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Level Of Knowledge Use Survey (LOKUS) instrument: Documenting knowledge use by stakeholders

Joseph P. Lane* and Vathsala I. Stone
Center for Assistive Technology, University at Buffalo (SUNY), Amherst, NY, USA

Abstract. Sponsors and scholars engaged in applied technological R&D are increasingly challenged to demonstrate evidence that their project outputs are adopted by stakeholders outside of academia. Potential knowledge users in the Assistive Technology field include clinicians, consumers, manufacturers, policy makers and information brokers. This paper first summarizes prior work to create the LOKUS instrument, a web-based tool designed to survey the level of knowledge use by these stakeholders. It then explores the value of the instrument for measuring change in knowledge use over time.

Keywords: Measurement, knowledge translation, level of use, knowledge uptake, non-awareness, awareness, interest, use, validated instrument, web-based, survey, stakeholders

1. Background

This paper first reviews the socio-economic context in which documenting knowledge uptake and use by non-traditional stakeholders is becoming increasingly important. It then summarizes the creation and initial administration of a new survey instrument (the LOKUS instrument). It concludes by discussing the new instrument's value and utility to the sponsors and investigators of applied R&D programs.

Over the past century, scholars and the government agencies sponsoring their projects, gradually broadened their shared mission [1]. Their original mission was building the global knowledge base through basic research, which fell within the purview of universities. Contributions were easily identified and tracked through established bibliometrics of authorship and citation, all within the realm of academic peers.

The mission gradually expanded to address societal issues through applied scientific research and engineering development (R&D). Examples of large and sustained programs include the European Union's Framework Programs, and the Engineering Research Centers in the United States. Despite their distinctly applied nature, the majority of program funding is still directed towards universities rather than to R&D laboratories in the private sector.

Documenting the anticipated contribution of university faculty to beneficial socio-economic outcomes – particularly those involving advances in technology-based product and service – is more challenging than tracking scholarly citations, so it occupies a fair share of the literature on research and innovation policy in Western nations [2,3].

The traditional explanation – the linear model of innovation – rested on a major assumption that funding university research at the front end, somehow and in some way generates market innovations at the back end. The assumption persists in public policies regarding the allocation of R&D funding, despite having been explored and dismissed in both theory and practice over time [4].

The lack of empirical support for the linear model of innovation prompted elected officials and the general public to demand greater accountability from such ap-

*Corresponding author: Joseph P. Lane, Center for Assistive Technology, University at Buffalo (SUNY), Amherst, NY, USA. Tel.: +1 716 204 8606, x211; Fax: +1 716 204 8610; E-mail: joelane@buffalo.edu.

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plied R&D programs [5,6]. Tolerance for aspirational rhetoric (e.g., *these findings may someday contribute to* ...), is giving way to calls for evidence that these programs are delivering practical results to society [7].

This rising demand for accountability results from two converging factors: economic contractions force all publicly-funded programs to compete for diminishing resources, the meager output level from the pipeline after decades of public investment. The field of Assistive Technology is one example where the generation of scholarly publication outcomes far outstrips the delivery of innovative device and service outcomes.

Sponsors and scholars engaged in applied R&D insist that they are making substantial contributions, but tracing the causal link between project outputs and societal impacts is difficult and nearly impossible to quantify [8]. Assessing the contributions of scholars under the expanded mission of applied R&D is indeed complicated by the required participation and collaboration of stakeholder groups outside of academe. These include manufacturers, policy makers, practitioners, brokers (e.g., educators/employers) and end users [9]. These stakeholders operate outside of scholarly metrics, so assessing the contribution of university-based outputs to market outcomes and impacts is a challenge.

But just how to go about this critical yet daunting task of identifying knowledge users who by definition are 'non-traditional,' who could be members of virtually any stakeholder group, and who's use may be difficult to detect through traditional metrics?

Knowledge Translation (KT) offers strategies to help scholars find these non-traditional stakeholders and communicate the value of new knowledge from R&D projects to them. The appraisal, uptake and adoption of new knowledge is recognized as an intermediate outcome and indicator of progress towards achieving the intended beneficial impacts in the long-term [10]. The KT strategies applied to improve communication with such stakeholders, includes targeting recipients, tailoring material to their values and contexts, and employing multi-media channels [11].

However, successfully communicating new knowledge from R&D is insufficient for this evidence-based environment. Actors also need some feedback mechanism on knowledge uptake and use by these stakeholders to both: 1) Measure and track the extent to which the targeted stakeholders engage with the new knowledge, and 2) Document the extent to which engagement leads to actions by stakeholders generating beneficial outcomes and impacts.

These twin challenges are magnified by the need for a data collection instrument to reach a widely distributed population of stakeholders, through remote media mechanisms, in an asynchronous manner, and capable of generating repeated measures over extended timeframes.

2. The LOKUS instrument

The authors' project team responded to these formidable challenges by designing, authoring and testing a new web-based survey questionnaire called the Level Of Knowledge Use Survey (LOKUS) instrument. The LOKUS instrument was specifically designed to differentiate between levels of knowledge use, and to detect changes in levels of use over time.

The methodologies employed for the conceptualization, design, testing and validation of the LOKUS instrument are fully described in a 2014 paper previously published via Open Access [12]. Five key features of the LOKUS instrument are:

- It is broadly structured on the Stages of Innovation Adoption analysis [13], with item generation protocol guided by the Levels of Use Framework [14].
- A series of content experts and samples representing the five stakeholder groups systematically validated it.
- It classifies four distinct levels of knowledge engagement: 1) Non-awareness, 2) Awareness, 3) Interest, and 4) Use, with Use subdivided into two forms: A) As intended by knowledge creator, or B) As modified by the recipient.
- Psychometric results show high reliability, validity and responsiveness to change, with limitations due to variance in self-reported responses and required recall over time.
- The actual LOKUS instrument is available for inspection as a questionnaire template, both in PDF document [15] and a web-based format [16].

Participants in the 2015 bi-annual conference of the Association for the Advancement of Assistive Technology in Europe (AAATE) recognized the potential value of the LOKUS instrument. A presentation on the creation and initial validation of this instrument [17] was invited by AAATE to be transformed into a manuscript for the peer-reviewed journal *Technology & Disability*. Given that conference paper was excerpted from a previously published paper [12], this invited paper focused on the implications of the socio-economic context in the front section, and now discusses the instrument's utility for practitioners and further scholarly inquiry by academics.

3. Practical utility

The availability of the LOKUS instrument as a new tool for measuring knowledge use is necessary but not sufficient to address the challenge facing sponsors and investigators. Creating, testing and demonstrating the quality and value of this instrument was only a beginning. It is time to explain to investigators and sponsors why they should care about it and how it can prove useful to them. Both groups need to recognize its value and apply this new tool within their own programs.

Essentially, the LOKUS instrument allows sponsors and investigators a means to gather objective and quantifiable evidence showing that their activities are resulting in knowledge uptake and use. Its open-ended questions permit respondents to supply specific case examples of the consequent outcomes and impacts for individual users and for society at large.

These are important capabilities for scholars and sponsors to gain, given the foreseeable economic realities of flat or contracting government budgets. To keep their programs viable, sponsors, universities and investigators must find ways to demonstrate how their applied R&D activity is influencing and benefitting targeted stakeholder audiences in society.

Those programs and fields of application able to demonstrate the uptake, adaptation, adoption and use of new knowledge by non-scholars, will have a strategic advantage over those that cannot. The key advantage lies in furnishing examples, based on data derived from actual users, of how the knowledge is resulting in beneficial socio-economic impacts. Such examples could justify continued and perhaps even increased funding for effective projects and programs. In this era of shrinking economies the competition for funding is becoming a zero-sum game.

Overall, the Level Of Knowledge Use Survey (LOKUS) instrument responds to public calls for greater accountability from government sponsored applied R&D programs. It addresses the thorniest conceptual and logistical issue: How to demonstrate evidence of uptake and use of new knowledge outputs particularly by non-traditional stakeholders?

Subsequent to its creation and validation, the project team administered the LOKUS instrument in three randomized controlled case studies, conducted in three distinct areas of the Assistive Technology field (i.e., wheeled mobility, AAC and recreational devices) [18]. These three case studies showed that the LOKUS instrument can assess the extent to which various stakeholders – traditional and non-traditional – are aware of, interested in and engaging with new knowledge outputs, and is sufficiently versatile to perform this assessment in varying topic area of interest.

The LOKUS instrument's versatility allows for altering the context of survey questions in order to address use of knowledge generated for technology-oriented topic area within the physical, health or social sciences. Thus, investigators working with any such subject matter can apply the LOKUS questionnaire through a web-based survey to track the level at which the outputs from their research projects have been found, read, understood and applied by clinicians, manufacturers, consumers or brokers, or any other identified non-traditional stakeholder group.

The key is ensuring that the narrative within each question provides sufficiently detailed information for respondents to recognize the new knowledge – and hopefully its source – when it is presented. When creating questions, the study team recommends obtaining input from the original investigator(s) who generated the new knowledge, to help ensure that the original findings are accurately paraphrased within the survey's question set.

Psychometric testing of the LOKUS instrument demonstrated its high content and construct validity, reliability and responsiveness to change, so users can assure policy makers that the data provides credible evidence of knowledge use. And this knowledge use is not simply a binary distinction. Instead LOKUS differentiates between the four levels of knowledge use: 1) Non-awareness, 2) Awareness, 3) Interest, and 4) Use.

This level of differentiation was previously unavailable, but it is now crucial for supporting the arguments of sponsors and investigators that uptake and use involves the diffusion of information over time. Information sharing between stakeholder groups follows an omni-directional pattern, depending on what is shared, when it is shared, with whom and for what purpose.

The LOKUS instrument could be used to query about new knowledge released in any of three different forms – publication of new concepts, announcement of concept applications in prototypes, or market release of new products with evidence of consumer benefits. Given this capability, the instrument can be used to trace the diffusion of new knowledge over time and across stakeholder groups. In the case of technology-oriented projects, it could trace the impact of new R&D outputs through the full range of new product development. For example, materials scientists could be queried about their awareness, interest and use of discoveries (new concept) regarding the properties of advanced fabrics (i.e., carbon, resin, aramid). At a later point in time, product engineers could be queried about their awareness and use of such fabrics in prototype devices. As new products containing advanced fabrics reach the marketplace, practitioners could be queried about their awareness and use (prescription) of those fabrics for consumers, and consumers can be queried about the awareness and use (purchase) of the beneficial product options. Policy makers and brokers could also be queried about their awareness and use (decision to approve and pay for) the beneficial products containing those advanced fabrics. However, in all these cases, the LOKUS will identify only the level of awareness, interest and use, but not yield information about how exactly the knowledge is being used, for which a follow up query of the respective stakeholder is necessary.

The above example illustrates how awareness, interest and use of new knowledge could change within each stakeholder group, and across those groups over time. Some instances could represent a supply-push from creators to consumers, while others might represent a demand-pull from consumers to creators. Gaps in knowledge use within or among groups might represent opportunities for targeted knowledge translation or dissemination efforts. At a minimum, LOKUS would generate objective evidence regarding the reach and results achieved by public investments in advanced fabrics.

Of course, customizing the LOKUS question set to new subject matter introduces potential threats to content validity and test-retest reliability. The LOKUS instrument's documented strength in content validity, test-retest reliability, and construct validity for distinguishing levels of knowledge use, both across published findings and across stakeholder types, is limited to the questions designed for the pilot and intervention studies already completed.

Care must be taken to check such new content with additional validation procedures. The LOKUS instrument is designed so it can be modified and replicated for any new topic content or stakeholder group, these same psychometric tests should be conducted for each new subject matter version. It is also advisable to involve the original R&D investigator in the review of the questionnaire's content, to ensure fidelity between the R&D outputs and narrative contained in the LOKUS questionnaire.

The LOKUS instrument can be prepared and distributed as a hardcopy document, in a web-based format, or both. Having a web-based version is valuable for extending a survey's geographic reach to any stakeholder member with Internet access. It may also encourage participation, which in turn, increases response rates, because the Internet delivery allows for asynchronous query and response timeframes. At the same time, the hardcopy option permits inclusion of stakeholders who lack Internet access due to economic or geographic conditions. Reaching the broadest range of potential respondents increases the generalizability of findings from the data collected.

4. Research value

The validation and application of the LOKUS instrument so far completed by the project team represents a first opportunity to test and analyze its quality and value, while acknowledging the need to expand its scope in further studies. Those analyses focused on the four topmost – and therefore most general – levels of knowledge use.

The full LOKUS instrument contains eight dimensions and thirty-seven activities distributed within these four levels. Much additional work is needed to further refine and validate the content of questions corresponding to the dimensions and activities, so they can be useful in eliciting the exact details of knowledge use by each different stakeholder group through a single application of the LOKUS instrument.

The limitation of the current version of the LOKUS can be seen in the example presented earlier, where new knowledge available in different forms, is used by different stakeholder groups in different ways and at different times in the diffusion process. The example focused on research findings (new knowledge) about advanced fabric properties taking on different forms over time. The stakeholders in that case include material scientists, product engineers, consumers, policy makers – where each of the groups would be interested in a different form (concept, prototype, product) of the new knowledge – and each group would use them in ways unique to their context and need.

The current version of the LOKUS instrument is able to identify the level of use of each stakeholder group in terms of awareness, interest and use, but would not define in detail how the knowledge is being used. Investigators would require a second step to get at this level of detail. After identifying people who are aware, interested or using the knowledge, they would conduct a follow up query or interview to determine the exact way in which the knowledge is being used to achieve some beneficial impact.

Further work to expand the scope of the instrument that includes the needed finer and deeper distinctions within the within the four levels hold promise for unfolding further details about the exact status of knowledge use by specific stakeholders. Unfortunately, initial results regarding the sequential nature of these dimensions and activities remains inconclusive for now, due to the low cell frequencies in our initial studies and subsequent analyses.

Additionally, the dimensions and activities still require further study to establish and verify their proper sequence. The applicability of these dimensions and activities also needs to be validated for other subject areas, which also require larger numbers of participants. Once these expanded studies are conducted and the dimensions and activities are refined, data from the LOKUS instrument will provide even more detailed understanding of how various stakeholders assess, integrate and apply new knowledge from scientific research or engineering development.

The LOKUS instrument functions effectively either in its paper version or in a web-based version that can be administered remotely and asynchronously. This addresses the main research study conundrum of reaching non-traditional stakeholders, who may or may not have had any prior exposure to the new knowledge described within the LOKUS questionnaire. As noted in a companion study [9], national professional organizations are willing to work with investigators to identify, contact and engage their own members, offering an opportunity to reach high numbers of individuals presumed to have potential interest in the new knowledge being queried through the LOKUS questionnaire.

Although the LOKUS questions and details were initially tailored to the field of Assistive Technology, the specific items can be altered and substituted to represent queries addressing any study finding, topic area or discipline where technology-oriented scientific research and engineering development is conducted. The current items clearly apply, sequentially or otherwise, to any investigation that involves technology-based outputs, since these were created and validated for the same applied context. Their applicability for assessing knowledge use from research in general warrants a re-validation or adaptation.

Another research opportunity involves substantiating the sequential nature of the four levels of knowledge use, and to examine the interrelationships among the many dimensions contained within each level of use. Those forms of analysis must await new applications of the LOKUS instrument, along with replications involving larger numbers of participants in the additional surveys conducted.

Summing up, the LOKUS instrument is an effective new tool by which sponsors and investigators can explore and report the diffusion (uptake and use) of new knowledge generated by technology-oriented R&D projects. Objective evidence of the transformation of such knowledge into laboratory prototypes and products in the marketplace is becoming essential to justifying continued public investment in programs claiming to provide beneficial socio-economic impacts. The LOKUS instrument addresses an unmet need so researchers have additional opportunities to apply and analyze its attributes.

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Conflict of interest

The authors have no conflict of interest to declare.

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