Center on Knowledge Translation for Technology Transfer (KT4TT)

Project: Measuring reach and uptake of new knowledge from technology innovations.

Working Paper II: Creation and validation of the Level of Knowledge Use Survey (LOKUS) instrument.

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Abstract

Background

Sponsors and investigators of Research and Development (R&D) projects are expected to demonstrate impact of technology-related new knowledge outputs generated through their projects. A measure capable of addressing the dynamics of knowledge use across diverse and diffuse stakeholder types that can also be used to track the progress of uptake through awareness, interest, and use, is therefore essential. This paper describes the creation and validation of the Level Of Knowledge Use Survey (LOKUS) instrument that was developed to address this need. One companion paper addresses the instrument's design and construction, while another recounts the establishment of its psychometric properties.

Methods

Fifty seven items in a self-reported format were generated to comprise the initial LOKUS web-based survey questionnaire. Guided by a slightly modified version of Hall and colleagues' Levels of Use (LoU) framework, the items addressed behaviors under a structure of 9 levels x 7 categories. Four experts in knowledge translation judged their content validity on relevance and uniqueness. Overall ratings, Item Content Validity Index (I-CVI), Scale Content Validity Indent (S-CVI/Ave) and Kappa coefficients were computed. Three experts in technology transfer further evaluated the items during a second round of content validity testing. Relevance ratings determined item inclusion. Rater comments on uniqueness guided item revision and questionnaire restructure to a 10 level x 6 category framework, consisting of 47 total items. Five representative stakeholders participated in one-on-one usability testing. Response pattern of 215 participants of a pilot randomized controlled intervention study in Augmentative and Alternative Communication technology enlightened the instrument's conceptual model.

Results

The items within the 10x6 framework met the relevance standard (I-CVI>0.78; S-CVI/Ave>0.90). Content validity indices from two rounds of expert ratings (n=4; n=3) determined item inclusion for two web-based versions of LOKUS: one for lay consumers and the other for professional stakeholders. One-on-one testing determined instrument usability. Data from the pilot intervention study (n=215) revealed that levels within the 10x6 framework could not be concluded as developmental. A final sequence of four levels: *Non-awareness, Awareness, Interest, and Use*; branching into 8 dimensions and 6 categories resulted.

Conclusions

The LOKUS instrument has demonstrated feasibility and validity as a web-based, self-report measure of knowledge use by multiple stakeholders of technology-related new knowledge outputs. Pending replication in other technology contexts, and further psychometric investigation, research and development investigators and sponsors can apply LOKUS to gain an overview of knowledge use at any given time, and track changes through repeated measurement.

Background

This is second in a series of three papers that address the development of the Level of Knowledge Use Survey (LOKUS) instrument, created by the University at Buffalo's Knowledge Translation for Technology Transfer (KT4TT) Center. The rationale and context of the instrument's conceptual development is addressed in an earlier paper [1]. This paper describes the design and construction of the LOKUS instrument, while a third paper discusses the establishment of its psychometric properties [2].

LOKUS is a web-based, self-report survey instrument designed to measure an individual's level of awareness, interest and use of new knowledge generated in the context of technologically-related new knowledge, through research (R), development (D) and/or production (P) activities. New knowledge (NK) is viewed as an output from these three different, yet similarly systematic methods, and exists in three alternate states: 1) discoveries in conceptual form, generated by research (R) through scientific methods; 2) inventions in prototype form generated by development (D) through engineering methods; 3) innovations in commercial form generated by production (P) through industrial methods [3]. The LOKUS instrument collects evidence of reach and use of technology-based new knowledge outputs by stakeholders such as practitioners/clinicians, designers/manufacturers, lay consumers, information brokers and policy makers. It may hold value to research and development (R&D) sponsors and grantees who wish to measure changes in knowledge use over time, to generate evidence of outcome impact among these target stakeholder audiences.

The context for the development of LOKUS came from a series of randomized controlled intervention studies (RCTs) that sought to compare the relative effectiveness of knowledge translation (KT) approaches to communicating new knowledge to various stakeholder types [1]. The pilot RCT in the area of Augmentative and Alternative Communication (AAC) technology served as the test-bed for the

LOKUS instrument's development. For details of design and implementation of the RCTs, see Exhibit One.

The instrument's conceptual basis is broadly grounded in Roger's stages of innovation diffusion [4] and guided by Hall and colleagues' Levels of Use (LoU) framework [5]. Through empirical validation, the instrument was progressively modified to fit the knowledge use context of technological innovations [1].

Methods

All three papers relate to the flowchart on LOKUS development summarized in Figure 1. This paper describes the first phase of development, before psychometric properties of LOKUS were established in the second phase. Phase One included survey development and validation - specifically, item development focused on (i) *item generation and content validation*; (ii) *instrument construction*, where improved items and framework were organized, formatted and tested for usability and online administration; and (iii) *instrument piloting* for field testing and context validation. Empirical basis for evaluative decisions in Phase One came from the subsequent data.

Participants

Two successive rounds of content validity testing were conducted for the generated items. Four researchers with expertise in knowledge translation participated in the first round. Three of whom were experienced KT scholars with special interest in technology use. The fourth researcher was a specialist in Knowledge Translation (KT) for Technology Transfer (TT) with prior experience in assistive technology related TT. Improved items were tested in the second round by three researchers with extensive prior experience in technology transfer, with special focus on assistive technology. Each of these three researchers also brought exclusive knowledge of stakeholder contexts specific to AAC technology, which was addressed by the pilot RCT that provided the test bed of LOKUS. The stakeholder contexts included:

clinicians, manufacturers, policymakers, transition brokers, researchers, and consumers with communication disabilities.

Data about the instrument's usability came from one-on-one testing by stakeholder representatives relevant to AAC technology, who pilot tested LOKUS for content comprehension, meaningfulness and accessibility. The participants included: (a) a licensed clinician who provided therapy for adult AAC users, (b) the director of the University at Buffalo disability services, who brokered disability services to students, and who tested the instrument for accessibility as a visually impaired individual; (c) a researcher who conducted AAC related clinical research; (d) a manufacturer of AAC related equipment and accessories; and (e) an adult consumer of AAC device.

The empirical basis of the conceptual model for LOKUS came from the examination of response patterns to the instrument, through its pilot application in AAC [6]. A total of 215 stakeholders answered LOKUS at baseline and follow-up tests, with an interval of four months in between each test. Participants were drawn from a national pool of candidates and recruited through professional organizations of their affiliation. They included: clinician-therapists of adult AAC users (n=45); brokers in college life application of AAC (n=65); manufacturers of AAC related equipment and accessories (n=26); researchers in AAC (n=29); and adult users of AAC (n=50).

Item Development: Generation and Validation

Item Generation: Items were generated for the web-based survey instrument by referencing respondents (participants) to findings from three research studies (i.e., Study A, B and C) about AAC technology. Each item represented behaviors of new knowledge use from multiple stakeholder perspectives. Hall and colleagues' LoU matrix of seven levels (from Non-use to Renewal) and seven categories (from Knowledge to Performing) was used as the basic guide [5], making needed changes to the matrix, which increased the initial number of levels to nine and re-named several of the seven categories. Only the matrix cells judged as relevant to knowledge users were populated, generating

knowledge user behaviors based on a critical review of the original LoU suggestions in these cells. All definitions for specific behaviors were tentative, open to further revision as necessary. Table 1 presents the initial distribution of items within the 9x7 framework.

Each behavior was transformed into an item, referencing it to a standard, one-paragraph description of Study A (or B or C). The description included the original paper's citation, the core new knowledge from the study, and the author's affiliation. Each item was written in an objective format appropriate for self-reporting, as either a dichotomous response, or a simple check-off to indicate the respondent's affirmation of that specific behavior pertaining to knowledge use. Although querying about the specific new knowledge in question, the item described the behavior in "generic" terms, so it could apply to outputs from any other technology-based R, D or P project. This ensured compliance with the conceptual basis defined for the instrument, considering the: (a) five stakeholder types addressed by the pilot RCT in AAC; (b) three types of use - instrumental, strategic and conceptual; (c) three states of knowledge and (d) four types of output discussed in an earlier paper [1,3]. Yet, items were made specific enough to meaningfully differentiate between behaviors of different user types and for different uses (purposes). For details, see Exhibit Two.

This process generated 57 items in multiple choice/check-off formats: one item to discriminate between *Awareness* and *Non-awareness* levels of use; eight items referring to the remaining eight levels of use; and 49 items describing specific categories of use (Table 1). Additionally, five open-ended items queried respondents about (a) where the user had first learned about the new knowledge; (b) why it was used or not used; (c) how it was used, if used; (d) the user's preferred media for receiving information about new knowledge; and (e) general comments about receiving and using new knowledge. To ensure that each drafted item met these requisites, all items were subject to scrutiny by a team of six researchers at the KT4TT Center experienced in working with the specific contexts of the targeted stakeholders. The research team checked each item through investigator triangulation [7,8], pairing separately and then in

common, to ensure that the item was suitable for web-based administration and that it appeared to be free from respondent bias inherent in self-reporting. Finally, each item was verified for comprehensibility at an 8th grade reading level, through the software program Readability Formulas Version 7.4, by Micro Power and Light Co. [9].

Validation: In order to identify valid items to compose the final survey instrument, the 57 items were subject to content validity testing by four experts in KT, none of whom were involved in the creation of items. The key questions about items assessed (i) relevance: does each describe a behavior representative of the intended level or category as defined? and, (ii) uniqueness: do they describe behaviors mutually exclusive of one another i.e., is each item unique and distinctly different from another item so there is no overlap? In addition, the experts were invited to judge and comment on the hypothetical relevance of the labels of the stated levels and categories, to knowledge use.

The experts received an overview that explained the context and purpose of the envisioned survey instrument, along with a research study summary from the field of AAC to exemplify the studies included in the instrument. Items were presented in a separate rating form. Experts were asked to judge each item on a five-point scale, indicating SA (strong agreement)/ A (agreement)/ N (neither agreement nor disagreement) /D (disagreement)/ SD (strong disagreement) with each of two statements:

- The item is relevant to the level (or the category); and
- The item does not overlap with other items (i.e., item is unique)

Experts were asked to offer explanatory comments where they disagreed with the statements, inviting suggestions about item revision, and comments about the pertinence of the item's level or category. Finally, they were asked to agree or disagree with two additional statements, and to elaborate with explanations or suggestions as appropriate:

- The levels are developmental, overall.
- The categories are exhaustive.

Expert ratings were dichotomized for analysis, collapsing the five-point scale to a three- point scale, setting ratings SA and A equal to 3; rating N equal to 2; and ratings D and SD equal to 1. Thus, a rating of 3 "approved" the item on relevance (or uniqueness as the case may be) whereas a rating of 1 did not approve the item on relevance (or uniqueness). Both face validity and content validity were examined. Face validity required that each item be rated 3 in order to be considered good (i.e., "relevant" or "unique"). For content validity, the following indices were calculated for each item:

- Overall ratings or the sum of scores by all four experts, ranging from a minimum of 4 to a maximum of 12.
- Item content validity index (I-CVI) calculated separately for relevance and for uniqueness; as recommended in literature, it was computed as the percentage of experts that "approved" the item or gave it a score of 3 [10,11]. For example, if the item had a perfect score of 3 by 3 out of 4 experts, then the I-CVI would be 3 divided by 4 or 0.75.
- Based on the I-CVI values, scale content validity indices (S-CVIs) were computed separately for different item sets. The recommended S-CVI /Ave method was used, computed as the mean of all the I-CVIs [10,11].

The K* (kappa) coefficients for correcting (adjusting) for chance agreement among experts were calculated separately for: (i) overall scale (set of 9 level items); and (ii) sub-scales (sets of 7 category items) under all levels that had categories. The level items formed the important set, the main scale; the category items under each level formed separate individual item sets or sub-scales.

Expert judgement was the basis for retaining, eliminating, revising or replacing items in the instrument version to be generated. As a standard for judging the goodness of items and scales, I-CVI values of .78 or higher for items were used as well as S-CVI/Ave values of 0.90 or higher for scales [11,12,13]. Items with I-CVI values below par were subject to revision or elimination, the main guide being the experts' recommendations and comments.

The resulting modifications to item descriptions, and consequently, to labels and definitions of the corresponding levels and categories were then reviewed by an internal team of three experts in technology transfer – each with knowledge of a targeted stakeholder's context but no prior involvement in item generation. This second round of experts were asked to judge each item as either "okay" or "not okay" for inclusion as presented. Ensuing discussions among the judges and the instrument development team, some item definitions were further modified. Details of the foregoing analyses are presented in the Results section.

Instrument Organization

The revised items were organized in a logical branching sequence for online administration to respondents, where they would first report their status regarding a specific level of use of the new knowledge and are then taken to the corresponding page of queries on categories i.e., behaviors subordinate to that level. Three open-ended questions were placed at the end of all the questions that called for multiple choice/check-off responses for each study (A, B or C), and two general questions were placed at the end of the instrument. Considering the importance of differentiating between "beneficiary" and "intermediary" stakeholders that apply new knowledge, two parallel versions of the instrument were created – one for lay consumers and one for professional stakeholders- with item descriptions matching their knowledge use context. Both versions were uploaded onto a web-based platform within the Vovici software program (Version 5, www.vovici.com) [14].

Usability testing followed, which involved one-on-one testing of the web-based instrument with an individual representing each of five stakeholders. An AAC device user tested the lay consumer version; the professional version was tested by a manufacturer, a transition broker, a researcher and a clinician – all related to AAC. Each pilot tester first completed the online survey as a legitimate respondent, registering their responses to each item as the program directed, and noted the time elapsed. They were then instructed to navigate every page of the instrument, to critically review each item for

linguistic clarity, accessibility and relevance to their stakeholder's context. They commented on any navigation problems related to the mechanics of completing an online survey instrument. Revisions were made in the LOKUS instrument and its Vovici interface before being designated as complete and ready for application as a data collection instrument. In all, the initial development process of the LOKUS took 18 months from literature review to ready-to-use format in Vovici for use in the pilot RCT in AAC.

Model Configuration

The conceptual model of LOKUS evolved as its initial 9x7 design based on the LoU framework was progressively refined to a framework of 10 levels by 6 categories, in function of empirical data generated through content validation. Crucial to LOKUS's model development is also an investigation of the developmental nature of levels, since this is the assumption behind placing individuals along a scale of levels ranging from low to high. Although an independent investigation, based on application of LOKUS with a convenience sample of therapists and researchers (n=69), had reported that the ten levels appeared to be sequential, the conclusion was limited to the first four levels (Non-awareness to Preparation) [15]. The interrelations among the other levels of use (Initial use to Modification) were inconclusive due to low response frequencies. Therefore, the sequential nature of the levels of knowledge use was revisited during the first field application of LOKUS as a measure of KT effectiveness in the pilot RCT in AAC, as described in Appendix One. Response patterns of the participants were examined and analyzed to verify possible inter-relations. Details of these additional analyses are provided in the Results section.

Results

Item Relevance

Face Validity: Eight of the nine initial levels within the 9x7 framework (all except Renewal) scored A or SA by the experts, (the equivalent of 3 on the scale of 1-3), and met the requirement for approval as relevant items (100% expert concurrence). Not all category items met this requirement on

relevance. Expert concurrence was least for category items under Routine use, averaging 46%. Curiously, all category items under Renewal met with 100% expert concurrence.

Content Validity: Tables 3 through 6 summarize results from the content validity analyses, including overall ratings, I-CVIs and S-CVIs.

Table 2 presents how standards were calculated for interpreting these results, i.e., the kappa coefficient equivalents of I-CVI values that adjust for chance agreement among the raters [11]. Column 1 in this table shows the number of experts/judges used (n=4); the hypothetical number of judges approving the item is shown as A in Column 2; and Column 3 shows the four possible I-CVI values in each case. Thus, if all four judges approved the item (i.e., A=4), the I-CVI would be equal to 1.00; whereas if only 3, 2 or 1 expert approved an item (see column 2), it would be .75, .50 or .25 respectively (see column 3). Column 4 shows the probability that the experts approved the item just by chance, which was calculated as Pc = [N!/A!(N-A)!], and these values were used to calculate the kappa coefficient in Column 5. Finally, the last column shows the standards for item acceptability reported in literature [49]. This was the basis for evaluating results in Tables 3-6.

Table 3 shows relevance of level items. For each level presented in Column 1, it includes overall ratings (Column 2), the I-CVI values (Column 4) and the corresponding kappa coefficient (last Column) derived from Table 2. All computations were based on the scale of 1 to 3 points. On overall ratings, all levels except Renewal received perfect score of 12 or 100% while Renewal got a score of 10 (or 80%). This corroborates our earlier results on face validity. Regarding the I-CVI values, all nine levels except Renewal reached the perfect score of 1.00 on relevance, the acceptability standard recommended in literature [9,10]; which corroborates the earlier results on overall ratings. However, the Renewal level scored an I-CVI of .75 and a K* of .67, thus reaching the standard of "good" (.60-74), as per Table 2. Table 3 also shows, (see end of Column 4) a scale content validity (S-CVI/Ave) of 0.97, for the nine level items taken together, or the mean of the individual I-CVIs. It meets the acceptability standard of 0.90

recommended in literature [10]. In sum, the nine level items individually and as a scale, met the standard of acceptability on relevance.

Table 4 presents relevance data for the category items under the levels. Column 1 lists the seven levels, each with seven category items (column 2) as was described in Table 1. Columns 3 and 4 respectively report the range and the mean of overall ratings on relevance. Not all category items met the standard for item acceptability on relevance i.e., a combined score of 12 from all experts. *Renewal* was an exception where all category items met this standard, which again corroborates face validity results. On the whole, 31 items met the standard (as detailed later in Table 7), while the other 18 items were marked for scrutiny and eventual revision. These results are corroborated by the corresponding range of I-CVI values reported for category items in Column 5 of Table 4. Only items under Renewal reached the standard of 1.00 on relevance; under the other 8 levels, not all category items met the standard, although the I-CVIs ranged from 0.75 upwards, or K* values >.67, and hence making the items "good" if not perfect (per Table 2). Items under Routine use categories fared the worst, with low I-CVIs. Further, judging from the last column which reports S-CVI/Aves for the sub-scales (category sets) under each level. Thus, six of the seven sub-scales (all except Routine use) reached the standard of 90% (or close to 90%) for relevance. These results on relevance are also consistent with the earlier results on overall ratings.

Item Uniqueness

Content validity analyses were repeated for uniqueness of level and category items, and are summarized in Tables 5 and 6.

On overall ratings, Table 5 (located in Additional file 8) shows that the levels Non-use, Non-use/Awareness, Integration and Renewal fell below the perfect score standard, suggesting problems of overlaps with other items. Their corresponding I-CVI values of < 1.00 (penultimate column) corroborate

this result. In particular, the last two levels scored unacceptably low as per standards laid out in Table 2; whereas the first two did reach the "good" standard with an I-CVI of .75 or a k* of 0.67. Further, the value of S-CVI (0.81) calculated for the overall scale of nine levels did not reach the 90% acceptability standard. Unlike results on relevance, the level items did not fare well on uniqueness, which suggested problems of overlaps/redundancies between items.

Regarding uniqueness of category items, Table 6 shows that not all category items met the standard of a perfect score of 12 for overall ratings, under any of the seven levels. As detailed in Table 7, only 12 category items met the standard, and the remaining 37 items did not. In particular, all category items under Orientation and Preparation levels failed to reach the required standard for perfection, although Table 7 shows that seven of these reached "good" standard or I-CVI values of 0.75 (i.e., a k* value of 0.67). On the whole, the I-CVIs are consistent with the overall ratings results, which again points to overlap/redundancy issues regarding the 37 items.

Table 6 shows the S-CVI values (last column) that address uniqueness of category scales. None of the scales met the standard of 90%, which again confirms redundancy issues.

Instrument Improvement

Items were included or excluded based on expert item ratings and approval on relevance. All nine level items were retained, as there was expert approval on 8 of the 9 levels, and none scored "unacceptably low". On uniqueness, only 5 of the 9 levels were approved. The other items were examined for overlaps and redundancies, and were modified based on expert comments. This included revisions in their labelling and consequently their definitions.

Similarly, category items were also examined. As Tables 4 and 6 showed unacceptably low scores for a number of category items under Orientation, Preparation and Routine use, both elimination and

modification were necessary. Expert comments and suggestions were aggregated for each item that failed to meet the standard, and were cross checked against expert comments about the labels of the levels and categories the item represented.

The foregoing prompted revisions in areas of structural weakness, as distinct from the item itself in need of improvement. The process resulted in 37 items distributed under the refined 10x6 framework in addition to ten items to measure levels as shown in Table 8.

As endorsed by the three experts in technology transfer's review, the layout is reflective of the typical pattern of knowledge use by stakeholders of technological innovations, especially the levels from initial use through modification. A significant addition in this regard was collaboration to follow Expansion and bridge it to Integration and Modification. Table 8 also summarizes the redistribution of categories under the modified 10 level structure, where the question numbers denote the levels and categories retained in the final instrument. To reiterate, the former improvements resulted from interacting feedback from the two sets of experts, taking the structural identity closer to technology related knowledge use than originally. The two parallel versions of the survey were maintained after the final item organization, making both suitable for online administration via the software program *Vovici*. Additional file 2 illustrates how LOKUS items are structured for online administration.

Usability Testing

Items in the two survey versions were repeated so they can address the three different outputs from three different studies A, B, C in AAC technology. This design permits the inclusion of multiple knowledge outputs (i.e., knowledge generated by different R/D/P projects in a particular knowledge area). One-on-one pilot test results showed that respondents required an average of 35 minutes to complete the online survey, ranging from 5 minutes to 1 hour and 30 minutes. The shortest time corresponded to respondents who were unfamiliar with any of the three knowledge outputs so they were made to automatically skip web pages that would probe for further detail. In comparison, the longest time

indicated familiarity with all three knowledge where the "yes" response automatically required the respondent to navigate through all of the available categories and levels for each knowledge output. Being aware of their role as item reviewers was a likely factor, with pilot testers spending more time on survey questions and their own responses, than would a typical respondent. Survey use in the field will determine the final statistics on completion time. One-on-one usability testing included accessibility testing by a person with visual impairment; and results helped resolve accessibility issues and navigation issues.

Conceptual Model of LOKUS

Although modified to suit the technological innovation context, the levels of knowledge use in the initial 9x7 version of LOKUS were based on the LoUs by Hall and Colleagues [5], which were considered by these authors to form a logical sequence with no guarantee "that an individual will move through all levels in a lock-step developmental fashion (p.11)" [5]. During content validation, three of the four experts (75%) agreed on the overall developmental nature of these levels, which provided the basis to maintain the original sequence of levels in the revised structure shown in Table 8, with new labels and item descriptions. Subsequently, the independent investigation of LOKUS (n=69) suggested that at least the first four levels, i.e., Non-awareness, Awareness, Orientation, and Preparation are in sequence, leaving the last six levels –Initial use to Modification – open to further investigation [15].

As mentioned earlier, data from the first field application of LOKUS at the Center's pilot RCT in AAC was analyzed to investigate the issue. Table 9 presents these analyses, showing frequencies of responses to LOKUS in relation to the use of new knowledge in the Studies A, B and C [16-18] included in the instrument. The table shows how responses were distributed among the ten levels of knowledge use, at baseline and then at the first follow/up after four months, for 215 participants representing five types of stakeholders. Note that responses in all three tables are further distributed among treatment

groups T1 and T2, and a control group C; because, as described earlier, participants had received treatment only about Study A, while Studies B and C were mask studies, with no intervention.

Difference in response frequencies between baseline and follow/up indicates how knowledge use changed among participants during the first four month period. If levels are developmental, the response pattern should indicate a steady upward movement of individuals from one level to the next (Non-awareness to Awareness and so on) between baseline and follow/up – i.e., decrease in responses to Non-awareness level, and a steady increase in responses to other levels. However, the table shows bi-directional movements through levels during this time interval. There are several frequencies higher at baseline than at follow/up (see shaded cells), suggesting regressive movements through levels.

Intriguingly, upon closer examination, about 8% (50 out of 645 responses) of these regressed to Non-awareness. This included four respondents from T1 and T2 groups to Study A (Table 9 -first segment) where upward movement was expected due to intervention effect. These last four likely made a truthful correction at follow/up, based on their exposure to intervention. The other cases are likely due to recall difficulties after a four month interval, or just careless or un-truthful, responses. Overall, however, such a response pattern is counterintuitive to the assumed developmental nature of levels.

Table 10 illustrates how individuals moved along LOKUS levels between baseline and the first follow/up. This table is a partial developmental table based on responses from the two treatment groups, T1 and T2, together (n=151). The first row tracks the 131 people who were Non-aware at baseline and the second row tracks the other 20 who were at other levels regarding Study A. As everyone in the first row started being Non-aware and are enclosed within a boundary of four months, this row permits a more objective basis to compare user movement. The second row refers to respondents with a prior starting point, i.e., the time point when they were at Non-awareness level, which is unknown. Also, the relatively fewer frequencies (n=20) in this row limit the credibility of conclusions.

Of the 131 respondents who were Non-aware at baseline, 93 remained Non-aware; 9 became Aware; 6 were Orienting themselves; and 6 were Preparing for use. Interestingly, there was none present at the Initial or Routine use level, but many already engaged in Expanding (n=1), Collaborating (n=12), Integrating (n=1) and Modifying (n=3) the new knowledge. These frequencies however, are not progressively increasing, thus do not support these levels as a sequence. These results suggest that: (a) it is possible for users to skip the levels of Initial and Routine use, and move directly to modified application; and (b) within modified application, use may occur at the Expansion, Collaboration, Integration or Modification levels in any order, or even in parallel.

This finding corroborates the expert comments during content validation who had argued that new knowledge use behaviors in the context of technological innovations, unlike the LoU behaviors in Hall's scale context, would include knowledge transformation. New knowledge users might take one of two paths after Preparation, they argued, either using the knowledge as intended (Initial use and Routine use) or opting directly for Modified use (i.e., Expansion, Collaboration, Integration, Modification). Both the state of the K and the stakeholder type, individually or in combination, might determine the movement.

The foregoing results, combined with the conclusion about the first four levels generated by the independent investigation (n=69), suggest a sequence of Non-awareness, Awareness, Orientation, Preparation and Use within LOKUS, where the Use level itself may take two parallel paths – intended or modified. Under the two paths of use the original levels can be considered as dimensions, further recognizing that data is insufficient to conclude about their sequential nature.

Finally, the correspondence of this sequence with Roger's stages of innovation diffusion, as well as with Hall and Colleagues' LoUs, can be seen in Table 11, where the three sequences are juxtaposed. Note that both LOKUS and the LoU framework cover Roger's stages, and extend it further – to Expansion, Collaboration, Integration and Modification (in LOKUS); or to Refinement, Integration, and Modification (in the LoU framework). Notably, Roger considers Decision as an explicit stage, but omits

Preparation, while the LoU framework includes Decision implicitly between levels, but includes Preparation level explicitly prior to use. Arguably in the case of LOKUS, Decision is still present at the Preparation level as it leads to alternate paths of use. In light of this, and in follow up discussions with the three technology transfer experts who had participated in second round of content validation, both Preparation and Orientation were collectively recognized as dimensions of a broader level, where user identity is with Interest in the new knowledge that has not yet materialized into (a decision about) actual use.

The foregoing suggested a new model configuration for LOKUS with a four level sequence, as seen in Figure 2.

As shown in Figure 2, they consist of:

- L1. Non-awareness;
- L2. Awareness;
- L3. Interest; and
- L4. Use, with two sub-levels:
- L4a. Intended Use; and
- L4b. Modified Use.

Eight of the original levels are absorbed as "dimensions" under the levels Interest and Use:

- D1. Orientation; and D2. Preparation (located within L3. Interest);
- D3. Initial Use; and D4. Routine Use (located within L4a. Intended Use);
- D5. Expansion, D6. Collaboration, D7. Integration and D8. Modification (within L4b. Modified Use);

Likewise, categories under the original levels are recognized as user actions under these dimensions, and labelled six Activities of Use:

A1. Being Aware, A2. Getting Information, A3. Sharing, A4. Assessing, A5. Planning, A6. Implementing, where Activities only appear under the appropriate Levels or Dimensions.

Discussion

This paper described the development of the Level of Knowledge Survey (LOKUS) instrument, a web-based survey instrument for measuring the extent of stakeholder awareness, interest and use in relation to new knowledge generated by technology-oriented research, development or production projects. Broadly based on Roger's stages of innovation diffusion [13] and conceptually guided by the Levels of Use framework for measuring innovation use [11], LOKUS emerged as a feasible new instrument to validly capture knowledge use by multiple stakeholders of technology innovation, through systematic empirical validation in context.

Quality assurance during the development process addressed both merit (intrinsic psychometric quality) and worth (external value or relevance to users) by: (a) including multiple stakeholder contexts in the scope of construct of knowledge use ; (b) using empirical basis to validate and improve items comprising the instrument; and (c) verifying its feasibility and context validity through field piloting to ensure its utility to the knowledge producers, the instrument's primary stakeholders held accountable for beneficial outcomes from the knowledge they generate.

Results indicated that, overall, items measuring the levels of knowledge use have good face and content validity, scoring high on relevance. While the subscales of category items under the original levels did not perform as well, rater comments to specific items and labels substantially corrected overlap issues, which resulted in an improved instrument with 10 levels and 37 subordinate category items. Final analyses from the pilot RCT in AAC strongly suggested a four level conceptual model of knowledge use to encase these ten levels and category sets. They were: Non-awareness, Awareness, Interest and Use, with eight dimensions as sub-levels under interest and use, further expanded through 37 category items of

user actions as relevant. Although results suggested an overall sequential order of the four levels, they were inconclusive about the sequence of the dimensions within Use. Interrelations among categories of user actions were not part of this investigation. Formal establishment of the psychometric properties of LOKUS, including content validity and developmental nature of scale is necessary to confirm and complement these results on instrument merit.

The instrument's worth is tied closely to its potential utility to grantees and sponsors of R/D/P projects, both of whom need a feasible and credible instrument to track the outcomes arising out of their project outputs and/or for demonstrating effectiveness of their KT strategies to relevant target audiences. In lieu of this, LOKUS is formatted for branched administration of self-reported items, for online completion. There are two versions of LOKUS: the consumer version for people expected to benefit from the application of knowledge, and the professional version for all other potential users. Results from validation by representative stakeholders engaged in usability testing showed that both LOKUS versions meet the interface and logistic criteria of simplicity, feasibility and usability, while its web-based platform can reach diverse and distributed audience.

Results reported in this paper bear direct reference to data obtained in the AAC technology field, as the Center's pilot RCT that provided the test bed for the instrument development process focused on new knowledge in the form of freeware in the area of AAC. However, items in LOKUS are designed for response by anyone considered to be a potential user of new knowledge in a technology related field. The authors are currently applying in replications of the RCT in related technology areas, which will explore the feasibility and generalizability of the instrument across applications, to verify the instrument's potential worth or external value.

LOKUS can broadly place respondents along one of four levels of knowledge use. When applied across multiple stakeholders for any given knowledge output generated from a technology oriented R, D or P projects, it should be able to permit an overview of knowledge use in the form of frequency

distributions of surveyed stakeholders across all four levels. Further, changes in knowledge use behaviours over time can be documented through periodic re-assessment. Thus, the instrument's sensitivity to capture temporal changes is an area of further psychometric investigation, and is addressed in a companion paper [2].

A limitation of the instrument's utility at this time refers to the responses to the sub levels i.e., dimensions and category items. While they identify and describe the user's specific status on knowledge use, their generic format may not provide enough information for follow up training or technical assistance, requiring additional probes by individual investigators. Future expansion of the instrument tailored to each stakeholder type is necessary. A general limitation posed by the feasibility requirement relates to the instrument's self-report approach (e.g., socially desirable responses); its structured format (e.g., inability to probe for additional details regarding a response); and its key word prompts (e.g., accuracy of recall or association between prompt and lesson learned). To the extent that documenting the use of new knowledge is important to demonstration project efficacy, and justifying budgetary allocations for sponsored programs, LOKUS and future expansion efforts may prove invaluable to investigators and sponsors alike.

Conclusions

LOKUS is a web-based instrument designed to measure self-reported knowledge use by multiple stakeholders of technological innovations. Although conceptually guided by the LoU chart proposed by Hall and colleagues for innovation use, it differs from the LoU scale both in final structure and operational model. Its four-level conceptual model consists of Non-awareness, Awareness, Interest and Use, that branch into sub-levels of 8 dimensions (user behaviors) and 37 user actions under categories. The instrument has strong face validity, and has good content validity as an overall measure of levels and dimensions. Formal establishment of its psychometric properties, including content validity, reliability and sensitivity to change are necessary.

Current findings are based on performance of LOKUS in the context of new knowledge related to AAC technology. On-going validation of its performance in replication studies involving K generated by other R/D/P projects, including those under way at the KT4TT Center will establish the generalizability of results beyond current findings. The test of the instrument's ultimate utility will be its performance in supporting project accountability, by documenting evidence of use as outcome, which can then be tracked further to demonstrate eventual beneficial impacts for the target beneficiaries.

Authors' Contributions

Dr. Vathsala Stone conceptualized, led and participated in all three phases of the project, created the initial draft tool version and prepared the manuscript. Douglas Usiak and Michelle Lockett contributed to creating the consumer tool version, collaborated on instrument usability testing, recruited participants for field testing, and provided input for manuscript preparation. Amanda Nobrega monitored and collected field piloting data, conducted supplementary analyses and contributed to manuscript preparation. All authors read and reviewed the manuscript.

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phases; and to Shreya Telang for accommodating LOKUS on the Vovici platform for online administration.

References

1. Stone VI, Lane JP: **Measuring reach and uptake of new knowledge from technology innovations: need, context and concept**. *KT4TT Center, Working Paper I*, 2012. [http://kt4tt.buffalo.edu/publications/WorkingPapers/Working%20paper%20I.pdf]
2. Tomita MR, Stone VI, Telang SR: **Development of the Level of Knowledge Use Survey (LOKUS) instrument: psychometric properties**. *Manuscript in progress*.
3. Lane JP, Flagg JL: **Translating three states of knowledge: Discovery, invention & innovation**. [http://www.implementationscience.com/content/5/1/9] *Implementation Science* 2010, **5**:9.
4. Rogers E: *Diffusion of Innovations* (3rd. Ed.), New York: The Free Press; 1983.
5. **Hall GE, Dirksen DJ, George AA (2006).** [www.micropowerandlight.com] *Measuring Implementation in Schools: Levels of Use. Austin, TX: Southwest Educational Development Laboratory (SEDL). 30.5 Micro Power and Light Co. Readability Formulas Version 7.4.*
6. Stone, V.I. **Knowledge Translation (KT) in Augmentative and Alternative Communication (AAC): A Randomized Controlled Study (RCT).** KT4TT/SEDL: Webcast presentation #32, Sep 22, 2011. [http://www.ncddr.org/webcasts/webcast32.html].
7. Denzin NK: **The research act** (3rd ed.). Englewood Cliffs, NJ: Prentice Hall. Publications; 1989.
8. Patton MQ: **Qualitative evaluation and research methods** (2nd ed.). Newbury Park: Sage Publications; 1990.
9. **Micro Power and Light Co. Readability Formulas Version 7.4** [www.micropowerandlight.com].
10. Polit DF, Beck CT: **The content validity index: are you sure you know what's being reported? Critique and recommendations**. *Research in Nursing and Health* 2006, **29**, 489-497.

11. Polit DF Beck CT, Owen SV: **Is the CVI an acceptable indicator of content validity? Appraisal and Recommendations**. *Research in Nursing and Health* 2007, **30**, 459-467.
12. Lynn MR: **Determination and quantification of content validity**. *Nurs Res* 1986, **35**, 382-385.
13. Waltz, CF, Strickland OL, Lenz ER: **Measurement in nursing and health research** (3rd ed.) New York: Springer; 2005.
14. **Vovici Corporation: Vovici 6.** Herndon, VA; 2011 [www.vovici.com]
15. Telang SR: **Establishing psychometric properties of the Level of Knowledge Survey questionnaire for knowledge translation for technology transfer.** *MA Thesis*, University at Buffalo, Department of Rehabilitation Science; 2011.
16. Bryen DN: **Vocabulary to support socially-valued adult's roles**. *Aug Alt com* 2008, **24**:294-301.
17. McNaughton D, Symons G, Light J, Parsons A: **My dream was to pay taxes: The self-employment experiences of individuals who use augmentative and alternative communication**. J *Vocational Rehab* 2006, **25**: 1–196.
18. McKelvey M, Dietz A, Hux K, Weissling K, Beukelman D: **Performance of a person with chronic aphasia using personal and contextual pictures in a visual scene display prototype**. *J Med Speech Language Patho* 2007, **15**:305-317.
19. Miller ET, Spilker J: **Readiness to Change and Brief Educational Interventions: Successful Strategies to Reduce Stroke Risk**. *J Neurosci Nurs* 2003, **35**:215-222

EXHIBIT ONE

Randomized controlled intervention study in augmentative and alternative communication (AAC) technology: Test bed for the development of the LOKUS instrument.

This document describes the Randomized Controlled Trial (RCT) in Augmentative and Alternative Communication (AAC) Technology, which provided the opportunity and the test bed for developing the Level Of Knowledge Use Survey (LOKUS) instrument. The RCT on AAC was the first in a series of intervention studies to evaluate the effectiveness of multiple communication strategies designed to promote the uptake and use of new knowledge generated by technology-oriented research and development projects. Knowledge use is an indicator of communication strategy effectiveness in these RCTs, so the LOKUS instrument was created as a measure of reach, uptake and use of new knowledge by stakeholders of technological- related knowledge. The instrument helped verify the comparative effectiveness of the communication strategies. In turn, the RCT in AAC provided the test bed for the construction and field testing of LOKUS.

With approval from the institutional review board, the RCT in AAC was implemented from July 2010 to July 2011. Participants consisted of five types of stakeholders identified as potential users of new findings published in the AAC field: 1) clinicians (therapists), 2) manufacturers, 3) researchers, 4) in-transition brokers (for example, disability service coordinators for students about college life) and 5) consumers with complex communication needs. Peer reviewed journal articles were selected as the subject findings, as that is the typical form in which new knowledge from Research and Development (R&D) projects is published. Two different communication strategies were studied for effectiveness in promoting the use of such new knowledge in the AAC field: Tailored and Targeted Dissemination of Knowledge (TTDK) and Targeted Dissemination of Knowledge (TDK). These two strategies were compared with a Control group (C). The TTDK intervention exposed the stakeholders to materials that *tailored* the new knowledge (i.e., added lay language narrative to explain the findings relative to each

stakeholder's context). These materials consisted of: (1) a Contextualized Knowledge Package (CKP) which included the journal article where the new knowledge was published, along with supporting textual and graphic materials about its use and stakeholder relevance; (2) a contextualized webinar that was tailored for each type of stakeholder; and (3) offer of technical assistance to any stakeholder that chose to use the new knowledge. Stakeholders exposed to the TDK intervention only received the new knowledge in its original format (i.e., the published journal article, without additional tailoring, to represent how stakeholders would encounter these findings in the field).

The interventions addressed the work of Dr. Diane Bryen of Temple University [1], which had generated AAC vocabulary and symbol sets on topics missing from AAC devices but important to the lives of adult AAC users (i.e., stakeholder relevance). The findings were published in 2008 in *Augmentative and Alternative Communication.* They consisted of a vocabulary set for adult users of AAC technology. The design of the intervention study was a randomized controlled, pretest-posttest experiment, as shown below.

Randomized controlled pretest-posttest design for evaluating KT methods in AAC technology

Group	Publication	Baseline measure	Intervention (4 months)	Follow-up 1	Intervention (4 months)	Follow-up 2
T_1	A	O	X (TTDK/CKP)	O	X(TTDK/ WEBINAR + TECH ASSIST)	O
	B	O		O		O
	C	O		O		O
T_2	A	O	X (TDK)	O	----	O
	B	O		O		O
	C	O		O		O
Control	A	O	----	O	-----	O
	B	O		O		O
	C	O		O		O

Sample size was determined by a power analysis based on a study by Miller and Spiller [2]. To achieve a statistical power of .80 at α_1= .05, with the small effect size of .24, 206 participants were needed. Using a convenience sampling method, 239 stakeholders were recruited from national

organization memberships through their announcements. Inclusion criteria were individuals who (1) were 18 years or older, (2) were classified under one of the five stakeholder types, and (3) were members of a national organization related to the AAC field. Participant stakeholders were randomly distributed to T1, T2 and C groups where T1 and T2 represented the two treatment groups that were exposed to TTDK and TDK methods of communication respectively, and C represented the control group which was not exposed to either method. Participants were tested for their level of knowledge use, once at baseline, next at a four-month follow/up and once again at an eight-month follow/up using the online LOKUS instrument, designed for this purpose. The T1 group received the CKP about Bryen's findings during the first four months, and a tailored webinar about the same findings during the second four month period. The T2 group received the journal article during the first four months and nothing afterwards. The C group received nothing. The letter O in columns 3, 5 and 7 signify the three times LOKUS was answered by the participants, showing the level of knowledge use at each survey time.

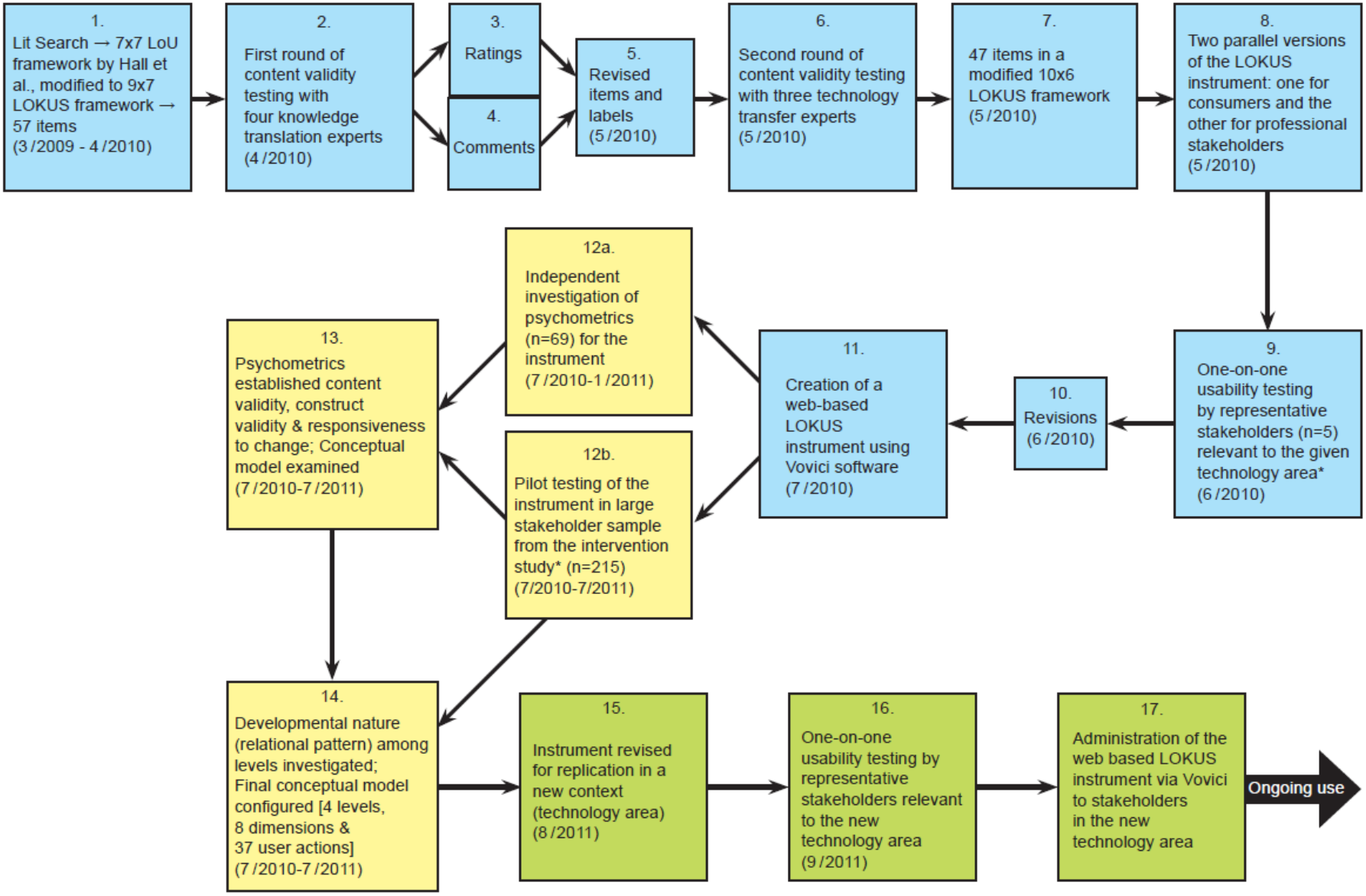
In order to maintain design integrity, the RCT designated Bryen's publication as Study A (or Publication A), and introduced two other publications (Studies B and C) into LOKUS to serve as "masks" or distracters, for which there was no intervention. Study B was "My dream was to pay taxes: The self-employment experiences of individuals who use augmentative and alternative communication" by David McNaughton, Gary Symons, Janice Light, & Arielle Parsons, published in 2006 in the *Journal of Vocational Rehabilitation* [3]. The published finding referred to the experiences of AAC users with cerebral palsy reported about self-employment in a focus group discussion conducted on the Internet. The third publication (Study C) was "Performance of a person with chronic aphasia uses a visual scenes display prototype", by Michelle McKelvey, Aimee Dietz, Karen Hux, Kristy Weissling, & David R. Beukelman [4].The article was published in 2007 in the *Journal of Medical Speech-Language Pathology.* The published findings referred to visual scene displays (contextual scenes) for adults with aphasia. All three studies were conducted through the Rehabilitation Engineering Research Center on Augmentative

and Alternative Communication funded from 1998-2008 by the National Institute on Disability and Rehabilitation Research of the U.S. Department of Education.

References

1. Bryen DN: **Vocabulary to support socially-valued adult's roles**. *Aug Alt com* 2008, **24**:294-301.
2. Miller ET, Spilker J: **Readiness to change and brief educational interventions: successful strategies to reduce stroke risk**. *J Neurosci Nurs* 2003, **35**:215-222.
3. McNaughton D, Symons G, Light J, Parsons A: **My dream was to pay taxes: the self-employment experiences of individuals who use augmentative and alternative communication**. J *Vocational Rehab* 2006, **25**: 1–196.
4. McKelvey M, Dietz A, Hux K, Weissling K, Beukelman D: **Performance of a person with chronic aphasia using personal and contextual pictures in a visual scene display prototype**. *J Med Speech Language Patho* 2007, **15**:305-317.

Figure 1. Development of the LOKUS instrument: Summary flow chart*



*For a better understanding of terms, see Exhibit One.

Table 1. Levels and Categories distribution in initial LOKUS Questionnaire based on Hall et al (2006)

Levels		Categories						
		Knowing	Acquiring info.	Sharing (info) for possible use	Assessing (for using/not using)	Planning	Defining status (about use)	Performing (using)
(0) Non-Use – level zero: User has little or no awareness of the new knowledge (NK); not involved, and not trying to be involved.		*No category items are included*						
(1) Non-Use/Awareness: User has some awareness of the NK; but not involved; nor becoming involved		*No category items are included*						
(2) Orientation (Interest): user has acquired/ is acquiring information about NK; has explored/is exploring its value, its demands upon user.		x	x	x	x	x	x	x
(3) Preparation: user is preparing for initiating use of NK		x	x	x	x	x	x	x
(4) Mechanical use: Focus on short-term, day-to-day use of NK with little time for reflection. Changes to meet own needs. User primarily mastering the use. Operation not yet smooth.	**Level Items 0-8**	x	x	x	x	x	x	x
(5) Routine Use: Stable use of NK. Few changes in ongoing use; little preparation or thought on improving NK's use or its consequences.		x	x	x	x	x	x	x
(6) Refinement: Different use of NK to increase results within immediate sphere of influence. To suit short- and long-term consequences for clients.		x	x	x	x	x	x	x
(7) Integration: Combines own efforts to use NK with activities of colleagues to achieve collective results within their common sphere of influence.		x	x	x	x	x	x	x
(8) Renewal: Re-evaluates use of the NK; seeks major modifications or alternatives, to increase results on clients, examines new developments, toward new goals.		x	x	x	x	x	x	x

EXHIBIT TWO

Below is an MS word version of the LOKUS instrument. It lists items that address the first of three studies about AAC technology as an example. It is a linear listing. Its online structure is described at the end (Exhibit 2.1), by illustrating how the branching is done in the online version of the questionnaire.

Exhibit 2.1 Level of Knowledge Use Survey (LOKUS) Instrument

This survey is designed to measure your current state of awareness, interest, and/or use of new knowledge published in the field of Augmentative and Alternative Communication technology. New knowledge (published research findings) can be in the form of new devices, instruments, freeware, and standards/guidelines.

This survey queries you about three research studies. Once you begin the survey, you are presented with the first study and a brief description of the new knowledge it contains. You are then asked a series of questions about your current state of awareness, interest, and/or use of the new knowledge.

Once you have answered the questions pertaining to the first study, you will repeat the process for the remaining two studies.

Please read each question carefully and answer honestly. Remember that your responses should reflect your current state of awareness, interest, and/or use of the new knowledge from each study.

1) Please enter the unique ID provided by the Investigator to you for undertaking this survey.

_____

Please read the description of Study A below and answer the question that follows it.

STUDY A

Citation: Diane Bryen. Vocabulary to support socially-valued adult roles. Published in *Augmentative and Alternative Communication*, 2008.

New knowledge reported: Age Appropriate Vocabulary and Symbol Sets (AAVSS).

Description: Study explored the extent to which three currently existing and widely used AAC symbol sets contained specialized vocabulary required in six socially-valued adult roles.

Primary Investigator: Dr. Diane Bryen, Professor, and Executive Director of Institute of Disabilities, Temple University

2) Question: Are you familiar with the new knowledge (AAVS) from Dr. Bryen's study?

- ☐ I had not heard of the new knowledge from this study until now.
- ☐ I had heard of the new knowledge from this study before.

3) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

I had heard of the new knowledge from this study, but I have not tried to get more information about it.

Please click yes/no based on the entire statement.

☐ Yes ☐ No

4) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

I am seeking details on whether the new knowledge from this study will be useful; however I have not yet decided to use it.

Please click yes/no based on the entire statement.

☐ Yes ☐ No

5) You indicated that you are seeking details of the new knowledge (AAVSS) from Dr. Bryen's study, but have not made a decision to use it yet.

Please review each statement and check all options that represent your current position.

☐ I am aware of the existence of the new knowledge from this study and that it might be useful.

☐ I am obtaining information that explains the new knowledge from this study through the internet, journals, conferences, meetings, etc.

☐ I am discussing the new knowledge from this study with others. I exchange information, materials, or ideas about it and also learn about what is involved in using it.

☐ In order to make a decision about using the new knowledge from this study, I am analyzing and comparing further information about it – such as what it contains, what is required for using it, evaluation reports about it, what I can get out of it, and its strengths and weaknesses.

☐ I have explored the new knowledge from this study and also what is required for its use. I am ready to decide if I am for or against using the new knowledge.

6) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

I am preparing to use the new knowledge from this study, but have not used it yet.

Please click yes/no based on the entire statement.

☐ Yes ☐ No

7) You indicated that you are preparing to use the new knowledge (AAVSS) from Dr. Bryen's study, but have not used it yet.

Please review each statement and choose all options that represent your current position.

□ I am aware of the benefits of using the new knowledge from this study, but I need more information such as practical needs, resources and timing.

□ In order to prepare to use the new knowledge from this study, I am looking for information and resources specifically related to using it.

□ I am sharing information with others about resources needed for initial use of the new knowledge from this study. To prepare myself for first use, I join others in opportunities such as pre-use training, planning for resources, practical set up and scheduling.

□ I am identifying the resources needed and available, as well as the steps and procedures necessary for initial use of the new knowledge from this study.

□ I have prepared myself for initial use of the new knowledge from this study- such as, studying reference material, sharing information, arranging my schedules, resources and practical set up, and receiving any needed training.

8) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

I have just begun to use the new knowledge from this study, but I have not yet mastered how to use it.

Please click yes/no based on the entire statement.

□ Yes □ No

9) You indicated that you have just begun to use the new knowledge (AAVSS) from Dr. Bryen's study, although you have not mastered how to use it.

Please review each statement and check all options that represent your current position.

□ I am still looking for information to better manage the use of the new knowledge from this study. This includes such things as practical set up, resolving initial problems, scheduling, and identifying the amount of time and work it takes for me to use the new knowledge.

□ I am examining what it takes to use the new knowledge from this study. My assessment is usually related to resolving practical problems and difficulties related to time, schedules and resources.

□ Based on the information obtained and my assessment, I have begun to use the new knowledge from this study.

10) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

I am using the new knowledge from this study regularly and I do so with ease. However, I have not tried using it in ways other than originally intended.

Please click yes/no based on the entire statement.

□ Yes □ No

11) You indicated that you are regularly using the new knowledge (AAVSS) from Dr. Bryen's study, and have not tried a different way of using it.

Please review each statement and choose all options that represent your current position.

□ I am aware of what is required to use the new knowledge from this study, both short term and long term.

☐ I am evaluating my routine use of the new knowledge from this study.

☐ I am planning to continue using the new knowledge from this study as intended. I am not yet concerned about different ways of using the new knowledge.

☐ I use the new knowledge from this study routinely with minimal problems.

12) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

Based on my own evaluations, I am using the new knowledge from this study in ways different than the author originally intended.

Please click yes/no based on the entire statement.

☐ Yes ☐ No

13) You indicated that you are using the new knowledge (AAVSS) from Dr. Bryen's study in ways different from originally intended, based on your own evaluations.

Please review each statement and choose all options that represent your current position.

☐ I am aware that it would be beneficial to expand the use of the new knowledge from this study; that is, to use it in ways different from originally intended.

☐ I am looking for information and materials that relate specifically to expanding my current use of the new knowledge from this study.

☐ I am discussing with others how I would expand my current use of the new knowledge from this study.

☐ I am evaluating all information about the new knowledge from this study for the purpose of expanding my current use of it.

☐ Based on my evaluation, I am developing intermediate and long-range plans to expand the use of the new knowledge from this study.

☐ I have explored and tried different ways of combining the new knowledge from this study with existing practices.

14) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

I am either considering collaborating with others, or have started to do so, on the use of the new knowledge from this study.

Please click yes/no based on the entire statement.

☐ Yes ☐ No

15) You indicated that you are either considering collaborating with external colleagues, or have started to do so, on the use of the new knowledge (AAVSS) from Dr. Bryen's study.

Please review each statement and choose all options that represent your current status.

☐ I am aware that collaborating with others in the use of the new knowledge from this study would be beneficial.

☐ I am seeking information and opinions for the purpose of working with others in the use of the new knowledge from this study.

☐ I am talking to others about working together to use the new knowledge from this study.

☐ I am evaluating how to work with others and use the new knowledge from this study, including the advantages and disadvantages of such collaboration.

☐ I am planning and scheduling resources and time for collaborating with others on the use of the new knowledge from this study.

☐ I have started working with others on the use of the new knowledge from this study.

16) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

My collaboration with others has led to a different way in which we use the new knowledge from this study.

Please click yes/no based on the entire statement.

☐ Yes ☐ No

17) You indicated that your collaboration with others has led to a different way in which you use the new knowledge (AAVSS) from Dr. Bryen's study.

Please review each statement and choose all options that represent your current position.

☐ I am aware that integrating my work on the use of the new knowledge from this study with the work of others would be beneficial.

☐ I am seeking information and opinions for the purpose of integrating my work with the work of others on the use of the new knowledge from this study.

☐ I am evaluating the integration of my work with the work of others regarding the use of the new knowledge from this study, including the strengths and weaknesses of such integration.

☐ I have integrated my work with the work of others leading to joint expansion of the use of the new knowledge from this study.

18) Does the following statement describe your current state of awareness, interest or use of the new knowledge (AAVSS) from Dr. Bryen's study?

I am making modifications to the new knowledge from this study, individually or jointly with others.

Please click yes/no based on the entire statement.

☐ Yes ☐ No

19) You indicated that you are involved in making changes to the new knowledge (AAVSS) from Dr. Bryen's study, individually or jointly with others.

Please review each statement and choose all options that represent your current position.

☐ I am aware that making modifications to the new knowledge from this study, individually or jointly with others, would be beneficial.

☐ I am seeking information and materials in order to modify the new knowledge from this study, individually or jointly with others.

☐ I am weighing the advantages and disadvantages of making modifications to the new knowledge from this study, individually or jointly with others.

□ I have made modifications to the new knowledge from this study, individually or jointly with others.

20) Mark all the options that describe your state of awareness, interest, or use of the new knowledge (AAVSS) from Dr Bryen's study before taking this survey.

□ I had not heard of the new knowledge from this study until now.

□ I had heard of the new knowledge from this study, but I have not tried to get more information about it.

□ I am seeking details on whether the new knowledge from this study will be useful; however I have not yet decided to use it.

□ I am preparing to use the new knowledge from this study, but have not used it yet.

□ I have just begun to use the new knowledge from this study, but I have not yet mastered how to use it.

□ I am using the new knowledge from this study regularly and I do so with ease. However, I have not tried using it in ways other than originally intended by the author.

□ Based on my own evaluations, I am using the new knowledge from this study in ways different than the author originally intended.

□ I am either considering collaborating with others, or have started to do so, on the use of the new knowledge from this study.

□ My collaboration with others has led to a different way in which we use the new knowledge from this study.

□ I am making modifications to the new knowledge from this study, individually or jointly with others.

We now ask you to briefly comment on your answers regarding Study A. The description of Study A is repeated for your reference. Please read it and answer the questions that follow.

STUDY A

Citation: Diane Bryen. Vocabulary to support socially-valued adult roles. Published in *Augmentative and Alternative Communication*, 2008.

New knowledge reported: Age Appropriate Vocabulary and Symbol Sets (AAVSS).

Description: Study explored the extent to which three currently existing and widely used AAC symbol sets contained specialized vocabulary required for participation in six socially-valued adult roles.

Primary Investigator: Diane Bryen, Professor, and Executive Director of Institute of Disabilities, Temple University, Philadelphia, PA.

21) Question: When and where did you first learn about this study?

_____

_____

_____

22) What reasons made you decide to use (or not use) the new knowledge (AAVSS) from Dr. Bryen's study?

_____

_____

_____

23) If you did make use of the new knowledge (AAVSS) from Dr. Bryen's study, briefly describe what you did.

_____

_____

_____

24) Thank you for completing the questions pertaining to Study A.

We are now moving on to Study B. Make sure you click on Next Page to continue.

☐ Study B

NOTE: All the above questions were repeated for Studies B and C.

Exhibit 2.2. Item branching in the online LOKUS instrument.

Items created for the LOKUS instrument referred to use of knowledge generated in the particular context of AAC technology, so they reflect that specific content. However, LOKUS can be applied to any technology field by simply replacing the context-oriented terms. For descriptive purposes we retain the original field's terminology in the following description. Items shown in the questionnaire above represent their distribution according to the layout conceptualized for LOKUS in terms of the levels/dimensions of K Use and the related user actions under categories (See Table 8). They refer to Questions Q2 to Q19d, distributed across the cells of the matrix. The first item (Question 1) was reserved for the participant's ID number.

The levels/dimensions of K use range from non-awareness to modification. Questions (items) numbered 2, 3, 4, 6, 8, 10, 12, 14, 16 and 18; all describe user behavior related to these levels/dimensions. These questions are dichotomous, asking the Knowledge user for Yes/ No responses. The rest refer to user actions subordinate to these levels/dimensions. Note that the items are introduced by a short description of Study A (i.e., Bryen (2008)); all questions refer to AAVSS (Age Appropriate Vocabulary and Symbol Sets), the new knowledge produced through Bryen's (2008) study. The branched web-administration of the items is monitored through *Vovici*. It is illustrated through the sequence of the first five questions.

Responses determine an individual's path on LOKUS through the questions. The Q2 is the first branching point in the path, where a "Yes" response affirms familiarity with the subject study, at which point respondents move to subsequent related questions, starting with Q3. A "No" response skips all further questions about that study, leading directly to any other study included.

The Q3 item is somewhat unique because there are no "action" questions or category items branching off the Awareness level. Consequently, both "Yes" and "No" responses to Q3 move automatically to Q4. Theoretically, if the levels of knowledge use represented in LOKUS are "developmental", respondents answering "YES" to Q3 will answer "No" to all remaining questions. These respondents are classified at the *Awareness* level of Knowledge use, but report no action behaviours associated with its application. Those responding "No" to the Awareness level, are still free to respond "Yes" to a higher level as they progress through the branching structure of LOKUS.

From Q4 (Orientation) onwards, LOKUS is designed to lead affirmative responses to a set of "category" questions under Q5 in order to probe further concerning their specific behaviors; while leading negative responses to skip these probing items and move on to Q.6 (not shown in Appendix). Thus, a "Yes" response to Q4, will direct respondents to questions 5a, 5b, 5c, 5d and 5e, to indicate all actions related to Orientation. In such a case, one person may be sharing the information, or assessing it for decision making, and so on, or displaying any combination of these behaviors. This response-driven branching continues through the multiple-choice items. As one final example, someone responding "Yes" to Q14 is using the new knowledge in a manner different than the manner originally intended by the investigator, and this modified use may involve Assessing a Collaboration (if Q14d is checked), or Implementing a Collaboration (if 14e is checked).

Table 2. Computation of Kappa statistic (K*) values for Item Content Validity Indexes (I-CVIs)[a]

Number of experts used in the study (N)	Number of experts approving• the item on relevance/ uniqueness (A)	% of experts approving the item on relevance/ uniqueness (I-CVI)[§]	Probability of a chance occurrence (Pc)[□]	Kappa statistic designating agreement on item approval (k^*)	Item acceptability
4	4	1.00	0.125	1.00	Excellent (>.74)
4	3	0.75	0.063	0.67	Good (.60-.74)
4	2	0.50	0.375	0.20	Unacceptable (<.40)
4	1	0.25	0.25	0.00	Unacceptable (<.40)

NOTE:
[a] (Polit et al, 2007; p. 465)
• Approval: the expert considers the item relevant/unique; item scored 3 on a scale of 1-3.
[§] Calculated as % of experts scoring item relevant (score of 3).
[□] Calculated as Pc = [N!/A!(N-A)!]
k^* - calculated as k* = (I-CVI - Pc)/ (1-Pc).

Table 3. Relevance of Level items in early version of LOKUS: Overall ratings, I-CVIs and S-CVI

LEVELS	Overall rating[+] on Relevance (Min.4; Max.12)[++]		I-CVI[§] on Relevance	k*
LEVEL 0: Non-use	12		1.00	1.00
LEVEL 1: Non-use/Awareness	12		1.00	1.00
LEVEL 2 : Orientation	12		1.00	1.00
LEVEL 3: Preparation	12		1.00	1.00
LEVEL 4: Mechanical use	12		1.00	1.00
LEVEL 5: Routine use	12		1.00	1.00
LEVEL 6: Refinement	12		1.00	1.00
LEVEL 7: Integration	12		1.00	1.00
LEVEL 8: Renewal	10		0.75	0.67
Total	106	Total	8.75	
Mean	11.78	S-CVI/Ave[§§]	**0.97**	

NOTE:
[+]Sum of individual ratings by 4 experts
[++] Ratings on collapsed scale of 1-3; where 3= relevant and 1= not relevant.
[§] Calculated as % of experts scoring item relevant (score of 3). Number of experts =4;
[§§] Calculated as the mean of the I-CVIs (Polit & Beck, 2006)
[k*] Calculated as explained in Table 1.

Table 4. Relevance of Category items in early version of LOKUS: overall ratings, I-CVIs and S-CVI

		Overall Ratings* (Min. 4; Max.12)**		I-CVI§	k*	S-CVI/Ave§§ for item-set
LEVELS	No. of Category items	Range	Mean	Range	Range	
LEVEL 2 : Orientation	7	10-12	11.43	0.75 - 1.00	1.00-1.00	0.93
LEVEL 3: Preparation	7	10-12	11.14	0.75 - 1.00	1.00-1.00	0.89
LEVEL 4: Mechanical use	7	10-12	10.86	0.75 - 1.00	1.00-1.00	0.86
LEVEL 5: Routine use	7	6-12	**7.71**	**0.25-1.00**	**0.00-1.00**	**0.46**
LEVEL 6: Refinement	7	10-12	11.71	0.75 - 1.00	1.00-1.00	0.96
LEVEL 7: Integration	7	10-12	11.43	0.75 - 1.00	1.00-1.00	0.93
LEVEL 8: Renewal	7	12-12	12.00	1.00-1.00	1.00-1.00	1.00

NOTE:
* Sum of individual ratings by 4 experts
** Ratings on collapsed scale of 1-3; where 3= relevant and 1= not relevant.
§ Calculated as % of experts scoring item relevant (score of 3). Number of experts =4;
§§ Calculated as the mean of the I-CVIs (Polit & Beck, 2006)
k* Calculated as explained in Table 1.

Table 6. Uniqueness of Category items in early version of LOKUS: overall ratings, I-CVIs and S-CVI

		Overall Ratings[+] (Min. 4; Max.12)[++]		I-CVI[§]	k*	S-CVI/Ave[§§] for item-set
LEVELS	No. of Category items	Range	Mean	Range	Range	
LEVEL 2 : Orientation	7	6-10	8.29	**0.25**-0.75	0.00-0.67	**0.54**
LEVEL 3: Preparation	7	8-10	9.43	**0.50**-0.75	0.20-0.67	**0.68**
LEVEL 4: Mechanical use	7	8-12	10.57	**0.50**-1.00	0.20-1.00	0.82
LEVEL 5: Routine use	7	6-12	**7.71**	**0.25**-1.00	0.00-1.00	**0.46**
LEVEL 6: Refinement	7	8-12	10.57	**0.50**-1.00	0.20-1.00	0.82
LEVEL 7: Integration	7	8-12	10.00	**0.50**-1.00	0.20-1.00	0.75
LEVEL 8: Renewal	7	10-12	10.86	0.75-1.00	0.67-1.00	0.86

NOTE:
[+] Sum of individual ratings by 4 experts
[++] Ratings on collapsed scale of 1-3; where 3= unique and 1= not unique.
[§] Calculated as % of experts scoring item unique (score of 3). Number of experts =4;
[§§] Calculated as the mean of the I-CVIs (Polit & Beck, 2006)
[k*] Calculated as explained in Table 1.

Table 7. Relevance and uniqueness of category items in early LOKUS version: I-CVI's and S-CVI/Ave (n=4)

		CATEGORIES							
		Knowing	Getting	Sharing	Assessing	Planning	Defining	Performing	S-CVI/ Ave*
		I-CVI for RELEVANCE (% of experts who gave a rating of 3)							
LEVELS	LEVEL 2: Orientation	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.93
	LEVEL 3: Preparation	1.00	1.00	0.75	0.75	1.00	0.75	1.00	0.89
	LEVEL 4: Mechanical use	0.75	0.75	1.00	0.75	1.00	1.00	0.75	0.86
	LEVEL 5: Routine use	1.00	**0.5**	**0.25**	**0.25**	**0.5**	**0.25**	**0.5**	0.46
	LEVEL 6: Refinement	1.00	1.00	1.00	1.00	1.00	0.75	1.00	0.96
	LEVEL 7: Integration	1.00	1.00	0.75	1.00	1.00	0.75	1.00	0.93
	LEVEL 8: Renewal	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		I-CVI for UNIQUENESS (% of experts who gave a rating of 3)							
	LEVEL 2: Orientation	0.75	**0.25**	**0.5**	0.75	**0.5**	**0.5**	**0.5**	0.54
	LEVEL 3: Preparation	0.75	0.75	0.5	0.5	0.75	0.75	0.75	0.68
	LEVEL 4: Mechanical use	1.00	0.75	0.5	1.00	1.00	0.75	0.75	0.82
	LEVEL 5: Routine use	1.00	**0.5**	**0.5**	**0.25**	**0.25**	**0.25**	**0.5**	0.46
	LEVEL 6: Refinement	0.75	1.00	1.00	0.75	1.00	**0.5**	0.75	0.82
	LEVEL 7: Integration	1.00	**0.5**	0.75	0.75	1.00	**0.5**	0.75	0.75
	LEVEL 8: Renewal	1.00	0.75	0.75	1.00	1.00	0.75	0.75	0.86

* Calculated as the mean of the I-CVI's

Table 8. Revised structure of the LOKUS instrument: Item distribution over a 10x6 layout.

			CATEGORIES					
LEVELS	**Related Q #**	**DESCRIPTION**	**Being Aware**	**Getting Information**	**Sharing**	**Assessing**	**Planning**	**Implementing**
Non-awareness	**Q2**	*User had not heard of the new knowledge from the study until present time (Vs. User had heard of the new knowledge from the study before)*	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Awareness	**Q3**	*User had heard of the new knowledge from the study but has not tried to get more information about it.*	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Orientation	**Q4**	*User is seeking details on whether the new knowledge from the study will be useful; however has not yet decided to use it.*	**Q5a**	**Q5b**	**Q5c**	**Q5d**	**N/A**	**Q5e**
Preparation	**Q6**	*User is preparing to use the new knowledge from the study; but has not used it yet.*	**7Qa**	**Q7b**	**Q7c**	**N/A**	**Q7d**	**Q7e**
Initial use	**Q8**	*User has just begun to use the new knowledge from the study, but has not yet mastered how to use it.*	**N/A**	**Q9a**	**N/A**	**Q9b**	**N/A**	**Q 9c**
Routine use	**Q10**	*User is using the new knowledge from the study regularly and does so with ease. However, User has not tried using it in ways other than originally intended.*	**Q11a**	**N/A**	**N/A**	**Q11b**	**Q11c**	**Q11d**
Expansion	**Q12**	*Based on own evaluations, User is using the new knowledge from the study in ways different from originally intended.*	**Q13a**	**Q13b**	**Q13c**	**Q13d**	**Q13e**	**Q13f**
Collaboration	**Q14**	*User is either considering collaborating with others, or has started to do so, on the use of the new knowledge from the study.*	**Q14a**	**Q14b**	**Q14c**	**Q14d**	**Q14e**	**Q14f**
Integration	**Q16**	*User's collaboration with others has led to a different way in which they use the new knowledge from the study.*	**Q17a**	**Q17b**	**N/A**	**Q17c**	**N/A**	**Q17d**
Modification	**Q18**	*User has made modifications to the new knowledge from the study, individually or jointly with others.*	**Q18a**	**Q18b**	**N/A**	**Q18c**	**N/A**	**Q18d**

Note: Q2 to Q18d refer to item numbers in LOKUS; N/A indicates no item (category not relevant).

Table 9. K Use level for the three groups at Baseline and Follow/up

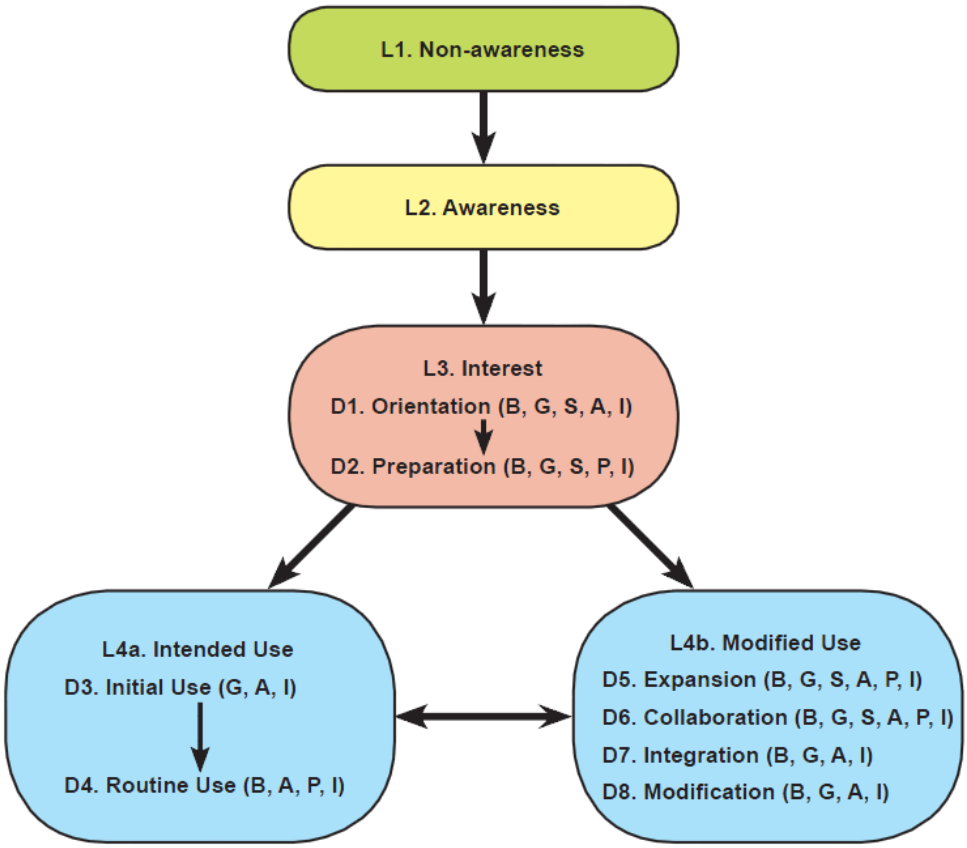
Level	T1 - Treatment Group 1				T2 - Treatment Group 2				C - Control			
	Baseline		Follow/up		Baseline		Follow/up		Baseline		Follow/up	
	Frequency (%)		Frequency (%)		Frequency (%)		Frequency (%)		Frequency (%)		Frequency (%)	
Study A (n=215)												
0-Non-awareness	66	8.0%	47	2.7%	65	85.5%	51	67.1%	55	85.9%	51	79.7%
1-Awareness	5	6.7%	6	8.0%	4	5.3%	6	7.9%	1	1.6%	1	1.6%
2-Orientation	1	1.3%	3	4.0%	0	0.0%	3	3.9%	0	0.0%	2	3.1%
3-Preparation	0	0.0%	7	9.3%	2	2.6%	2	2.6%	1	1.6%	3	4.7%
4-Initial Use	0	0.0%	0	0.0%	**1**	**1.3%**	**0**	**0.0%**	**1**	**1.6%**	**0**	**0.0%**
5-Routine Use	0	0.0%	3	4.0%	0	0.0%	3	3.9%	0	0.0%	1	1.6%
6-Expansion	1	1.3%	1	1.3%	**1**	**1.3%**	**0**	**0.0%**	0	0.0%	1	1.6%
7-Collaboration	1	1.3%	6	8.0%	0	0.0%	8	10.5%	1	1.6%	3	4.7%
8-Integration	0	0.0%	1	1.3%	**1**	**1.3%**	**0**	**0.0%**	**1**	**1.6%**	**0**	**0.0%**
9-Modification	1	1.3%	1	1.3%	2	2.6%	3	3.9%	**4**	**6.3%**	**2**	**3.1%**
TOTAL	75	100.0%	75	100.0%	76	100.0%	76	100.0%	64	100.0%	64	100.0%
Study B (n=215)												
0-Non-awareness	**57**	**76.0%**	**59**	**78.7%**	63	82.9%	59	78.7%	**50**	**78.1%**	**50**	**78.1%**
1-Awareness	5	6.7%	10	13.3%	2	2.6%	10	13.3%	1	1.6%	2	3.1%
2-Orientation	1	1.3%	1	1.3%	0	0.0%	1	1.3%	0	0.0%	0	0.0%
3-Preparation	**1**	**1.3%**	**0**	**0.0%**	**1**	**1.3%**	**0**	**0.0%**	**3**	**4.7%**	**1**	**1.6%**
4-Initial Use	1	1.3%	1	1.3%	0	0.0%	1	1.3%	2	3.1%	2	3.1%
5-Routine Use	**2**	**2.7%**	**0**	**0.0%**	**3**	**3.9%**	**0**	**0.0%**	**1**	**1.6%**	**0**	**0.0%**
6-Expansion	0	0.0%	0	0.0%	**1**	**1.3%**	**0**	**0.0%**	0	0.0%	0	0.0%
7-Collaboration	**4**	**5.3%**	**1**	**1.3%**	**3**	**3.9%**	**1**	**1.3%**	**4**	**6.3%**	**0**	**0.0%**
8-Integration	**2**	**2.7%**	**0**	**0.0%**	**1**	**1.3%**	**0**	**0.0%**	0	0.0%	2	3.1%
9-Modification	2	2.7%	3	4.0%	2	2.6%	3	4.0%	3	4.7%	7	10.9%
TOTAL	75	100.0%	75	100.0	76	100.0%	76	100.0%	64	100.0%	64	100.0%
Study C (n=215)												
0-Non-awareness	53	70.7%	49	65.3%	**52**	**68.4%**	**55**	**72.4%**	**41**	**64.1%**	**41**	**64.1%**
1-Awareness	2	2.7%	4	5.3%	4	5.3%	7	9.2%	3	4.7%	3	4.7%
2-Orientation	2	2.7%	2	2.7%	**1**	**1.3%**	**0**	**0.0%**	**3**	**4.7%**	**3**	**4.7%**
3-Preparation	2	2.7%	8	10.7%	**2**	**2.6%**	**1**	**1.3%**	2	3.1%	2	3.1%
4-Initial Use	2	2.7%	3	4.0%	**2**	**2.6%**	**0**	**0.0%**	**5**	**7.8%**	**5**	**7.8%**
5-Routine Use	**4**	**5.3%**	**0**	**0.0%**	**4**	**5.3%**	**2**	**2.6%**	0	0.0%	0	0.0%
6-Expansion	**2**	**2.7%**	**1**	**1.3%**	0	0.0%	1	1.3%	0	0.0%	0	0.0%
7-Collaboration	1	1.3%	2	2.7%	6	7.9%	6	7.9%	5	7.8%	5	7.8%
8-Integration	2	2.7%	6	8.0%	0	0.0%	4	5.3%	1	1.6%	1	1.6%
9-Modification	**5**	**6.7%**	**0**	**0%**	**5**	**6.6%**	**0**	**0%**	**4**	**6.3%**	**4**	**6.3%**
TOTAL	75	100.0%	75	100.0%	76	100.0%	76	100.0%	64	100.0%	64	100.0%

Table 10. Movement of T1 & T2 groups through Levels in LOKUS in 4 months.

		4-month Follow/up										
		Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	
Baseline	**Level 0 (Non-awareness) (n=131)**	**93**	9	6	6			1	12	1	3	131
	Levels 1-9 Awareness Plus (n=20)	5	**3**	0	3	0	6	0	2		1	20
	(n=151)	**98**	**12**	**6**	**9**	**0**	**6**	**1**	**14**	**1**	**4**	**151**

Legend:
Level 0 = Non-awareness;
Level 1 = Awareness;
Level 2 = Orientation;
Level 3 = Preparation;
Level 4 = Initial use;
Level 5 = Routine use;
Level 6 = Expansion;
Level 7 = Collaboration;
Level 8 = Integration; and
Level 9 = modification.

Figure 2. Conceptual model of the LOKUS instrument



Note:

1. L1, L2, L3, L4a and L4b indicate Levels.

2. D1- D8 stand for Dimensions.

3. Letters in parentheses indicate user action categories as follows: B: Being Aware, G: Getting Information, S: Sharing, A: Assessing, P: Planning, I: Implementing.

EXHIBIT THREE

Improvements to the LOKUS instrument

Level-items; Items were included or excluded based on expert item ratings and approval on relevance. All nine levels were retained, as there was good expert concurrence on their relevance (8 out of 9 levels approved; and none "unacceptably" low). None of the levels scored "unacceptably" low on uniqueness, however only 5 out of 9 levels were approved. Items were examined for overlaps and redundancies, and marked for modification. Further, as reviewer judgements supported their overall "developmental" or progressive nature, their general sequential order was also maintained. However, experts' comments on specific levels prompted revisions in their labelling and consequently their definitions. For example, comments to "Mechanical use" and "Routine use" suggested lack of distinction between the two regarding "automatic" usage: (i) "*The label (for mechanical use) doesn't match the description or the question. It might be termed "primitive" or "rudimentary" use. Mechanical use suggests an obvious application but missing some opportunities due to lack of reflection". (ii) "Define 'automatic' and how it relates if it does to the 'mastering of all details'. (iii) "This level (routine use) seems to be the true "mechanical" level"* Therefore, mechanical use was re-named Initial use. On the other hand, comments such as: "*How would this item (routine use) be scored - As a success in routine use or a failure in modification?"* prompted a distinction between intended and modified use behaviors, routine use associated with the former. Recognizing this as typical of the TT process (context of technological innovations), the rest of the levels were revisited and discussed. Refinement was changed to Expansion and redefined as taking the new knowledge beyond original intent. A new level Collaboration was added before Integration, as supported by the expert comments that suggested "*Too big a leap in logic perhaps"* (from refinement to integration); and *"overlap* (of integration*) with "refinement" in the minds of some respondents".* Additionally, Renewal was redefined as Modification to be consistent with the sequence related to technology use, and supported by the comment: "*Not sure I like the term Renewal because it*

doesn't get at examining new developments." The newly defined levels are presented in Fig. 2. This new set of 10 levels, especially initial use through modification, reflect a pattern of knowledge use typical of stakeholders of technological innovations, as further endorsed by the internal experts' review, who endorsed them.

Category-items: A similar rationale guided the elimination, retention or modification of a category item. As per Tables 3 and 5, a number of category items under Orientation, Preparation and Routine use showed unacceptably low scores, so that both elimination and modification were necessary. Expert comments and suggestions were aggregated for each item that failed to meet the standard, and were cross checked against expert comments about the labels of the levels and categories the item represented. This shed light on any areas of structural weakness, as distinct from the item itself in need of improvement. For example: "*I have already indicated that "mechanical" doesn't seem to be the right label"; "Assessing is a bit counterintuitive to mechanical use. Doesn't seem to fit well"; "This points to the boundary problems mentioned before. The coverage may be fine but the progression is not always clear"* As a result, Knowing was re-named Being Aware as it was considered "*not synonymous with awareness"* commonly cutting across many levels. Defining Status and Performing were seen overlapping between each other and with Planning in comments such as: "*What does "defining status" add to having reached the "planning" stage*?" and "*I don't see what is being performed…"* So Defining status was eliminated; and Performing was renamed Implementing. Some categories were deemed irrelevant under specific levels and eliminated entirely, changing item descriptions in function of re-definitions. Fig.2 summarizes the retained categories and their redistribution under the modified 10 level structure. The question numbers in the figure denotes the levels and categories retained in the final questionnaire. We reiterate that all foregoing improvements resulted from interaction of the feedback from the two sets of experts. As mentioned earlier the new structure more closely identifies with technology related knowledge use than before. The final organization of items still maintained two parallel versions of the survey and both

versions are suitable for online administration via the software program *Vovici*. See the table below for details.

Exhibit 3.1 Changes made to draft version of LOKUS

Original Level/Category	Original Format	Final Format	Justification- reviewer feedback
LEVELS:			
Level 0: Non-Use	Labelled as Non-Use	Re-labelled as Non-Awareness	Non-use involves levels 0-3, until actual Use starts in Level 4. Non-awareness better characterizes level zero.
Level 1: Non-Use/Awareness	Labeled as Non-Use/Awareness	Re-labelled as Awareness	Non-use involves levels 0-3, until actual Use starts in Level 4.
Level 2: Orientation	Labelled as Orientation	Re-labelled as Orientation (Interest)	Recognized as a step toward interest, therefore part of a broader level.
Level 3: Preparation	Labelled as Preparation	Labelled as Preparation	Also part (or dimension) of Interest. A bridge to Use. Decision has been made, but use has not yet begun.
Level 4: Mechanical Use	Labelled as Mechanical Use	Re-labelled as Initial Use	To eliminate confusion with "unthinking" or primitive use. . Reviewer Comment: *The label doesn't match the description or the question. It might be termed "primitive" or "rudimentary" use. Mechanical use suggests an obvious application but missing some opportunities due to lack of reflection.*
Level 5: Routine Use	Labelled as Routine Use	Labelled as Routine Use	
Level 6: Refinement	Labelled as Refinement	Re-labelled as Expansion	Discussion based on the above comments leading to revisiting levels 6, 7 and 8 as TT process steps. Expansion suggests going beyond original intent of new K, and is more typical of the TT process (context of tech. Innovations).
Level 7: Integration	Labelled as Integration	Labelled as Integration	
Level 8: Renewal	Labelled as Renewal	Re-labelled as Modification	See above.
Level 0: Non-Use	Are you familiar with the study?	Revised Language: Are you familiar with the new knowledge(XYZ) from Study X?	Awareness of the new K -versus awareness of the study- is the focus at this level. Comment: *Unclear what you mean by familiar; could be heard of this study or it could mean they know the results of the study.*
Level 1: Non-Use/Awareness	I have heard of this study; however I have not tried to get more information about it.	Revised Language: I had heard of the new knowledge from this study but I have not tried to get more information about it.	Awareness of the new K -versus awareness of the study- is the focus at this level. The second half suggests no further action or movement toward interest.

Level 2: Orientation	I am seeking details on how to put the new knowledge from the study to use within my work; however I have not yet decided to use the new knowledge to increase its impact on the intended beneficiaries.	Revised Language: I am seeking details on whether the new knowledge from this study will be useful; however I have not yet decided to use it.	To become interested one first needs to make sure that the NK will be useful before ensuring how to put it to use. Reviewer Comment: *I am seeking details on whether the new knowledge from the study will be useful to my work; however I have not yet decided to use the new knowledge to increase its impact on the intended beneficiaries.*
Level 3: Preparation	I have decided to incorporate the new knowledge within my work to increase its impact on the intended beneficiaries; but have not done so yet.	Revised Language: I am preparing to use the new knowledge from this study; but have not used it yet.	First half unnecessarily long – "preparing" implies that decision has been made. Also, the reason for decision (to increase ....) should be left open to accommodate different stakeholder purposes.
Level 4: Mechanical Use	I have just begun to use the new knowledge within my work to increase its impact on the intended beneficiaries; my use is not automatic; I have not mastered all the details.	Revised Language: I have just begun to use the new knowledge from this study; but I have not yet mastered how to use it.	Again, first half too long (see previous item). "automatic" was commented as "vague" Reviewer Comment: *Define "automatic" and how it relates if it does to the " mastering of all details"*
Level 5: Routine Use	I use the new knowledge regularly within my work to increase its impact on the intended beneficiaries and I do so with little effort. However, I have not tried new ways of using it.	Revised Language: I am using the new knowledge from this study regularly and I do so with ease. However, I have not tried using it in ways other than originally intended.	To contextualize the language. New ways is vague. Applications different from originally intended) is more specific to the context of technological innovations. Reviewer Comments: 1. *How would this item be scored? As a success in routine use or a failure in modification?* *2. This level seems to be the true "mechanical" level.3. Presenting too much information in item.*
Level 6: Refinement	Based on my own evaluations, I make changes to how I use the new knowledge in my work; I do this to be more effective in increasing its impact on the intended beneficiaries.	Revised Language: Based on my own evaluations, I am using the new knowledge from this study in ways different from originally intended.	Simplify language. Accommodate all stakeholder perspectives of use.
		Collaboration added as a level. Item:	Need for making explicit this bridge to integration. It had been left out. See reviewer comment to next level

		I am either considering collaborating with others, or have started to do so, on the use of the new knowledge from this study.	7.
Level 7: Integration	I am working with others whose activities relate to the new knowledge so we can increase the collective impact on the intended beneficiaries; I make changes to how I use the new knowledge based on my collaboration with others.	Revised Language: My collaboration with others has led to a different way in which we use the new knowledge from this study.	The new language is more representative of the TT process that ends in transformed K. Reviewer Comments: *1. Awkward phrasing "working with....so we can increase" Too big a leap in logic perhaps.* *2. This level may overlap with "refinement" in the minds of some respondents.* *3.I see some overlap with item 8.*
Level 8: Renewal	I'm seeking major modifications or alternatives to the current new knowledge; this is in order to expand its impact on the intended beneficiaries and the system.	Revised Language: I am making modifications to the new knowledge from this study, individually or jointly with others.	See above. Reviewer Comments: 1. *Not sure I like the term Renewal because it doesn't get at examining new developments.* *2. Seeking major modifications or alternatives makes the new knowledge sound like it is sorely inadequate as a research evidence.*

LEVEL 2- ORIENTATION: CATEGORIES

Orientation-Knowing	Labelled as Knowing	Re-labelled as Being Aware	Eliminate terminology confusion between knowing (becoming aware) and knowing (discovering). Reviewer Comment: "*Knowing" in this context is ambiguous and in general is not adjusted with a question of "awareness."*
Orientation-Getting Information	Labelled as Getting Information	No change	
Orientation-Sharing	Labelled as Sharing	No change	
Orientation-Assessing	Labelled as Assessing	No change	
Orientation-Planning	Labelled as Planning	Irrelevant; category removed.	Overlaps with getting info. Should have occurred before assessing.
Orientation-Defining Status	Labelled as Defining Status	Irrelevant; category removed.	Confusing. Overlaps with Getting info and assessing. See comments below. –also performing.
Orientation-Performing	Labelled as Performing	Labelled as Implementing	Implementing a plan more appropriately describes end of process than performing (an action). Reviewer Comment: *I don't see what is being performed… Also, "observed others using it" seems to be the*

			only part of this item distinguishing it from the others…
		Revised Language:	
Level 2-Orientation-Knowing	I am aware of general information about this new knowledge, such as where it came from, what it consists or, and what is required for using it in my work.	I am aware of the existence of the new knowledge from this study and that it might be useful.	Change consistent with the above rationale. Reviewer comment: Not sure you need the "what is required" as it will overlap with next item because you might have to get info to know what is required.
Level 2-Orientation-Getting Information	I try getting information that explains this new knowledge; I ask for other people's opinions and their knowledge through discussions, visits, or workshop.	Revised Language: I am obtaining information that explains the new knowledge from this study through the internet, journals, conferences, meetings, etc.	Removed "people's opinions" to eliminate overlap with Sharing. Reviewer Comments: 1. *Your example of asking other people through discussion is "Sharing" to me. You are limiting the choices for getting information by only using people; what about written materials for example? 2. It seems difficult to provide well defined boundaries between this category and the following one because getting information generally involves getting it from others and cannot be separated very well from sharing since there will be some reciprocity expected when asking for help on something.*
Level 2-Orientation-Sharing	I engage in general discussions about the new knowledge with others. I exchange information, materials, or ideas about it and also learn about what is expected in using it in my work.	Revised Language: I am engaging in general discussion about the new knowledge from this study with others. I exchange information, materials, or ideas about it and also learn about what is involved in using it.	Use broadened beyond work-related use; to suit all stakeholder contexts, to include personal use in activities of daily living. See reviewer comments above.
Level 2-Orientation-Assessing	In order to make a decision about using the new knowledge in my work, I have analyzed and compared further information about it-such as what it contains, what is required for using it, evaluating reports about work, what I can get out of it, and its strengths and weaknesses.	Revised Language: In order to make a decision about using the new knowledge from this study, I am analyzing and comparing further information about it – such as what it contains, what is required for using it, evaluation reports about it, what I can get out of it, and its strengths and weaknesses.	Language consistent with assessing" rather than "assessed".
Level 2-Orientation-Planning	In order to make a decision for or against using the new knowledge in my work, I need more information		Reviewer Comments: 1. *Unless the sequence is previously revealed to the respondent, the statement might also be true of an earlier stage. It might be*

	and resources; I am planning to gather them.		*prior to assessing as the question is stated.2. What if one doesn't need more information? 3. This category (Assessing) is VERY similar to planning. In fact, it almost seems backward… Planning says that I need more info and resources, while assessing says that I have analyzed and compared information about it. Shouldn't this be the other way around?*
Level 2-Orientation-Defining Status	I am presently exploring and getting a sense of what exactly this new knowledge involves and does not involve.		Reviewer Comments: *1. Seems to overlap with getting information and assessing.* *2. This is a very general statement and fits better with "Acquiring information". I have repeatedly struggled with this item in this questionnaire.* *3. Again, the question seems to suggest a category prior to "knowing" unless all the categories are known in advance and certain assumptions are made.*
Level 2-Orientation-Performing	I have explored this new knowledge and also what is required for its use within my work. I have talked to others about it; I have reviewed information and materials; I have attended orientation or training sessions, or I have observed others using it.	Revised Language: I have explored the new knowledge from this study and also what is required for its use. I am ready to decide for or against using this new knowledge.	Reviewer Comment: *It is unclear how one defines performance within orientation since the outcome of Orientation is defining status as to whether you would use it or not. To clarify, some of your examples are very specific. Will all studies have orientation and or training* sessions? 2. *Performance is irrelevant to Orientation.*
Level 3-Preparation-Knowing	Labelled as Knowing	Re-labelled as Being Aware	See above Reviewer Comment: *"Knowing" seems too strong. The question asks about "awareness".*
	I am aware of what is needed for starting to use this new knowledge within my work such as, practical needs, resources and timing. I also know what initial impact it can have on the results of my work.	Revised Language: I am aware of the benefits of the use of the new knowledge from this study, but I need more information such as practical needs, resources and timing.	Consistency with new level definition - see Preparation. (Aware of usefulness, not how to do use it, yet). Reviewer Comment: 1. *Item overlaps with Getting Info. If you keep the last part of the sentence since they will need to acquire info in some cases to figure out initial impact.* *2. Might want to say something like "I have a basic awareness of what is needed… I know what initial impact… but have not yet fully prepared to use it" Otherwise why would you get*

			more information if you already know everything?
Level 3- Preparation- Getting Information	Labelled as Getting Information	NO CHANGE	
	In order to prepare myself for using this new knowledge in my work, I look for information and resources specifically related to preparing to use it.	Revised Language: In order to prepare myself for using the new knowledge from this study, I am looking for information and resources specifically related to preparing to use it.	Restriction of use to "work" removed; broadened. *Again, the boundaries with the next category seem blurred*.
Level 3- Preparation- Sharing	Labelled as Sharing	NO CHANGE	
	I talk with others about resources needed for beginning the use of this new knowledge within my work. To prepare myself for first use, I join others in opportunities such as pre-use training, planning for resources, practical set up, scheduling, etc.	Revised Language: I am sharing information with others about resources needed for initial use of the new knowledge from this study. To prepare myself for first use, I join others in opportunities such as pre-use training, planning for resources, practical set up and scheduling.	"Talk" limits to oral exchange of information. "Initial use" is language consistent with new term for the level Initial use. Reviewer comments: *1. As written, "Talking with others" is not sharing info it is getting info. 2. Overlap with the previous category.*
Level 3- Preparation- Assessing	Labelled as Assessing	Irrelevant; category removed.	See below. Overlaps with planning & getting info.
	I have considered in detail what resources I need and what resources are available for beginning to use this new knowledge within my work.		Reviewer Comment: *This sounds more like Getting Information. 2. Wouldn't "considered in detail" include identifying steps and procedures? I think that something should be added to this to differentiate it from planning.*
Level 3- Preparation- Planning	Labelled as Planning	NO CHANGE	
	I have identified what steps and procedures are necessary for initial use of this new knowledge within my work; such as, obtaining resources	Revised Language: I am identifying the resources needed and available, as well as the steps and procedures necessary for initial use of the new knowledge from the study.	Changed the language to show "person is still getting ready". ...to differentiate it from assessing and defining status. Reviewer Comment: *Again, need to differentiate this from Assessing.*

	and/or arranging my activities and needed events.		
Level 3- Preparation- Defining Status	Labelled as Defining Status	Irrelevant; category removed.	See above. Redundant
	I have prepared myself for initial use of this new knowledge within my work.		Reviewer Comment: 1. *This sounds more like planning.2. This is an outcome of Defining Status.*
Level 3- Preparation- Performing	Labelled as Performing	Labelled as Implementing	Same as before.
	I have studied reference materials in depth, arranged my schedules, resources and practical set up and received any needed training in preparation for initial use of this new knowledge within my work.	Revised Language: I have prepared myself for initial use of the new knowledge from this study; such as, studying reference material, sharing information, arranging my schedules, resources and practical set up, and receiving any needed training.	*Language to be consistent with the end of preparation process - person being "ready" or "prepared". To distinguish it from getting info.* *Reviewer Comment: 1.Overlaps with acquiring information. 2. Performing is not relevant to Preparation. 3. Some doubts about the boundaries and overlap of the categories.*
Level 4- Mechanical Use- Knowing	Labelled as Knowing	Irrelevant; category removed.	*Redundant. Person has made the decision based on earlier levels.*
	I am aware of what is needed for using this new knowledge within my work. I know what is involved in the short term, and what short term effects it has on my ability to impact the intended beneficiaries, but I do not know about its long term effects.		*1. ....shouldn't it start off with slightly less 'knowing'? .....Otherwise it sounds like they already know everything that they would need to know at this point, and there would be no need to move onto the other items within this level.2. This goes back to the idea that "knowing" is not synonymous with awareness. Secondly, I have already indicated that "mechanical" doesn't seem to be the right label*
Level 4- Mechanical Use- Getting Information	Labelled as Getting Information	NO CHANGE	
	I look for information to manage the use of this new knowledge within my work. This includes such things as practical setting, how to schedule, and how to reduce the amount of time and work it takes from me to use the new knowledge.	Revised Language: I am looking for information to better manage the use of the new knowledge from this study. This includes such things as practical set up, resolving initial problems, scheduling, and identifying the amount of time and work it takes for me to use the new knowledge.	"Better" manage is more appropriate as it calls for new information. Again, "use" should be broadened beyond "work" context. 1. *The item is confusing. What do you mean by manage. With the examples that you give sounds more like preparation. Don't we need to assume they are a user so suggest adding "BETTER" before MANAGE. 2. The distinction is blurred*

			again. It is hard to see how getting info and not getting it from others (i.e. sharing) may be consistently observed.
Level 4- Mechanical Use- Sharing	Labelled as Sharing	Irrelevant; category removed	Too many overlaps. Overlaps with getting info. See comment above and below. Also with sharing.
	I discuss issues related to the use of this new knowledge within my work, including its management and practical problems. I share resources and materials for purposes or reducing management difficulties and practical problems related to such use.		Reviewer Comment: 1. *Seems to be overlap with "getting info". 2. Overlaps with assessing as written; because to identify need to reduce management difficulties that would involve assessing those difficulties.*
Level 4- Mechanical Use- Assessing	Labelled as Assessing	NO CHANGE	
	I examine my use of the new knowledge; it is usually related to practical problems and difficulties related to managing time, schedules, and resources; and how it might increase my ability to impact the intended beneficiaries.	Revised Language: I am examining what it takes to use the new knowledge from this study; my assessment is usually related to resolving practical problems and difficulties related to time, schedules and resources.	Consistent with "assessing" rather than "assessed". Reviewer Comment: *Assessing a bit counterintuitive to mechanical use. Doesn't seem to fit well.* Note- item maintained in light of elimination of other categories under this level. Not counterintuitive any more.
Level 4- Mechanical Use- Planning	Labelled as Planning	Irrelevant; category removed.	Judged Redundant for Initial use, in light of all earlier comments. User can proceed to implement after assessing.
	I plan my resources, activities, and events in relation to immediate use of the new knowledge within my work. Any changes I might plan are usually related to short-term issues about practical problems.		
Level 4- Mechanical Use- Defining Status	Labelled as Defining Status	Irrelevant; category removed.	Same as above. Redundant for Initial use- can proceed to implement.
	Most of my efforts to use the new knowledge in my work are focused on practical problems, managing time, arranging resources, etc.		*The category is unclear in this case. What does "defining status" add to having reached the "planning" stage?*
Level 4- Mechanical Use-	Labelled as Performing	Labelled as Implementing	Performing is a confusing term. See comment below.

Performing			
	My use of new knowledge in my work is not always efficient. I often cannot tell what the immediate consequences will be; the steps do not seem to flow smoothly. When I change how I use the new knowledge, it is mainly to get over practical problems and management difficulties.	Revised Language: Based on the information obtained and my assessment, I have initiated use of the new knowledge from this study; however, the steps do not seem to flow smoothly.	Reviewer Comment: *Might fit better as part of DEFINING STATUS. The first statement is leading. It describes the level better. Need to link type of performance to description in level better.* Language was made consistent with flow of steps from assessing to implementing. General Comments: "*KNOWING SEEMS IRRELEVANT"; This points to the boundary problems mentioned before. The coverage may be fine but the progression is not always clear.*
Level 5- Routine Use- Knowing	Labelled as Knowing	Labelled as Being Aware	See earlier comments and below.
	I am aware of what is required in using the new knowledge within my work, both short term and long term; as well as how to use it with minimum effort or stress.	Revised Language: I am aware of what is required in using the new knowledge from this study, both short term and long term.	*1. Not sure you need the part about MINIMUM EFFORT OR STRESS. 2. We already mentioned the "knowing" versus "awareness" issue.3..... you're giving them too much for knowing here....*
Level 5- Routine Use- Getting Information	Labelled as Getting Information	Irrelevant; category removed.	Redundant – see below.
	I am able to make use of the new knowledge routinely within my work; I make no special effort to seek information.		*1. It seems that the categorical progression is not relevant at this level. If by routine we mean a sort of "automatic pilot" then there is no need for the progression of categories. This may be a case like levels 1 and 2 where the categories are not relevant.2. I like the wording up to ";"3. Would anyone rate him/herself as making no special effort to seek information?*
Level 5- Routine Use- Sharing	Labelled as Sharing	Irrelevant; category removed.	Redundant – see above.
	I routinely use the new knowledge within my work and describe to others how I use it; currently I am not concerned about changing the way I use it.		*1. Same comment as before. The underlying idea for the succession of categories seems not to apply to this notion of routine. The questions for each category are all negative statements making them all redundant.2.If routinely using, then less inclined to be sharing.*
Level 5-Routine Use- Assessing	Labelled as Assessing	Labelled as Assessing	
	I evaluate how I use the	Revised Language:	Reviewer Comment: *The second*

	new knowledge within my work; however, it is mostly to see what is required to put it into practice; it is not for the purpose of changing the way I use it.	I am evaluating how I use this new knowledge from this study routinely.	*phrase seems unrelated to assessing. 2. If routinely using, then less inclined to be assessing. 3. Again, the meaning of "routine" applied before doesn't seem to allow assessment.* Category maintained and revised. Redundancy had been reduced by eliminating other categories.
Level 5- Routine Use-Planning	Labelled as Planning	Labelled as Planning	
	My plans of using the new knowledge within my work are concerned about the routine use of resources. They do not concern different ways of using the new knowledge.	Revised Language: I am planning to continue using the new knowledge from this study. I am not yet concerned about different ways of using the new knowledge.	*1. Planning seems to be prior to the establishment of the routine rather than a later stage of achievement at this level. 2. ROUTINE USE of resources seems too specific.* 3. *Second sentence seems odd; one could have both routine and new uses, perhaps.* **NOTE: SUGGESTED INTENDED AND MODIFIED USE AS BROADER LEVELS.**
Level 5- Routine Use-Defining Status	Labelled as Defining Status	Irrelevant; category removed.	Redundant. See below.
	My use of the new knowledge within my work is going along satisfactorily; I have few problems, if any.		*1. I don't understand the purpose of this statement, that is, at what it is driving.2. Doesn't seem to fit with ROUTINE USE. If participant thinks use is going along satisfactorily then is that not the best outcome for them. .*
Level 5- Routine Use-Performing	Labelled as Performing	Labelled as Implementing	
	I use the new knowledge within my work smoothly with minimal management problems; and there is a steady pattern to my routine use.	Revised Language: I use the new knowledge from this study routinely with minimal problems.	*1. Very similar to defining status. 2. Same as before.3. ROUTINE USE implies the level of performance.* General Comments: 1.The categories seem irrelevant to this level. It is a stable state throughout that doesn't seem to offer an obvious progression of improved routine levels. 2. Again, it just seems like there is some repetition here- some items that could be combined.3. Difficult section because it is tied to performance.
Level 6- Refinement-Knowing	Labelled as Knowing	Labelled as Being Aware	Reviewer Comment: *"Awareness" is different from "knowing".*
	I am aware of the effect of the new knowledge	Revised Language:	Reviewer Comment: *By becoming aware of how to*

	on my ability to impact the intended beneficiaries; I am also aware of how to increase the impact.	I am aware that it would be beneficial to expand the use of the new knowledge from this study, that is, use it in ways different from originally intended.	*increase impact, does this not include getting information to know this?*
Level 6-Refinement-Getting Information	Labelled as Getting Information	Labelled as Getting Information	
	I want to increase the effect of the new knowledge on my ability to impact the intended beneficiaries; so, I look for information and materials that relate specifically to changing my current use of it.	Revised Language: I am looking for information and materials that relate specifically to expanding my current use of the new knowledge from this study.	Consistency with new level names.
Level 6-Refinement-Sharing	Labelled as Sharing	Labelled as Sharing	
	I want to increase the effect of the new knowledge on my ability to impact the intended beneficiaries; so, I discuss with others how I would modify the current use of it.	Revised Language: I am discussing with others how I would expand my current use of the new knowledge from this study.	See above.
Level 6-Refinement-Assessing	Labelled as Assessing	Labelled as Assessing	
	I want to increase the effect of the new knowledge on my ability to impact the intended beneficiaries; so I have evaluated the new knowledge for the purpose of changing my current use of it.	Revised Language: I am evaluating the new knowledge from this study for the purpose of expanding my current use of it.	See above. Reviewer Comment: *This could overlap with sharing because might assess first and then share the assessment.*
Level 6-Refinement-Planning	Labelled as Planning	Labelled as Planning	
	I have developed immediate and long-range plans to increase the effect of the new knowledge on my ability to impact the intended beneficiaries; the plans include steps, resources, and events designed to increase the impact.	Revised Language: I am developing intermediate and long-range plans to expand the use of the new knowledge from this study.	Reviewer Comment: *Not sure you need to include last part of item that specifies plans.*
Level 6-	Labelled as Defining	Irrelevant; category removed.	Reviewer Comment:

Refinement-Defining Status	Status		*ITEM describes performing. Defining status seems relevant.*
	I have used the new knowledge within my work in different ways to increase its impact on the intended beneficiaries.		
Level 6-Refinement-Performing	Labelled as Performing	Labelled as Implementing	See confusion indicated in comments below.
	I have explored and tried different ways of combining the new knowledge with existing practices so that I get maximum impact for the intended beneficiaries.	I have explored and tried different ways of combining the new knowledge from this study with existing practices.	*1. Similar to defining status* *2. Need to drop explore because as written overlaps with assessing.* Language made compatible with new level Expansion.
		Collaboration categories added.	See rationale for Collaboration level earlier mentioned.
		Labelled as Being Aware	
		I am aware that collaborating with external colleagues in the use of the new knowledge from this study would be beneficial.	
		Labelled as Getting Information	
		I am seeking information and opinions from others for the purpose of working with external colleagues in the use of the new knowledge from this study.	
		Labelled as Sharing	
		I am talking to others about working with external colleagues in using the new knowledge from this study.	
		Labelled as Assessing	
		I am evaluating how to work with external colleagues and use the new knowledge from this study, including the advantages and disadvantages of such collaboration.	
		Labelled as Planning	
		I am planning and scheduling resources and time for collaborating with external colleagues on the use of the new knowledge from this study.	

		Labelled as Implementing	
		I have started working with external colleagues on the use of the new knowledge from this study.	
Level 7- Integration- Knowing	Labelled as Knowing	Labelled as Being Aware	
	I know how to coordinate the use of the new knowledge with others to increase its impact on the intended beneficiaries.	Revised Language: I am aware that integrating my work on the use of the new knowledge from this study with the work of external colleagues would be beneficial.	*Reviewer Comments:* *1. You need to define "OTHERS".*
Level 7- Integration- Getting Information	Labelled as Getting Information	Labelled as Getting Information	
	I ask for information and options from co-workers and interested others for the purpose of working with them in the use of the new knowledge.	Revised Language: I am seeking information and opinions from others for the purpose of integrating my work with the work of external colleagues on the use of the new knowledge from this study.	*Reviewer Comments:* *1. LIMITING SOURCE OF INFORMATION ONLY TO CO-WORKERS. OVERLAPS WITH SHARING; 2. Difficult to separate from the next category, sharing.*
Level 7- Integration- Sharing	Labelled as Sharing	Irrelevant; category removed.	See above.
	I talk to co-workers and interested others about working with them in using the new knowledge, in efforts to increase the impact on the intended beneficiaries.		Reviewer Comments: 1. *NOT SURE "TALKING TO" IS SHARING. SEEMS ONE-SIDED.2. Seems to overlap with the previous one. At this level the category is "sharing" about an overall interaction pattern. This seems redundant or self-referential.*
Level 7- Integration- Assessing	Labelled as Assessing	Labelled as Assessing	
	I am evaluating how to work with others and use the new knowledge so it increases the impact on the intended beneficiaries; I am also examining the strengths and weaknesses of such co-working.	Revised Language: I am evaluating the integration of my work with the work of external colleagues regarding the use of the new knowledge from this study, including the strengths and weaknesses of such integration.	Reviewer Comments: 1. *OVERLAPS WITH PLANNING. AS WRITTEN MIGHT OCCUR BEFORE SHARING*
Level 7- Integration- Planning	Labelled as Planning	Irrelevant; category removed.	
	I plan actions to		

	coordinate my own use of the new knowledge with others in order to get more impact for the intended beneficiaries.		
Level 7- Integration- Defining Status	Labelled as Defining Status	Irrelevant; category removed.	
	I spend time and energy working with others and integrating my own use of the new knowledge.	Revised Language: I have integrated my work with the work of external colleagues leading to joint expansion of the use of the new knowledge from this study	Reviewer Comments: 1. *Sounds like performance. 2. Can't tell the difference with performing.* General Comments: 1. *Overlap with defining status and performing; Assessing and Planning. 2. Sharing is redundant and so is performing w/r to defining status.*
Level 8- Renewal- Knowing	Labelled as Knowing	Labelled as Being Aware	
	I have become aware that I need to either make changes to the new knowledge or replace it, for use within my work, in order to improve my ability to impact the intended beneficiaries.	Revised Language: I am aware that making modifications to the new knowledge from this study, individually or jointly with external colleagues, would be beneficial.	Reviewer Comments: 1. *Back to "knowing" versus "awareness".*
Level 8- Renewal- Getting Information	Labelled as Getting Information	Labelled as Getting Information	
	I am now seeking information and materials about other studies that contain similar new knowledge for use within my work; these can be helpful either as replacements to the current new knowledge or help with major adaptations to it.	Revised Language: I am seeking information and materials in order to modify the new knowledge from this study individually or jointly with external colleagues.	Reviewer Comments: *1. We are dealing again with the tenuous distinction between "getting information" and "sharing" under these circumstances. Unless there are actual material channels or sources of information for this particular set of activities that clearly does not involve interaction, it is difficult to imagine it without sharing.2. Need to add seeking "NEW" information, i.e., not previously available or else this sounds like preparation level.*
Level 8- Renewal- Sharing	Labelled as Sharing	Irrelevant; category removed.	
	I discuss with other interested persons, studies that can help with major changes to the current new knowledge for use within my work or as replacements for it.		
Level 8- Renewal-	Labelled as Assessing	Labelled as Assessing	

Assessing			
	I am at the point of weighing the advantages and disadvantages of changing how to use the new knowledge within my work; I will consider either replacements or major modifications.	Revised Language: I am weighing the advantages and disadvantages of making modifications to the new knowledge from this study, individually or jointly with external colleagues.	
Level 8- Renewal-Planning	Labelled as Planning	Irrelevant; category removed.	
	I am actively looking for enhancing or replacing the current new knowledge for use within my work; and I have a plan for doing so.		Reviewer Comment: *Need to be more specific about having a plan. ACTIVELY LOOKING is GETTING INFORMATION.*
Level 8- Renewal-Defining Status	Labelled as Defining Status	Irrelevant; category removed.	
	I am now seriously considering the use of a replacement or making major modifications to how I use the current new knowledge within my work.		Reviewer Comments: 1. *I have some concern that this is somewhat similar to "knowing" Although becoming aware and seriously considering are two different things, one could imply the other… I didn't think this was enough of a problem to call it overlapping though…* *Seems to overlap with planning. How do you "seriously consider" to use without planning? It would not be a credible statement.*
Level 8- Renewal-Performing	Labelled as Performing	Labelled as Implementing	
	I have already explored new knowledge from other studies that can be combined with the current new knowledge for use within my work or to be used in place of it.	Revised Language: I (individually or with external colleagues) have made modifications to the new knowledge from this study.	Reviewer Comments: *1. As written, doesn't reflect performance.* General Comments: *1. I know that the level on the overview sheet doesn't say anything about implementing the new knowledge to make these changes, but I still feel that this section is lacking that action… What if they had gone that far? I guess we're just not looking to measure beyond intention to modify the knowledge?* *2. Some categories seem to overlap.*