This paper was presented at The ISPIM Innovation Conference – Innovation, The Name of The Game, Stockholm, Sweden on 17-20 June 2018. The publication is available to ISPIM members at www.ispim.org.

Research-based Innovations through Challenge Competitions?

Nina Kahma*

Consumer Society research Centre, University of Helsinki, P.O. Box 24, 00014 University of Helsinki, Finland.
E-mail: nina.kahma@helsinki.fi

Mikko Rask

Consumer Society research Centre, University of Helsinki, P.O. Box 24, 00014 University of Helsinki, Finland.
E-mail mikko.rask@helsinki.fi

Veronica Ahonen

Consumer Society research Centre, University of Helsinki, P.O. Box 24, 00014 University of Helsinki, Finland.
E-mail veronica.ahonen@helsinki.fi

* Corresponding author

Abstract: Research and innovation funding agencies are increasingly investing in different types of challenge competitions. Such competitions introduce researchers a chance to develop science-based products or scientific processes addressing complex societal challenges within the public sphere. In this paper we explored 45 challenge competitions to explore their characteristics and impacts. This paper will contribute to the distinction between product- and process-oriented challenge competitions and provide preliminary findings about the impacts of such activities. Based on our analysis, product- and process-oriented challenge competitions have different implications and "additionality" in terms of funding and research support actions. Examples of the benefits include shortened time span between research and its publication, funders' access to notable research resources with small investments, meriting and branding of both researchers and organizers as well as new capacities and skills developed.

Keywords: Additionality; challenge competitions; innovation production; researcher competence; scientific competition; societal challenges.

1 Grand challenges and recent changes in science making

Challenge competitions have become a new tool for universities and the academia to orient research activities toward addressing societal challenges. There are good reasons for this. First, societal or grand challenges - such as health of aging populations, food security, clean and efficient energy, climate change, and safety of societies - are pervasive and compelling issues for societies to act and academia to contribute. Second, under increasing legitimacy crises and shrinking funding of European science, vindicating that science can provide more effective solutions to these problems is among the most powerful ways to legitimize public spending on R&D (Rask et al., 2018). Third, focus on challenges, according to Stefan Kuhlman and Arie Rip (2014), involves an open-ended mission and systemic transformation approach, which stimulates innovation potentially more broadly than more traditional R&I policies in particular domains of technology through dedicated funding programmes.

So far, little if no attention has been paid to the impact of the widening scope and increasing market orientation of challenge competitions (d'Andrea et al. 2018). The few studies on science competitions have focused on competitions targeted for school children and students (Blankenburg et al. 2016, Kuch & Sanford 2014).

According to scientists, such as Ziman (1996) and Alberts and colleagues (2014), the structural change of science fosters competition within science. The literature on academic capitalism (Slaughter & Leslie, 1997; Slaughter & Rohades, 2000), on the other hand, has accounted for the increasing weight of market dynamics and competition in the life of university institutions under the pressure of globalisation process. Such research has been more focused on issues such as accessing funds, in patenting, and activating university-industry partnerships.

Literature on innovation management has studied the role of challenge competitions and crowdsourcing as a strategy of innovation production (e.g., Howe, 2008). Such research focused on product-oriented competitions where the aim is simply creating new solutions, rather than process-oriented competitions, where the emphasis is in showcasing the activities of cutting edge research consortia while processing their research-based solutions further.

More recently, a completely different, 'shark tank' type of challenge competition, where the emphasis is rather on the process of presentation than on the product, has emerged. While it is well-known that product-oriented challenge competitions can be effective in crowdsourcing new ideas and solutions, it has remained less clear what the impacts of process-oriented challenge competitions to the production of innovations actually are. We examine the difference between product- and process-oriented competitions and ask, what is the additionality of challenge competitions as compared to more traditional means of research funding and support.

2 Challenge competitions

The definition of a challenge competition

Challenge competitions are processes that introduce researchers a chance to develop science-based products or scientific processes addressing complex societal challenges within the public sphere. Moreover, they often are framed with Grand Challenges that call for the mobilization of heterogeneous social elements (Rip & Kuhlman 2014).

Competitions do not offer funding for all the participants, but instead, they offer researchers new skills, networks, mentoring and tools to develop products and processes. Challenge competitions for scholars form a new means for promoting researcher brand as well as supporting research. An interesting feature of them is, as some scholars propose, the articulate goal of improving effectiveness and productivity, which makes science competitions an epitome of intensification of the interaction between universities, industry and society (see Lemont 2009, Holmwood 2010, Rosa 2010, Fochler et al. 2016).

Challenge competitions differ from traditional research funding by their application processes not being focused solely on measuring research performance through consortium credentials (academic degrees, publications and research plans), but the valuation of also on researcher branding, presentation skills, display of teamwork and reactions of the public.

From a broad perspective, challenge competitions include a wide array of competitions targeted at producing scientific findings and innovations. From a narrower perspective, however, challenge competitions differ from academic prizes and awards that do not involve the process of science making and lead either to product or process innovation. Moreover, challenge competitions include interaction between science and society.

In our initial typology (Table 1), two theoretical extremes of challenge competitions, process-oriented and product-oriented challenge competitions, are distinct in many respects: first, the scientific input in process-oriented competitions is expected to produce throughput, in other words a behavioural additionality that is expected to benefit the researchers in their career in the long run. In product-oriented challenge competitions the input is thought to foster a specific outcome – either an innovative solution or an improvement to an existing one. Second, the goal-setting of process-oriented competitions has been defined loosely, whereas in product-oriented competitions it is defined beforehand. Third, the expected outcomes are addressed differently depending on the orientation of the competition.

Table 1 Features of product and process oriented competitions

Process-oriented	*Product-oriented*
Input – throughput	Input – outcome
Open-ended – creative	Closed – predefined
Concept – prototype	Innovation – demonstration

Additionality of challenge competitions

The differences and historical origins of product and process-oriented challenge competitions will be summarized based on scanning of recent university-based challenge competitions internationally. We will explore the impacts of these competitions on innovation production in the science competition descriptions. We will reflect upon the impact through the concept of additionality.

Following Georghiou & Keenan (2006) we define additionality as the extent, to which an activity would have taken place without a particular intervention. To evaluate additionality, we therefore have to first understand the intended impacts of challenge competitions, and then ask whether these are something that can best be acquired through this particular means rather than through traditional means of research funding and support.

While evaluating additionality, there are different expectations of the impacts of product vs. process-oriented challenge competitions. In product-oriented competitions, additionality can be found in the products presented at the final stages of the competition, for which reason attention has to be paid at the new formulations of research problems and processes as well as innovations and fixes produced. In process-oriented challenge competitions, instead, additionality can be found in the new routines, practices and skills that the participants develop.

3 The analysis

As there is no comprehensive listing of existing science competitions, the data consists of public descriptions of challenge competitions available in English. In our web searches we used the search words "challenge" + "competition" + "researchers". As a result, were found 45 competitions with descriptions in English. We omitted the competitions targeted for school children, and the competitions not involving researchers. Due to the space limitation, this data is not provided here.

Based on the impact descriptions, we will categorize challenge competitions in product- and process-oriented competitions. Cases will be used to illustrate the characteristics of the different categories, and we also reflect on their dynamics in terms of temporality, locality, and causality.

4 Findings

Challenge competitions are a recent phenomenon (Verhoeff 1997), and even the most established competitions are from the beginning of this century. Of the challenge competitions, 28 can be characterized as product-oriented and 17 as process oriented. Table 2 shows some recent examples of product- and process-oriented competitions.

Table 2 Examples of challenge competitions

Country	*Challenge*	*Years*	*Orientation*
Helsinki Challenge	Theoretical, social	2015, 2017	Process
InnoCentive	Technical and theoretical	2001 –	Product
NEF Challenge	Technical, social	2013 –	Product –> process
Allen AI Science Challenge	Technical, social	2015–2016	

Case 1: InnoCentive

InnoCentive is a well-known case in the field of innovation studies. In their challenge competition scheme, the company posts technical and theoretical challenges of different corporations online for scientists and engineers to solve.

The competition is a classic example of product-oriented challenge competitions: all that matters is the quality of the innovation or the end product. The concept has proved effective in stimulating innovative solutions – often more successfully when the solvers have had less experience in the directly relevant scientific disciplines (Howe, 2008, 46, Travis 2008).

Case 2: Helsinki Challenge

Helsinki Challenge is a large-scale effort to create a new instrument for a university to highlight its research activities, support science-in-society interaction, and orient research to reach the UN Sustainable Development Goals (SDGs). So far, it has been organized twice. In the first cycle, the competition was organized among researchers of the University of Helsinki. In the second cycle, the competition was opened to nine other Finnish universities.

The competition for multi-disciplinary research consortia requires participants' engagement for almost a full year. The research proposals are research-based suggestions on solutions for certain problems outlined in the call. The proposals are developed further during multiple phases in the competition, and pitch nights are central fora for reporting research results. During the competition, research ideas are developed, and the participants are being trained and mentored. The final solutions can be anything from a new scientific field to a commercialisable idea, entrepreneurship or pioneering research.

Case 3: NEF Challenge

The Next Einstein Forum's Challenge of Invention to Innovation is a multidisciplinary challenge competition that operates as a platform connecting science, society and policy and Africa and beyond. It is targeted at young African scientists in the STEM disciplines, with an innovation that can be scaled up.

Case 4: Allen AI Science Challenge

The Allen AI Science Challenge is a challenge competition open for teams formed by individuals over the age of 18. It is built on an ongoing Aristo project that is building a structured knowledge base.

Product- and process-orientation in challenge competitions

On the basis of the four examples of challenge competitions, the demarcation between product- and process-oriented competitions seems to be clear.

InnoCentive is an example of an open challenge competition that is primarily product-oriented, hence some challenges posed also allow for theoretical solutions in addition to technological ones. The interaction in the challenge competitions happens in between the researcher(s), InnoCentive and the organisations defining the research challenges. Therefore, the research can be defined as applied research or contract research.

Helsinki Challenge, on the contrast, can be characterized more as an exclusive, process-oriented competition. The one year process includes mentoring, workshops, bootcamps and an accelerator program to develop the participants' skills and concepts. The goal of the whole competition lies more in building partnerships and collaborations, than developing an individual innovation. An important aspect of Helsinki Challenge lies in the pitch night events, to which researchers are prepared by professional moderators and science communications specialists.

The NEF challenge is an example of a challenge competition with mixed features. It represents a product-oriented competition format, as the scientists are expected to pitch innovation ideas. However, what is offered to the scientists, is an opportunity to develop their innovation as well as their personal skills further with experienced entrepreneurs acting as mentors.

Allen AI Science Challenge is also an example of a mixed concept. It was built on an ongoing Aristo project that could foster models, analyses and methodologies produced by the participants of the challenge competitions. The impact the competition was thought to have included behavioural additionality manifested in the form of practical skills gained by the participants as well as development of the project operating as a basis for the competition.

5 Conclusion

On the basis of our analysis, additionality from the viewpoints of researchers and research funders seems different for product- and process-oriented challenge competitions (Table 3).

Table 3 The manifestations of product- and process-oriented competitions

Dimension	*Process-oriented*	*Product-oriented*
Temporality	Phased research, results made public sooner	Fixed time frame for finishing the innovation or end product
Locality	Network	Corporate context
Orientation	Competences, skills	Product, innovation

First, if we consider the additionality of challenge competitions as compared to traditional research funding, challenge competitions usually reward the winner, whereas other participating researchers receive no compensation for their effort, although challenge competitions offer a platform that forces the research to be finished in schedule. The additionality from the viewpoint of research funder is obvious, as the subscriber of the research gains notable research resources with a small investment. Therefore, challenge competitions are often in favour of the organiser.

Second, considering the additionality of competitions in relation to science communication, there are obvious benefits related to meriting of the researchers as well as branding of the organisers.

Third, looking at challenge competitions as compared to the traditional research support actions, product-oriented challenge competitions may not build researcher skills and capacities to the same extent as process-oriented competitions. Whereas process-oriented challenge competitions often include mentoring and researcher training as well as the opportunity to build researcher brand, product-oriented challenges more often build on the skills the researcher already has.

The analysis presented in this paper is exploratory, but it gives reasons to believe that a systematic evaluation on challenge competitions and their additionality is called for. The scope of this analysis should be broadened to comprehend researcher experiences as well as viewpoints of organizers of these events.

References

Alberts, B., Kirschner, M. W., Tilghman, S. and Varmus, H. "Rescuing US biomedical research from its systemic flaws*," Proceedings of the National Academy of Sciences* 111, no. 16 (2014): 5773–5777.

d'Andrea, L., Federico, M., Kahma, N., & Vase, S. (2018) Fostering Improved Training Tools for Responsible Research and Innovation: Report on the Literature Review. (*Forthcoming*)

Blankenburg, J.S., Höffler, T.N., Peters, H. and Parchmann, I. "The effectiveness of a project day to introduce sixth grade students to science competitions," *Research in Science & Technological Education*, 34, no. 3(2016): 342–358.

Fochler, M., Felt, U. and Müller, R, "Unsustainable growth, hyper-competition, and worth in life science research: Narrowing evaluative repertoires in doctoral and postdoctoral scientists' work and lives," *Minerva*, 54, no. 2 (2016): 175–200.

Georghiou, L. and Keenan, M." Evaluation of National Foresight Activities: Assessing Rationale, Process and Impact," *Technological Forecasting and Social Change*, 73, no. 7 (2006): 761–777.

Holmwood, J. "Sociology's misfortune: disciplines, interdisciplinarity and the impact of audit culture," *British Journal of Sociology*, 61, no. 4 (2010): 639–658.

Kuech, R. and Sanford, R. "Academic competitions: Perceptions of learning benefits from a Science Bowl competition", *European Scientific Journal*, vol. 1 (2014): 388–394.

Kuhlmann, S.and Rip, A. "The Challenge of Addressing Grand Challenges," Working Paper, 2014. https://ec.europa.eu/research/innovation-union/pdf/expert-groups/The_challenge_of_addressing_Grand_Challenges.pdf , accessed Sep 2017.

Lemont, M. *How professors think: Inside the curious world of academic judgement.* Cambridge, MA: Harvard University Press, 2009.

Rask, M., Macukaite-Zviniene, S., Tauginiene, L., Dikcius, V., Matschoss, K., Aarrevaara, T. and d'Andrea, L. *Public Participation, Science and Society: Tools for Dynamic and Responsible Governance of Research and Innovation*. London, UK: Routledge, 2018.

Rosa, H. *Alienation and Acceleration: Towards a Critical Theory of Late-Modern Temporality*. Malmö: NSNU Press, 2010.

Slaughter, S. and Leslie, L. *Academic Capitalism: Politics, Policies, and the entrepreneurial University*. Baltimore, MD: Johns Hopkins University Press, 1997.

Slaughter, S. and Rhoades, G. (2000) "The Neo-liberal University." In *Crowdsourcing: How the power of the crowd is driving the future of business,* ed. J. Howe. New York, NY: Random House.

Travis, J. "Science by the Masses," *Science*, 319, no. 5781 (2008): 1750–1752.

Verhoeff, T. "The Role of Competitions in Education," Working Paper, 1997. http://olympiads.win.tue.nl/ioi/ioi97/ffutwrld/competit.html , accessed May 2018.

Ziman, J. "Post-academic science: Constructing Knowledge with Networks and Norms". *Science Studies*, 9, no. 1 (1996): 67–80.