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Characterization Types of Transitions between Stages of 'Bioinquiry' Open Inquiry Process and the Causes of Logical Connection Patterns in that Transition

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Abstract

In an era when quantity and availability of information are growing every year, when knowledge keeps growing older every day and when information is accessible to all, the knowledge provided by teacher is not as important as it was fifty years ago. The changes in the importance of knowledge lead to modifications in education and to the beginning of a constructivist era. Instead of granting knowledge, educators are required to provide students with skills and capability to process the information, to criticize it and even be able to create a new subjective thinking of their own. These qualifications and skills emphasize students thinking. The changes were internalized in science teaching in Europe, the United States, and Israel and they emphasize the importance of improving students' scientific thinking. A means of improving scientific thinking is in studying science through inquiry method which simulates the process of scientific research. The inquiry is a dynamic process that changes and develops according to scientific knowledge, and its goal is to find information or understanding of a studied or researched subject. In fact, the Inquiry serves as a means, as a pedagogical strategy for teaching, and as content of teaching science.

In the school year 2014, for the first time, all high school students who study Biology in higher level (5 units scale), were demanded to perform an open inquiry, along with experimenting through using 'progress tracks' between developing dynamic inquiry questions, and summarize it in an inquiry summary paper called 'bioheker'. So far, there were no systematically research for logical connection patterns between the formulated and performed inquiry questions of the students. This study had two main aims: (1) Mapping and characterizing the types of the logical transitions within the 'bioheker' inquiry questions and (2) Characterizing the factors that contribute the logical connection patterns of the inquiry questions. The research population counted 285 students from 16 different high schools in Israel that conducted 116 students' inquiry summary papers. Analyzing the summary papers was according to indicators developed and validated by two Judges. Each 'bioheker' was categorized to a progression track according to its inquiry questions, the inquiry skills and the quality of the knowledge type required to move between the inquiry questions and the logical connection between them that were tested.

Among different 'bioheker' project models we found three progression tracks between the inquiry questions: (1) Transition from a preliminary experiment or preliminary tests to a major inquiry question as part of the inquiry procedure (track A- PT- from conducting a Preliminary experiment to conducting a Test to a major inquiry question). (2) Second type of progression track between the inquiry questions was found between two practical inquiry questions (sequential or parallel) that were performed to expand the understanding of the chosen subject of the inquiry (track B- TT- from conducting a Test to one inquiry question to conducting a Test of another inquiry question). (3) The third track was conducted by carrying out an inquiry question to formulate a theoretical continuation question (track C, TTh- from conducting a Test to one inquiry question to Theoretical planning of another inquiry question).

The conclusions from this study indicate that there is a significant dependence between the progression paths between the inquiry questions to the models of their logical connection. The logical connection model that follows the questions of inquiry is better explained in the progression track A (PT) and significantly through the application of procedural knowledge. However, the logical connection model that corresponds between the inquiry questions is better explained through situational knowledge in progression track B (TT), in compression to the two other tracks. The logical connection model that partly corresponds between the inquiry questions is better explained in the progression tracks of the further questions, practical or theoretical (TT, TTh), after conducting experiment and clearly through implementation of situational knowledge.

The claim of Pedaste et al. (2015), that the transition between five investigation levels in inquiry -based learning is not a unified linear process but is given to different transitions and is therefore called the inquiry cycle, was confirmed in this study. Moreover, in all three progression tracks between inquiry questions and the different models of their logical connection, using the analysis, interpretation and implementation exploration skills, was higher in comparison to using planning inquiry skills. This finding is also supported by the approach to the inquiry concepts of evidence concepts. The inquiry cycle in different progression tracks between inquiry questions demanded unique thinking skill of understanding and conceptualization of inquiry findings or data Interpretation and not only practical inquiry skill. The required knowledge for `thinking behind doing` was based on knowledge of concepts to be understood, and not only on

practical or procedural processes that must be routinely controlled. This knowledge emphasized the difference between the conceptual characterization of a scientific practice required for meaningful learning and the other general description of processes.

Another find of this study is that the prevalence of typical quality of knowledge was different between the progression tracks of inquiry questions and in the various logical connections between them. Procedural knowledge and strategic knowledge were largely applied in progression track A (PT) and were hardly implemented in the progression tracks B (TT) and C (TTH), in which situational knowledge was more common than track A. At the same time, logical knowledge, which relates to causality- what leads to what, reason and the result - was common in all progression tracks between the inquiry questions and in all the logical connections between them.

It seems that despite the approach of inquiry teaching, that suffices with theoretical recognition of the inquiry stages, or with planning a theoretical experiment, this study findings indicate a different approach and are supported in further studies (Qing, Jing, Yazhuan, Ting, & Junping, 2010). Designing theoretical inquiry does not encourage development of critical and creative thinking skills as it develops in the progression paths that require hands-on experiments.

In view of the limitations of this study regarding the absence of an explicit instruction of logical connection between inquiry questions in the `bioheker` project, the findings that have been proven to be significant are sharpened. It is therefore possible to say that the recommendation of this study is to encourage execution of hands-on experiments is essential in view of the centrality of logical thinking in the inquiry process, and particularly in open inquiry, and the challenge of learning it. We can assume from these findings and based on literature (Pedaste et al., 2015) that following the repeated experience of students in various progression paths between inquiry questions, there may also be an improvement in the types of knowledge quality and in various inquiry skills, they will acquire. However, this assumption has not been proven in the current study and remains a target for further study.