Developing an Innovation Self-Efficacy Survey

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Abstract—**Innovation is critical to our economic and social prosperity. We rely on industry, university, and government employees to develop, modify, and implement innovative ideas while navigating ambiguous problem contexts, overcoming setbacks, and persisting in competition with courses of action. Research has shown that self-efficacy, or individuals' belief in their ability, influences the pursuit of and persistence in challenging work, suggesting the criticality of self-efficacy for innovation. Despite resource-intensive efforts to foster innovation in organizations, we inadequately understand how to measure the impact of these interventions on individuals' judgment of their own innovation ability. As part of our work to design innovation-related interventions and evaluate impact, we share early stage work to develop and validate a survey measure for Innovation Self-efficacy (ISE), or the belief in one's ability to innovate.**

Keywords – self-efficacy; innovation; assessment

I. INTRODUCTION

Environment. Education. Security. Transportation. Communication. Government, academia, and industry are continuously called upon to innovate solutions to challenges in these and other domains. Innovation has been defined as the intentional implementation of novel and useful processes, products, or procedures to a new domain, designed to benefit society [1]. Contemporary examples include online courseware, data mining, electric vehicles, online crowd funding, and modular carpeting.

The work of innovating can be unpredictable, controversial, and in competition with current courses of action despite the obvious benefits. Innovators must develop, modify, and implement ideas while navigating ambiguous problem contexts, overcoming setbacks, and persisting through uncertainty [2].

Self-efficacy has been defined as an individual's judgment of their capability to organize and execute courses of action for a given task [3]. Being efficacious toward a task is an important factor in an individual's ability to attempt and subsequently perform the task successfully. Research has found that self-efficacy views influence intrinsic motivation, engagement in specific behaviors, and the ability to pursue certain tasks [3]. This suggests that individuals may not engage or persist in innovative efforts if they do not believe in their abilities.

While resource-intensive efforts to foster innovation in organizations are plentiful, we inadequately understand how to measure the impact of these interventions on individuals' judgment of their own innovation capabilities. In this paper, we share early stage work to develop and validate a survey measure for Innovation Self-efficacy (ISE).

A. Innovation Self-efficacy

Innovation self-efficacy refers to an individual's belief in his or her ability to accomplish tasks necessary for innovating [4, 5]. It is becoming more apparent in the literature that self-efficacy is a critical component for innovation [6]. The nature of innovation requires a high level of persistence to overcome setbacks. Positive self-efficacy beliefs are not only tied to persistence, but also have the potential to influence innovation by strengthening creative performance, increasing the tendency to engage in expended effort, and inducing learning from failure [7, 8, 9].

B. Specific Abilities Necessary for Innovation

Our modern understanding, definition, and identification of innovation are understandably complex and varied across different fields. Research has suggested a number of important components of innovative work including transferring knowledge from one domain to another [10], developing novel and useful ideas [1], experimentation with ideas, and learning from experimentation [11]. Task-specific survey measures applicable to engineering innovation have been developed to assess self-efficacy of creativity [12], engineering design [13], modeling [14], tinkering [15], and entrepreneurship [16]. Scholars have yet to develop an integrated measure that relates to a collection of tasks associated specifically with innovation.

The focal areas of our study are in the areas of creativity, engineering, and design to build off of the previous work by the authors, however we believe that this research will be generalizable to other disciplines interested in fostering innovation.

II. METHODS OF RESEARCH

Our early stage work included four primary components: (1) Conducting a literature review of self-efficacy and tasks associated with innovation in different fields, including psychology, engineering, education, business, design, and organizational management; (2) Collecting interview and survey data about task-related indicators of innovation from practitioners and academics in innovation-related fields to understand what they felt was important from their own work and experience; (3) Using the research to develop a preliminary model of innovation self-efficacy, clustering and mapping the indicators into schemata based on existing beliefs in the model of innovation; and (4) Piloting a set of survey items (task-specific statements) based on this model.

III. Results

Our literature review and interview data suggested 38 indicators (task-related skills, behaviors or attitudes) of innovation self-efficacy that could be learned or cultivated in an innovator. To conceptualize our model, we grouped the indicators into nine clusters: communication, creativity, exploration, flexibility, resourcefulness, implementation, iteration, synthesis, and vision.

The survey of importance conducted with academics and practitioners (N=22) asked participants to rate each indicator from 1 (not at all important) to 5 (extremely important). Results from this exploratory survey allowed us to see, for this group, which indicators most participants believed were most crucial to innovation, and thus begin to hone in on the indicators that we want to measure. We created a pilot survey from the 25 indicators that the majority of participants found most important.

We administered our pilot survey to engineering students at a large state university (N=62). The pilot survey asked students to rate their degree of confidence in their ability to do each of the 79 tasks (3-4 task-specific self efficacy statements mapped onto each indicator) on a 100-point Likert scale (0 = cannot do this at all; 100 = highly certain can do) [17].

Factor analysis was run on statements within each cluster (our sample size was not large enough to run on the entire survey) and groupings of statements were refined accordingly, resulting in 13 indicators (Table 1); each with three task-specific self-efficacy items. Reliability analysis was run on each 3-item scale to ensure that Chronbach's alpha was >.70 [18] (it ranged from .761-.837).

TABLE I. Indicators of innovation self-efficacy

Clusters	Indicators	Description
Vision	Vision	Identify new opportunities
Exploration	Awareness/Empathy	Pay attention to what is around and adopt others' viewpoints
	Observation	Imagine and understand how things work
Synthesis	Information processing	Make connections
Creativity	Creativity	Have original and unique ideas
Iteration	Idea testing	Assess ideas for viability, feasibility and desirability
Resourcefulness	Collaboration	Work with others
	Knowledge building	Utilize people, tools, and other resources
	Persistence	Continue to approach problems despite setbacks
Implementation	Decision making	Set goals and choose how to proceed
	Risk-taking	Go against what is expected or safe if necessary
Communication	Oral and written communication	Craft and share information through written and oral means
	Visualization of information	Translate ideas into visualizations

IV. Future Work and Implications

This preliminary investigation describes an exploratory pathway for studying innovation self-efficacy. We hope to refine and retrace these steps with larger and more diverse sample sizes to obtain more robust validity determinations. The planned extensions include administering the survey of indicator importance to a larger network of engineering and design experts to determine focal indicators and administering a refined pilot survey of self-efficacy with a sample of students and practitioners of engineering and design large enough to run more powerful factor analyses on the entire measure. We also plan to examine what the resulting survey is capable of measuring by comparing results to external measures of innovation such as number of patents, project work and assessments, or employer/collaborator ratings. We hope that our findings will allow us to extend our analysis of innovation self-efficacy with respect to elements that can influence self-efficacy such as domain expertise, motivation and work place conditions.

We believe this research will result in a valuable instrument for innovation self-efficacy that can be used to evaluate interventions designed to foster innovation for individuals within an organization, and can more broadly inform the design and development of such innovations and programs.

References

[1] M.A. West and J.L. Farr, Eds, *Innovation and Creativity at Work, Psychological and Organizational Strategies*. New York: Wiley, 1990.

[2] S. Scott and R. Bruce, "Determinants of Innovative Behavior: A path model of Individual Innovation in the Workplace," *Academy of Management Journal*, vol. 37, no. 3, pp. 580-607, 1994.

[3] A. Bandura, "Self-efficacy," in V.S. Ramachaudran (Ed.), *Encyclopedia of human behavior*, vol. 4, pp. 71-81. New York: Academic Press, 1994.

[4] E. Gerber, "Innovation Self-Efficacy: Fostering Beliefs in Our Ability Through and By Design," *Core 77*, October 24, 2011. http://www.core77.com/.

[5] E. Gerber, J. Olson and R. Komarek, "Extracurricular design-based learning: Preparing students for careers in innovation," *International Journal of Engineering Education* (2011, forthcoming).

[6] C. Shalley, J. Zhou, and G.R. Oldham, "The Effects of Personal and Contextual Characteristics on Creativity: Where Should We Go from Here?" *Journal of Management*, vol. 36, no. 6, pp. 933-958, 2004.

[7] T.M. Amabile, *Creativity in Context*. Boulder, Colorado: Westview Press, 1996.

[8] M.R. Redmond, M.D. Mumford, and R. Teach, "Putting creativity to work: Effects of leader behavior on subordinate creativity," *Organizational Behavior and Human Decision Processes*, vol. 55, no. 1, pp. 120-151, 1993.

[9] F. Pajares, "Self-efficacy beliefs in academic settings," *Review of Educational Research*, vol. 66, no. 4, pp. 543-578, 1996.

[10] A. Hargadon A. and R.I. Sutton, "Technology Brokering and Innovation in a Product Development Firm," *Administrative Science Quarterly*, vol. 42: 716-744, 1997.

[11] S.H. Thomke, "Managing Experimentation in the Design of New Products," Management Science, vol. 44, no. 6, pp. 743-762, 1998.

[12] P. Tierney and S.M. Farmer, "Creative self-efficacy: its potential antecedents and relationship to creative performance," *Academy of Management Journal,* vol. 45, no. 6, pp. 1137–1148, 2002.

[13] A. Carberry, H.S. Lee, and M.W. Ohland, "Measuring Engineering Design Self-Efficacy," Journal of Engineering Education , vol. 99, no. 1, pp. 71-78, 2010.

[14] T.P. Yildirim, M. Besterfield-Sacre, L. Shuman, "An Engineering Modeling Self-efficacy (EMSE) Scale", *Proceedings of the 117th*

Annual Conference of American Society for Engineering Education, Louisville, Kentucky, June 20-23, 2010.

[15] D. Baker, S. Krause, and S.Y. Purzer, “Developing an instrument to measure tinkering and technical self-efficacy in engineering,” in *American Society for Engineering Education Annual Conference and Exposition*, Pittsburgh, PA, 2008.

[16] C.C. Chen, P.G. Greene, and A. Crick, “Does entrepreneurial self-efficacy distinguish entrepreneurs from managers?”, *Journal of Business Venturing*, vol. 13, pp. 295-316, 1998.

[17] A. Bandura, “Guide for constructing Self-efficacy scales.” *Self efficacy Beliefs of Adolescents*. Infomation Age Publishing, pp. 307-337, 2006.

[18] D. George and P. Mallery, *SPSS for Windows step by step: A simple guide and reference*. Boston, MA: Allyn and Bacon, 2003.