STEM Education – Developing Knowledge and Skills

The Afeka Framework

Implementing Change in an Educational Process Using the Principles of Engineering Design

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AFEKA
The Academic College of Engineering in Tel Aviv

STEM EDUCATION

THAT INSTILLS
KNOWLEDGE, SKILLS AND VALUES
IS THE BASIS FOR THE
NATIONAL SOCIOECONOMIC RESILIENCE
OF THE STATE OF ISRAEL

Executive Summary

It is commonly suggested that up to 65% of today's first graders will work in fields that currently do not exist. While the accuracy of the statement itself can be debated, its essence is indisputable, raising the question of how we decide what to teach school children today in order to prepare them for the future. Technology is advancing at an exponential rate, redefining the world as we know it and influencing all aspects of our lives, making it increasingly crucial to develop a skilled human resource pool that will advance Israel's capabilities, maintain the country's international status in the fields of science and technology, and preserve, or even strengthen, its economic resilience. With this emerging reality in mind, we at Afeka Tel Aviv Academic College of Engineering decided to change the way we educate engineers. We set out on the journey with many unanswered questions, such as – What is expected of an Afeka graduate in order to succeed as an engineer in today's constantly changing employment market? And how can we be best prepare our students for the future?

In this paper we chose to share the framework we developed for implementing change in our educational process, its outcomes, and just as importantly, the experience we gained and the lessons we learned along the way. We chose to do so because we believe that this framework can serve other educational structures – from classrooms, through municipalities and up to the national education system – and benefit the future of our children, the Israeli economy and the nation as a whole. The COVID19 crisis gave us all an opportunity to witness the consequences of exponential change and the enormous effect science and technology have on our daily lives – thus further strengthening our resolve to share what we learned and to take part in the national effort to prepare for the future.

STEM (Science, Technology, Engineering and Mathematics) education is a vital tool in developing a skilled national workforce. It provides an interdisciplinary, integrative approach to learning scientific disciplines and developing relevant skills such as critical thinking, problem solving and multidisciplinary teamwork. It offers both formal and informal learning by combining personal interest, enjoyment, and passion – whether on an educational campus or off – in the community or in the workplace. The importance of STEM education as a tool is clear – the economy of the future will be STEM oriented, and the world's leading countries have already begun formulating STEM education strategies along their educational continuums. This reality, together with the awareness that quality STEM education is critical for the successful assimilation of future graduates of our educational system into society, and more specifically into the workplace, makes it imperative to establish a strong STEM education infrastructure in Israel.

In order to develop skilled human capital, the educational system must "instill in its students {…} the skills they need to thrive and succeed personally, professionally and as members of 21st century society" (State Comptroller, 71b Annual Audit Report from March 2021). However, the current lack of clearly set goals for the educational process and the lack of holistic planning encompassing the entire national educational continuum are inhibiting, not only the realization of our personal, societal, and national potential, but also the ability to effectively plan relevant actions and assess the country's capacity to attain these goals. With the rate at which the world is changing, this reality is damaging to Israel's socioeconomic resilience. To strengthen the country's resilience, we must strengthen its human capital, and to strengthen its human capital, we must strengthen the educational system – and more specifically, the educational process. The first stage in achieving this is to define our educational system's "graduate profile" for STEM knowledge and skills on a national level. The definition should be agreed upon by all relevant parties along the educational continuum – and subsequently graduate profiles for each stage of the continuum, that are consistent with the goals of the final graduate profile, should be defined. This will serve as the basis for our ability to execute changes in the STEM educational process.

The Afeka Framework proposes a methodology for planning and implementing change in the K-12 STEM educational process, which is based on its intended outcome - the graduate profile. To validate the proposed model, we have chosen to share the transformation undertaken over the past several years in the educational process of engineering students at Afeka College – a transformation that began with defining the Afeka graduate profile, which has since served as our compass for all aspects of the change process. We propose adopting this model and defining the ultimate STEM education graduate profile for each stage of the K-12 educational process as a compass for developing a national roadmap for a STEM education process that provides students with the skills required in the everchanging workforce.

We believe that in today's rapidly changing world it is crucial for Israel to define an optimal national process, that is both structured and managed, to assure the robustness of its human capital, not only quantitatively, but also qualitatively. Furthermore, we believe that the proposed methodology – and even more so the practical experience gained through its planning and execution – can serve as a model for such a national process.

The proposed framework is pioneering in three aspects: It is rooted in a unique approach to implementing comprehensive change in an educational process based on the principles of engineering design (Ask, Imagine, Plan, Create, Experiment, Improve), that begins with defining the graduate profile; the insights and recommendations for action detailed in this paper are all based on its actual implementation that was aimed at revising the engineering education process at Afeka; the framework is presented as the basis for a national, holistic approach to STEM education, but can be adapted to any ecosystem level – national, regional, municipal, or even the school or class level, and across the entire education continuum from Pre-K to academia, and it can be continuously updated.

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The Need - Developing Skilled Human Capital

Technology is an integral part of virtually all aspects of our daily lives – it shapes the way we communicate, learn, work and think. Furthermore, the fields of science and technology are the driving forces behind Israel's flourishing economy and its national resilience. Israel's leadership and technological breakthroughs in these fields have positioned the country at the forefront of international technological innovation.

The 21st century is characterized by rapid technological changes affecting all aspects of life, particularly the workplace. For Israel to continue developing its capabilities, maintain its dominance in the fields of science and technology and preserve its national resilience, skilled human capital is even more crucial than ever before. The rest of the world, including our neighboring countries, are investing substantial resources in these fields and their progress is clear. Thus, the mere preservation of Israel's standing is insufficient at this stage – Israel must place itself in a leadership position, accelerate its progression and increase the realization of its existing potential. Educational, vocational, and academic systems play a crucial role in preparing human capital for military service, the industry and for all sectors of the Israeli economy – as a national strategic asset.

STEM Education as a Method for Developing Skilled Human Capital

The Core of STEM Education – Integrating Knowledge, Skills and Values

STEM education is an interdisciplinary integrative approach to the instruction of science-based subjects and the development of skills – a learning process focusing on science and engineering related topics. In addition to transferring knowledge in mathematics and science and familiarizing students with the world of engineering and technology, STEM education provides opportunities for personal development, thus impacting all areas of daily life. The STEM educational approach offers the ability to develop crucial skills such as critical thinking and complex problem-solving. It combines formal and informal learning within schools, the community and the workplace. STEM education also enhances the comprehension of math and science by providing a context for applying knowledge to real-life situations and adapting it to constant change.

STEM Education: Global Status

The issue of STEM education has been widely debated around the world for over a decade. Recently, discussions have evolved to include skills, and countless models and taxonomies have been generated by states, countries, schools, academic institutes, high-tech industries, NGOs, etc.

In the future, the Programme for International Student Assessment (PISA) will place greater focus on evaluating skills – PISA 2022 included a section evaluating creative thinking, and PISA 2025 will incorporate evaluations of independent learning skills and the use of digital tools. This new focus on assessing skills and abilities in addition to knowledge, reflects the growing importance of skills – making it even more crucial for Israel to work towards imparting these skills and defining the competencies and behaviors that demonstrate them.

STEM Education: Status in Israel

The issue of skills has also been addressed by a number of reports and committees in Israel, in both STEM and general contexts. However, most discussions are focused on a single link along the educational chain and are directed at the practicalities of imparting and assessing knowledge and skills, but without establishing a multi-sectoral dialogue involving all segments of the educational continuum. A graduate skills profile was defined by the Israeli Ministry of Education as a basis for implementing change.

Traditionally, the national educational system focuses on areas of disciplinary knowledge with defined and tangible learning outcomes. However, while there is a widespread consensus regarding their importance, skills do not have the same kind of tangible, or "testable", learning outcomes, partially due to a lack of relevant and widely accepted skill evaluation tools. In practice, the average score of Israeli students is below the OECD (Organisation for Economic Co-operation and Development) average in the core subjects of reading, mathematics, science and skills.

The role of the educational system is to provide its graduates with the knowledge, skills and values needed to successfully integrate into their next stages of life – academia, the workplace and society in general. Through proper STEM education, Israel will be able to assure that the graduates of its educational system are better prepared to function in society and meet the challenges that lay ahead.

The Proposed Approach - Transforming the Educational Process using the Principles of Engineering Design

The Aim

We believe that now, more than ever before, a holistic multi-sectoral approach is required to implement the necessary revisions to Israel's STEM education process. The intention of this paper is to introduce a methodology rooted in the principles of engineering design, for decision making and change implementation in the STEM education process across the entire educational continuum. The proposed model was developed as a combined result of our own motivation to change and the practical experience we acquired in planning, formulating, implementing, learning and improving upon the model while transforming the process of educating engineers at Afeka.

It is our view that such a process should begin by defining a common agreed upon goal – the knowledge, skills and values expected of a graduate of the K-12 educational continuum – otherwise known as the "graduate profile". A national consensus regarding the graduate profile, combined with a change process based on the principles of engineering design, will enable systemic transformation via various silos – administrative, pedagogical, and budgetary – as the basis for achieving a national holistic solution. The universality and flexibility of the model presented makes it applicable and adaptable to all ecosystem levels – from the local school level, through the municipal level and up to the national level.

Definitions

One necessary step in establishing a basis for discussion and call to action on any topic, particularly one as complex as the one addressed here, is the use of thoroughly defined and widely accepted terminology. For the purposes of this paper, we propose adopting the OECD and WEF (World Economic Forum) taxonomies on five key concepts: competencies, skills, knowledge, attitudes and values, and abilities. Both organizations identify competencies as the meta-concept encompassing the knowledge, skills, attitudes and abilities needed by an individual to be able to complete a task, and the way in which he or she utilizes the different components in order to complete the task or job.

In this paper, we will focus on the concept of skills. The OECD and WEF taxonomies define skills as the capability of executing processes, and the ability to use self-knowledge in achieving a given goal, completing a task or performing a job. We decided to steer away from any professional debate on the essence of the various skills or on the components of the fields of knowledge that STEM is comprised of, as these issues have been discussed exhaustively in a variety of professional publications. Rather, we have chosen to focus on a conceptual framework – the proposed model and methodology itself – in order to ensure an educational process that provides its graduates with the skills needed to successfully integrate into today's technology-driven world.

From Theory to Practice - Applying the Proposed Model at Afeka

Afeka College began transforming its engineering educational process over five years ago. We were motivated by the desire to align the process with the characteristics of today's students, and by the responsibility we have in ensuring that our graduates enter the constantly changing workforce with an optimal set of vital skills. We began by defining the profile of the ideal Afeka graduate (see Figure 1) and since then have initiated broad measures aimed at setting change in motion with the newly defined graduate profile as our ultimate goal.

The approach we have taken is based on the six main principles of the engineering design process: Ask, imagine, plan, create, experiment and improve.

Ask

Our journey began with the understanding that the world around us is changing – the Israeli high-tech industry is looking for engineers with a specific set of skills, and the new students entering Afeka's gates are different from those that came before them – therefore, the methods of teaching and learning must also change accordingly.

We began our own learning process by defining the goal, and asked ourselves the following questions:

Do we have a deep enough understanding of the graduate profile desired by the industry, and specifically the Israeli high-tech industry?

To ensure that we do, we learned from the knowledge and experience of Afeka's faculty, studied research reports and surveys from around the world and conducted our own independent survey.

Are we admitting new students based on the criteria most strongly related to academic success?

At this stage we focused on the students – reviewing our admission standards and their correlation to actual academic success.

What is being done globally in engineering education?

We studied international reports on Engineering Education, spoke with academic institutions around the world and visited Colleges and Universities in the United States to observe and learn from various approaches taken there.

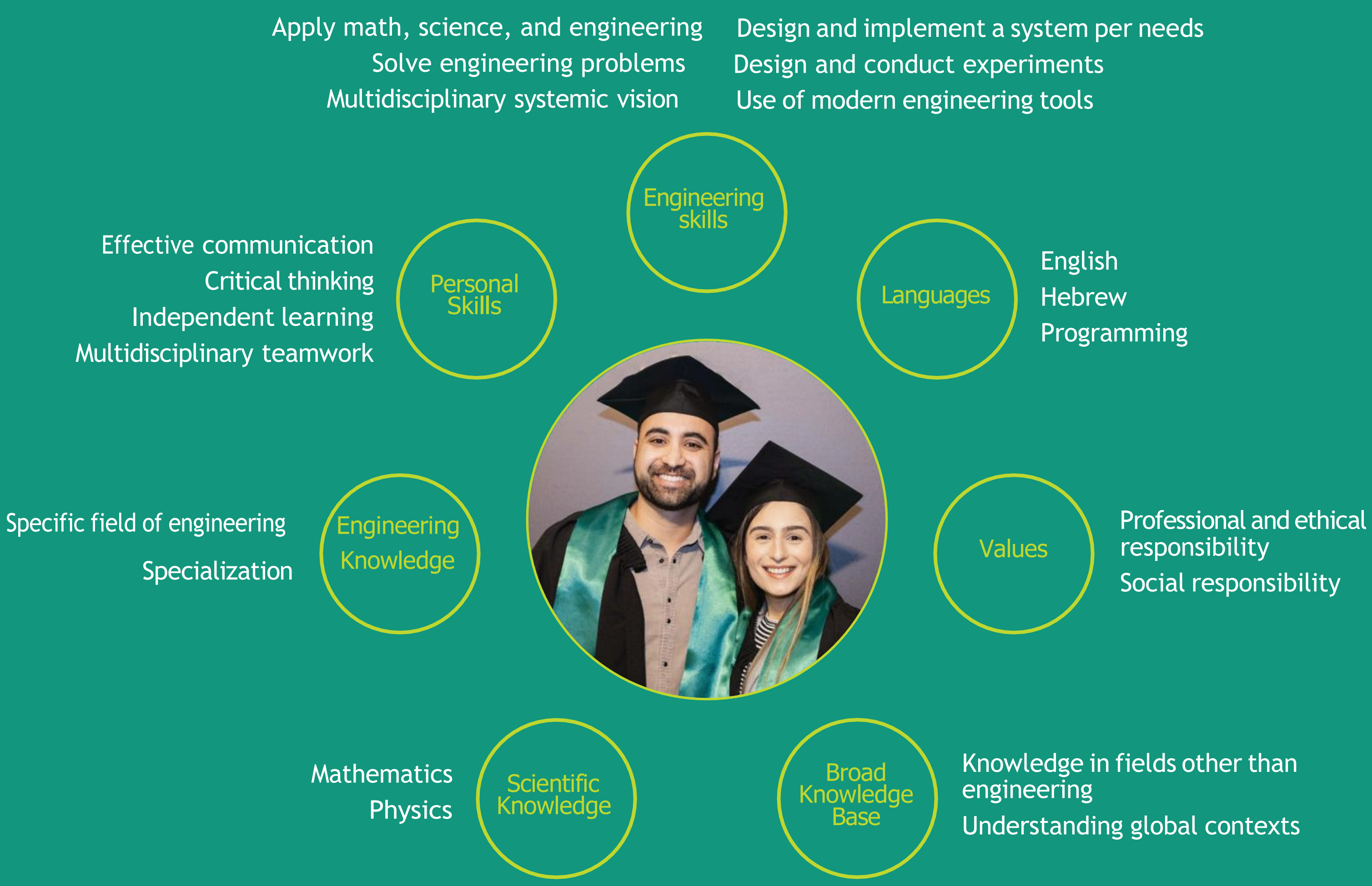
This all led us to the conclusion that changing the educational process – both teaching and learning methods – is no longer an option, but an obligatory part of our responsibility as educators. To achieve this, we understood that it would be necessary to on-board faculty and students, form a supportive organizational culture, develop platforms that encourage collaborative learning, and in general, to bring the change to life through all areas of our activity.

Imagine and Plan

Based on the insights and the knowledge accumulated during the "ask" phase, we formulated an agreed upon definition of the Afeka graduate profile – knowledge in the field of engineering, personal and professional skills, languages, values and an overall broad education. It was clear to us that, from this point forward, the profile we defined would serve as a compass for the entire change process. Recognizing the importance of its accuracy, clarity and inter-organizational acceptance, we detailed the various components of the profile by defining each characteristic and the expected learning outcomes for various stages in its acquisition. We paid particular attention to defining skills and their learning outcomes. The knowledge we expected of our graduates had been well-defined throughout the years and adapted as needed, but before we engaged in this process, skills were never properly addressed.

The final stage of the process included combining all of the components together into one cohesive educational process, across all of our bachelor's degree programs. **Each process was aligned to one common goal – achieving the learning outcomes reflected by the graduate profile we defined.**

Figure 1: The Afeka Graduate Profile



Create

Once the planning phase was complete and the educational infrastructures needed to achieve our desired graduate profile were in place, the implementation phase began. The main goal of the educational process is the learning itself; in our view, the tools needed to attain the knowledge and skills defined in our graduate profile should be continuously provided to our students, with the graduate profile itself being not only the goal, but also the link between the various tools. The underlying concept is that, in order to achieve the expected learning outcomes at the individual level, all channels of activity and the system itself should be consistent with the same educational goals, whether in or outside of the classroom. The new learning outcomes were incorporated into several parallel paths involving faculty and staff that worked together in a mutual learning process:

Updating the Curriculum: All undergraduate programs were reviewed and updated – courses, labs and specializations were all re-examined; the programs for all supporting academic departments (Mathematics, Physics, English, General Studies and Final Projects) were reviewed and their targets redefined; learning outcomes for each course were adjusted in accordance with the graduate profile and defined in terms skills, not only knowledge. As part of this process, the overall four-year educational plan for students was mapped out, with the learning outcomes of each course building on those developed in previous courses in order to form a coherent learning continuum leading to the gradual development of the desired graduate profile.

Integrating relevant pedagogical methods: Pedagogy is a critical tool in developing knowledge and skills and evaluating all levels of the learning processes. As such, any comprehensive change in the educational process dictates reform in supporting pedagogical methods, so as to establish a clear common language in relation to the graduate profile. To do this, faculty members integrate relevant teaching methods into their courses aimed at achieving the updated learning outcomes, while adhering to the principle that learning should be an interactive experience that invokes curiosity and a passion for learning. Each of the courses and lessons are considered independently, and the pedagogical approach selected is aimed at achieving the optimal relevant learning outcomes. In order to involve faculty members in the change process we established an annual call for relevant pedagogy, encouraging them to suggest new pedagogical approaches to implement in their courses, and to then share their insights at a year-end conference. Dozens of courses are now taught at Afeka using new approaches, all formulated by the lecturers themselves.

Promoting student-led extracurricular activities: The holistic approach adopted during the change process led to the conclusion that we should focus on more than just the formal curriculum – that it is equally important to encourage students to initiate and lead activities born of their own personal interests, passions and desire to excel. Student-led extracurricular activities promoting the attainment of both knowledge and skills were provided with the necessary resources and facilities. Current activities include a range of student clubs, participation in international competitions and various activities in our Innovation and Entrepreneurship Center.

Modifying campus learning and working spaces: While it can be difficult to trace a direct link between the learning environment and the role it plays in motivating learning, we believe that the learning space is an integral part of the learning process. Therefore, any change in an educational process must be fully reflected in the spaces where learning occurs – whether classrooms and labs, open spaces that encourage group study or inspirational wall art - our experience is that investing in the learning environment significantly improves the atmosphere on campus.

Adapting infrastructures and organizational culture to the change:

- **Expanding existing supporting infrastructures and activities -** we first ensured that all supportive infrastructures (information systems, computers, technical support, the Social Engagement Unit, the Career Development Center, etc.) are working towards facilitating our intended goal of integrating skills as an essential learning outcomes – each within its area of responsibility (e.g., that the Career Development Center is assisting students in acquiring the skills needed for career management; and that the Social Engagement Unit is instilling in students the value of contributing to the community).

- **Developing new foundations -** it quickly became clear that in order to realize our goals we would need to introduce new relevant foundations that provide professional intraorganizational support during the change process. This included for example, Centers for Promoting Teaching and for Promoting Learning, an Innovation and Entrepreneurship Center and both internal and external communication units. An important component of these platforms is the support they provide faculty members who are expected to embrace the change not only theoretically, but practically as well – by revising their teaching methods and the digital tools they use on a daily basis.

- **Instilling a supporting organizational culture –** in addition to developing new units that provide professional support, we found it necessary to lay the foundations for providing social support as well – in order to promote an organizational culture that accepts and facilitates the change.

We encouraged the creation of student and faculty-led communities, activities or innovations that are based on areas of common interest; equally important – we encouraged collaborative learning mechanisms that embrace failure by promoting trial and error as a way of moving forward. We also placed a great deal of importance on communication and established consistent communication channels for explaining the reasoning behind the change, announcing the various stages of the process and sharing insights with all stakeholders – faculty, staff, students, alumni, external partners and the industry.

- **Building an ecosystem –** we created on-campus ecosystems though inter-departmental collaborations and through the new organizational culture; and off-campus ecosystems by building mutually beneficial relationships with partners such as the Ministry of Education, the IDF (Israeli Defense Forces), industry and high-tech organizations, governmental ministries, municipalities, NGOs etc.

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Experiment And Improve

With the understanding that the change we are undertaking is a multi-year process that needs continuous updating, we began holding annual faculty and staff gatherings as a platform for sharing and monitoring our progress. These meetings create an environment of mutual learning and retrospection that helps us stay on track and continuously improve. Afeka's administration, academic faculty and students also hold open discussions on their experiences and lessons learned in order to continue improving ongoing activities.

Assessment and Evaluation

In addition to standard methods for assessing student progress (e.g. exams), we incorporated new tools for assessing and evaluating the knowledge gained through the educational process. These include team projects for example. In parallel, we began examining various methods for evaluating skills. These mainly included observing students and assessing their performance on certain tasks using dedicated questionnaires. In addition to evaluating student progress during specific courses, we also plan to create evaluation markers at the end of each academic year, in order to ascertain each year's contribution to the overall skill development process for each individual student. With time, we also hope to collect feedback from industry partners regarding the level of skills our alumni exhibit in their place of work.

It is important to stress that the difficulty in evaluating skills has not hindered or delayed the change process. Methods for evaluating skills will develop over time and their current insufficiency is not enough to prevent including skills acquisition in the educational process.

Lessons Learned

What have we learned from this process? The overwhelming importance of defining an engineering graduate profile as a mutually agreed upon goal by all stakeholders – to serve as a compass throughout the change process.

Collaboration is a must

The importance that Afeka places on this process, along with the understanding that we represent only one link on the educational chain, led us to understand that it is essential to form an ecosystem that promotes ongoing dialogue with the Ministry of Education, the IDF and Israeli industry with regards to the role of each link in preparing its graduates for the next stage. This dialogue also serves as a basis for mutual learning with the goal of continuous improvement.

Communities based on mutual interest are crucial

We strive to learn from others and share our experiences. Afeka s internal constituents (faculty, staff and students) and external stakeholders (colleagues and partners from the academic community in Israel and abroad) are encouraged to form communities around shared activities and goals. These communities provide a platform for exchanging ideas and sharing different approaches to coping with the change process – both at the personal and organizational level.

Internal communications and initiatives are important tools in advancing change

Any organizational change is expected to be met with reservation and even resistance – whether overt or covert, and all the more so when the change is focused on an issue at the core of the institution. Constant communication on the part of the administration, along with clear and consistent inter and cross departmental messaging, helps engage employees and encourages internal initiatives that align with the goals of the change process. Promoting these initiatives via the internal communication channels encourages and empowers those involved while inspiring others.

Change is an ongoing joint learning process

This type of change process takes years. Similar to a product development process, it is necessary to allocate time for monitoring and examining the effects on the educational process that may lead to product updates" – i.e. integration of the lessons learned. To this effect, it is important to encourage trial and error and embrace failure as part of the learning process (experiment and improve).

A Holistic National Solution Adapted to Ecosystems on Varying Levels

Based on the insights we gathered during the implementation of the proposed framework at Afeka, we recommend several main channels of activity for facilitating a similar change in the STEM education process at the national level:

Building Platforms for Promoting Change

To ensure the implementation of the proposed change and its continuity over time, it is necessary to take action on a number of levels concurrently.

At the international level:

Active participation in international committees and organizations focusing on STEM education and developing international collaborations – for the purpose of mutual learning, open dialogue, trend analysis and establishing Israel as a world leader on this issue.

At the national level:

- **Establishing a national STEM council** – typically, a collection of locally run independent programs without shared parameters and goals ultimately leads to localized results with limited impact. A national STEM council that establishes the country's objectives for STEM education can provide the necessary support and tools to all links on the educational continuum in order to implement programs supporting these objectives. Experiences from other countries have shown that only a coordinated effort by all stakeholders along the continuum – the educational system, the community, academia and the workplace (and in the case of Israel, the IDF as well) led by a national entity will result in the desired outcome over time.

- **Developing a national ecosystem** – a wide-ranging collaboration between the Ministry of Education, other government ministries, academia, the IDF, municipalities and NGOs etc. aimed at developing a multi-year plan with shared goals and learning processes and creating a supportive national culture.

- **Encouraging research in academic institutes and establishing a national STEM-based applied research center** – expanding knowledge and formulating policies for integration within the educational system, gaining insights based on experience and sharing lessons learned with all relevant stakeholders.

At the municipal and regional levels:

Based on the assumption that local municipalities understand of the nature and needs of their communities, and that they contain all the functions required to implement national goals and policies within their school systems, we believe it is also important to establish ecosystems at the municipal and regional levels.

At the school level:

Schools can develop their own educational processes with the support and guidance from the municipal and/or national levels, while still preserving autonomy, flexibility and the unique DNA of the community they serve.

Concrete actions (across all levels):

Holding conferences and exhibitions; building learning communities for education leaders, teachers, and students that are aimed at mutual learning – sharing knowledge, insights and success stories.

STEM Education - Defining the Graduate Profile

The main reason for establishing a national STEM council is to formulate a collaborative and comprehensive work plan based on several key principles:

- Defining the desired learning outcomes of the entire STEM education process – the STEM knowledge and skills required of a graduate of the educational system. Differentiation between graduates of STEM-related matriculation tracks and non-STEM tracks can be defined.

- Establishing the knowledge and skills required upon completion of each stage of the educational continuum – from preschool and kindergarten, through elementary and middle school, and upon graduation from high school.

- Integrating engineering education into the curricula – instilling the principles of engineering design in STEM programs.

- Developing curricula, pedagogy and evaluation methods that help attain the goals set.

- Establishing metrics for evaluating long term success.

- Developing national and local mechanisms for teacher and staff training and establishing communities that share knowledge and learn together.

Integrating Technology into Teaching and Learning

Technology is a central component in the teaching and learning process in general, and even more so in the area of STEM. For suitable technological platforms to be established, the process must begin at the national level and then be adapted to the local level - regional and school, so as to include:

- Technological infrastructures for interactive teaching and learning from anywhere, anytime - whether in person, online, or hybrid.

- Advanced technologies such as artificial intelligence, virtual reality and augmented reality to incorporate into the teaching and learning processes.

- Foundations for providing pedagogical support for teaching, learning and evaluation using various hybrid methods - remote-physical, synchronous-asynchronous, personal-group, frontal-interactive.

- The ability to universally manage the entire learning process (objectives, planning, content, skills, feedback, assessment and measurement), so that the process accompanies both the learner and the teacher along the journey towards the desired learning outcomes.

- The capability to create asynchronous content for individual learning as a supplement to in-class learning. In addition to establishing these infrastructures, teachers should be trained in using the technologies and in defining desired learning outcomes and identifying the technologies best suited to achieve them.

Using Communication as a Motivational Tool

Communication can be an effective tool for motivating target constituents:

- Formulate a plan for presenting STEM education and its benefits to the relevant target audiences - students, teachers, principals, parents, organizations, etc; Adapt the content and delivery strategy to each target audience to stimulate curiosity, generate engagement and motivate commitment.

- Set up communication channels for all target audiences.

- Maintain open ongoing communication with the various constituents.

- Publicize success stories to position and brand the process as one worth being a part of.

In Conclusion

Over the past few years there has been ongoing dialogue fueled by the motivation to define the graduate profile of the Israeli educational system. Recently, the Ministry of Education published a paper focusing on the issue of skills and their definition – an important step in the right direction. The definition must be translated into learning outcomes, and used to formulate relevant pedagogy, teaching and learning practices and evaluation and measurement methods, in order to ensure optimal assimilation of the necessary changes into the educational system.

Due to the rapid changes in the world around us and the heightened rate at which technology is integrated into all aspects of our lives, defining a graduate profile in the context of STEM education for each stage of the educational continuum – from preschool through high school (see Figure 2) – is even more urgent. The graduate profile does not need to be one uniform rigid set of traits, but should be flexible and adaptable to various needs. The intention is to optimize the potential of the educational system's human capital for future success in society and the workforce.

At each stage of the process, the expected outcome (graduate profile) must be clear, and it must correspond with the needs of the next stage in the educational process. This is crucial on several levels: First and foremost, for the student – who is expected to acquire the tools necessary for personal success; for educators – who need a clear definition of what is expected of them and a future objective to work towards; for the IDF – who require skilled soldiers capable of fulfilling its missions; for academic faculty – who expect to receive graduates of the educational system that are equipped with the skills that promote in-depth learning; for the Israeli economy – that is in need of skilled human capital that can ensure an increase in productivity and accelerate processes; and for Israel's global positioning as a technology superpower and the preservation of its national resilience.

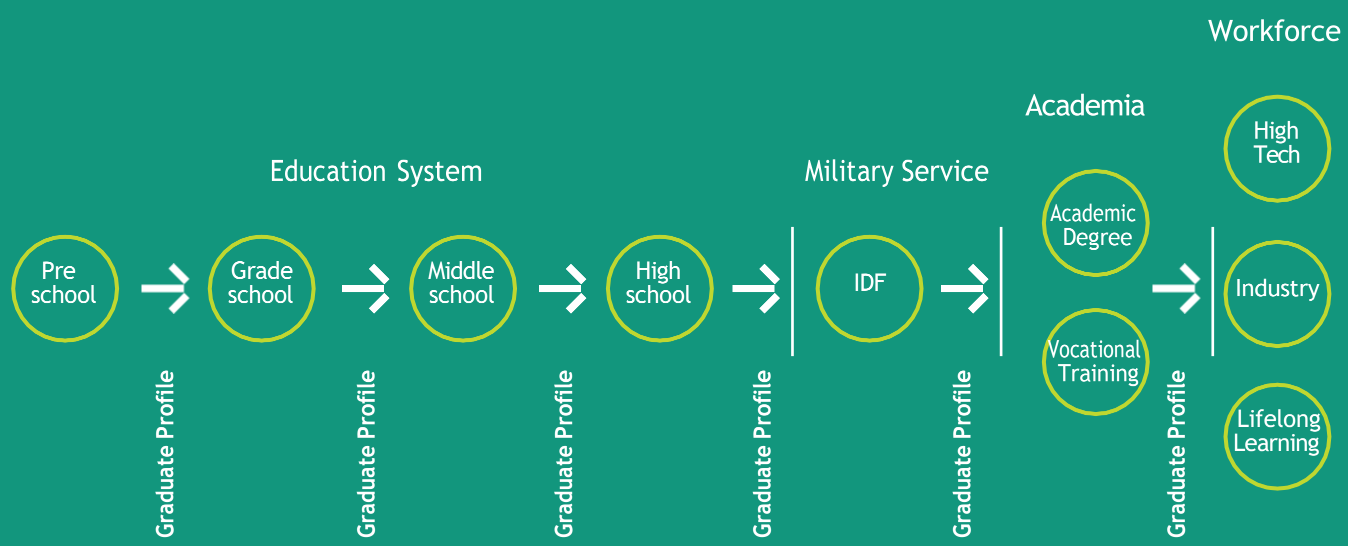
Implementing this approach at Afeka has highlighted the importance of defining a nationally accepted "outcome" when revising educational and academic systems in the rapidly changing modern world, and that such a definition should exist for each stage of the continuum and be agreed upon by all relevant stakeholders. It is also possible to define several profiles bearing a broad common denominator, but that also include components that are adapted to individual students.

Formulating the change process according to the principles of engineering design (ask, imagine, plan, create, experiment and improve) can help us turn the country's educational vision into reality, and through collaborative work, form a holistic national solution that can be implemented by ecosystems on all levels.

We envision a national initiative that begins with the following mission statement:

All students in the State of Israel will have access to quality STEM education that provides the knowledge, skills and values that best prepare them for acquiring an academic education, assimilating into the workforce and contributing to society – as a means of developing skilled national human capital and establishing Israel's standing as a world leader in STEM fields and technology innovation.

Figure 2: Defining a Graduate Profile for each Stage of the Educational Continuum



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https://portraitofagraduate.org/

Examples of Graduate Profiles at the Country, State, City, and School Level

Pasadena, USA:

https://www.pusd.us/departments/secondary-education/pusd-graduate-profile-graduation-requirements

Virginia, USA:

https://www.doe.virginia.gov/parents-students/for-students/graduation/policy-initiatives/profile-of-a-virginia-graduate

Pittsburgh, USA:

https://pittsburgusd.net/

Ontario, Canada:

http://www.edu.gov.on.ca/eng/curriculum/secondary/2009science11_12.pdf

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