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Strategic Analysis of Educational Systems:

Risk Management of STEM (Science, Technology, Engineering and Mathematics) Education in Israel

Abstract[1]

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[1] The abstract is based on the doctoral research of Anat Even Zahav conducted at the Faculty of Education in Science and Technology at the Technion under the supervision of Prof. Orit Hazzan.

This research presents the implementation of a Risk Management process to STEM (Science, Technology, Engineerimg and Mathematics) education in Israel's high school education system. Much like in a business organization, a three-phase, risk-management process was employed: **Risk Identification, Risk Assessment** & **Prioritizing,** and **Risk Response.**

Strategic objectives for STEM education in Israel emphasize the importance of building scientific and technological human resources, in order to maintain the high-tech industry's role as a central driver of the country's economy. STEM education can promote equal opportunity, and enable potential-realization across population groups and strata. Science and technology knowledge is part of the general education necessary for the contemporary citizen, and even more so for the future one. STEM education also contribute to the development of learner functioning, adopted to the 21st century.

The main goals of STEM education in Israel are, therefore, to increase the numbers of students who choose studying STEM subjects in high school on the highest level, to institutionalize excellence programs, and to attract as many students as possible to those programs. Those goals become ever more challenging, as one witnesses the expected shortage of STEM teachers in Israeli high schools in the coming years.

Facing this reality, and the challenges it presents, professionals across the board – both in Israel's education system, the academia, the military, and the industrial sector – are encouraged to realize the need for action. It is necessary - if Israel wants to preserve its relative edge in research, if it wants remain a high-tech superpower, if it seeks to maintain its human capital, which is a direct result of wise investment in education.

This research performs a strategic analysis of high-school STEM education. The **research goal** is to outline **a risk-management plan** to STEM education in Israel based on the concetions of five stakeholders groups (below, research participants): Educators, academics, industrials, military and philanthropy actors, who all have vested interest in STEM education in general and in promoting STEM education in high school education system in Israel in patricular.

The risk management process performed in the research included SWOT analysis aimed at identifying risks, a Delphi method for the purpose of risks prioritizing, and a response plan aimed at mitigating risks faced by STEM education in Israel.

Research findings are presented according to the three phases of the risk management analysis performed in the research:

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 central objectives. The risks identified by STEM teachers are ones directly regarding teachers, bearing the marks

of possible ramifications of those risks on them **as teachers** (e.g. risks associated with professional opportunities, training and professional status). Risks identified by other stakeholders express the risks they perceive as having potential effects of their organizations. Thus, for instance, failings in forming a clear learning and pedagogical path from high school to academia to the work market, can trigger manpower shortages in the military, the industry and the academia; high school pupils' self-perceptions with respect to scientific subjects, and social perceptions regarding diminished status of technology professions may effect the work market.

B. Delphi Method produced risks prioritizing. Delphi survey reached out to 186 research participants. The survey's 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 in Israel; and sectorial gaps resulting from deeply rooted perceptions as well as historic processes which generated them.

C. Risk response planning that may reveal opportunities to mitigate strategic risks. ***A reaction plan for strategic risk mitigation*** that proposes action items to *mitigate* strategic risks, by *avoiding* operational risks and *accepting* external risks is formulated. Thirteen modes of action were proposed: five regarding internal action within the education system, eight involving cooperation with stakeholders of STEM education in Israel.

Proposed actions regarding internal action within the education system include: (1) Proposals to strengthen the training component among STEM teachers; opening professional tracks to promote STEM teachers career; constructing accompanying programs for novice teachers; (2) The granting of academic freedom for teachers while releasing supervision of the teacher's work; (3) Creating STEM education policy managed by the education system to encourage students to choose STEM studies in high school; (4) focusing on developing capability and competence among students and avoiding referring them to low level courses in STEM subjects; (5) Equalizing the wage to novice and senior STEM teachers.

Proposed actions involving cooperation with stakeholders of STEM education in Israel include: (1) Seeking ways to enable integration of STEM teachers in the industrial sector; (2) Designing curriculum of STEM studies and career planning programs, which are future-work-market-oriented; (3) Exposing students to the high-tech industry; (4) Creating cross-sector cooperation to advance populations under-represented in STEM education; (5)

Improving teachers' income through part-time employment in the industry; (6) Generating budget growth for STEM education through business and philanthropy involvement; (7) The establishment of a National Council for STEM education, thus joining stakeholders in a common national effort; (8) Creating Institutionalized Collaboration with business sector, NGO (Non-Government Organizations) and military as a way of coping with challenges and conflicts in multi-sectoral relations.

The research has both theoretical and practical contribution.

As for the **theoretical contribution**, the strategic risk management analysis provided educational administration research with tools and methods (SWOT, Delphi and Risk Management) for analyzing educational systems. As for the **practical contribution**, the empirical data and knowledge accumulated in this research, mainly with respect to STEM teachers' perceptions, is critical: teachers are under-represented in relevant committees, and their voices are seldom heard in relevant fora. The research's practical contribution provides an applicable action plan, which is largely based on the teachers' voice, aimed at confronting the challenges facing STEM education in Israel, a plan which might serve policy makers.

It should be noted, in conclusion, that in reality cooperation already takes place, between the education system and other stakeholders – academia, military, industry, and philanthropy institutions. Such cooperation is much desired, but the research suggests it should be carefully examined, so that the best mode of cooperation is adopted, one which accounts for the weaknesses and strengths of all stakeholders.

One possible mode of action is the creation of **institutionalized cooperation, cross-sectors**, one which preserves the role of the education system as the carrier of primary responsibility for public education, and yet enables other sectors and stakeholders to act in the service of one important goal: advancing STEM education, for the benefit of society, and future generations.