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Workplace information literacy: Measures and methodological challenges

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Abstract

This paper focuses information literacy (IL) from a methodological perspective, addressing quantitative IL measures, suitable for evaluating the role of IL in supporting work activities. So far, IL in workplace contexts has mostly been studied using qualitative methods, designed for studying situational and context-dependent practices. Therefore it is important to explore how quantitative measures could be used to bring forward the relation between IL and organisational outcomes, that is the assessment of the *impact* of IL in workplace contexts. Quantitative research into IL is not unknown, but has been mainly developed in higher education, in order to measure students' abilities to make use of information.

This paper brings forward three separate studies, conducted by the authors, highlighting different workplace contexts: small and medium enterprises; universities; and community councils. The common approach is that survey instruments were used to measure IL and its impact in these organisational contexts. The methodological implementations and insights are presented and combined, and methodological strengths and challenges are discussed, *with the aims of (1) building knowledge about IL measures in workplace settings that is currently lacking, (2) finding additional measures for the complex IL construct, and (3) considering the scope of the practices that can be measured.* The paper highlights the complexity of studying the impacts of IL in workplace contexts, and the importance of using multiple methods. It constitutes an important step towards a more unified understanding of how to study workplace IL.

Keywords

Information literacy, workplace learning, information literacy measures, quantitative methods, methods development

1. Introduction

There is more information available for decision-making than ever before, but unfortunately this does not guarantee well-informed decisions. Information literacy (IL), that is mastering huge amounts of information, evaluating its reliability, and judging what information to use and how, is not easy, even though IL has been identified as central to the development of competitive advantages for firms, workplaces and the knowledge economy (Catts & Lau, 2008; Forster, 2017; Coonan et al., 2018). Although originally created in the world of work (Crawford, 2013; Zurkowski, 1974, p.6), IL is a concept that has mostly been developed within higher education, to support students in their academic progress, and is therefore widely studied in educational contexts. The emphasis is on operationalising IL for better learning outcomes. It focuses on measuring and quantifying the outcome of effective IL teaching, and on developing IL standards for library educators (for example ACRL). Because IL has also been defined as crucial in other domains than education, there is a growing need for different methods and measurement tools that can be applied into various contexts. An ideal would be to develop a general, context-independent measure of IL, making it possible to compare, for example, populations and situations (Hollis, 2018). However, IL is not only an individual skill that is easily transferred from one context or situation to another. IL is constructed and developed over time and space, as a way of knowing (Lloyd, 2017). This approach focuses on understanding IL from a sociocultural perspective, using qualitative methods such as phenomenography and discourse analysis (for example Tuominen et al., 2005; Limberg et al., 2012) to better understand how individual and environmental factors interplay and affect IL. Workplace information practices are mainly informal (Lloyd, 2017), workplace environments are faster paced and less predictable than those in higher education, and collective action and the roles of co-workers as information sources are much more important (Head et al., 2013). This means that knowledge about and measures for studying IL that are developed within the educational domain are valuable and important, but they are not necessarily transferable as workplace information literacy (WIL) measures. The qualitative approach to studying IL as a sociocultural construct brings an important depth to holistic understanding, but lacks the possibility of assessing the impact of IL in the workplace on a larger scale (Williams et al., 2014). IL is a complex matter, with individual, organisational, and societal dimensions, and there is a need for increasing the dialogue between the existing approaches of studying IL (Lloyd, 2017), and for trying out additional ways and methods, with emphasis on bringing quantitative measures to workplace IL research, that are currently lacking. Finding ways for clearly showing that IL impacts on, for example, business outcomes, would be beneficial in the process of making IL relevant beyond library and information science and across disciplines, such as business administration and knowledge management (Cheuk, 2017).

This paper brings forward lessons learned from three quantitative approaches, conducted by the authors, in different workplace contexts; small and medium enterprises (SMEs) (Ahmad, et al., 2020); universities (Nikou et al., 2018, 2019; Nikou et al., 2020); and community councils (Cruickshank et al., 2020). The common strategy was that survey instruments were used to measure IL and its impact in organisational contexts, contributing to a better understanding of how to study IL in workplace contexts. The IL constructs used in the studies build on existing IL measures and further developed to fit the contexts of study. The methodological implementations and insights are presented and combined, and the strengths and challenges of the quantitative approaches are discussed, *with the aims of (1) building knowledge that is currently lacking about IL measures in workplace settings, (2) finding additional measures for the complex IL construct, and (3) considering the scope of the practices that can be measured.*

2. Studying workplace information literacy (WIL)

Although IL has been acknowledged as an important skills-issue in the context of working (Ahmad & Widén, 2018; Bruce, 1999; Kirton & Barham, 2005; Lloyd, 2011), there are still no

specific IL measures developed for that context. Notably, measures for studying the impact of IL for workplace efficiency and effectiveness are lacking (Williams et al., 2014; Forster, 2017). It has been stated that IL in workplace contexts must be viewed from a more holistic perspective, as sets of skills that help people to work collectively, and with an understanding of workplaces as social constructs (Forster, 2017; Lloyd, 2010; Lloyd, 2017; Tuominen et al., 2005). IL is understood as a socio-cultural practice as much as it is an individual competence (Lipponen, 2010; Lloyd, 2017). Information skills are not only about handling information in textual forms. For example, 'people as information sources' adds an important social dimension to IL in workplace contexts (Bruce, 1999; Kirton & Barham, 2005; Crawford & Irving, 2009). The collaborative aspects of information-related skills and competencies become important, while knowledge and meaning are built through dialogue and debate (Tuominen et al., 2005). IL in workplace contexts has focused on learning, using information to learn, being aware of forms of information, how information is used, and how it transforms work (Bruce et al., 2012). Qualitative research methods have therefore been most suitable for studying these factors.

WIL research has brought an understanding about how IL is constructed and valued, but less is known about how IL supports efficiency or other organisational goals. Quantitative research would bring forward more knowledge about the relationship between IL and organisational outcomes. Quantitative research into IL is not unknown. However, it has been based on 'classroom' situations where teachers can 'externally' award marks based on 'objective' scales. Examples include investigation of predictors of ICT literacy (Fabbi, 2015), known and desired 'learning outcomes' (Sachs et al., 2013), and other investigations into relationships between quantifiable variables. For example: Kwon (2008) found an inverse relationship between critical thinking dispositions and library anxiety; Stokes and Urquhart (2011) found relationships between learning style and self-efficacy; Mery et al. (2011) found that locally-developed online IL assessments are good predictors of scores in a national standardised IL test. Scoring IL can be relatively easy within higher education where researchers can assess marked results, or easily test measures such as 'was a student able to find a useful piece of information?' or 'how well has a student exploited the information he or she has found?' In such cases, even if a fixed ideal cannot be stated, Likert scales can provide relative quantitative measures.

Scoring of this kind requires agreeing where the 'top' of each IL competence is. In an everyday life or workplace environment, this is even more complex. While in addition to everyone's own context or personal information landscape, we are part of a larger information landscape of a team or even an organisation (Lloyd, 2010), affecting the ongoing construction of our IL. This leaves a dependence on respondents assessing their own achievements. Generally, because respondents are not IL experts, they cannot know how well they are achieving in relation to any IL framework, but they can express their awareness of IL competencies, how they value IL, and the role of IL in relation to organisational activities and goals. This in turn, can deliver important insights about the impact of IL in workplaces that are currently absent.

3. Developing WIL measurement tools

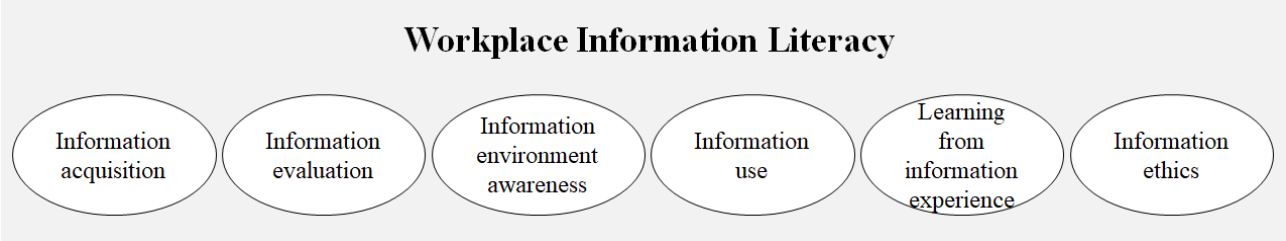
In this section, research conducted by the authors using quantitative methods on IL in workplace contexts is described. The results of the studies are presented in (Nikou et al. 2018, 2019; Nikou et al., 2020; Ahmad et al., 2020; Cruickshank et al., 2020), but a deeper methodological presentation and discussion is lacking in those works. The combined methodological implementations and insights are presented in this paper in order to better discuss methodological strengths and challenges in such research. The study contexts are different, as are the methods for analysis. However, the common approach is that survey instruments were used to measure IL and its role in organisational outcomes.

3.1. WIL and innovation

The first example (Ahmad et al., 2020) is a traditional quantitative approach, with the purpose of investigating the relationship between IL and innovation as an organisational outcome. This study adopted an interdisciplinary perspective to assess the impact of SME CEOs' IL on opportunity recognition, exploitative innovation and exploratory innovation. Because there was no available standardized tool for measuring workplace IL, a new workplace IL scale was developed. Building on previous literature (Forster, 2017; Hicks, 2017, Jyothibabu et al., 2010; Lara & Salas-Vallina, 2017; Kurbanoğlu et al., 2006; Somerville & Bruce, 2017) information literacy was operationalised as a multidimensional concept comprising many interrelated information activities which together reflect information literacy of employees in a workplace. Multidimensional operationalisation is useful for analysing concepts which are complex and prone to jangle fallacy - variants of a 'single phenomenon is operationalized separately under the guise of two or more variables' (Johnson et al., 2011, p.2) - which is sometimes the case with information literacy. Statistically, multidimensional information literacy was operationalized using repeated indicator approach, which means IL as a higher or second-order construct is an overall abstraction of its first order dimensions (Law et al., 1998) and is measured through the sum of all of the indicators of its first order dimensions.

A comprehensive analysis of IL research including theory and IL scales led to the identification of six WIL dimensions namely information acquisition, information evaluation, information use, awareness of information environment, learning from information experience and information ethics (see Figure 1). These six dimensions are in alignment with the definition of WIL provided in the study which considers WIL a combination of various information activities. Three of these dimensions, information acquisition, information evaluation and information use, can be considered as core dimensions as they have been discussed extensively in previous research and have also been part of previous information literacy scales developed in educational context (e.g. Kurbanoğlu et al., 2006). While attending to the intricacies of workplace environment, recent qualitative research suggests that WIL, in addition to core information activities, also encompass a good understanding of workplace information environment (Hicks 2017), ethical and moral concerns (Forster, 2017) as well as tendency to learn and develop from information (Somerville & Bruce 2017), which in the new WIL scale is reflected through the other three dimensions.

Figure 1: Information literacy as a multidimensional construct (Ahmad, Widén & Huvila, 2020)



In the cases of information acquisition, evaluation and use, a huge inventory of measurement items is available (e.g. Radcliff et al., 2007; Kurbanoğlu et al., 2006). This was helpful in developing new measurement items. Nevertheless, most of the items were created from scratch to better reflect recent IL research (e.g. Gilbert, 2017; Goldstein & Whitworth, 2015) and organisational context. An example of context specific scale development can be found in the construct of awareness of the information environment. Organisational information environment is multi-layered which includes both organisational and team specific information activities (Forster, 2017). Therefore, awareness of the information environment, as visible in its measurement indicators, tries to capture an employee's knowledge of company information policies, organisation of company information as well as immediate team or department's acceptable ways of information sharing.

Information related concepts in business management, such as organisational learning and absorptive capacity, were also analysed to get a better understanding of information activities in organisational context. In this regard, organisational learning was particularly useful. Organisational learning is an information and knowledge creation, sharing and absorption process and has well established measurement scales (Chiva et al., 2007; Jyothibabu et al., 2010; Lara & Salas-Vallina, 2017) which capture many information related organisational activities such as development of environmental awareness. Therefore, organisational learning helped in creating new measurement items as well as in modifying them so that they align with organisational information environments.

A comprehensive survey was conducted among SME CEOs in Finland. Due to the multidimensional nature of the WIL scale, partial least square structural equation modelling (PLS-SEM) was used to validate the scale and to analyse the relationship between IL and SME innovation. Statistical analysis showed that the newly developed WIL scale is reliable and valid. It also confirmed the multidimensional nature of the IL scale. This is in alignment with previous qualitative studies on information literacy. Regarding the impact of IL on innovation, the study revealed that the CEOs' IL has a positive impact on exploratory and exploitative innovations in SMEs. It was shown that IL also influences opportunity-recognition, which acts as a mediator between IL and both forms of innovation. Moreover, IL was found to be more strongly associated with exploitative innovation than with exploratory innovation, suggesting that IL might add more value to innovations entailing refinements which involve a high awareness of available information sources. This study shows the potential of using quantitative measures on a complex construct such as IL in relation to concrete outcomes, such as innovation. However, both IL and innovation evolve over time, making the cross-sectional nature of the present study a major limitation. A longitudinal research design is required to understand whether varying trajectories of innovation in SMEs emanate from variance in IL of CEOs.

3.2. WIL and the intention to use digital technology

The second example presents two studies where quantitative approaches, i.e. Structural Equation Modelling (SEM) and fuzzy-sets Qualitative Comparative Analysis (fsQCA) have been used to understand differences in IL and digital literacy (DL) skills between generations in a university context and higher education setting (Nikou et al., 2018; Nikou et al., 2019; Nikou et al., 2020). These studies aimed to provide insights on antecedent factors and how they affect intention to use digital technology. As the context of these studies was higher education environments, a quantitative approach deemed appropriate to measure university staff and students' intention to use digital technologies for teaching and learning purposes. In this section the focus is on the fsQCA method – a less-used method in this kind of research – to bring important insights to the methodological discussion. In these studies, IL is defined as the ability to search for, locate and assess web-based information and content. Furthermore, information literate people, in particular university staff and students, are expected to be critical thinkers (Ng, 2012) in assessing information and using digital tools and devices. Therefore, DL was assessed separately in addition to IL. According to Ng (2012), DL is understood as being composed of three dimensions: technical literacy, cognitive literacy, and social-emotional literacy. It was assumed that DL and IL together impact attitudes toward using and consequently intention to use digital technology for teaching and learning purposes. The proposed models in the two studies include also social norms (Thompson et al., 1991) and self-efficacy (Bandura, 1995) as factors affecting intention to use digital technology, either directly (Venkatesh et al., 2012) or by influencing IL and DL (Kurbanoğlu, 2003). These two constructs have been shown to be strong predictors of intention to use technology (Van Acker et al., 2013) and contribute to the understanding of WIL. Attitude toward using digital technology is defined as an individual's overall affective reaction towards using a system. It is one of the strongest predictors of behavioural intention (Venkatesh et al., 2003). In those studies, intention to use technology was used as a proxy of an individual's intention to use digital technology, in other words, the dependent variable in the conceptual models used in the studies. The core

theoretical objective in those studies was to use additional influential variables (e.g. digital literacy, social norms, and self-efficacy), in addition to information literacy, to overcome challenges addressed earlier, that is information literacy is situational and contextual concept and should be examined based on the context is being used.

We have provided a detailed report on the analysis and results in Nikou et al. (2018) and Nikou et al. (2019). From a methodological standpoint, Structural Equation Modelling (SEM) was the main approach to analyse the data but, because IL is a complex and contextual construct, Fuzzy-set Qualitative Comparative Analysis (fsQCA) was also employed to enable further exploration of the data and obtain new insights about IL and DL (Nikou et al., 2020). Fuzzy-set Qualitative Comparative Analysis is a configurational thinking approach developed by Ragin (1987). In contrast to traditional regression-based methods that assume the net effects of a specific variable (outcome), fsQCA allows the development of theories that refer to a pattern of multiple independent variables that are related to a dependent (outcome) variable (Delery & Doty, 1996). Moreover, fsQCA overcomes some of the limitations of traditional methods by enabling researchers to understand the causal complexity of phenomena through the concepts of *conjunction*, *equifinality* and *asymmetry*. Conjunction refers to an outcome occurring from the interdependence of multiple variables or conditions (Schneider & Wagemann, 2012). Equifinality (Gresov & Drazin, 1997) refers to the possibility of the existence of multiple pathways to the same outcome. Asymmetry refers to a situation where variables or conditions found to be causally related in one configuration are unrelated in another configuration (Meyer et al., 1993, p.1178).

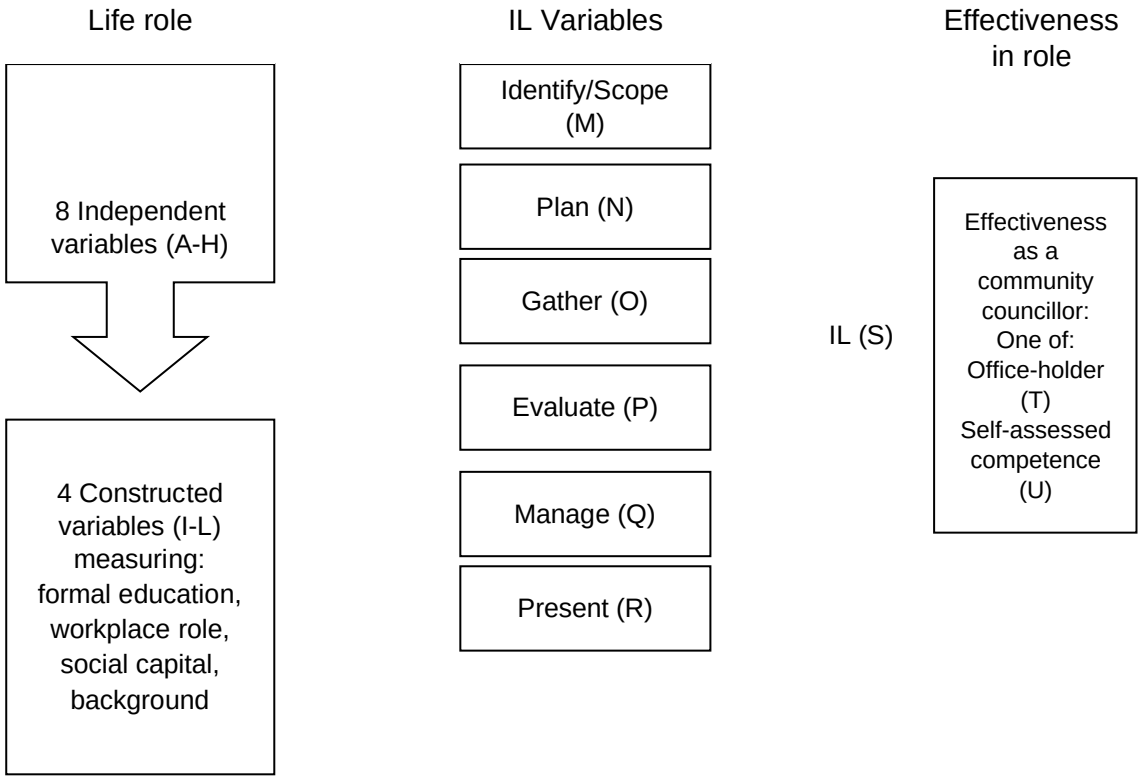
The use of fsQCA method enabled us to obtain additional insights to the phenomena (i.e. the impact of IL and DL on intention to use technology in the higher education context) under investigation and reinforced the SEM findings in several ways. For example, the fsQCA results showed that there are multiple pathways (in other words, equifinality) to the same outcome of interest (intention to use digital technology), whereas in the SEM approach we only found if the path relationship was significant or not. In addition, the results showed that variables found to be causally related in one configuration appeared to be unrelated in another configuration (in other words, asymmetry). Moreover, in Nikou et al. (2018), the SEM analysis showed some differences between females and males. More specifically, the SEM results showed that the path-relationships between IL and attitude towards using digital technology and the path between attitude toward using digital technology and intention to use were only significant for females in Generation X. Whereas, in another study by Nikou et al. (2019), the fsQCA results revealed multiple configurations of conditions leading to outcomes (intention to use) that were unique to females in among both Generations X and Y. Another additional insight which we were able to obtain was that the SEM results showed that, for the younger generation, the path between attitude towards using digital technology and intention to use technology is not significant. In contrast, the fsQCA results showed that not only that this variable is important for the decision of this generation on whether to use technology, but also that the presence of this condition appeared to be important in multiple configurations, thus signifying the importance of this condition. Such detailed insights about the nuances of the complexity of IL and DL are valuable insights which could not be gained from SEM alone, underlining the importance of trying out different methods of analysis, complementing each other.

3.3. WIL and effectiveness as a local democratic representative

The third example reports on a failed attempt to measure IL in Scotland's community councillors. A community council represents, and is nominally elected by residents in, a small geographical area, for example, a village and its environs, a town or a part of a city. It was assumed that community councillors could be considered as operating in a workplace context, even though they are not paid. The basic idea of this model is that various 'life-roles' and social factors would enhance individuals' IL, and hence lead to these people being more effective as community councillors. This model was developed into a set of hypotheses (outlined in Figure 2

below), then investigated using an online survey of community councillors that resulted in 1036 usable responses.

Figure 2: Outline of hypotheses tested



The survey was based on the SCONUL IL model (SCONUL, 2011), as outlined below. Hence this attempt can be seen as a test of whether IL models developed in educational contexts can be applied in workplace-like contexts. It was also designed to help investigate the background factors that shaped individual community councillors' ILs, and hence community councils' collective ILs; the extent and nature of joint information work in community councils; and the effects of the social context in the form of life roles. The researchers' overall significant aim was to investigate how well IL works as a model in a situation where information sharing is a significant element of information practices, in particular for community representatives. Data gathering methods and findings are discussed elsewhere (Cruickshank et al., 2020). This narrative focuses on the narrow issues associated with attempts to investigate these matters.

This study set itself three major measurement challenges. The first was to measure the 'life-role' variables associated with the left side of Figure 2 (Independent variables A to H were used to construct variables I to L.) The second challenge was to measure IL, the middle part of Figure 2. The IL variables (variables M to R) were derived from the SCONUL 7-pillar model of information literacy (SCONUL 2011), except that the *Identify* and *Scope* pillars were combined because the researchers considered that if an information need is so small (its scope) that no action is taken, it effectively does not exist (in other words, no real need has been identified. The IL variables were conceived of as whether community councillors undertook activities relevant to each pillar on their own, jointly with their peers or not at all. An overall IL variable (variable S) was calculated as the mean of each participant's responses to the IL variables.

The third challenge was measurement of effectiveness, shown in the right of Figure 2. Effectiveness in this context was defined as 'making effective use of information', following a precedent in research into IL and knowledge management in NHS24 staff (O'Farrill, 2010).

Because the information available – or found – will differ from case to case, there are contextual problems when trying to measure effectiveness, and any measure will be plagued by (self-)belief. Two ways of constructing community councillors' effectiveness were used. *Firstly*, it was assumed that a respondent who has been an office-holder for a long time is an effective community councillor, because ineffective ones would soon be voted out: This is represented by variable T. However, contested community council elections are very rare (Goodlad et al., 1999; Ryan & Cruickshank, 2012, p.5), so it may well be that contests for office-holder roles are equally rare. Also, candidates might be popular but actually very ineffective. *Secondly*, it was assumed that effective community councillors would have few training needs: this is represented by variable U. However, respondents might not know that they are ineffective, or might be aware of their ineffectiveness but unwilling to take on more training.

All possible connections between elements in Figure 2 were translated into 122 testable hypotheses, between:

- all life-role variables, and all IL variables
- all IL variables, and the two versions of effectiveness as a community councillor.
- all life-role variables, and the two versions of effectiveness as a community councillor.

To test hypotheses linking life-roles with IL, variables A to L were entered into regressions as independent variables, with variables M to S as dependent variables. To test hypotheses linking life-roles directly with effectiveness as a community councillor, variables A to L were entered into regressions as independent variables, with variables T and U as dependent variables. To test hypotheses linking IL with effectiveness as a community councillor, variables M to S were entered into regressions as independent variables, with variables T and U as dependent variables.

Few statistically significant connections were found. Those that were found were weak or very weak, with less than 3% variance. Therefore, it was concluded that the model in its entirety was unproven. Translating the SCONUL IL pillars into participant-friendly survey questions may have resulted in vague questions, particularly as the survey was originally designed to gather qualitative data because the researchers did not anticipate so many responses. Also it is likely that there are too many linkages between life experience and effectiveness for them to be easily testable. The statistical analysis did not support the model directly, but it is worthwhile considering the reasons for the failure to prove it, given that the model still appears plausible.

4. Discussion

Studying IL in workplace context requires a holistic approach, understanding workplaces as social constructs (Forster, 2017; Lloyd, 2010, 2017; Tuominen et al., 2005) with a strong social dimension in relation to information sources and interaction (Crawford & Irving, 2009; Bruce et al., 2012). Previous research has foremost applied qualitative approaches, to better understand the complexity of individual and social factors interplaying and affecting WIL. What is less focused, is studying WIL in relation to organisational goals, understanding the impact of IL in the workplace on a larger scale (Williams et al., 2014).

The aim of this paper is to develop the knowledge about IL measures in workplace settings, finding measures to quantitatively study the IL construct, and considering the scope of the practices that can be measured. To reach this aim we have presented examples of how IL has been studied and measured, using quantitative methods, in different organisational contexts. The examples reveal insights on the importance of testing different approaches to measuring the role of IL in connection to organisational outcomes. In the following section we discuss the lessons learned, contributing to the holistic understanding of WIL, its research and practice.

4.1. The WIL construct

When studying a phenomenon using quantitative measures, it is important to clearly define what is being measured. A single definition of WIL is not available and the studies included in this paper have used different constructs. All examples used previously validated IL-definitions, but these definitions were developed further to fit the different contexts. This means that the WIL measures are not exactly comparable – indeed there was no such aim – but they have the common approach of focusing on the role of information-handling skills in relation to work practices and goals.

In the first example (3.1.), a new scale to measure WIL was developed, based on previous work on IL in workplace contexts (Gilbert, 2017; Goldstein & Whitworth, 2015; Lloyd, 2007), as well as on research into organisational learning and into information management (Chiva et al., 2007; Lara & Salas-Vallina, 2017). This was done to also make use of measures similar to IL that were developed in other disciplines, such as business management where efficient use of information and knowledge is an important area of study. The strength of this solution was that the measure was well adjusted to the business context. However, it is less comparable to IL measures that have been validated within higher education and library and information science.

The second example (3.2.) approached IL in combination with DL, with emphasis on DL as a three-dimensional construct of technological, cognitive, and socio-emotional literacies (Ng, 2012). The study focused on differences in the intention to use digital tools between generations in university (Nikou et al., 2018). Therefore it was important to include the concept of DL along with the more general concept of IL. However, this came with the challenge that there is an overlap between IL and DL, leading to difficulties in clearly differentiating the effects of these two literacies.

In the third example (3.3.) the IL variables were derived from the 7-pillar model of IL (SCONUL 2011), a model developed in higher education. Qualitative data were used to develop the conceptual model which was then used to investigate connections between life-roles, IL, and work-effectiveness. The authors believe that the model used is valid, and it was able to support further analysis. However, the absence of clear results shows that the scope of attempted measurement needs to be carefully thought out. This project attempted to measure too much at once, so was not able to collect data that was clear and precise enough to support statistical analysis. This example also showed that educational IL models do not easily translate into workplace studies while the SCONUL model was difficult to adopt in the analysis, and that it seemed that the model would need an 8th pillar in the workplace, around achieving an outcome with the presented information. However, further work is needed to test this claim more rigorously, while there were challenges with the survey design.

To summarize, while there is no single approach to studying WIL, and there is no exact scale for measuring levels of IL in workplace contexts, the data for the different variables were self-reported and depended on participants' own ideas of their ability to gather, evaluate and use information. This means that the surveys did not test, for example, the participants' actual information seeking skills or critical assessment of some particular information. Therefore, the actual IL skills between the respondents might vary, and it is not possible to claim that a particular level of IL skills is directly connected to organisational success. Instead, the survey instruments measured the respondents' awareness of IL, how they valued IL skills, and how they see information and IL as a resource in their work.

4.2. Lessons learned, contributions and limitations

The studies reported in this paper underline **the importance of careful research design that clearly defines the IL construct** used in the study, building on previous IL research, avoiding

an even more fragmented understanding of IL. The studies presented in this paper all included hypothesis-testing, meaning there were theoretically-derived assumptions that there is a relationship between IL, in terms of awareness of IL as described above, and the intention to use technology, the ability to effectively perform different kinds of work tasks or orgainsational activities. Different analytical approaches were used (regression analysis, SEM and fsQCA), showing both strengths and weaknesses in quantitative analysis, and underlining the importance of trying out different methods when developing methodological understanding of complex phenomena such as WIL. Especially **linear analyses have some limitations when looking at a complex construct such as IL.** However, using alternative approaches to quantitative analysis, such as fsQCA, reveals factors affecting IL that have not been predicted on the basis of previous research, thus bringing novel insights to future research.

The main lesson learned is that **WIL *can* be measured using quantitative data, giving an overall understanding about the connection between IL and work activities** that cannot be achieved using only qualitative approaches. Two of the examples clearly showed a relationship between IL and organisational outcome. The studies acknowledge that IL is socially constructed and a way of knowing (Tuominen et al., 2005; Lloyd, 2017), and therefore actual IL skills are not assessed. Instead, knowledge of IL, perceived high IL skills, and an awareness of its importance, are clearly connected to concrete outcomes such as innovation (3.1.) and ability to adopt new technology (3.2.). However, the studies indicated that clearer methods for validating self-reported data are needed. **Furthermore, this paper shows that quantitative IL research validates insights from qualitative research**. This is an important addition to the area of WIL research, where qualitative research focuses on exploring the phenomenon, reaching towards a deeper understanding of how IL skills are developed over time and place (Limberg, 2012; Lloyd, 2017). Quantitative measures can translate these insights to statements and combine them with other variables, such as outcomes (for example, innovation in 3.1. and willingness to use new technology in 3.2.). These results are important also in the process of making IL relevant across disciplines, not only within library and information science (Cheuk, 2017), contributing to fields such as knowledge management, underlining a holistic approach to the knowledge resource. More work is of course still needed, and such statements should be tested in relation to impact in various contexts, to be able to standardise the measurement tool.

One key challenge in the studies reported in this paper, was the fact that IL is a complex construct (Head et al., 2013; Williams et al., 2014). **Quantitative WIL research would probably benefit from a tighter scope, for example, focusing on one aspect of IL** to avoid complex constructs that lead to lengthy surveys. An alternative modelling technique could be to conceptualize the impact of WIL at dimensional instead of aggregate level. Some dimensions of WIL may be more important than others due to the nature of work. To capture such nuances, analysis of direct relationships between WIL dimensions and dependent variables should be considered. However, a tighter scope might have an unintended consequence of limiting the IL measure, and again, making it more context dependent.

Overall, from the lessons learned, it can be concluded **that the benefit from using quantitative WIL measures is that it gives an additional dimension of understanding IL on a larger scale, in combination with outcome factors**. It is clear that WIL is dependent on situation and context (Tuominen et al., 2005; Lloyd, 2017), and that what WIL exactly entails differs from workplace to workplace. Some workplaces require highly technical information skills, whereas other workplaces require more social and communicative information skills. However, the common factor is that the respondents in the three studies were asked to consider their information skills in terms of information acquisition, location, assessment, and use, which was then related to different impact factors, showing that there is a positive relation between a higher awareness of IL and reaching organisational goals. The assumption is that the context does not affect that relation to any large extent. The challenges with quantitative WIL measures are related to finding a clear and commonly accepted definition of WIL, that would clearly be the

basis for the survey construct. In the examples in this paper, the survey instruments were developed using slightly different IL definitions. However, the core of IL is present in all three examples, that is understanding IL as the ability to locate and critically evaluate information for one's work tasks.

Finally, based on the experiences from the studies reported in this paper, we would like to state that **WIL research benefits from a multiple methods design**, combining qualitative, quantitative, and longitudinal approaches. Quantitative scales, based on findings from qualitative research, would benefit from being validated back through qualitative studies, or combined with qualitative measures. Furthermore, although it has been stated that quantitative measures are difficult to transfer across studies, because WIL is situated and contextual, these measures should be tested in multiple organisational contexts, to compare their explanatory strength and versatility. But attempting to apply statistical techniques to data that were not gathered for this form of analysis should be avoided.

5. Conclusions

IL has been identified as central to the development of competitive advantages for firms, workplaces and the knowledge economy (Catts & Lau, 2008; Forster, 2017; Coonan et al., 2018). Still, IL measures suitable for evaluating the role of IL in supporting work activities are lacking. This paper has addressed the importance of developing IL measures that fit workplace contexts, especially for studying the impact of IL on organisational outcomes. Methodological insights from several studies, using quantitative research design, have been presented and discussed, showing that it is possible to assess the impact of IL on innovation, for example, and the intention to use workplace IT. However, the studies also highlight the complexity of studying the impacts of IL, that the constructs of IL include many factors, and that the relation of IL to organisational activities or goals is challenging. This is not least because there are many things that affect both IL and the outcome studied. The importance of using multiple methods is therefore highlighted, as is testing the measures in various organisational contexts. Simply studying only one aspect of IL at a time is a possible solution to this challenge.

Although this paper presents studies that have adopted quantitative approaches to investigating WIL, they are a small number of cases, and so under no circumstances do they fill the current gap of suitable WIL measures. However, these studies constitute an important step towards a more unified understanding of how to study IL in workplace contexts, and in future work these insights could be brought towards bridging IL research with knowledge management research. This is valuable because these two research traditions have much in common, such as emphasizing information and knowledge as resources for individual and organisational achievements. On a practical side, there is still much to be done in the area of developing WIL measures, and in bringing quantitative and qualitative IL research into a tighter dialogue (Lloyd, 2017). Doing so would deepen our understanding of IL as an individual competence learned for example in higher education, and as a socially-constructed and reconstructed competence that is highly context-dependent.

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Appendix, survey instruments (measuring WIL)

Study 3.1.

Information acquisition

1. I can easily get my hands-on right information when needed.
2. When looking for information I can easily identify the right information sources (e.g. company employees, intranet, online sources and clients).

Information evaluation

1. I can spot inaccuracy, errors, etc. in information acquired from different sources.
2. I can determine the reliability of the information.
3. I can identify points of agreement and disagreement among information sources.

Information use

1. I am good at putting information into action (problem solving, informed decisions etc.).
2. I am good at using information for positive changes in work practices.
3. I am good at using information to challenge traditional mindset to see things in different ways.

Awareness of information environment

1. I understand our company's procedures for receiving and sharing information.
2. I know how my company enables employees to get needed information.
3. I understand my team's acceptable ways of information sharing.
4. I am aware of the organization of information in my company.

Learning from information experience

1. I can identify what sources and processes will be helpful for finding and using information in the future.
2. When I find new information, I try to find out how I can use it new ways.
3. I revise my thinking as a result of group discussions or information collected.
4. Information makes me think or act beyond the boundary of my own job.

Information ethics

1. I always pay attention to the information security in our company's print and electronic environments.
2. I obtain, store and disseminate information according to laws and regulations.
3. I understand when to give credit or hide my information sources.

Study 3.2.

Social Norms

1. Most people who are important in my life approve my using of digital technologies
2. Most people who are important in my life think it is desirable that I use digital technologies
3. Most people who are important to me think I should use digital technologies

Self-Efficacy

1. I will be able to achieve most of the goals that I have set for myself by using digital technologies
2. When facing difficult tasks, I am certain that I will accomplish them by using digital technologies
3. In general, I think that I can obtain outcomes that are important to me by using digital technologies
4. I believe I can succeed at most any endeavour to which I set my mind by using digital technologies
5. I will be able to overcome many challenges by using digital technologies successfully
6. I am confident that I can perform effectively on many different tasks by using digital technologies
7. Compared to other people, I can do most tasks very well by using digital technologies
8. Even when things are tough, I can perform quite well by using digital technologies

Dimensions of Digital Literacy (Technical)

1. I know how to solve my own technical (ICT related) problems
2. I can learn new digital technologies easily
3. I keep up with important new digital technologies
4. I know about many different digital technologies.
5. I have the technical skills I need to use digital technologies for working/learning and to create artefacts (e.g. presentations, digital stories, wikis, blogs) that demonstrate my understanding of what I have learnt
6. I have good digital technology skills

Dimensions of Digital Literacy (Cognitive)

1. I am confident with my search and evaluate skills in regards to obtaining information from the Web
2. I am familiar with issues related to web-based activities e.g. cyber safety, search issues, plagiarism

Dimensions of Digital Literacy (Social-Emotional)

1. Digital technology enables me to collaborate better with my peers on project work and other learning activities
2. I frequently obtain help with my university work from my friends over the Internet e.g. through Skype, Facebook, Blogs

Attitudes towards Using Digital Technology

1. I like using digital technologies for working/learning
2. Digital technologies make working/learning more interesting
3. I am more motivated to work/learn with digital technologies
4. Digital technologies enable me to be a self-directed and independent worker/learner

5. There is a lot of potential in the use of mobile technologies (e.g. mobile phones, PDAs, iPods, smartphones etc.) for working/learning

Information Literacy

1. When given a work task, I feel confident determining what information I need to search
2. I am sometimes unsure of how much information I need for solving work related problems
3. I can easily get my hands on right information when needed
4. I understand the organization of information in my workplace
5. When looking for information, I can easily identify the right information sources (e.g. colleagues, intranet/database, clients, and partner organisations)
6. I can determine the authoritativeness, correctness and reliability of the information.
7. I am not confident that the information I get is accurate

Intention to use digital technologies (tools, applications and services)

1. I will not hesitate to use digital technologies to access information
2. I plan to use digital technologies to seek information in the future
3. I intend to use digital technologies to obtain information
4. I am very likely to use digital technologies to gain information
5. I will continue using digital technologies in the future
6. I will recommend my friends to use digital technologies

Study 3.3.

The full survey is too large to reproduce here but is available at https://communityknect.files.wordpress.com/2020/09/2017_03_06-lildem-survey-final-for-posting.pdf

The key questions were:

Independent variables

- Formal education: Q23
- Workplace roles: Q17 (lines 5 and 6)
- Social capital: Q17 (lines 3, 4, 7)
- Background: Q17 (lines 1 and 2)

Constructed variables (workplace roles, social capital and background) combined data from relevant lines in Q17. Formal education [Q23] was used as both an independent and a constructed variable.

IL variables

- Identify/scope: Q3 (line 1)
- Plan: Q3 (line 2)
- Gather: Q4 (line 1)
- Evaluate: Q5
- Manage: Q4 (line 3)
- Present: Q4 (line 4)

Overall IL was calculated as the mean of the above 6 IL variables

Effectiveness

- office-holder: Q15 (column 1: current role)

- self-assessed competence (i.e. not needing various forms of training): Q9, Q10.