

BAR-ILAN UNIVERSITY

**Conception of the Nature of Science and the Nature of Inquiry Process
Among Students Who had Experienced Guided Inquiry Learning in
Comparison to Students Who had Experienced the Open Inquiry
Learning in High School Upon Graduation and Over Time as Adults**

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ABSTRACT

Most educators agree about the importance of inquiry-based teaching, but there is no agreement regarding the preferred inquiry-based types for teaching in the classroom. Academics and teachers deliberate between inquiry-based teaching types, especially between "guided inquiry" and "open inquiry", when the differences between them are connected to the level of student's independence and teacher's involvement while conducting the inquiry. In **guided inquiry**, usually the teacher chooses the inquiry question and together with the student decides how to continue researching the problem. The teacher is very involved and gives working instructions at every stages of the inquiry process, except for the conclusions stage. On the other hand, in **open inquiry**, the student is at the center. The students poses the inquiry question and they are the ones deciding on inquiry means up to concluding the process, when the teacher assists with decisions having to do with different inquiry stages.

This research examined the positions of students learning the guided inquiry system and those learning the open inquiry system regarding the nature of the inquiry process in time. Also examined was their conception of the nature of science after time. In addition, the positions of students learning the open inquiry system nearing their graduation were compared to their positions as adults, nine years after graduating high-school.

The research questions were divided to quantitative and qualitative.

The quantitative research questions:

1. What is the connection between positions of students experiencing open inquiry learning towards the inquiry project upon completion of high-school and their positions to the inquiry project after time and their conception of the nature of science after time?
2. What is the difference in positions towards the inquiry project after time between participants experiencing guided inquiry learning and open inquiry-based learning?
3.
 - 3.1 What is the difference in conceiving the nature of science after time between participants experiencing open inquiry learning and those experiencing guided inquiry-based learning?
 - 3.2 What is the difference in conceiving the nature of science after time between participants with more positive positions towards the inquiry project after time and those with less positive positions?
 - 3.3 How does the expected difference in conceiving the nature of science after time of participants experiencing open inquiry learning compared to those experiencing guided inquiry-based learning changes according to positions towards the inquiry project after time?

The qualitative research questions:

1. What are the positions of students experiencing open inquiry learning in high-school regarding the implementation of inquiry project in school and regarding the nature of the dynamic inquiry process upon graduation and after time?
2. What are the positions of students experiencing guided inquiry-based learning as opposed to those experiencing open inquiry-based learning in high-school regarding the implementation of inquiry project and the nature of inquiry process after time?
3. What are the positions of students experiencing guided inquiry learning as opposed to students experiencing open inquiry learning-based regarding the conception of the nature of science after time?
4. What are the significant things connected to Biology studies remembered by students experiencing guided inquiry-based learning as opposed to students experiencing open inquiry learning in high-school after time?

The research included 20 subjects, Biology students in high-school, who graduated 9 years before the beginning of the inquiry-based project. The participants were divided into two groups according to the type of inquiry they had performed during studies in high-school. Ten of the participants studied according the "regular" curriculum for teaching inquiry – "the Biotope", which focuses on conducting guided inquiry. The other ten participants studied according to the innovative curriculum – "the Biomind". These students experienced open inquiry learning and formed the first cycle of this experimental project. The research integrated quantitative and qualitative research tools.

The quantitative research tools included three questionnaires: Attitudes regarding the inquiry project upon graduating high-school; Attitudes regarding the inquiry project after time and conception of the nature of science after time. The qualitative inquiry tools included interviews and documents (open feed-back, interviews and reflection).

The quantitative data analysis used theoretical statistics (average and standard deviation), correlations (Spearman correlations) and various statistical tests such as One way MANOVA and Two Way ANOVA. The qualitative data were processed in order to identify categories and trends stemming from the interviews transcription. Categories identification was performed by dividing the texts into small contents units and then searching for significant, outstanding, interesting and repeated components in the data collected, while rereading of the texts.

The main research findings are presented in reference to the above research questions.

Quantitative research findings:

In reply to the first research question, it was found that the more positive positions of students experiencing open inquiry towards the inquiry project upon completion, the more positive their positions are after time and their concept of the nature of science is deeper.

In reply to the second research question – in all measurements of positions towards the inquiry project after time, there was no significant difference between students experiencing open inquiry and those experiencing guided inquiry.

In reply to the third research question:

3.1 It was found that among participants experiencing open inquiry learning, the level of conceiving the nature of science after time was significantly higher than those of participants experiencing guided inquiry learning.

3.2 It was found that among participants with more positive positions towards the inquiry project after time, the level of conceiving the nature of science after time was significantly higher than those with less positive positions towards the project after time.

3.3 The research findings pointed on the fact that only among participants experiencing open inquiry learning with less positive positions towards the project after time, the level of conceiving the nature of science after time was significantly higher than those experiencing guided inquiry learning with less positive positions. Among participants with more positive positions towards the inquiry project after time there was no significant difference in measuring the nature of science after time per inquiry type.

The qualitative research findings:

In reply to the first research question – the research findings pointed on positive positions of subjects experiencing open inquiry learning in high school towards the inquiry project implementation. The positive positions were expressed in the academic side (the contribution to knowing the scientific inquiry manner, developing personal responsibility, independent learning and thinking competencies) and the emotional side (the experience in implementing the inquiry project, the interest and diversity in this process, feeling of satisfaction from the process as well of the end product, having fun in general and team work in particular). Side by side to their recommendations to continue the inquiry project in schools, the interviewees mentioned suggestions for changes and improvements of the inquiry project and recommendations to students starting the inquiry project. The research findings had also pointed that the teacher is a significant figure in implementation of the inquiry project. There was also referral to the characteristics of dynamic inquiry: changes during inquiry, procedural learning, procedural understanding of the inquiry process and effective aspects.

In reply to the second research question- all research participants, those experiencing open inquiry learning and those experiencing guided inquiry learning had recommended to implement the inquiry project and were unanimous as to the type of preferred work in high-school. Some of them had underlined in their explanations the experience in implementing the inquiry project and others mentioned the acquired educational value during the project or at its conclusion. Yet, part of the participants who had experienced guided inquiry learning had expressed their dissatisfaction about various aspects and recommended changes in implementation of the inquiry project.

In addition, interviewees experiencing guided inquiry learning and those experiencing open inquiry learning had referred to characteristics of dynamic inquiry: changes during inquiry, procedural learning, learnings as a process and affective points of view. In some categories the referrals were similar and in others there were differences between the two research groups.

In reply to the third research question – the findings show that the participants in both groups, those experiencing open inquiry learning and those experiencing guided inquiry learning in high-school, thought that science is indefinite and is given to changes along the years and generations and mentioned that experiments and observations are means to developing knowledge in science. More participants experiencing open inquiry learning referred to our need to experiment in order to validate or disprove the theory. Other aspects referred to: the nature of laws and theories, scientific ideas influenced by the social and cultural society and scientific results are a product of human conclusions.

In reply to the fourth research question, the research findings pointed at significant memories relating to the experience of implementing the inquiry project, the inquiry project's contribution and the teacher.

The research findings and conclusions led to recommendations for highlights in teaching inquiry.

This research had added a unique aspect of **graduates'** attitudes towards inquiry and had contributed to the ongoing discussion about the preferred inquiry method for teaching in the classroom, a method that will lead to development of competencies and skills enabling the young generation to cope with scientific, technologic, economic, cultural and social challenges of the 21st Century.

Each teacher will form his/her own opinion as to the preferred method according to discussion about the advantages and disadvantages of each inquiry method and other conditions.