Implement an Educational Innovation: Factors Differentiating Users and Non-Users of Cooperative Learning. *Educational Psychology*, 24, 2, 201-216.

Aronson, E., Stephan, C., Sikes, J., Blaney, N. & Snapp, M. (1978): *The Jigsaw Classroom*. Beverly Hills, CA: Sage Publication.

Dewey, J. (1927): *The school and society*. Chicago, IL: The University of Chicago Press.

Farmer, W. A. & Farrell, M. A. (1980): *Systematic instruction in science for the middle and high school years*. Reading, Mass.: Addison Wesley.

Gillies, R. M. & Ashman, A. (Eds.) (2003): *Co-Operative Learning: The Social and Intellectual Outcomes of Learning in Groups*. London: Routledge Falmer.

Hertz-Lazarowitz, R. (1992): Understanding students' interactive behavior: Looking at six mirrors of the classroom. In R. Hertz-Lazarowitz & N. Miller (Eds.) *Interaction in cooperative groups*. New York: Cambridge University Press, 71-102.

Hertz-Lazarowitz, R. (2005): Cooperative Learning in Israel. *IASCE Newsletters*. http://www.iasce.net

Hertz-Lazarowitz, R. (2008): Beyond the classroom and into the community: The role of the teacher in expanding the pedagogy of cooperation. In R. Gillis (Ed.) *Thinking and Learning during Cooperative Learning.* London: Routledge Falmer.

Hertz-Lazarowitz, R. & Zelniker, T. (1995): Cooperative learning in the Israeli context: Historical, educational and cultural perspectives. *International Journal of Educational Research, 23,* 267-285.

Khalil, M. & Lazarowitz, R. (2002): *Developing a learning unit on the science-technology-environment-peace-society mode. Students' cognitive achievements and attitudes toward peace.* The Annual Meeting of the National Association of Research in Science Teaching (NARST). New Orleans April, 7th-10th. USA.

Khalil, M., Lazarowitz, R. & Hertz- Lazarowitz, R. (2009): A Conceptual Model (The Six Mirrors of the Classroom) and its Application to Teaching and Learning about Microorganisms. *Journal of Science Education and Technology*, 18 (1), 85-100. (Online 10.1007/s10956-008-9135-1. November 11, 2008.

Lazarowitz, R. (2000): Research in science, content knowledge structure, and secondary school curricula. *Israel Journal of Plant Science*, 48, 229-238.

Lazarowitz, R. (2007): High School Biology Curricula Development: Implementation, Teaching and Evaluation: From the 20th to 21st Century. In: S. K. Abell & N. Lederman (Eds.) Chapter 20, 561-598. *Handbook of Research on Science Education.* Mahwah, NJ: Lawrence Erlbaum Associates.

Lazarowitz, R. & Hertz-Lazarowitz, R. (1998): Cooperative learning in science curriculum. In B. J. Fraser & K. G. Tobin (Eds.) *International handbook of science education* (pp. 449-471). Dordrecht, Netherlands: Kluwer Academic Publishers.

Lazarowitz, R. & Karsenty, G. (1990): Cooperative leaning and students' self esteem in tenth grade Biology classroom. In Sharan, S. (Ed.) (1990): C*ooperative Learning: Theory and Research*. New York: Praeger publisher, 123-149.

Lazarowitz, R. & Tamir, P. (1994): Research on using laboratory instruction in science. In D. Gabel (Ed.) *Handbook of Research in Science Teaching and Learning.* NY: The Macmillan Publishing Comp., 94-128.

Ron, S. & Lazarowitz, R. (1997): *The Classroom Learning Environment of High School Students who Studied Evolution in a Cooperative Mode*. International Conference on Science, Mathematics & Technology Education and National Development, Hanoi, Vietnam, January 6-9.

Sharan, S. & Hertz-Lazarowitz, R. (1980): A group investigation method of cooperative learning in the classroom. In Sharan, S., Hare, P., Webb, C. & Hertz-Lazarowitz, R. (Eds.) *Cooperation in Education*. Provo, Utah: BYU Press, pp. 14-46.

Sharan, S. & Hertz-Lazarowitz, R. (1986): Kooperatives Lehren. In A. Weber (Hrsg) *Kooperatives Lehren und Lernen in die Schule.* Heinsberg, West Germany: Agentur Dieck, pp. 201-222.

Slavin, R. E. (1995): *Cooperative learning: Theory, research and practice* (2nd ed.). Boston: Allyn & Bacon.

Slavin, R. E., Hurley, E. & Chamberlain, A. (2003): Cooperative learning and achievement: Theory and research. In W. Reynolds & G. Miller (Eds.) *Handbook of Psychology*. Vol 7 (pp. 177-198). New York: Wiley & Sons.

Prof. Dr. Reuven Lazarowitz
Department of Education in Technology and Science
Israel Institute of Technology, Technion
Haifa, Israel
rlazar@tx.tecnion.haifa.ac.il

Prof. Dr. Rachel Hertz-Lazarowitz
Faculty of Education, The University of Haifa
Haifa, Israel
rachelhl@construct.haifa.ac.il

Mahmood Khalil, President
The Academic College of Sakhnin for Teacher Education
Sakhnin, Israel
mahkh@macam.ac.il

Salit Ron
Director of the Education Section
Ramath Hanadiv, Zichron Yaakov
Israel
www.ramathhanadiv-edu.org.il