Children As Explorers:
Exploratory Data Analysis
By Junior High School Students
In A Computer Assisted Environment

By
Dani Ben-Zvi

Department of Science Teaching

PH.D. THESIS

Submitted to
The Feinberg Graduate School
The Weizmann Institute of Science

June 10th, 2001

Abstract

The overall goal of this dissertation is to advance the understanding of learning and teaching Exploratory Data Analysis (EDA) in a carefully designed computer assisted learning environment for the junior high school level. This thesis, presented as a collection of papers, documents and analyzes three dimensions of students' activity, their evolving conceptions, their interactions, and their adoption of points of view. The theoretical framework informing the analysis of students' learning assumes that competence in a new and complex domain, such as statistics, involves more than particular set of skills, strategies, or knowledge. Following Resnick (1988), the framework includes viewing competence of a domain as adopting the habits, language and dispositions of interpretation and sense making (enculturation).

Firstly, I analyze at a very fine level of detail the ways in which a pair of students began to make sense of data and data representations, as well as the process of adopting and exercising the habits and points of view that are common among EDA experts. The focus is on the ways they started to develop global views of data and their representations on the basis of their previous knowledge and different kinds of local observations. I examine how knowledge was gradually constructed through complex cognitive and socio-cognitive processes, which included their interactions with each other, the teacher, the materials and the computerized tool. I analyze the ways in which the same 'pieces' of students' prior knowledge which seemed to hinder progress, ultimately became the support for the construction of new meanings. Of special interest were the teacher's interventions, which though

short and not necessarily directive had catalytic effects, can be characterized in general as interesting instances of appropriation.

Secondly, through the analysis of students' 'research projects', I suggest an initial framework of student reasoning in the domain of EDA with an emphasis on handling data representations. I then use written assessments to characterize student sense making of statistics after the end of their experience with the curriculum. Finally, I analyze the interrelationships between curriculum design and research in order to characterize the nature of the instructional activities, including the role and impact of computerized tools, which have the potential to promote meaningful learning of EDA.

The research methodology is mainly qualitative in nature with some quantitative aspects. The subjects for this study were seventh grade students (13-year-old) of mixed ability from the experimental classrooms that used the curriculum. The analysis is based on:

1) focused and detailed data on one pair of students, which were videotaped at almost all stages of their learning statistics;
2) classroom data that was gathered in three experimental classes; and
3) summative assessment data that consist of students' 'research projects', written assessments, students' evaluations, and teacher's comments.

These data were used to characterize important phenomena related to the following questions:

1) how students choose, interpret, design, transform and use data representations?;
2) what are the contributions of student interactions with their peers and their teacher to their understanding of data representations?; and
3) how students adopt the habits and points of view that are common among EDA experts, in particular the experts' point of view on local-global approaches to data interpretation and their representations?

The dissertation shows how meaningful learning of EDA took place through complex socio-cognitive processes of enculturation, the processes of teacher-student (and, possibly, student-student) appropriation, the students' exposure to carefully designed learning arenas and relevant computerized tools, and the students' long-term involvement in constructing a 'research project.'