

Chapter 2

SWOT Analysis of STEM Education in Academia: The Disciplinary versus Cross Disciplinary Conflict

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Abstract In this chapter, we show how to turn a SWOT analysis process of an academic faculty into a strategic plan in a way that fosters the strengths, eliminates the weaknesses, exhausts opportunities, and deals with outside strengths. The case described in this chapter focuses on the Technion's Faculty of Education in Science and Technology. The SWOT characteristics, though specific to this particular faculty, are also a result of the tensions that exist almost in any universality between teaching and investigating *disciplinary* content knowledge on the one hand and the application of *general* pedagogical principles, approaches, and methods on the other hand. On top of these tensions, there are also constraints of funding, human resources, and workload of both faculty and students, which are common to all the academic disciplines. As such, the analysis can serve as a useful managerial tool for coping with the challenges that a Science, Technology, Engineering, and Mathematics (STEM) faculty faces while finding creative avenues for growth and improvement of their teaching and research.

Keywords Academia · Disciplinary vs. interdisciplinary · STEM education · SWOT analysis

2.1 Introduction

This chapter focuses on how to find effective ways for managing an academic STEM education faculty for delivering STEM education at the highest possible level in the face of a lingering conflict between disciplinary focus and interdisciplinary orientation.

There are several models for promoting STEM education. One is STEM discipline affiliation, i.e., science educators are research faculty who are affiliated with the respective STEM departments, that is, a mathematics educator in the math department, a biology educator teaches and conducts research as a faculty member

in the biology department, and so forth. Examples of universities that apply STEM affiliation include North Carolina State University (e.g., Robert Beichner—a physics educator at the Department of Physics); University of Massachusetts Boston (e.g., Hannah Sevia—a chemical educator at the Department of Chemistry), or University of Arizona (Vicente Talanquer—a chemical educator at the Department of Chemistry and Biochemistry). Another category under this model is a “second career in STEM education”—scientists who chose to focus on science education research and practice in addition to “pure science” (e.g., Carl Edwin Wieman a physicist and educationist at Stanford University, who was awarded the Nobel Prize in Physics; Joe Redish at the Department of Physics at Maryland University; John Belcher at the Department of Physics at MIT).

A second model is STEM education affiliation in which a group of STEM educators operates as an independent unit or as part of a school or college of education. Technion, Weizmann Institute, Michigan State University, and University of Georgia are examples of the STEM education affiliation model.

Each of the models—the STEM affiliation model and the STEM education affiliation model—has advantages and challenges presented in Table 2.1.

In this chapter, we present and analyze a case study involving the Faculty of Education in Science and Technology at the Technion. This STEM education academic unit is unique, since it is equivalent to a school in the US university system, and it is the one of a few that covers every STEM discipline.

Focusing on this academic unit, we carry out a detailed SWOT analysis to identify advantages and challenges with respect to delivering STEM education to almost all age levels at the highest quality possible.

Table 2.1 The STEM affiliation model and the STEM education affiliation model—advantages and challenges

Educational model	Characteristics	Advantages	Challenges
STEM affiliation	Focus mostly on higher education	Possible collaboration with faculty teaching the courses; immediate access to research population and settings	Often one science educator is alone in a discipline; little interaction with other STEM educators at the same university
STEM education affiliation	Focus on investigating various age groups	A group of science educators who can collaborate on big projects	Distance from some research settings, e.g., schools
		Focus on broad areas of research: learning, teaching, informal education, out-of-school education, science communication, educational technology	

2.2 Theoretical Background

As noted in the introduction, science education scholars and researchers affiliation follows one of two main models: STEM affiliation, in which the science educator is associated with a mathematics, science, or engineering department, or the STEM education affiliation, in which the science educator is associated with a school, college, or department of education. The Policy Forum of Science Magazine (Handelsman et al. 2004) has emphasized scientific teaching, which involves active learning strategies to engage students in the process of science and teaching methods that have been systematically tested and shown to reach diverse student populations. The authors explicitly noted: “Universities need to provide venues for experienced instructors to share best practices and effective teaching strategies. This will be facilitated, in part, by forming educational research groups within science departments. These groups might be nucleated by hiring tenure-track faculty who specialize in education...” (p. 522). Almost a decade later, the Discipline-Based Education Research (DBER) Report (Singer et al. 2012) acknowledged the field of education research in higher education and recommended that “science and engineering departments... clarify expectations for DBER faculty positions.” (p. 4). However, much research on teaching science and engineering is done by science educators affiliated with dedicated academic units that focus on science education which may be independent, like the Faculty of Education in Science and Technology at the Technion, or located within a school or a college of education, as is the case with the School of Education of University of Colorado Boulder or the College of Education at the University of Missouri-St Louis and many more such departments.

STEM education studies are collaborative efforts of STEM educators and scientists. Such initiatives have been described in (a) Two Special Issue of Journal of Science Education and Technology—JOST focusing on Educational reform at MIT (Dori 2007, 2008) and (b) the Special Issue of the Journal of Research in Science Teaching—JRST on Discipline-Centered Post-Secondary Science Education Research, co-edited by a scientist and a science educator (Coppola and Krajcik 2014). Indeed, most papers in the JOST special issues and the one of the JRST Special Issue were written collaboratively by scientists and science educators or engineering educators and engineers. Such collaborations occur regardless of affiliation and position (e.g., Barak et al. 2007; Dori and Belcher 2005; Dori et al. 2007; Lipson et al. 2007; Marbach-Ad et al. 2010; Mintz et al. 2013; Mitchell et al. 2011; Tsaushu et al. 2012), but in general, science educators are more focused on K-12 rather than on post-secondary teaching and learning.

Examining the two models of STEM educators’ affiliation, the question that arises is whether the structure matters. Biglan (1973) found that social connectedness was significantly higher among scientists (“hard areas”) than among social scientists (and other “soft areas”). In contrast, researchers in “soft areas” are more

committed to teaching. Such distinctions imply that scholars in different fields have unique and different cultures. Becher and Trowler (2001) referred to mapping of “Tribal Territories” and use the metaphor of landscape to emphasize that these territories are not only natural, but also socially constructed. They argued that in light of differences between academic territories and landscapes, attention should be paid to differences between disciplinary and even to subdisciplinary groups. Hativa and Marincovich (1995) acknowledged the pioneering work of Biglan and his analysis of $2 \times 2 \times 2$ matrix of hard versus soft areas, applied versus pure areas, and life versus non-life area. They argued that in addition to the recognition of differences between disciplines, there is growing recognition of the differences in learning within the disciplines. Despite the increasing awareness of the power of disciplines, there is relatively little research on the boundaries between them and their characteristics in terms of quality of teaching and learning in higher education.

Given this state of affairs, the question raised is what possible ways of operating and managing faculty and experts would provide high-quality STEM education?

The focus of the analysis provided hereinafter is on the Faculty of Education in Science and Technology at the Technion, Israel Institute of Technology. This Faculty is an independent science and technology education faculty (school in US terms), which is situated within a science and engineering research university. Using Biglan’s terms, the question being asked is: What is the status of an academic unit that does “soft” research on teaching and learning in “hard” disciplines?

Using Becher and Trowler metaphors, we look at landscapes while using the ecological metaphor of relationships.

2.3 Setting

The Faculty of Education in Science and Technology at the Technion, Israel Institute of Technology, is one of 18 academic units (mostly Faculty). With 12 faculty members including the dean, the mission of the Faculty of Education in Science and Technology (hereinafter “the Faculty”) is to pursue excellence and maintain international leadership in science, technology, engineering, and mathematics (STEM) education. The Faculty conducts this mission through our highly innovative research on learning, instruction, and assessment in both formal and informal educational settings and across the learner’s life span. The Faculty is the largest of its type in Israel and one of the largest worldwide. It has 12 full-time faculty members, six of whom are tenured and six in tenure-track positions. The faculty members are distinguished, established scholars and leaders in their respective STEM education communities. Their achievements include extensive lists of publications and participation in international and national professional fora, including invitations to give keynote lectures in conferences and seminars.

2.3.1 Structure, Organization, and Research of the Faculty

The Faculty is structured to support our mission by achieving excellence in research, educating prospective teachers and training in-service teachers, mentoring of future generations of researchers, and sustaining communities of practice in STEM teaching and learning. Dean (first author of this chapter) heads the Faculty. In addition to the 12 faculty members, there are about 30 adjunct teaching specialists and nine administrative and technical staff. The Faculty's academic programs cover learning and teaching of all the STEM topics within the context of six thematic areas: teaching and teacher education, curriculum, learning environments, lifelong learning (LLL), science communication, and educational neurosciences. Educational research methods are also a distinct teaching theme. Faculty members are responsible for the academic programs and core teaching activities in all the themes.

Basic and applied research within the Faculty covers both the traditional fields of STEM education, such as learning, teaching, and assessment, and new areas, such as learning sciences, neuroimaging and neuro-education, science communication, multicultural education, ethics education, and entrepreneurship. Our research spans these STEM topics, as represented in the Faculty's research portfolio. Faculty members and their graduate students publish in leading journals and collaborate extensively both nationally and internationally. In addition to formal and informal science learning environments, faculty members conduct applied research that takes place in and informs K-12 education, higher education, the public and private sectors, and third sector organizations.

2.3.2 Academic Programs at the Faculty as a Way to Achieve Excellence in STEM Education

Recalling that the goal of this chapter is to propose a way to organize an academic unit for achieving excellent STEM education, in this section, we describe the six academic programs at the Faculty and how their organization serves the purpose we seek to achieve.

The Faculty offers several programs for a large body of students: (a) a four-year B.Sc.Ed. program, (b) Views I program in STEM Education for Technion STEM graduates, which is a postgraduate program,¹ (c) M.Sc. with and without research thesis, (d) Views II program—M.Sc. with teaching certificate for excellent Technion STEM graduates, (e) a Ph.D. program, and (f) a teaching certificate for non-Technion graduates. Orthogonal to this cross-disciplinary set of programs,

¹The Council for Higher Education (CHE) considers graduates of this program as completing an additional B.Sc. degree.

studies are organized around eight disciplinary education tracks: biology, chemistry, computer science, electrical engineering, environmental sciences, mathematics, mechanical engineering, and physics. Additionally, there are six cross-disciplinary themes, including educational neuroscience, educational technology, science communication, science education in informal environments, project assessment, higher education, and career paths.

Accounting for the 14 tracks (comprising the eight disciplinary and six cross-disciplinary tracks) on one hand and the six study programs, there are 84 cells in a matrix, where each cell is a theoretical combination of a study program in some track. However, in practice, students from different tracks and level of maturity in the research and non-research tracks are studying together. One example is integrated courses in the B.Sc.Ed. and M.Sc. programs in Mathematics Education. Another is the M.Sc. and the Ph.D. program in Electrical Engineering Education.

This matrix organization, while difficult to manage, provides at least a partial solution to the inherent tension existing between general educational principles—pedagogical knowledge—and domain-specific or disciplinary knowledge—pedagogical content knowledge (PCK, Shulman 1986), i.e., pedagogical knowledge that is specific to each STEM domain and needs to be studied and applied separately for almost each of our eight disciplinary educational tracks. Moreover, the six programs span a wide spectrum of expertise levels, from the basic one that B.Sc.Ed. students get all the way to the Ph.D. programs. This variability requires adjusting the level of teaching and learning in order for them to be in par with the diverse capabilities and backgrounds of the students enrolled in these programs.

How is this feasible? How can a faculty body of 12 members control such a bewildering variety of programs, disciplines and cross-disciplinary domains? This is indeed a huge challenge, which is discussed as part of our SWOT analysis, described in the next section.

2.3.3 The Method: SWOT Workshop

SWOT analysis highlights the strengths and weaknesses of an organization, as well as the opportunities and threats it faces (see more details in Chap. 1 of this Brief as well as Afzalur Rahim (2002)). This type of analysis facilitates the development of strategies that amplify the strengths, maximize the advantages of opportunities, and defend the organization from weaknesses and threats.

Strengths are characteristics of an organization that give it advantages over others. Weaknesses are characteristics that place the organization at a disadvantage. Opportunities are phenomena, generally external to the organization that can be used to its advantage, and threats are external conditions that can hinder the organization's ability to achieve its goals.

The present SWOT analysis was the product of a multistage process. The initial impetus was the highlighting of constraints and opportunities for growth within Research–Practice Partnerships (RPPs) at a national symposium organized by the third author in the Faculty. This was followed by a daylong workshop (Faculty Day) attended by faculty members, adjunct teachers, and administrative staff.

Participants in the workshop were divided into groups for thinking about main issues concerning the current and future status of the Faculty. These included issues such as hiring future faculty, preserving and extending tracks, tending to the needs of graduate students, and more. Each group was asked to think about their subject in relation to the SWOT characteristics. The groups then shared their work in the plenary, where additional ideas were raised and discussed.

At the end of this process, a smaller team of senior faculty went through the SWOT table obtained in the workshop, refined entries that needed elaboration, and collapsed redundant entries. The senior faculty then reviewed the final table (see Table 2.2) and agreed on its contents. They made sure that each characteristic listed in Table 2.2 is also related to a specific set of actions that feed into the Faculty's strategic planning.

2.4 Findings

The general theme emerging from the SWOT analysis is as follows: The faculty in its current format has many strengths, including a relatively large number of faculty members and students, compared to other academic institutions; Faculty members are positioned to impact STEM education in Israel; multidisciplinary facilitates widespread and varied teaching and research collaborations. Weaknesses identified included unstable research budgets and inadequate research support facilities. Opportunities included a growing demand for the Views I and Views II programs and the current need for technology and engineering professionals, driven by a parallel demand for high school teachers in these fields. Finally, threats identified included large proportion (25%) of faculty members who will retire within the next five years relative to the total number of faculty members (3 out of 12).

The action points detailed in the right-hand column of Table 2.2 are an integral part of the SWOT analysis and were key in developing the strategic plan.

2.5 Strategic Plan

This section focuses on four aspects of the Faculty future and strategic plans: (1) hiring plans, (2) teaching load, (3) the Views program, and (4) the graduate program.

Table 2.2 Faculty SWOT analysis

<i>Strengths</i>	
Strengths: faculty and faculty members	
Characteristic	Strategic plan item
The Faculty is the largest STEM education academic unit in Israel in terms of number of faculty members and number of students	Capitalize on the critical mass to maintain excellence and pursue new directions in teaching and research
Tenured, tenure-track faculty members, and adjunct lecturers are professional and dedicated. Each has a proven record of accomplishment in research, teaching, or both	Ensure opportunities for advancement and professional development Enable adequate career opportunities for adjunct staff
The Faculty is well positioned to impact STEM education in Israel:	
Alumni of the various tracks in the Faculty hold positions in which they can influence developments in educational practice and policy through the education system (including Ministry of Education), in industry and the public sector, NGOs, and academia	Maintain high level of interdisciplinarity and multi-sector focus in training of students to develop their awareness of their potential role in education Maintain high level of interaction with education system and adjust teachers' training priorities as appropriate
Faculty members influence developments in educational practice and policy through the dissemination and application of their research, through consulting activities (e.g., with Ministry of Education, Ministry of Science, Technology, and Space, CHE) and by training cohorts of highly skilled educators	
Faculty members are well informed about trends in Israel's education system and able to address programming needs proactively. For example, through the Views programs and through promotion of training of high school teachers with expertise in engineering and technology	
Faculty members, alumni, and Views I/II students have strong ties to industry	Maintain these ties through relevant applied research and the training of educators with industry-relevant skills
Strengths: research	
Characteristic	Strategic plan item
The Faculty's multidisciplinary nature facilitates research collaboration within the Faculty and with other Technion units. Links with the following Technion departments are especially strong: environmental engineering, architecture and town planning, and industrial engineering; electrical engineering, biomedical engineering, and medicine	Actively expand collaborations by engaging with other Technion researchers whose work has synergies with fields in education

(continued)

Table 2.2 (continued)

<i>Strengths</i>	
Research within the Faculty includes important, cutting-edge topics in K-12 and post-secondary STEM education that is relevant within Israel and internationally	Recruit outstanding research student and postdocs with interest in cutting-edge STEM topic Orient recruitment strategy toward hiring new faculty members with appropriate skills and interests Enhance research support infrastructures such as laboratories
Strengths: teaching	
Characteristic	Strategic Plan Item
The Faculty program of graduate studies is acknowledged as one of the leading programs in Israel for training high-quality educational researchers and practitioners	Maintain the quality of graduate program; raise and secure funds for graduate scholarships
The Views program is a highly innovative approach to training STEM educators. By recruiting outstanding students who already have strong academic backgrounds in STEM disciplines and in some cases complementary professional experience, the program has increased the supply of excellent high school STEM teachers	Expand opportunities for student recruitment and financial support Recruit new teaching staff in key areas Promote research opportunities for Views II students
The Faculty's teaching activities are closely linked to the school system and education field ensuring both smooth integration of alumni into the teaching profession, maintaining communities of practice and enhancing the application and dissemination of research	Maintain these ties through teacher training and mentoring programs for early career teachers and support through teaching centers
The Faculty is the only unit in Israel to prepare engineering and technology high school teachers	Given current and anticipated future shortages of qualified teachers in these areas must be priorities within Faculty teacher training
Excellence in teaching and pedagogical design evidenced by external recognition; for example, the receipt of the Yanay Award for special excellence in teaching by two faculty members.	
Strengths: impact	
Characteristic	Strategic Plan Item
Faculty alumni hold positions in which they can influence developments in educational practice and policy through the education system (including Ministry of Education), in industry and the public sector, NGOs, and academia	Maintain high level of interdisciplinarity and multi-sector focus in training of students to develop their awareness of their potential role in education

(continued)

Table 2.2 (continued)

<i>Strengths</i>	
Faculty members influence developments in educational practice and policy through the dissemination and application of their research, through consulting activities and by training cohorts of highly skilled educators	
Faculty members are well informed about current and future trends in Israel's education system and able to address programming needs proactively. For example, through the Views program and through promotion of training of high school teachers with expertise in engineering and technology	Maintain high level of interaction with education system and adjust teacher-training priorities as appropriate
<i>Weaknesses</i>	
Weaknesses: faculty and faculty members	
Characteristic	Strategic plan item
Changes in education require augmentation of Faculty by researchers having the necessary skill sets	Recruitment of new faculty members is an attempt to respond to these needs and increase the faculty member body and its diversity
We lack faculty members in certain research areas of education and disciplines. Expected faculty retirement in chemistry and engineering education is looming	
Weaknesses: research	
Characteristic	Strategic plan item
Research budgets are not stable	Improve grant writing and increase fundraising efforts
Research support facilities are inadequate	Secure increased funding from the Technion
Weaknesses: teaching	
Characteristic	Strategic plan item
High ratio of students to faculty limits our ability to meet demand for expanded teaching programs and number of mentored research students	Increase number of faculty members through recruitment of excellent Ph.D. students near graduation. We proactively approach such students and encourage them to pursue postdoctoral fellowships
The demographics of faculty members does not represent the diversity of student body and proportion of student from the Arab sector	Make greater efforts to hire new faculty members from underrepresented groups
Lack of well-defined progress track for adjunct lecturers	Introduce formal process for advancement of adjunct lecturers
Mentoring of junior teachers of engineering in the areas of PCK	Prioritize this area within existing mentoring programs

(continued)

Table 2.2 (continued)

<i>Weaknesses</i>	
Weaknesses: finance, administration, and infrastructure	
Characteristic	Strategic plan item
The Faculty building and facilities are aging and in need of major renovations and expansion, including office space, laboratories, conference rooms, future learning spaces (FLS) classrooms, video conference rooms, collaborative learning spaces, library, and equipment	Raise external funds and secure budgets from the Technion for modernization of building and facilities
Insufficient support of management staff, including management of research budgets, purchasing, hosting visits, reserving rooms, and organizing conferences	Clarify job definitions and responsibilities, introduce professional development programs aimed at Faculty management staff
Lack of services and technical staff such as laboratory technicians, statistics, graphics, and language editors	Expand operating budget to meet these needs
Weaknesses: impact	
Characteristic	Strategic plan item
Lack of formalized links between academia and the education system limits the ability to influence. Influence is overly reliant on informal channels and individual initiatives	Maintain networks through outreach infrastructures—teacher centers, etc.
<i>Opportunities</i>	
Characteristic	Strategic plan item
Young and growing Faculty, that is able to draw on its rich prior experience as a department and benefit from advantages accompanying the Faculty status; for example, the opportunity to increase the number of Faculty member appointments	Increase the number of faculty members and integrate early career scholars
Demand among non-Technion graduates for participation in Views I and Views II and potential, dependent on increased funding	Build on early successes of the Views program to recruit new highly qualified students. Expand Technion support and attract financial support from external sources
Informal/lifelong learning has risen in importance within industry, government, and NGO sectors. Links to advanced industry have not yet been fully realized	Engage stakeholders from all sectors, through participation, application, and dissemination of research and by continuing to develop teacher-training courses that are relevant to non-academic environments. Where relevant engage Views students who have professional experience in engaging with these sectors
There are growing needs for technology/engineering professionals accompanied by derived demand for high school teachers in these fields	Increase training opportunities for high school teachers in technology and engineering; hire faculty and adjuncts with appropriate specializations; promote research (especially applied research) in this field

(continued)

Table 2.2 (continued)

<i>Opportunities</i>	
The Faculty and the Technion attract excellent students	Active outreach to prospective students including promotion of STEM education as a field of study and profession
Two education-oriented units within the Technion—the Pre-Academic Unit and the Center for Promotion of Teaching and Learning—have interests and expertise that is complementary to the Faculty’s	Promote collaboration with these two units
New York and Chinese campuses offer expanded opportunities for collaboration and for providing students and Faculty members with high-quality international experience	Encourage students and faculty to study and collaborate with these campuses. Develop opportunities for academic exchanges
The relationship of students and faculty members with industry can foster further innovations in the world of educational technologies	The Faculty’s teaching programs train professionals with skills to deal with these issues
The global and changing job markets require new teaching and learning methods for interdisciplinary domains and twenty-first century skills	
<i>Threats</i>	
Characteristic	Strategic plan item
Three out of 12 faculty members will retire within the next five years. This is a large proportion of the total number of faculty members. Retirement at the age of 67/68 is mandatory in Israel	Priority must be given to planning for and managing the transition by hiring new faculty members with similar specialties to those of the retiring faculty members and by ensuring that the “institutional expertise” of veteran members is not lost
Heavy reliance on adjunct instructors (relative to the number of permanent faculty members) carries with it the risk that the instructors may not be well integrated	Ensure that processes for integrating of adjuncts are established and ongoing
There is shortage of qualified candidates for recruitment of faculty members in Israel and inability to recruit candidates from abroad due to language barrier	Flexibility in hiring practices, for example, permitting the hiring of promising candidates prior to their gaining international experience and reputation
There is uncertainty regarding the CHE’s decisions on the ultimate status of the postgraduate program status	Develop alternate plans for academic programs including support from the Technion. For example, promote Views II as an advanced degree, which will not be affected by the CHE decision
Insufficient support and investment in science and engineering education in government level in Israel	Take part in advancing the issue in policy agendas

2.5.1 Recruiting New Faculty in the Next Five Years

Faculty's hiring plans were designed to overcome the Weakness of lack of faculty in specific areas, the Threats of expected retirement and to take advantage of the Opportunities of young and growing faculty. As such, they are aligned with the demographics of its members, with developments in the field of STEM education as well as with changes in the student population and the needs of the education system. Particular attention is paid to ensuring that all STEM fields continue to be represented, and that our unique approach to interdisciplinary teaching and research is maintained.

The Faculty's demographic differs from the "classic" academic model. Many of our researchers and lecturers completed their Ph.D.'s and joined the Faculty after a number of years of professional experience within the education system as teachers. As a result, the age at entry is higher than in many other academic units. This has several implications, such as the average age within the Faculty is older. A similar challenge relates to the problem of finding faculty member candidates who have the requisite postdoctoral experience abroad prior to joining the faculty. As a result, an important element in the Faculty's recruitment strategy is to consider recent Ph.D. graduates and some who are very close to completion and who have published at least one or two peer-reviewed papers, but who still lack international experience. These young scholars are hired at a Lecturer rank, which is the lowest rank in the tenure track (similar to the British system) and are expected to obtain extended international experience as postdocs or visiting scholars during their tenure-track period. The faculty had good experience with such a process when previously hiring biology education and math education faculty members.

Given the anticipated retirement of several faculty members over the next five years, criteria for assessing candidates for recruitment therefore include demonstrated excellence in STEM education, especially at the high school level as well as DBER in higher education as a primary research interest. This is particularly true of technology and engineering education since the Technion is the only university that trains high school engineering teachers in Israel. Cross-disciplinary educational research experience is also a highly desirable qualification. This includes, experience in educational policy, assessment, advanced information and communication technologies, informal learning, science communication, creativity, giftedness, learning disabilities, and game-based learning.

Recruitment also focuses on the candidates' potential to develop high-level collaborations with other units within the Technion, within Israel and abroad (Dori and Belcher 2005). Similarly, the capacity to train future teachers in transformative education models such as MERge (Hazzan and Lis-Hacohen 2016) that promotes the amalgamation of management, education, and research is highly valued.

2.5.2 Teaching Load

As a general rule, each faculty member teaches two courses per semester, totaling four to six weekly hours. These courses usually include one undergraduate and one postgraduate course. Some faculty members also take academic responsibility for additional courses that are taught by adjunct faculty. In addition, adjuncts are an integral part of our teaching staff. Most adjuncts also maintain in roles in schools and colleges of education (teacher training institutions). Thus, the close relationship with them maintains the Strength of ties with the educational system.

With the introduction of the Views program, the Faculty's student population has grown dramatically, and this growth is expected to continue. Therefore, and in line with our goal to overcome the Threat of reliance on non-tenured adjuncts, recruiting and sustaining adjunct faculty as teaching faculty is a high priority. Recruitment targets Ph.D. alumni of the faculty and others from industry, government, and other sectors with expertise in particular fields.

2.5.3 The Views and Graduate Programs

As mentioned earlier, the Views program is targeted at excellent B.Sc. graduates of the Technion, training them in the course of around 1–2 days a week over 4–6 semesters to become high school teachers. Views I offers an additional minor in STEM education, which includes a teaching certificate, while Views II offers an M. Sc. degree. Both programs provide students with full tuition scholarships. The two Views programs have become the Faculty's flagship teacher education programs and figure highly in the Strengths rubric of the SWOT analysis. Therefore, consolidating Views I and advancing Views II is a major aspect of the Faculty's strategic plan. So is developing and disseminating research on Views as a model for STEM teacher training, as well as its impact on STEM education within the school system and Israeli society as a whole. The first five years of Views I have shown that the program's alumni have skills in management, teamwork, and negotiation as well as the ability to cope with vagueness and manage risks. These are all highly relevant for mediating and applying STEM in multiple sectors and over the life course.

Views I graduates teach in Israeli high schools and have included over the past 5 years approximately 350 students. To overcome the Weakness of Views programs being targeted only at Technion graduates, the strategic plan includes raising funds to recruit outstanding graduates of other Israeli universities. This includes fundraising to provide scholarships that would support these candidates in a manner similar to that provided to the Technion alumni (currently, non-Technion degree holders are ineligible for the tuition support and can get partial support from the Ministry of Education).

The strategic plan for the Views program includes an extension in two directions—one is high school management and the other is educational technologies. These are elaborated below.

As mentioned in the Strengths component of the analysis, the Faculty program of graduate studies is acknowledged as one of the leading programs in Israel for training high-quality educational researchers and practitioners. The Faculty devotes thought and resources to continuous upgrading the program to ensure excellence in research and educational leadership. The recent recognition of our department as a faculty demands further development of the graduate program. Directions for the next five years include:

To take into account the Opportunity of Technion's international campuses, the strategic plan includes internationalization of the program. This is in line with the Technion's emphasis on the development of international collaborations in research and education. As part of this effort, the Faculty plans to open its gates to international graduate students in STEM education research. The Technion campuses in New York and China will also provide a platform for the effort. Challenges involve finding the appropriate balance of Hebrew and English languages, inclusion of students with diverse backgrounds, and the fact that they will need to function in the school system in which the language spoken is Hebrew or Arabic.

Excellence programs: In view of the Threat of shortage in young and promising educational researchers and/or leaders in the educational system, the Faculty plans to establish (a) flexibility in hiring practices for tenure-track positions, (b) a special framework for outstanding graduate students interested in academic careers, and (c) a leadership program for leaders in the educational system, preparing the next generation of school principals or national STEM superintendents. These last two programs will offer intensive courses, close involvement in research, and international student exchange.

Advanced educational technology infrastructure: To overcome the Weakness of the Faculty's facilities aging and in need of major renovation, the strategic plan includes raising and securing funds for such renovations. Modern STEM education is based on experiential learning in technology-rich environments. The Faculty believes that such infrastructure is essential for the professional development of graduate students as prospective teachers and researchers. As a first step, we are currently renovating the library and redesigning it into a collaborative learning space.

Interdisciplinary Graduate Study Programs: In line with the Opportunity of global and changing job markets, that require new teaching and learning methods for interdisciplinary domains, we plan to develop two Interdisciplinary Graduate Study Programs: (a) in sustainability, partnering with environmental engineering, architecture and town planning, and industrial engineering; and (b) in mind, brain, and education, partnering with several engineering units, such as biomedicine engineering, industrial engineering, as well as medicine.

2.6 Summary

In this chapter, we provided a detailed case study and SWOT analysis of the Faculty of Education in Science and Technology at the Technion as a case in point. It demonstrates both the viability of this academic unit and the challenge it faces to maintain and strengthen its position as a world-class unit of STEM education. Through the lens of this particular academic unit, we have been exposed to the problems and difficulties similar academic units or departments worldwide face as they struggle to deliver STEM education of the highest quality with limited resources. Projecting the specific situation of the Faculty to other similar academic units worldwide can serve as a yardstick to compare and contrast the challenges others in the domain of STEM education face as they struggle to fulfill their mission. Specifically, this monograph might provide assistance to those who are uncertain about the desired structure of newly created STEM academic units with respect to whether they should be distributed across the disciplinary STEM units or incorporated in the same unit. The analysis here clearly points to the benefits of having the STEM educators in an integrated unit while interacting with the disciplinary scientists about education.

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