

# Educational Indicators in Mathematics, Science, and Information and Communication Technologies<sup>(\*)</sup>

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## Summary

The following review was invited by the Initiative for Applied Education Research and the Israel Academy of Sciences and Humanities, as part of a plan to refresh an existing system of educational indicators. This review touches on two areas: mathematics and science teaching, and the area of information and communication technologies in education. The review consists of nine chapters and a concluding section. The following is a brief description of each of these.

The first chapter deals with different definitions of educational indicators. These definitions differ mainly in terms of their intended function: either to "point to" or provide an "at a glance" description of important features in a given educational system, on one hand, or, on the other, to evaluate, judge or explain the functioning of the system through a comprehensive and predictive set of indicators.

The second chapter draws attention to some limitations in using or interpreting data obtained from the indicator system. These limitations are concerned with the construct validity of the indicators, causal inferences drawn from them, and consequences of publishing them.

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<sup>(\*)</sup>The Initiative for Applied Research in Education's *The Expert Committee on Guidelines for Revising the System of Education Indicators in Israel* commissioned the scientific survey.

– The findings are in the author's own words and the conclusions reached are his own.

– Any mention or quote from the survey must be referenced in the following manner: Zuzovsky R. Nachmias R. (2008), Literature review on Educational Indicators in Mathematics, Science, and Information and Communication Technologies, a Survey Commissioned by the Expert Committee on Guidelines for Revising the System of Education Indicators in Israel.

<http://education.academy.ac.il/English/>

The third chapter describes two conceptualizations of schooling that affect the development of an indicator system. The *rational bureaucratic* view that perceives schooling in light of a production-function model, and one that perceives schools as small communities built and shaped around *social and personal interrelations*. The first view leads to an instrumental and pragmatic approach in developing an indicator system which is oriented toward solving problems and fulfilling policy-makers' needs, while the other yields a more theoretical and comprehensive approach for enlightenment purposes.

The fourth chapter presents the main conceptual frameworks (paradigms) used for developing an indicator system in school effectiveness research: *the input-output* framework and its extended versions; the *input-process-output* framework and the *organizational* framework, which emphasizes the importance of organizational features as well as the hierarchical nature of educational organizations. A more elaborated framework is one that addresses, not only a variety of variables, but also the interactions among them.

The fifth chapter provides examples of indicator systems from Europe and the United States that fit the above-described framework. Some are in line with the input-process-output framework and others are less restricted and more focused.

Indicator systems targeted at mathematics and science studies are presented in chapter six. The data that serve these systems are based on U.S. databases (National Assessment of Educational Progress), on data obtained in Europe through the national units of Eurydice, and on data obtained through international studies (PISA and TIMSS).

Chapter seven brings examples of indicator systems in the field of ICT. These systems follow the same conceptual framework as the mathematics and science indicator systems and provide indicators of inputs-budgets, infrastructure, trained teachers, space and time, indicators of processes – curriculum and instruction. Emphasis is given to indicators that represent innovative ways of integrating ICT in the teaching of other school subjects. A

less developed component in these indicator systems are the performance indicators, e.g., attitudes, aptitudes and skills.

The eighth chapter reviews existing Israeli national assessment projects. Some target achievement only, such as the national feedback mechanism that conducts regular external examinations on national samples in major subject areas including science and mathematics, as well as a more recent project that focuses on a broader range of growth and effectiveness measures (GEMS) – a system of periodic national testing and administration of a school climate questionnaire. Assessment activities in Israel that focus specifically on mathematics, science and ICT have been short-term and occasional, thus failing to systematically serve the needs of policy-making. Israel's constant participation in international studies, since the 1990's (TIMSS, SITES, PISA) opened the way for a more systematic, longitudinal monitoring activity. One attempt to use data obtained from a TIMSS and SITES studies are described.

The ninth chapter is devoted to describing research activities that are conducted prior to the development of an indicator system and to the evaluation of five options in developing such systems.

The literature review on the development of indicator systems worldwide and in Israel ends with some recommendations concerning a research and development plan that should preface and follow the development process.

Adopting the context, input, process, outcome multilevel conceptual framework is the first stage of this process. Deciding on relevant required indicators to fit this framework is the result of a research review and of negotiating policy-makers. The process of constructing and validating the indicators by their explanatory power over time will be conducted by researchers. This last step as such can be regarded as a monitoring activity essential for the understanding and interpreting of information obtained by an indicator system.

