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Author(s): Fred-Ojala, Alexander; Sidhu, Ikhtlaq; Johnsson, Charlotta; Suoranta, Mari

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The Berkeley Innovation Index: A Quantitative Approach to Measure, Track and Forecast Innovation Capabil- ity within Individuals and Organizations

1. Introduction

Innovation and entrepreneurship are essential processes for human development, market growth, and technological breakthroughs. Entrepreneurship is often thought of as the act of commercializing an innovation. In modern open economies, entrepreneurship is one of the key aspects for economic growth. However, innovation is quite a vague and abstract concept, and therefore it is inherently difficult to measure. Today it is almost impossible for an individual or organization to know how they can improve their innovation output or claim that they are great at innovation.

Measurement and performance matter, because you cannot improve what you cannot measure. Measurements and indices enable comparisons and the ability to track progress by the use of e.g. a performance score. Being able to measure and characterize innovation capability, of an individual or organization, is therefore crucial for that entity to know how they perform today and how they should act in order to improve in the future. A performance index enables insight into current capabilities as well as tracking of the development and progress of a selected trait.

Berkeley Method of Entrepreneurship is a holistic teaching and learning approach that is hypothesized to enable engineers to be more entrepreneurial. It stresses the fact that in order to be innovative, knowledge in the STEM subjects is not enough, an entrepreneurial mindset is also needed. If the majority of the members in a community has an entrepreneurial mindset, the result will be a vibrant entrepreneurial culture.

The Berkeley Innovation Index (BII) is a measurement and performance index that focuses on individual and organizational innovation capability, and related innovative mindsets. It builds on the hypothesis that innovation performance depends on the people, culture, and attitudes in an organization. With the Berkeley Innovation Index, the individual mindset or the culture of a larger organization, can be measured, analyzed, evaluated, and tracked. The BII also enables organizations and individuals to adopt a forward-looking approach to forecast and predict future innovation capabilities.

Empirical results from applying the BII demonstrate how it can diagnose the state of an organization as well as the traits and characteristics among the teams and the individual employees. The BII provides an important framework for granular insight into company culture, team alignment, mindset characteristics, and values, all of which can be used to inform strategic decisions and shape company objectives.

Innovation is one of the top three most important aspects of business success according to over 70% of executives surveyed in a recent study by McKinsey, but only 30% of the same executives believe that their company is well-equipped to innovate [Ref McKinsey survey]. This gap is what the BII aims to bridge, it is a tool designed to quantify innovation capability and give managers, leaders, and executives a data driven approach to increasing their innovation performance. The BII also provides the ability to benchmark an organization's current innovative state and compare it to other market players in the same geographical region or similar industry, as well as to track improvements over time and predict performance in the future.

This paper presents BII; how it can be used to track innovation performance for groups over time, how it can be used to measure innovation culture and operational focus of workgroups and how to track, evaluate, and improve their overall innovation performance. The paper starts by presenting our view on Innovation and Entrepreneurship (Section 2), as well as why Measuring, Tracking and Forecasting is important (Section 3). Thereafter follows a description of Berkeley Method of Entrepreneurship (Section 4) and the Berkeley Innovation Index (Section 5). Empirical results from applying the BII on a group are presented (Section 6), this is followed by the workgroup index extension of the BII (Section 7), and finally the conclusions (Section 8) are presented.

2. Innovation and Entrepreneurship

Entrepreneurship is often thought of as the act of commercializing an innovation. In modern open economies, entrepreneurship is one of the key aspects for economic growth [12], [3]. The economic engine over time has, in the US and other countries, been technology [13], as technology constitutes a fundamental part in many of today's innovations. Clearly, a good understanding of the fundamentals in technology is a prerequisite for Innovations and Entrepreneurship, and hence technical companies are investing in R&D activities. In parallel engineering education is focusing on providing a thorough understanding of science, technology, engineering and mathematics (STEM), where the hypothesis seems to be, the better understanding of technology and STEM, the higher the innovation potential.

Innovation is the ability to come up with original ideas, improve a process or a product, be creative, and to act as a pioneer. The current market landscape is characterized by rapid technological progress and disruptive forces,

an organization today needs to present solutions to new and old problems by applying new methods and emerging technologies. Without the ability to be innovative an organization or an individual experience stagnation, and in a world that encourages constant progress the lack of innovation capability becomes a major disadvantage [11].

Companies and organizations have identified the importance of innovation, and this is clearly reflected in the increase of global spending on Research and Development (R&D). Global R&D investments have increased significantly from 2005 to 2014, see Figure 1.

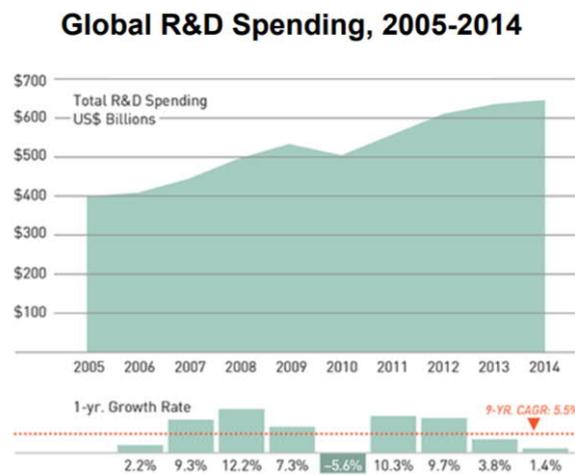


Figure 1: *Global R&D Spending from 2005 to 2014.*

Source: Bloomberg Data, Capital IQ data, Strategy and analysis

Innovation is evidently deemed to be important, but it is also a vague and abstract concept. Martín-de Castro et al. (2013) did a thorough study to define innovation, and they found that the foundation for all innovation processes in an organization is brilliant, motivated, experienced, and creative employees. They found that innovation processes are generally a collective achievement of the organization's members. An organization with a thriving innovation culture and people with the right mindsets are critical for the firm to pursue technological advancements and constitutes the best incentive towards obtaining new knowledge and innovating [4].

3. Measuring, Tracking, and Forecasting

The importance of innovation for organizations and individuals has created a need for a tool that can track and measure innovation capability. This in order to benchmark performance and discover how to optimize innovation

output. A measurement of innovation capability can help identify behaviors and strategies that can be implemented to develop an innovative culture and innovation mindsets. In the article *Why Measuring Innovation Matters* Brian Quinn (Senior Contributor, Forbes) eloquently expressed why it is important to quantify innovation capability:

What gets measured gets done [...] Without measuring these things [innovation], we're effectively driving without headlights — faintly hoping once again that innovation will deliver something useful rather than demanding it, and holding ourselves accountable for achieving it.

I.e., if you can set a target and measure where you are as well as tracking your progress, then any type of goal will be attainable. If a trait cannot be measured, it is inherently difficult, for any person or organization, to improve. Most past measures quantifying innovation capability and output have looked at hard financial metrics that have proved to have little to no correlation to innovation output. E.g., the numbers of patents filed within a year or the amount R&D spending have not shown any significant relationship with an organization's ability to be innovative nor to make profits [11].

4. Berkeley Method of Entrepreneurship

BMoE is a holistic teaching framework and a learning approach that is hypothesized to enable engineers to be more entrepreneurial. It stresses the fact that in order to innovate, knowledge in technical STEM subjects is not enough - an entrepreneurial mindset is also needed. Generally, the mindset is a way of thinking that influence the way someone sees and acts upon a situation; the mindset is reflected in the person's behavioral patterns [5]. BMoE has identified ten behavioral patterns of successful entrepreneurs and, by using inductive and game-based teaching, the mindset behind the behaviors can be explored. The ten behaviors are; Pay It Forward, Story Telling, Friend or Foe, Seek Fairness, Plan to Fail, Diversify, Role Model, Believe, Good Enough, and Collaboration [11], [7]. BMoE also presents a teaching and learning method used to get engineers to explore their own mindset in comparison to these ten behaviors [8]. The novelty of BMoE lies in its strong focus on mindset and the belief that an entrepreneurial mindset can be created and improve over time.

5. Berkeley Innovation Index

The Berkeley Innovation index is a psychometrics tool that quantifies and measures an individual's or organization's overall innovation capabilities [10]. The index assesses overall innovation capability as well as six subtraits. The subtraits constitute a subset of the ten mindsets in the Berkeley Method of Entrepreneurship, hence they are linked to innovation performance. The individual subtraits of the BII are defined in Table 1.

<i>Mindset and Description</i>	<i>Psychological Construct</i>	<i>Trait</i>
<p>Friend or foe Learn to trust others without expecting anything in return.</p>	Social cohesion, honest behaviour	Trust
<p>Plan to fail It is necessary to be wrong sometimes. Plan to experiment. Plan to fail (Fail fast). Analyze, adapt and repeat. The smarter you think you are, the harder this is going to be.</p>	Grit, resilience, entrepreneurial failure	Resilience
<p>Diversify Diversify your networks. Connect to people you would not normally, then go and listen, open up, and connect them to others.</p>	Social capital	Diversity
<p>Believe Believe that what you do can change the world</p>	Self-efficacy	Belief
<p>Good Enough Perfection is not good, but good enough is perfect.</p>	Perfectionism	Perfection
<p>Collaboration Individual vs. team and competitors vs. partners.</p>	Cooperation	Collaboration

Table 1: *List of Berkeley Innovation Index traits and characteristics linked to individual innovation capability.*

An entrepreneurial mindset constitutes of three sub-dimensions: innovativeness, risk-taking, and proactiveness [9]. The BII is based on a combination of entrepreneurial mindset characteristics and research findings from the fields of psychology, business, and mathematical statistics. The BII deconstructs six of the ten traits identified with an entrepreneurial mindset in the Berkeley Method of Entrepreneurship [11]. It is these six personality traits that form the basis of the BII. The approach is also intended to cover layers of innovation that range from the following fields: 1) Strategy and Leadership, 2) Innovation Culture from an Organization's Viewpoint, 3) Organizational Operations and Measures across functions, 4) Mindset: The Innovation DNA of the People, and 5) Tactical measures. [11].

To assess the BII scores of an individual or organization a two-part survey is distributed among the participants of the assessment. Each question belongs to a subcategory, and each category is related to a trait that has been linked to

innovation capability. The BII algorithm, that calculates the scores for the traits, has been developed utilizing a Higher- Order Item Response Theory approach. This makes the inferred index scores statistically relevant according to contemporary algorithmic theory and survey design [6].

The BII is also based on the assumption that innovation capability can be improved, i.e., it is not a static trait, but something that can improve if the right tools are employed. Therefore, the BII can be used to measure an individual's degree of innovation capability over time and track if any improvements have been made. The novelty of the BII lies in its forward-looking approach (i.e. the ability of being innovative), rather than focusing on past-oriented metrics such as investments (e.g. R&D spending) or actions (e.g. patents filed).

6. Track Individual Innovation Performance Increase

As of today (Feb 2018), over 6000 individuals from over 50 countries have completed the BII survey. The data has been collected by hosting the surveys on the research project's website. The samples are labeled and come from people in the industry (startups, mid-sized firms and Fortune 500 companies) as well as academics, scholars, and students. This data shows a trend where people exposed to mindset training can increase their innovation capability scores when taking the BII. Below is a sample case from the data set.

In January of 2016, the Berkeley Innovation Index survey was offered as an instructive aid to a four day intensive class at UC Berkeley called Berkeley Method of Entrepreneurship Bootcamp. In a controlled manner, the entire class of approximately 100 students was offered the survey instrument before the first session of class. Note that these results were shown with linear weighted scores but not as number of standard deviations from a mean. The results of the pre-test show a mean of 7.5 with a standard deviation of just under 1.0 and are presented in Figure 3.

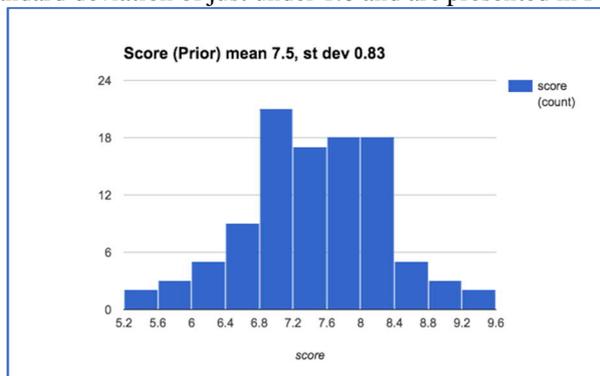


Figure 3. BII score results prior to attending the bootcamp.

Then, on day 3 of the bootcamp, the instrument was offered again but only to half of the students. At this stage of the course, there was no direct instruction to explain innovation mindset or entrepreneurial culture. However, mean score increased approximately by 0.5 (i.e. $\frac{1}{2}$ of a standard deviation), see Figure 4. The changes in scores at this point were only due to indirect exposures of growth mindset and innovation capability concepts.

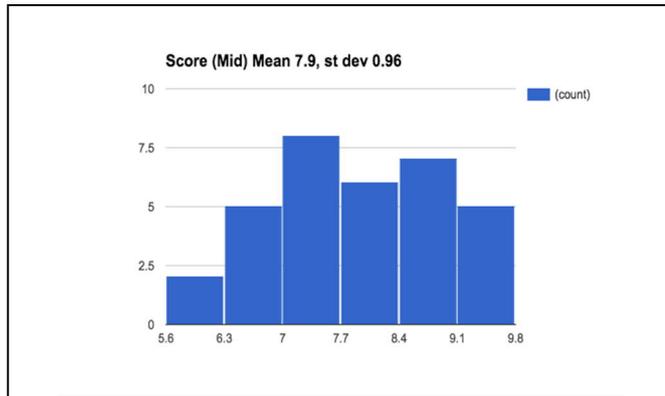


Figure 4. BII score results for half the class on day 3 of the Bootcamp (prior to mindset training).

The remaining half of the students retok the BII survey after the course completed on day 4. During day 4, instruction included an explanation of innovation mindset and resulting behaviors common to entrepreneurs who possess a growth mindset. The mean score of surveys taken on that day increased by over a full standard deviation, i.e., a relative increase of 0.9 in Berkeley Innovation Index score for the group.

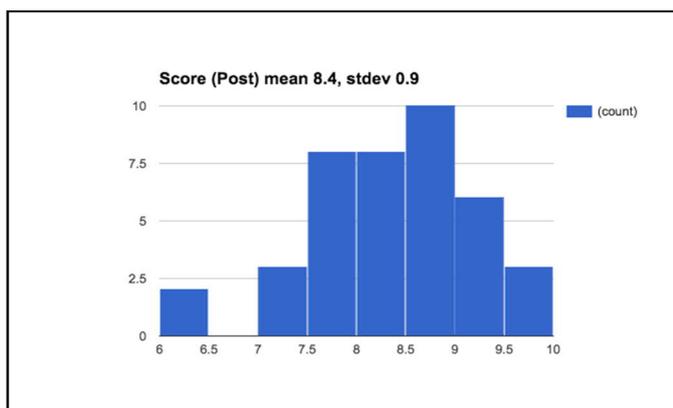


Figure 5. BII score results for half the class on day 4 of the Bootcamp.

It is important to understand that the test questions are not a measure of knowledge learned, but instead they form an instrument that measures what students believe about themselves at a psychological level. This result shows that the course influenced the students' psychological beliefs and behaviors, not simply the logical understanding of the materials. We believe that the students' actual, real-life behaviors will be driven by this change in mindset and psychology more than if they remember or have a logical understanding of the material introduced.

Teaching a person to be entrepreneurial and innovative must include the behaviors needed to adapt in a volatile environment and to be able to go forward in risky and uncertain situations. This is what is done at the BMoE bootcamp. The use of the BII survey instrument furthers our position that entrepreneurial behavior can be measured as well as learned. Innovation in large corporations also requires the right mindset and culture for most employees, or the correct balance of profiles among workgroups. The BII makes it possible to measure the individual mindset of groups, as well as to track progress and improvement generated by training programs.

7. Extending the Berkeley Innovation Index to Workgroups

In order to add additional components needed for the BII to provide insight on innovation within a larger organization, and not only aggregated results for individuals, a second psychometrics instrument has been designed and implemented in the Berkeley Innovation Index suite. This tool focuses on the culture of the workgroup as measured by the perceptions of the individuals in the workgroup on the organization and team they are part of.

Areas of measurement that are included in the Workgroup measurement:

1. Where ideas originate
2. Transparency in decision making
3. Organizational comfort with ambiguity and learning
4. Responses to organizational failures
5. Cultural understanding about operating measures such as product / service quality, customer happiness, cost, and market share.
6. Culture of execution

The organizational characteristics above are measured with statement questions on an ordinal Likert-scale related to the areas. All of these perspectives and aspects are critical components for an organization to recognize its strengths and weaknesses, form alignment with its team members, effectively allocating resources, and optimizing the organizational workflow according to project horizon needs. The results of these questions are then grouped to form a score and measure for the *innovation culture* (questions 1-3) and *operational focus* (questions 4-6). It is hypothesized that a balance

between these two skills is essential for any organization to be successful in the long run.

8. Conclusions

In this paper we presented a novel way to utilize the Berkeley Innovation Index framework to measure and track innovation performance, mindset, and capability. We also suggested an extended feature to the BII that incorporates a workgroup score with emphasis on organizational effectiveness (in the form of Innovation Culture and Operational Focus). A way to setup the BII as a process for companies to track and improve their innovation performance does also exist. The empirical results present a tool that can be useful for individuals as well as companies on a global basis. Over 6000 individuals have already taken the BII surveys, hence the data set in combination with the theoretical frameworks provide a unique and valuable tool to measure innovation capability together with recommendations on how it can be further improved.

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