

Research on the training model of high-tech talents based on the support of public sector

Cholu Kwon^{1,2}, Haijun Cao^{1, *}, Yongjae An^{1,3}

¹ School of Humanities and Law, Northeastern University, Shenyang, China

² Institute of Mechanical Engineering, State Academy of Sciences, Pyongyang, DPR Korea

³Institute of Development Strategy of Science and Technology, State Academy of Sciences, Pyongyang, DPR Korea

* yuzhizhai@163.com

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Abstract. Percentage of employees in Israel's hi-tech industry rose to 8.7% by end of 2018, up from 8.3% at end of 2017, bringing number of hi-tech positions (not including the communications sector) to over 307,000 by mid-2019. The growth in hi-tech employment reflects the sector's growing demand for employees in recent years and has been facilitated by a variety of government initiatives to increase the number of highly skilled workers in the field. This includes efforts by the Council for Higher Education to increase the number of students in STEM (Science, Technology, Engineering, Mathematics) studies and initiatives by the Israel Innovation Authority to diversify paths of entry into the hi-tech industry, including: Coding Bootcamp, which promotes advanced training in software and data science in non-academic settings; entrepreneurship tracks amongst the Arab sector, the ultra-Orthodox, and women; and other soon-to-be-launched programs[1]. The purpose of this study is to help policy makers effectively catalyze and utilize coding bootcamps to address the shortage of skilled labor in high-tech industries, based on the coding bootcamps program implemented by the Israel innovation authority.

1. Introduction

The growth rate of Israel's science and technology industry exceeds the supply of talents. Over the past five years, the number of people employed in the Israeli tech sector, as defined by the CBS, has grown from 240,000 to 280,000, but their percentage in the labor force is stagnant at around 8% of the total workforce. Despite the increase, there is a clear imbalance between supply and demand in the market, given a three-fold increase in Venture Capital financing during the same period as well as record numbers of multinational corporations entering the ecosystem and hiring Israeli talent [2].

In recent decades, in addition to experienced companies in the industry (such as Intel, Teva and check point), Israel's high-tech sector has also added some start-ups, which are funded by venture capital funds and R & D centers of multinational companies. Since the mid-1990s, the industry has grown rapidly and made significant contributions to economic development. However, the vitality of the high-tech industry has weakened, and since 2010, it is no longer the engine of economic growth. Since then, the expansion of the high-tech industry has been half that of other economies. The biggest challenge facing the industry is the lack of a supply of skilled labor [3].

The number of computer science and engineering university graduates has remained nearly flat for about a decade until 2016, implying that the growth of the demand for tech talent is outstripping the growth of supply, creating a growing imbalance. All the students that started in the relevant disciplines in all the universities in 2008, only 60% completed their initial degree within 6 years, and only 70% got a degree in any high-tech relevant field. Even when the graduates get their diploma, they may face difficulty getting a job in the tech sector, on average only 75% of graduates enter the tech sector [4].

Lack of diversity: Israel's labor market has improved significantly over the past decade, with employment reaching an all-time high [5]. However, women are under-represented in the technology

industry, by the Ministry of Finance report that about 24% of women working in the Tech sector [6]. While women are under-represented, in the case of the Arab and Ultra-Orthodox women the situation is much more extreme. Since 2007, more and more Arab and Ultra-Orthodox have found jobs, although their employment rate remains low [7].

Previous research has shown that if employment in the high-tech industry does not increase sharply, the Israeli economy will lose momentum and lead to greater income inequality. The government can change the distribution of market income through education and other human capital formation policies. For example, education spending may be a particularly effective policy tool. In addition to increasing the income of low-skilled workers, it also improves the overall level of human capital in the economy [8]. While university graduates might enter industry with better technical skills than bootcamp graduates, they will have accrued far greater loans and still lack many of the nontechnical skills that potential employers prize so highly [9].

The Israeli government recognizes that technical and vocational education and training remain an area that requires more investment, especially in certain minority groups.

On 15.1.2017, Government Decision no. 2292 was made "National Program for the Enhancement of Skilled Workforce for the High Tech Industry", aimed at providing a response to the current shortage of skilled workforce in the Israeli high tech industry by, inter alia, improving the existing relevant human capital in Israel. For this purpose, Benefit Track no. 34 was prepared—a program for advancement of non-academic training Institutions, encouraging non-academic training institutions to have more graduates trained in the fields of programming and increase the supply of skilled programmers and computer scientists with the suitable expertise for the high tech industry [10].

This study Outlines a coding boot camp program implemented by the Israel innovation authority that provides practical examples of how coding boot camps can be implemented in developing countries. The purpose of this study is to help policy makers effectively catalyze and utilize coding camps in order to address the shortage of skilled labor in high-tech industries.

2. Origin and categories of coding bootcamps

2.1 Origin of coding bootcamps

Coding bootcamps are a relatively new phenomenon that emerged around 2012 in response to the growing business needs of fast-growing technology companies in North America. The first movers were General Assembly and Dev Bootcamp in NYC and San Francisco, respectively [11]. Since the opening of the first training camp in 2012, the number of graduates from the coding training camp has been growing. Cumulatively, they were expected to train close to 20,316 students in 2018, with a 120 percent market growth rate compared to 2017(16,867), and 900 percent growth compared to 2013(2,178) [12]. Other cities quickly followed suit, with the highest number of coding bootcamps emerging in London, Barcelona, and Berlin, among others. The rise of these training programs could be explained by the growing tech skill gap that leaves hundreds of thousands of programming jobs unfilled in high-income U.S., Canadian, and EU economies [13]. Additionally, the promise of high postbootcamp employability (99 percent in certain cases), with higher than local average salaries attracts those seeking to switch careers by reskilling or upskilling. Finally, coding bootcamps offer skills training compressed into a short time span, at a fraction of the cost of traditional computer science university programs [11].

2.2 Categories of coding bootcamps

Coding bootcamp is a term that is applied generically to intense rapid tech-skills training programs. This kind of training varies in duration, depth, curriculum, and programs, and connection with employment opportunities. In their desk and field research on some 40 bootcamp providers in Africa, Asia, Latin America, the United States, and Europe, the International Telecommunication Union (ITU) conceptualized four broad models (Ready-to-Work, Bootcamp +, Mini Bootcamp and Early Education) dominating the coding bootcamp market [14]. Of the modes of coding bootcamps, the ready-to-work model is the most widely used in various countries. The model is being called

"standard" coding bootcamp [11]. Coding bootcamps are intensive, short-term training programs designed to equip training participants with employment-ready programming skills for entry-level tech positions [15]. In essence, coding bootcamps combine characteristics of traditional vocational training programs with the intensity of military bootcamps for new recruits, intermingling socioemotional and tech skills learning in an intense manner, serving as "skills accelerators" [11].

Table 1. Models of newly emerging tech skills

Bootcamp Model	Description
Ready-to-Work Model (Coding Bootcamp)	This is the traditional approach to coding bootcamps, intensive 12 to 24 weeks full or part-time rapid skills training programs that prepare people to qualify for employment shortly after the training ends.
Bootcamp+ Model	This is an extended training approach, longer training programs (one to two years) that equip students with a broader range of sustainable income-generation skills in addition to coding competencies.
Mini Bootcamp Model	These are very short-term training programs ranging in length from two days to one month. They are typically designed to spark interest in learning the basics of programming, to recruit or identify talent, for professionals to update their skills, and for outreach and community building.
Early Education Model	This model includes workshops, hackathons, and online platforms as well as more encompassing efforts such as schools integrating coding skills into their curriculum. Although not focused on employability in the short term, the early education model is an important trend to monitor

3. Israel coding bootcamps program

The Israel Innovation Authority (IIA) assists and promotes, directly or indirectly, technological innovation in the industry in Israel through a variety of tracks, tools and activities it organizes. On 15.1.2017, Government Decision no. 2292 was made "National Program for the Enhancement of Skilled Workforce for the High Tech Industry", aimed at providing a response to the current shortage of skilled workforce in the Israeli high tech industry by, inter alia, improving the existing relevant human capital in Israel. For this purpose, Benefit Track no. 34 was prepared – a program for advancement of non-academic training Institutions, encouraging non-academic training institutions (coding bootcamps) to have more graduates trained in the fields of programming and increase the supply of skilled programmers and computer scientists with the suitable expertise for the high tech industry [10].

The IIA launched a competition for coding bootcamps in 2018 for bids to operate a coding bootcamp program and receive compensation for achieving results. The selection committee for the competition comprised top-level government officials, including the head of the IIA; representatives from the Ministry of Economy and Industry and the Ministry of Finance; senior managers from the tech industry in human resources, research and development, and general management; and experts with computer science and engineering instruction experience.

The bidder must satisfy all of the following conditions simultaneously. First, the bidder is an Israeli corporation, lawfully incorporated and registered in Israel and operating in compliance with the laws of the State of Israel, including any higher education institution. Second, the bidder or any of its shareholders does not hold limited accounts and is not subject to any process of receivership, procedure freezing, liquidation etc. and do not have any outstanding payable debt to the Israel Innovation Authority. Third, the bidder shall attach an affidavit certified by lawyer, stating that it will not receive any further financing from the State of Israel for the expenditures of the coding bootcamp crediting it with a grant under this Benefit Track. Furthermore, any higher education institution shall be required to declare that it will manage, for the non-academic training conducted by virtue of this Benefit Track, a budget separate from the one for its other activities that are recognized by the Council for Higher Education.

On the one hand, part of this assurance includes a requirement that at least 50 percent of the bootcamp trainees are university graduates from the exact sciences (e.g., Mathematics or Biology), who have high abilities but do not have the time or money to return to university to study computer

science or engineering. On the other hand, the program does not intend to dictate or continuously approve course content. This was done on a one-time basis (during the application process) and is re-evaluated annually. Bootcamps are free to change up to 25 percent of course content without the involvement of the innovation authority, thus allowing bootcamps the freedom to follow and adapt to industry needs without constraint, for example, in being required to submit a course syllabus through several rounds of approval.

The winners would receive a conditional base amount to commence operation, although all of the grant money would be awarded via several “pay-for-performance” subgrants. For example, a training grant would be awarded based on whether or not the coding bootcamp meets at least half its proposed quota, and a placement grant would be awarded to bootcamps for each graduate who gets a job with a salary of at least NIS 14,000 a month (approximately US\$3,800) and stays employed for at least nine months within the one-year period post training. The placement grant is set according to the salary, determined by the difference between the wage and the baseline of NIS 14,000. Should the graduate earner be a woman or from a minority group, the grant awarded to the coding bootcamp increases [16].

On June 4, 2018, the Israeli Innovation Authority announced the establishment of a "coding training camp" to train high-quality software developers for the high-tech industry. Seven training camps (Tapuach, Infinity Labs, ITC -- Israel Tech Challenge, Experis Kicktart, Elevation Academy, Kav Mashve, Primrose) have been recognized and supported by the Israeli government [17].

Table 2. The winning coding bootcamps

coding bootcamps	Skills	place
Tapuach	Full Stack & Mobile	Ramle and Tel Aviv
Infinity Labs	Full Stack & C/ c++ Embedded	Ramat Gan and Haifa
ITC – Israel Tech Challenge	Data Science	Tel Aviv
Experis Kicktart	RT Embedded and Data Science	Tel Aviv and Haifa
Elevation Academy	Full Stack	Tel Aviv
Kav Mashve	Full Stack	Nazareth, Shfaram and Daliat al-Carme
Primrose	She code and Deep Learning Academy	Tel Aviv

4. Coding bootcamps implementation model

In recent years, the coding bootcamp phenomenon has firmly established itself as an international response to a perceived shortage of software developers. Coding bootcamps provide an opportunity to disrupt the paradigm of traditional technical skills training. Technical training, in particular technology training, faces the challenge of continuously shifting demand because of rapid changes in technology. The bootcamp approach has shown potential to boost skill development, including quick results in terms of equipping graduates to compete for better jobs and building future capabilities to increase competitiveness in the labor market. Though boot camps offered more diverse graduates to the so ware industry, it was these diverse students who were taking on large costs and risks with few guarantees [18]. So how can policy makers build on the successes of bootcamps and further catalyze such skills development for greater, longer-term impact? Based on the coding bootcamps program implemented by the Israel Innovation Authority, the following recommendations provide a series of projects designed to promote and use coding bootcamps to address the technical labor shortage in the high-tech industry.

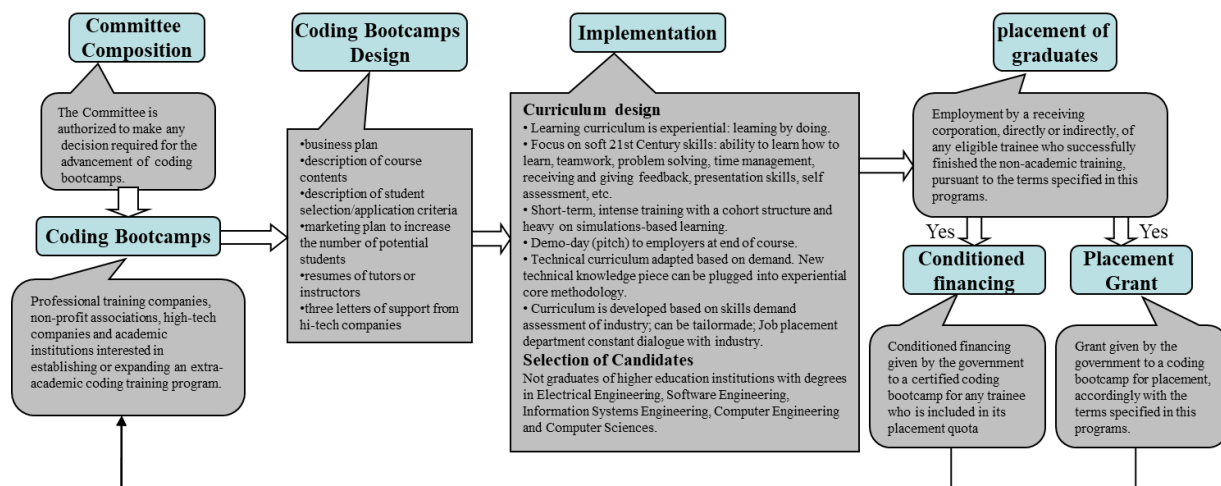


Fig.1. Coding bootcamps implementation model

5. Conclusion

Three lessons can be drawn clearly from the IIA policy intervention. First, a good public policy should make a constructive response to market development. The IIA undertook a detailed analysis of the digital talent shortage in the economy, subsequently gaining the ability to steer the bootcamps toward appropriate targets in terms of content. In Israel, the public sector decided to intervene to act as a catalyst to facilitate bootcamps and increase the number of local people with the digital talent companies were seeking. Via the competition, the IIA influenced and verified the quality of the selected training providers.

Second, coding bootcamps providers must establish mutually beneficial partnerships with key players in the local technology innovation ecosystem to achieve their strategic objectives. It is crucial for the coding bootcamps providers to build partnerships with large IT companies or small and medium enterprises, as the goal of the coding bootcamps is to help trainees find jobs after graduation. It is also important for coding bootcamps providers to build productive cooperation with academic institutions and civil society (for example, industry associations, it education providers, NGO and foundations). Academic institutions can assist in data collection to meet the needs of the coding bootcamps, support curriculum development and adjustment, Support training implementation and communication between students. Civil society can be an indispensable partner in promotion and activity planning, and they can also be an important source of applicants.

Third, the experience learning method of coding bootcamps can be applied to technical training beyond coding. Manufacturing is an area where bootcamps methods have been applied, in other advanced economies, to "advanced manufacturing" skills (that is, new skills needed for digital and automated manufacturing equipment).

References

- [1] Israel Innovation Authority, Israel's Hi-tech Jobs Surpass 300K: 8.7% of Entire Workforce, 2019. <https://innovationisrael.org.il/en/news/israels-hi-tech-jobs-surpass-300k-87-entire-workforce>
- [2] Israel Innovation Authority, Human Capital Report 2018, Tel Aviv, 2018. https://innovationisrael.org.il/en/sites/default/files/SNC_2018_Human_Capital_Report_Final.pdf
- [3] MoF (Ministry of Finance), Development in high tech sector in Israel, Ministry of Finance, Hebrew, 2016. www.mof.gov.il/chiefecon/economyandresearch/doclib/skiracalcalit_140216.pdf.

- [4] Mazuz-Harpaz, Y. and Z. Krill, Route to the Hi-Tech Industry, Ministry of Labor, *Social Affairs and Social Services and Ministry of Finance*, 2017a.
- [5] BoI, Israel's Banking System Annual Survey-2016, 2017.
www.boi.org.il/en/NewsAndPublications/PressReleases/Pages/24-05-17.aspx.
- [6] Mazuz-Harpaz, Y. and Z. Krill, Jumping to high-tech, MoF economy and research paper, Hebrew, 2017b.
http://mof.gov.il/ChiefEcon/EconomyAndResearch/ArticlesSet/Article_10092017.pdf.
- [7] MoF, Weekly Economic Review, Hebrew, September 24, 2017.
www.mof.gov.il/chiefecon/economyandresearch/doclib/skiracalcalit_24092017.pdf.
- [8] Jackson, C. Kirabo, Rucker C. Johnson, and Claudia Persico, The Effects of School Spending on Educational and Economic Outcomes: Evidence from School Finance Reforms, *The Quarterly Journal of Economics* 131(1): 157-218, 2016.
- [9] R. Mason and G. Cooper, Introductory Programming Courses in Australia and New Zealand in 2013—Trends and Reasons, *Proc. 16th Australasian Computing Education Conf. (ACE 2014)*, vol. 148, pp. 139–157, 2014.
- [10] Israel Innovation Authority, Innovation in Israel 2017 Overview, 2017.
https://innovationisrael.org.il/sites/default/files/Innovation%20in%20Israel%202017_English.pdf
- [11] Mulas, Victor, Paradi Guilford, C. M., E. Allende Letona, and Z.V. Dalphond, Coding Bootcamps: Building Future-Proof Skills Through Rapid Skills Training, Washington, D.C. World Bank Group, 2017.
<http://documents.worldbank.org/curated/en/795011502799283894/Coding-bootcamps-building-future-proof-skills-through-rapid-skillstraining>.
- [12] Liz Eggleston, 2018 Coding Bootcamp Market Size Study, Course Report, Washington, 2018.
<https://www.coursereport.com/reports/2018-coding-bootcamp-market-size-research>
- [13] Information and Communications Technology Council Canada (ICTC), Canada's First National Digital Talent Strategy Paves the Way Forward for an Innovative and Globally Competitive Economy, 2016.
<https://www.ictc-ctic.ca/canadas-first-national-digital-talent-strategy-paves-the-way-forward-for-an-innovative-and-globally-competitive-economy/>
- [14] International Telecommunication Union (ITU), Coding Bootcamps: A Strategy for Youth Employment, Geneva, 2016.
https://www.itu.int/en/ITU-D/Digital-Inclusion/Youth-and-Children/Documents/CodingBootcamps_E.pdf
- [15] Meng, Victoria, The Ultimate Guide to Coding Bootcamps: The Most Selective Bootcamps, Skilled Up, 2013. <http://archive.fo/YCwEA#selection-145.0-145.68>.
- [16] The Israel Innovation Authority, Benefit Track no. 34 – Program for Advancement of Non-Academic Training Institutions (Pilot), Tel Aviv, 2017.
- [17] The Israel Innovation Authority, Coding Bootcamp Winners, Tel Aviv, 2018.
<https://innovationisrael.org.il/en/news/coding-bootcamp-winners>
- [18] Wilson, Graham A., Could a coding bootcamp experience prepare you for industry? *IT Professional* 20.2, pp:83-87, 2018.