# Identifying Factors Associated with the Survival and Success of Grassroots Educational Innovations

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## 6.1 Innovations Are Everywhere

The word 'innovation' became an indispensable constituent of contemporary discourse. One can find it everywhere from advertisements of consumer goods to political speeches. Over the past 70 years, the use of the word 'novelty' remains stable, while 'innovation' has seen a sixfold increase (Google 2016). In the 2000s, this word could be heard during UK parliamentary debates ten times more often than in the 1960s (Perren and Sapsed 2013). Such overuse inevitably leads to the word's devaluation. A mere enhancement of a razor blade is called 'innovation' by its manufacturer; the improvement that can be hardly put on a par with the invention of printing press, electricity or antibiotics.

Nevertheless, its 'buzzword' reputation does not undermine the key role of innovation in economic development. As Joseph Schumpeter, the father of innovation economics, asserted, sustained long-term economic growth is impossible without ceaseless process of innovation (Schumpeter 1942), noting that 'add successively as many mail coaches as you please, you will never get a railway thereby' (Schumpeter 1934). Today it became evident that the same rule is applied to education. It is increasingly challenging for education to stay relevant in such rapidly changing environment as modern world, and the only way for it to keep up with these changes is through innovation (Taddei 2009).

Education is often considered to be a conservative and outdated field, but this statement is disputable. Many, including Sir Kenneth Robinson (2010) and Salman Khan (2012) in their popular TED talks, argue that modern educational system is a progeny of industrial revolution with the sole aim to train well-disciplined and docile citizens. In fact, the origins of the public education system can be traced to

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humanistic ideas and practices introduced by Comenius a century before industrial revolution (UNESCO 1999).

It is not unusual for education to be ahead of its time and to determine the future. The first female student was admitted to the University of Zurich at the same terms as men in 1867 (Simonton 2006). Only one hundred years later Switzerland gave its women the right to vote. In many developed countries, women reached parity with men in education, while there is still a gap in job market and politics. Some educational institutions had a major impact on whole industries as the famous art school Bauhaus that had a profound influence on modern design (Pevsner 1999). Finally, according to a recent OECD report, education by some measures is the second most innovative sector after manufacturing (OECD 2014).

## 6.2 Evidence-Based Policy for Grassroots Educational Innovations

To no surprise there is an increasing interest and demand for the study of innovation in education. While there is a growing number of literature about innovation both in private and public sectors, there is still a gap in our understanding if these findings can be applied to the field of education. One particularly underexplored area is grassroots innovations. Governmental reforms and top-down initiatives are often monitored by research institutions, but grassroots innovations in education escaped the attention of researchers so far. At the same time, it was argued that there is a great promise in such innovations, especially at the time when thanks to new technologies, availability of capital and increasing number of people with entrepreneurial skills and ambitions, it became possible for teachers, students and ordinary citizens to take on challenges that in the past were reserved exclusively for governments and large organizations (UNICEF 2015). The importance of such social entrepreneurial projects is emphasized by many authors (Christensen et al. 2006; Dees 2007; Reimers 2010).

In this paper we present results from an empirical pilot study that aspire to identify factors associated with the survival and success of educational grassroots innovations in a Russian context. The term 'innovation' was popularized in Russia in 2008 when Dmitry Medvedev was elected as president of Russia with the promise to modernize the economy by focusing on four 'I's: institution, infrastructure, innovation and investment. At the same time, the first post-soviet generation reached young adulthood. These people had an entrepreneurial mindset and desire to make the world a better place. Thus, the stage was set for the rise of Russian start-ups. One prominent example from that time is the social network site VK that became the largest social network in Europe. In 2010, hackathons, start-up weekends and other events for aspiring entrepreneurs spread. In large cities like St. Petersburg or Moscow, they are held almost on a weekly basis nowadays. Business incubators were opened in many universities including ITMO University, Moscow State University and Higher School of Economics. In 2013, Impact Hub Moscow, an accelerator for social entrepreneurs, was launched. In 2014, Digital

October hosted EdCrunch, the first conference on technology and education in Russia. At the same year, the Institute of Education organized a competition for innovators in education—KIVO (Competition for Innovations in Education) that attracted more than 500 applications. The demand for study innovations in education is now matched with sufficient amount of empirical data in Russia.

We use data from 240 applications of KIVO participants who completed a follow-up survey one year later, in 2015. We identify factors that are associated with the project's survival and success and build a predictive model. The generalizability of the model was tested on data about 250 participants of KIVO 2015 and the status of their project in 2016. We also compare predictive power of our statistical model with predictive power of experts' evaluation.

## 6.3 Pragmatic Definition of Grassroots Innovation

The term 'innovation' is known to be notoriously ambiguous and lacks a single definition (Adams et al. 2006). While business remains the main domain where the term is used it is now common in public sector too. In particular, OECD adapted its definition of 'innovation' from Oslo Manual (OECD 2005) for the use in educational contexts (OECD 2014):

> Educational organizations (e.g. schools, universities, training centres, education publishers) introduce (1) new products and services, e.g. new syllabi, textbooks or educational resources (2) new processes for delivering their services, e.g. use of ICT in e-learning services, (3) new ways of organising their activities, e.g. ICT to communicate with students and parents, and (4) new marketing techniques, e.g. differential pricing of postgraduate courses. These new practices are intended to improve the provision of education in one way or another, and therefore, innovations in education should be regarded as "improvements".

However, it remains unclear which changes should be considered as improvements, especially if they are beneficial for one group of stakeholders (e.g. high-income families) but not for another (e.g. low-income families). It is also unclear which improvements are significant enough to be called 'innovation'.

As a result of such ambiguity, a wide range of practices is called innovation in literature, including the use of learning management system in university courses (Soffer et al. 2010), student internship abroad (Spiering and Erickson 2006), change in time spent on lecture-style presentations in classrooms (OECD 2014), etc.

In our work we use a pragmatic definition of grassroots innovation. We base it on a simple fact that when decision makers are required to evaluate an educational initiative, they have to assess its viability and potential impact regardless of whether this initiative meets one or another formal definition of innovation. For the purposes of this research, we call 'grassroots innovation' any educational project initiated by a teacher, a student, an aspiring entrepreneur or an ordinary citizen, who work on it alone or in a small team and call this project 'an innovation'.

## 6.4 Survival and Growth as Proxies of Innovation Success

Most of the grassroots innovations fail before they achieve any impact or become adopted by a significant number of people. Nascent entrepreneurs often discover that they lack sufficient resources to make their project viable; they may discover that their initial idea doesn't work or they may change their personal priorities before the project becomes self-sustained (Cooper et al. 1994). The survival of a project is, therefore, the key metric to evaluate educational innovation at early stage.

If a project survives despite of the potential obstacles then the natural way to measure its success is to use growth as a proxy (Carter et al. 1996). Growth can be measured in the number of end users, number of employees or as completion of certain stages such as creating a prototype, achieving positive cash flow, etc. These stages are significantly linked to the probability of eventual success (Edelman et al. 2008).

## 6.5 Potential Predictors of Innovation Success

In our work we investigate factors that are associated with the survival and success of grassroots educational innovations that were part of KIVO competition. We base our hypotheses upon the most widely used theoretical framework in innovation studies: Rogers' diffusion of innovation theory (Rogers 1983). The framework is common in educational context (Shea et al. 2005; Warford 2005; Spiering and Erickson 2006; Soffer et al. 2010).

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers 1983, p. 5). It means that the successful diffusion of innovation depends not only on its own characteristics but also on characteristics of social environment and characteristics of change agents (p. 312).

According to Rogers, the following characteristics of innovation are related to its eventual success: relative advantage, compatibility, simplicity (complexity), trialability and observability (ibid, p. 14). We expect that all of these characteristics would be positively correlated with the survival and success of KIVO projects (Hypothesis 1). As the environment plays an important role in diffusion of innovations, we expect that the project that operates in a more open and less regulated environment such as extracurricular activities should have more chances to survive or succeed than projects within compulsory education system (Hypothesis 2).

The importance of human capital for entrepreneurial success was shown in numerous studies (Shane 2000; Marvel and Lumpkin 2007; Ucbasaran et al. 2008). We expect that the level of education of project team members and their experience would be closely connected with the success of their projects (Hypothesis 3). As the social capital of entrepreneur also contributes to the project success (Davidsson and Honig 2003), we expect that the team size and amount of its social activity would be positively correlated with success (Hypothesis 4). We expect that teams with entrepreneurial experience would outperform teams without such experience. We also expect that projects of self-identified entrepreneurs outperform projects that are led by people who identify themselves as students, teachers, researchers or full-time employees (Hypothesis 5). The importance of entrepreneurial self-efficacy was demonstrated by Chen et al. (1998).

There are two main approaches to decision-making often referred as clinical and statistical methods. In the clinical method, the decision maker combines or processes information in his or her head based on his or her knowledge and experience. In the statistical method, the human judge is eliminated and conclusions rest solely on empirically established relations between data and the condition or event of interest (Dawes et al. 1989). Empirical comparisons of the accuracy of the two methods (136 studies over a wide range of predictors) show that the statistical method is almost invariably equal to or superior to the clinical method (Grove and Meehl 1996). As all of the KIVO applications were evaluated by experts, it becomes possible to compare the predictive power of judges' evaluation with the predictive power of the model built on combination of significant factors. We expect that the statistical approach would provide at least the same performance (Hypothesis 6).

## 6.6 Empirical Data and Methodology

KIVO is an annual Russian competition for innovations in educations that is designed for early stage projects: more than an idea but less than a self-sustained project. There is no geographical, professional or age restriction for participation. More than 500 projects participated in KIVO in 2014 and more than 600 in 2015. Social and professional characteristics of participants were described by Koroleva and Khavenson (2015). The fact that most of the projects were not launched yet at the time of application helps to eliminate bias that is inevitable for surveys about already operating projects (Caliendo and Kritikos 2008).

Applications to KIVO were submitted in April and May of 2014 (the first wave) and in April and May of 2015 (the second wave) via an online form. One year later in summer 2015, for the first wave, and summer 2016, for the second wave, an online survey was sent to project leaders. 487 invitations were sent, and 240 responses were collected for the first wave; 585 invitations were sent, and 242 responses were collected for the second wave.

Project leaders were asked whether they would continue to work on a project that was submitted to KIVO competition. They were provided with four options: (1) they continue to work on the same project, (2) they work on a new or significantly modified project but within the same team, (3) they work on a new project (related to innovation in education) within a new team and (4) they do not work anymore on anything related to innovation in education.

The first and the second options are considered as survival. While in the case of the second option where the team may work on a different project, it can be considered as continuation of their previous work and typically called a 'pivot' in entrepreneurial literature (Blank 2013). The third and the fourth options mean that the project did not survive. There were 180 survived and 60 not survived projects in the first wave and 190 survived and 52 not survived in the second wave.

Among projects that survived, we additionally identify successful projects, namely, projects that launched a pilot or started production of a product, hired new employees or significantly (1.5 and more times) increased number of end users. There was scarce and inconsistent data on cash flow, investments and other financial characteristics, and it was consequently excluded from analysis. As a result of this designation, projects that moved to a new stage or achieved significant growth are considered as successful, while stagnant projects are considered as unsuccessful. Ninety-six out of 180 projects were successful in the first wave and 104 out of 190 in the second wave.

Note that leaders of survived projects completed an additional survey about their projects and that is why more information was available for analysis of factors associated with success than for analysis of factors associated with survival.

To determine whether Rogers' characteristics of innovation are associated with the survival and success of educational innovations (Hypothesis 1), project leaders were asked to assess trialability, compatibility, complexity and relative advantage of their projects (see Table 6.3 in Appendix for corresponding questions).

To study the effect of different environments on innovation success (Hypothesis 2), we compare innovations from large cities (Moscow, Saint-Petersburg) with innovations from smaller cities and innovations from different domains such as kindergarten, primary school, middle school, high school, university, extracurricular activities, professional education and family education. When asked about the domain of their innovation, project leaders were allowed to choose several options simultaneously.

To access the impact of human capital (Hypothesis 3), projects leaders were asked about the highest level of education of all team members and were asked to name universities from which they graduated. They were also asked if any of the team members studied or worked abroad for at least 3 months. In addition to past experience, they were asked about recent (during the last year) educational activities related to their project, including completing online courses, reading professional literature, looking for relevant research, studying competitors and existing analogues of their project.

The social characteristics of the team (Hypothesis 4) include team size, presence of mentors and also activities during the last year such as attending relevant events, participating in competitions and discussing project with experts.

Team members were asked about the domain of their current activities: education, entrepreneurship or industry. We distinguish teams with a leader who is a self-identified entrepreneur and teams that have at least one self-identified entrepreneur (Hypothesis 5).

Finally, we include having a project website at the time of application to KIVO as an additional variable of interest in our analysis.

There was a two-step procedure in the jury evaluation of KIVO applications. At the first stage, the expert chooses one of three options: (1) project does not deserve further consideration, (2) project should be considered according to the general procedure and (3) project deserves a special attention. If the second or third option is chosen, then the expert assesses the project's novelty, its scalability, significance of the problem it addresses and adequacy of the chosen approach to tackle the problem. These four characteristics are evaluated on the scale from 1 to 5.

For further analysis, all of the factors in question are converted into binary dummy variables, and then the Fisher's exact test (Fisher 1922) is used to identify factors that are significantly associated with project survival and success. This procedure leads to multiple hypotheses testing, and to account for it, we use Šidák correction (Šidák 1967). We choose a threshold of 0.1 for the assembly of variables, which was lowered to 0.015 for 7 independent variables related to the survival and lowered to 0.009 for 11 independent variables related to success. For the factors that are identified as significant, we compute the increase or decrease in odds for survival and success. The odds ratio is a standard way to determine the effect size for binary variables (Edwards 1963; Mosteller 1968).

To evaluate the combined predictive power of identified factors, we use standard machine learning techniques: logistics regression and random forests (Breiman 2001). The quality of the model was evaluated with area under the receiver operating characteristic curve (AUC). AUC is a better measure than accuracy in comparing predictive models (Huang and Ling 2005; Ling et al. 2003). AUC has the following intuitive interpretation: it is equal to the expectation that a uniformly drawn, random survived (successful) project is ranked by the model higher than a uniformly drawn random not survived (not successful). The statistical model was compared with judges' evaluation.

The design of this pilot study implies certain limitations. The data is potentially noisy, self-reported evaluations that may be biased; the choice of survey question despite being grounded in existing literature is still rather arbitrary. Even if the constructed model fits data well, it may have poor generalizability. To check the generalizability of the proposed approach, we cross-validated our model on an independent data set, namely, the model was constructed based on the first-wave data, and the predictive power was then checked on the second-wave data.

## 6.7 Team Matters More than the Project

Four factors were significantly associated with the survival of the project, and eight factors were significantly associated with the success (see Table 6.4 in Appendix). The respective odds ratio is presented in Table 6.1.

Hypotheses 1 and 2 were not confirmed. Neither characteristics of the innovation nor its environment were significantly associated with the project survival or success. As characteristics of innovations were evaluated by project leaders themselves, it may mean that they are unable to objectively judge their own project. It may also mean that our sample is too heterogeneous to find a significant effect of a single characteristic of innovation.

Unlike the characteristics of the project, several characteristics of the team were significantly associated with project success. In accordance with Hypothesis 3, human capital appears to play an important role in the project prospects. The

**Table 6.1** Changes in odds to survive and succeed

| Factor | Odds ratio | Factor | Odds ratio |
|---|---|---|---|
| *Survival* | | | |
| Project leader is an entrepreneur | 3.49 | Team has only one member | 0.69 |
| Project has a website | 2.77 | Project leader is a student | 0.35 |
| *Success* | | | |
| Team members has foreign experience | 8.41 | Attending online courses | 2.63 |
| Participating in competitions | 3.16 | Project leader is an entrepreneur | 2.44 |
| Studying competitors and analogues | 3.16 | Team members include graduates from top universities | 2.37 |
| Discussing with mentors and experts | 2.71 | Participating in events | 2.32 |

least experienced teams (those led by students) were less successful in comparison with other teams (odds ratio is 0.35). At the same time, the teams led by graduates from the top universities were more successful than teams without any graduates from the top universities (odds ratio is 2.37). Foreign experience of team members emerged as the single most powerful predictor of eventual project success (odds ratio is 8.41). It may be the consequence of foreign experience itself as some teams were inspired by projects elsewhere in the world and decided to launch a similar one in Russia. Foreign experience may also be the best proxy for the overall human capital.

Hypothesis 4 was also confirmed. The absence of team partners significantly decreased project chances to survival. Participation in events and discussions with mentors or experts significantly increased its chances to success.

The most powerful predictor of project survival was being led by entrepreneur. The same factor was significantly associated with project success, confirming the Hypothesis 5.

The result of our research is not an exception to the general observation (Hypothesis 6), showing little predictive power of experts' evaluation in respect to project survival or success.

In addition, we discovered that projects that have a website at the time of application had increased chances to survive in 1 year. The entry barriers for participation in KIVO are low as it does not require from applicants to have an already operating project or to provide an evidence of working technology. Some applications are, therefore, spontaneous, without a real commitment from the team to the project. The website turned out to be an effective way to filter such applicants.

**Table 6.2** Predictive power of statistical models and experts' evaluation measured as AUC

| | Wave 1 | | Wave 2 | |
|---|---|---|---|---|
| | Data | Experts | Data | Experts |
| *Survival* | | | | |
| Logistic regression | 0.76 | 0.54 | 0.60 | 0.55 |
| Random forests | 0.60 | 0.54 | 0.59 | 0.54 |
| *Success* | | | | |
| Logistic regression | 0.91 | 0.57 | 0.83 | 0.58 |
| Random forests | 0.82 | 0.54 | 0.81 | 0.54 |

## 6.8 Statistical Model Outperforms Expert Evaluation

To estimate the combined predictive power of different factors, we used logistic regression and random forests models. The quality of models was evaluated with AUC, and the results are presented in Table 6.2.

Results indicate that the expert evaluation has little predictive power with respect to project prospects and is easily outperformed by the statistical model. Remarkably, this result holds even after cross-validation; the model trained on 2014 data predicts survival and success of projects from KIVO 2015 better than jury evaluation.

## 6.9 Discussion

The main result of our study is that data that was gathered from projects at the time of the application to KIVO competition contain enough information to make some conclusions about their chances to survive or succeed in 1 year.

As the study is based on applications to one particular competition, it remains unclear if it can be generalized to educational initiatives in general. On one hand, the diversity of projects that participated in KIVO makes it reasonable to assume that identified factors are important for a wide range of projects. On the other hand, the same diversity does not account for the specificity of certain categories of projects, which may explain why none of the project characteristics was identified as associated with survival or success. If the same characteristic increases chances for success in one category of projects within one environment but decreases chances to success for another category of projects in another environment, then it cannot be identified by our method.

Survey data is inevitably noisy. However, applying the model trained on the first-wave data to the second-wave data provides a safeguard against overfitting and spurious correlations and proves the generalizability of our approach.

The results provide some guidance for the decision-making in the domain of grassroots educational innovations. First, they indicate that it is not enough to base decisions solely on the characteristics of the educational innovation, itself and underscore the importance of a project team. In addition to fixed characteristics of the team, it is important to take into consideration their activities and tangible results of such activities (e.g. a project website).

Second, it was shown that the expert evaluation has low predictive power and is inferior to statistical approach. While in many cases it is infeasible to eliminate human judgement from decision making, statistical models could be used as complementary tools. For example, a predictive model could be used at the first stage of the application selection process to filter the least promising applications and to reduce the amount of work for human judges. It can be used at the very last step as well by selecting the most promising applications among those that were ignored by experts. Such applications might warrant a second chance to be considered by experts. Even if statistical models are not used at all, it is important to validate an evaluation procedure because a mere fact of the experts' presence does not guarantee any predictive of their judgement.

It is important to note that a statistical approach has its own limitations. It is not casual: if some factors are associated with project success, this does not necessarily mean that by influencing these factors one can change a project's chances to succeed. And it can be gamed. For example, if the presence of a website is included in the model and participants know about it, they can create an empty website five minutes before application to formally satisfy the criteria. That would basically reduce the predictive power of this variable to zero.

Our study demonstrates the potential power of data-driven approaches to decision-making with respect to innovations in education. However, the available data is scarce, and there is a clear need for a framework for systematic and longitudinal data collection, its subsequent analysis and its integration into the decision-making process. In the absence of such a framework, decisions to support one or another initiative remain highly arbitrary. The framework would be an important step towards evidence-based policy in the field of educational innovation.

## Appendix

**Table 6.3** Survey questions related to Rogers' characteristics of innovation

| Rogers' characteristic | Question |
|---|---|
| Trialability | *How much time do users need to spend before they can actually start to use your product, service or method?*<br>• Several minutes<br>• Around one hour<br>• Several hours<br>• Several days<br>• A week or more<br>• Impossible to estimate |
| Compatibility | *The use of your product, service or method*<br>• Complement an existing practice and do not require its abandonment<br>• Require partial abandonment of an existing practice<br>• Completely substitute an existing practice and require its abandonment |

(continued)

**Table 6.3** (continued)

| Rogers' characteristic | Question |
|---|---|
| Complexity | *The time of a single use of your product, service or method*<br>• Several minutes<br>• Around one hour<br>• Several hours<br>• Several days<br>• Several months<br>• Other or impossible to estimate |
| Relative advantage (labour) | *How much does your product, service or method decreases labour effort compared with alternatives?*<br>Scale from 1 to 5 |
| Relative advantage (interest) | *How much does your product, service or method makes the work or the study more engaging comparing with alternatives?*<br>Scale from 1 to 5 |
| Relative advantage (effectiveness) | *How much does your product, service or method makes the study more effective?*<br>Scale from 1 to 5 |

**Table 6.4** Association of factors with survival and success

| Factor | *p*-value | Factor | *p*-value |
|---|---|---|---|
| City | | Project leader | |
| *Survival* | | | |
| Moscow | 1.000 | Student | 0.001* |
| St. Petersburg | 0.427 | Entrepreneur | 0.004* |
| Other | 0.276 | Teacher | 0.563 |
| Domain | | Full-time employee | 0.847 |
| Kindergarten | 0.082 | Other | 0.351 |
| Primary school | 0.316 | Team has | |
| Middle school | 0.881 | Entrepreneur | 0.056 |
| High school | 0.881 | Teacher | 0.457 |
| University | 0.210 | Full-time employee | 0.016 |
| Extracurricular | 1.000 | Jury evaluation | |
| Professional | 0.086 | Overall | 0.769 |
| Family | 0.051 | Novelty | 0.405 |
| Other | 1.000 | Importance | 0.822 |
| | | Relevance | 0.560 |
| Project has website | $<10^{-5}$* | Scalability | 0.795 |
| Only one team member | 0.002* | | |
| *Success* | | | |
| Moscow | 0.039 | Jury evaluation | |
| St. Petersburg | 0.277 | Overall | 0.631 |
| Other | 0.207 | Novelty | 0.648 |

(continued)

**Table 6.4** (continued)

| Factor | *p*-value | Factor | *p*-value |
|---|---|---|---|
| Domain | | Importance | 0.364 |
| Kindergarten | 0.841 | Relevance | 1 |
| Primary school | 0.870 | Scalability | 0.449 |
| Middle school | 0.651 | Rogers' characteristics | |
| High school | 0.175 | Complexity | 0.626 |
| University | 0.331 | Trialability | 0.296 |
| Extracurricular | 0.072 | Compatibility | 0.294 |
| Professional | 0.104 | Relative advantage (labour) | 0.104 |
| Family | 0.388 | Relative advantage (interest) | 0.294 |
| Other | 0.831 | Relative advantage (effectiveness) | 0.829 |
| | | Activities | |
| Project has website | 0.015 | Participating in events | 0.002* |
| Only one team member | 0.268 | Completing online courses | 0.001* |
| Project leader | | Reading professional literature | 0.270 |
| Student | 0.800 | Looking for relevant research | 0.059 |
| Entrepreneur | 0.004* | Studying competitors and analogues | 0.002* |
| Teacher | 0.849 | Discussing with mentors and experts | 0.001* |
| Full-time employee | 0.701 | Participating in competitions | 0.007* |
| Other | 0.717 | | |
| Team has | | Team members include graduates from top universities | 0.009* |
| Entrepreneur | 0.046 | Team members have foreign experience | $<10^{-5}$ * |
| Teacher | 0.296 | | |
| Full-time employee | 0.443 | | |

## References


Adams, R., Bessant, J., & Phelps, R. (2006). Innovation management measurement: A review. *International Journal of Management Reviews, 8*(1), 21–47.

Blank, S. (2013). *The four steps to the epiphany*. Pescadero, CA: K&S Ranch.

Breiman, L. (2001). Random forests. *Machine Learning, 45*(1), 5–32.

Caliendo, M., & Kritikos, A. S. (2008). Is entrepreneurial success predictable? An ex-ante analysis of the character-based approach. *Kyklos, 61*(2), 189–214.

Carter, N. M., Gartner, W. B., & Reynolds, P. D. (1996). Exploring start-up event sequences. *Journal of Business Venturing, 11*(3), 151–166.

Chen, C. C., Greene, P. G., & Crick, A. (1998). Does entrepreneurial self-efficacy distinguish entrepreneurs from managers? *Journal of Business Venturing, 13*(4), 295–316.

Christensen, C. M., Baumann, H., Ruggles, R., & Sadtler, T. M. (2006). Disruptive innovation for social change. *Harvard Business Review, 84*(12), 94.

Cooper, A. C., Gimeno-Gascon, F. J., & Woo, C. Y. (1994). Initial human and financial capital as predictors of new venture performance. *Journal of Business Venturing, 9*(5), 371–395.

Davidsson, P., & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing, 18*(3), 301–331.

Dawes, R. M., Faust, D., & Meehl, P. E. (1989). Clinical versus actuarial judgment. *Science, 243*, 1668–1674.
Dees, J. G. (2007). Taking social entrepreneurship seriously. *Society, 44*(3), 24–31.
Edelman, L. F., Manolova, T. S., & Brush, C. G. (2008). Entrepreneurship education: Correspondence between practices of nascent entrepreneurs and textbook prescriptions for success. *Academy of Management Learning & Education, 7*(1), 56–70.
Edwards, A. W. (1963). The measure of association in a 2× 2 table. *Journal of the Royal Statistical Society Series A (General), 125*(1), 109–114.
Fisher, R. A. (1922). On the interpretation of χ2 from contingency tables, and the calculation of P. *Journal of the Royal Statistical Society, 85*(1), 87–94.
Google. (2016). *The change in the usage of the words 'innovation' and 'novelty' with time according to Google Ngram Viewer*. http://goo.gl/hMf5BN
Grove, W. M., & Meehl, P. E. (1996). Comparative efficiency of informal (subjective, impressionistic) and formal (mechanical, algorithmic) prediction procedures: The clinical–statistical controversy. *Psychology, Public Policy, and Law, 2*(2), 293.
Huang, J., & Ling, C. X. (2005). Using AUC and accuracy in evaluating learning algorithms. *IEEE Transactions on Knowledge and Data Engineering, 17*(3), 299–310.
Khan, S. (2012). *The one world schoolhouse: Education reimagined*. New York, NY: Twelve.
Koroleva, D., & Khavenson, T. (2015). The portrait of a twenty-first century innovator in education. *Russian Education and Society, 57*, 338–357.
Ling, C. X., Huang, J., Zhang, H. (2003). *AUC: A better measure than accuracy in comparing learning algorithms*. Proceedings of 16th Canadian Conference on Artificial Intelligence, pp. 329–341.
Marvel, M. R., & Lumpkin, G. T. (2007). Technology entrepreneurs' human capital and its effects on innovation radicalness. *Entrepreneurship Theory and Practice, 31*(6), 807–828.
Mosteller, F. (1968). Association and estimation in contingency tables. *Journal of the American Statistical Association, 63*(321), 1–28.
OECD. (2005). *Oslo manual* (3rd ed.). Paris: OECD.
OECD. (2014). *Measuring innovation in education*. Paris: OECD.
Perren, L., & Sapsed, J. (2013). Innovation as politics: The rise and reshaping of innovation in UK parliamentary discourse 1960–2005. *Research Policy, 42*, 1815–1828.
Pevsner, N. (Ed.). (1999). *A dictionary of architecture and landscape architecture*. London: Penguin Books.
Reimers, F. (2010). Pathways for change educational innovation in Latin America. *Americas Quarterly*, Fall.
Robinson, K. (2010). *Changing education paradigms*. http://www.ted.com/talks/ken_robinson_changing_education_paradigms
Rogers, E. M. (1983). *Diffusion of innovations* (3rd ed.). New York: Free Press of Glencoe.
Schumpeter, J. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Cambridge, MA: Harvard University Press.
Schumpeter, J. (1942). *Capitalism, socialism and democracy*. New York, NY: Harper & Brothers.
Shane, S. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science, 11*, 448–469.
Shea, P., Pickett, A., & Li, C. S. (2005). Increasing access to higher education: A study of the diffusion of online teaching among 913 college faculty. *The International Review of Research in Open and Distributed Learning, 6*(2).
Šidák, Z. (1967). Rectangular confidence regions for the means of multivariate normal distributions. *Journal of the American Statistical Association, 62*(318), 626–633.
Simonton, D. (Ed.). (2006). *The Routledge history of women in Europe since 1700*. Abingdon: Routledge.
Soffer, T., Nachmias, R., & Ram, J. (2010). Diffusion of web supported instruction in higher education-the case of Tel-Aviv university. *Educational Technology & Society, 13*(3), 212–223.

Spiering, K., & Erickson, S. (2006). Study abroad as innovation: Applying the diffusion model to international education. *International Education Journal, 7*(3), 314–322.
Taddei, F. (2009). *Training creative and collaborative knowledge-builder: A major challenge for 21st century education*. Paris: OECD.
Ucbasaran, D., Westhead, P., & Wright, M. (2008). Opportunity identification and pursuit: Does an entrepreneur's human capital matter? *Small Business Economics, 30*(2), 153–173.
UNESCO. (1999). *Jan Amos Comenius*. Paris: UNESCO.
UNICEF. (2015). *The state of the world's children 2015*. New York: UNICEF.
Warford, M. K. (2005). Testing a diffusion of innovations in education model (DIEM). *The Innovation Journal, 10*(3).

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