פרופ' אורית חזן
הפקולטה לחינוך
למדע וטכנולוגיה

Faculty of Education
in Science and Technology

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Orit Hazzan: Research topics in *Policy of STEM (Science, Technology, Engineering and Mathematics) Education*

My recent academic – research and practice – work focuses on *Policy of STEM Education*, including:

- **Cross-sector collaboration:** upscale processes, collective impact, and RPP
- **Human resources:** predictions and professional development
- **Strategic analysis**: SWOT analysis, risk management, and change management

These topics are addressed in my academic work on K-12, academia and industry levels. Within the context of these topics, STEM education processes on *the national level* (beyond a specific program or initiate) are examined, in order to make a significant change in the Israeli eco-system to sustain Israel's economic growth and development

My work is largely based on my academic background in mathematics, computer science, education, and management and my acquaintance with the Israeli educational system in general and computer science education in particular, with the academia, and with the industry in Israel and its hi-tech sector.

In what follows, several examples of my recent research works, projects and activities on these topics are presented.

• Cross-sector collaboration in STEM education

- ***Collective Impact in Computer Science Education in NYC*** (with Leigh Ann Sudol-DeLyser)**:** Change in computer science (CS) education does not happen only in classrooms. The rapid expansion of CS education in New York City has built upon the efforts of many actors from both public and private sectors. This ongoing support cannot be tied to a particular program or curriculum, otherwise it will only last for as long as that program is relevant in an ever-changing world of technology.

  As we look at the larger ecosystem of stakeholders in the CS education landscape, *Collective Impact* theories can offer a framework for understanding and evaluating the roles of each subgroup/sector.

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In a recently submitted paper with Dr. Leigh Ann Sudol-DeLyser, Director of Education and Research at CSNYC - NYC Foundation for Computer Science Education, we focus on the larger ecosystem of entities with a stake in the expansion of CS education in NYC. In addition to the school-based community of parents, students, teachers, and administrators, we include in our discussion also policy makers, industry, non-profits, and community leaders. Specifically, in order to provide a lens to the NYC CS4All initiative, a 10-year plan to bring CS to every public school in NYC, we used the model of Collective Impact to describe the partnering organizations and the role they play in the NYC initiative. The lens of Collective Impact provided a theoretical focus on the rich public-private relationships enabling the potential sustainability of the NYC CS4All initiative.

- ***The (CS)^{2}V – Cross Sectorial Collaborative Shared Value – Strategy*** (with Bella Abrahams, Mariana Waksman and Ronit Lis-Hacohen)**:** The proposed Cross Sectorial Collaborative Shared Value – (CS)^{2}V – strategy aims to increase the impact of the organization's social investments and the effectiveness of Corporate Social Responsibility (CSR) divisions, whose traditional role is to bridge between the corporate and its external environments (i.e., other first, second and third sector organizations). The (CS)^{2}V strategy directs CSR divisions to connect the corporation's core business needs, from the corporate perspective, with the society's core needs, from the social and/or government perspective. This is done by addressing a national social problem that intersects with a business concern. In other words, CSR divisions can adopt the (CS)^{2}V strategy to fulfill their goals more meaningfully, by tightly and clearly connecting the corporation's core business, from the corporate perspective, with a society's core need, from the social perspective. Two examples are analyzed in the framework of this strategy: The 5X2 initiative whose target is to double the number of students who excel in math and science in Israel, and the MOOCs pedagogical approach. The following paper presents this perspective:
  http://edu.technion.ac.il/Faculty/OritH/HomePage/CSCSV_Strategy_March2016.pdf

- ***RPPs (Research Practice Partnerships) in STEM Education in Israel*** (with Einat Heyd-Metzuyanim and Judy Dori)**:** This research focuses on cross-sector research-based collaboration in STEM education in Israel. Cross-sector collaborations refer to partnerships among organizations from different sectors: the first (government and academia), second (industry), third (philanthropy) and fourth sectors (nonprofit) sectors. As it turns out, though many collaborations around educational efforts in the STEM subject exist in Israel among the different sectors, they are mostly neither research-based nor methodologically documented. Therefore, the knowledge generated as a result of the collaboration is not explored and does not serve other educational initiatives; in addition, organizations in

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general, and the Ministry of Education (MoE) in particular, are not exposed to kinds of collaboration that may foster their interest.

Specifically, a research project about RPPs in STEM education in Israel was conducted before, during and after a one-day conference that took place at the Technion, in which Professor Mary Kay Stein gave the keynote address about *Fostering Research-Practice Partnerships*. The data analysis revealed the following theme:

On the one hand, many research works in STEM education do focus on what goes on in the schools (and therefore, RPPs exist). On the other hands, such RPPs face obstacles rooted in the organizational structure and culture of both the Practice and the Research partners of the RPPs, that is, the MoE – from the Practice perspective, and the academia in Israel, from the Research perspective.

Therefore, while both the education system and academia agree on the necessity to collaborate, these collaborations are not fully actualized, and RPP in STEM education in Israel does not invest in the most critical problems needed for investigation for the improvement of these areas which are crucial for the economic growth and development of the state of Israel.

These observations were elicited from a SWOT (Strengths, Weaknesses, Opportunities and Threads) analysis we carried out on RPPs in STEM education in Israel, which identified the factors presented in Table 1. Based on this SWOT analysis, we also suggest several action items to better exploit the potential of RPP in STEM education in Israel.

Table 1: SWOT analysis of RPP in STEM education in Israel

Strengths	**Weaknesses**
1. Multiple activities in STEM education 2. Large research communities in the different STEM subjects in academic departments 3. In addition to the academic faculties, other research in education institutions exist	1. Culture Gap between the education system (schools and MoE) and the Academia 2. Regulations in the MoE 2.1. The structure of the teaching position 2.2. Organization structure of the MoE 2.3. Chief Scientist of MoE 2.4. The Mandatory Tenders Regulations No. 5753-1993 3. Academic culture and structure: Promotion, academic incentives, university reward system

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	4. Limited resources 5. A coordinating agent does not exist to match budgeting to initiatives as well as between resources and needs
Opportunities 1. The CHE (Council of Higher Education) evaluation report 2. Cross sectoral - Beyond 1st sector – awareness to STEM education in Israel: the IDF, the industry, philanthropy, non-profits	**Threats** 1. Priorities change 2. Responsibly of the education system is transferred from the state to private organizations

- ## Human resources in STEM education

  - ***Views:*** To proactively address the shortage in high school science and technology teachers in Israel, during my role as the Chair of the Department of Education in Science and Technology at the Technion (2011-2015), I initiated several programs. One of the most influential one is the *Views* program. The *Views* program invites Technion graduates back to the Technion to study towards an additional bachelor's degree in our faculty, which includes a teaching certificate for high school science and technology subjects. Technion graduates receive full study scholarships for two years, and they are not required to commit themselves to teach in the education system. Extending the program over two academic years enables the returning graduates to continue working concurrently with their studies. In its current, five years of operation (2011-2016), the program is attended by approximately 100 Technion graduates every year who returned to the Technion and study at our faulty. Since Israel is such a small country, it is estimated that this initiative will significantly impact Israel's science and technology education in the very near future.

    The following paper analyzes the *Views* program from a business perspective. It shows how it relates to, and is supported by, ten business-oriented ideas and principles: Hazzan, O. (2014). A Proactive Approach to High School STEM Education in Israel, *Tomorrow's Professor eNewsletter* 1337.

  - ***MERge*** (with Ronit Lis-Hacohen)**:** The *MERge* model contributes to the field of innovation and entrepreneurship by merging and consolidating different methodologies and insights borrowed from the meta-professions of **M**anagement, **E**ducation, and **R**esearch (which generate the prefix of *MERge*). The *MERge* model can be implemented in practitioners' professional development in general and in the context of STEM initiatives in particular, in

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industry, educational institutions and public sector organizations. Targeting three key groups—practitioners in industry, academic institutions and public sector organizations—this model proposes that all practitioners can further develop their unique expertise, as well as new skills, while acknowledging and applying the three meta-professions in their initiatives, on-going work and personal lives. The *MERge* model has recently published in a SpringerBrief: *The MERge Model for Business Development: The Amalgamation of Management, Education and Research*.

- ***Diversity in Computer Science Education*** (with Lenore Blum, Carol Frieze and Bernardine Dias)**:** There are some arguments that suggest women need academic handholding, such as a "female friendly" curriculum, in order for them to participate and be successful in CS and related fields. Then there are other arguments that suggest we need to change the field to suit women or help women adjust to the field. In this work with my colleagues at the School of CS at CMU, we present a different perspective that shows none of these may be necessary. The "Women-CS Fit" is already there. Specifically, under certain cultural and environmental conditions, we can see that women fit very well into computing fields and what we have been attributing to gender is actually the result of cultural and environmental conditions. The reasons for women participating in – or not participating in – the field of CS have little to do with gender and a lot to do with culture. In other words, we need to recognize that this is a cultural issue, and an issue that concerns us all. Appropriate local interventions in the micro-culture can have large effect. This argument is illustrated in the following paper by three case studies: A Cultural Perspective on Gender Diversity in Computing.

- ***Current Projects*****:** Due to the shortage of professional human resources in Israel in the STEM subjects, which are vital for the Israeli Industry in order to ensure Israel's economic development and growth, many activities take place in the Israeli eco-system. My recent work in this context focuses on:

  I. The Ultraorthodox sector, which currently is significantly underrepresented in the STEM subjects;

  II. Practical engineers, an expertise level, ranked between the high school diploma and the engineering diploma, which is of high needs for the Israeli industry.

• Strategic analysis of STEM education

- ***A Framework for Software Startup Ecosystems in Israel*** (with Fabio Kon, Daniel Cukier, Claudia and Harry Yuklea)**:** This work intends to improve the theoretical and practical understanding of the key elements and factors that promote the growth of a successful

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ecosystem by exploring the case of Israel, which hosts one of the most fruitful software startup ecosystems in the world. The data analysis led to answers to research questions related to sociocultural, institutional, technological, methodological, and educational aspects of entrepreneurship, startups, and their ecosystem. The following article introduces a conceptual framework of the Israeli startup ecosystem and presents lessons for entrepreneurs and policy makers. Finally, it proposes a generalized version of the framework that can be used as a basis for future research in the field: *A Conceptual Framework for Software Startup Ecosystems: the case of Israel*. Technical Report RT-MAC-2015-01.

- ***Risk Management of STEM Education*** (with Anat Even Zahav)**:** This work aims at illustrating how risk management can be applied to educational systems in general and STEM education in particular. The rationale for this attitude steams from the increased awareness of the importance and contribution of STEM education to nations' economy growth and development. Much like in a business organization, a three-phase, risk-management process was employed in our research for the case of STEM education in Israel. The research goal was to outline a risk-management plan to STEM education in Israel based on the conceptions of five stakeholders groups: Educators, academics, industrials, military and philanthropy actors.

  Research findings are presented according to the three phases of risk management process:

  A. **SWOT Analysis enabled risks identification.** The identified risks present the different perspectives of the research participants, and outline weaknesses and threats faced by the STEM education system, the existence of which endanger reaching national objectives.

  B. **Delphi Method produced risks prioritizing.** The findings indicate strategic risks, represent social perceptions in relation to STEM education. Strategic risks ranked as high-level risks in terms of the effect on the objectives of STEM education. Among those risks: high school pupils' self-perceptions with respect to scientific subjects; social perceptions regarding diminished image of technology studies; diminished public recognition granted to teachers; and sectorial gaps resulting from deeply rooted perceptions as well as historic processes which generated them.

  C. **Risk response - A reaction plan for strategic risk mitigation.** The research suggests the creation of *institutionalized cross-sector cooperation*, which preserves the role of the education system as the carrier of primary responsibility for public education, and yet enables other sectors to act in the service of advancing STEM education.