

Supporting spreadsheet users in knowledge sharing

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I. MOTIVATION

End-user programmers frequently engage in coding activities for professional purposes, but often lack formal programming education [1]. Developing and acquiring appropriate expertise in the workplace can be challenging, as competing responsibilities and demands can pose barriers to structured learning [2]. In such cases, voluntary knowledge sharing activities from work colleagues, such as providing recommendations, sharing resources, templates, previous worked examples, and answering colleague's help-seeking requests[3], is one of the most common and successful ways through which end-user programmers discover new features, practices, and solutions [4], [5].

While knowledge sharing has clear learning benefits for its recipients, motivating individuals to engage in the process of sharing can be challenging due to limited resources and a lack of motivation. My research, which aims to address these problems, are informed by two existing fields of literature. The first is knowledge management (KM), which provides useful theoretical models of the key psychological motivators and barriers to knowledge sharing activity [6], [7]. Research from this domain demonstrates that a variety of personal (e.g. self-efficacy), social (e.g. reputational gains, relationships between help-givers and -seekers), and organisational factors (e.g. monetary rewards) can influence people's attitudes, intentions, as well as actual knowledge sharing behaviours. This framework offers a theoretical basis for exploring how technology mediates the psychological factors influencing engagement in software-specific knowledge sharing.

The second is the field of software learning, particularly the branch of research which focuses on developing technologies to enhance social learning processes (e.g. by facilitating recommendation interactions, using crowd-sourcing techniques, or supporting help-seeking interactions). One of the primary design challenges is to create systems that equally address the needs of both knowledge 'sharers' and 'recipients'. Some tools focus on sharers by minimising the effort associated with documenting and sharing knowledge (e.g. [8]), while others focus on supporting help-seekers by making other users' knowledge (e.g. feature usage patterns) more visible, or by providing on-demand access to experienced users (e.g. [9], [10]). More recently, however, research from Giannakis et al. [11] suggests that there are greater nuances to knowledge sharers' needs beyond supporting the physical effort and time needed to encode or communicate knowledge to others. In particular, their study revealed that users can be willing to

expend more effort into documenting or sharing knowledge for the purpose of supporting another users' skill development, but retaining control over what information they share, when and how it is shared, and to whom, are nevertheless important user needs. A lack of consideration for these psychological barriers in system designs can lead to uncomfortable experiences in knowledge sharing or engaging with these dedicated systems [11], [12].

The goal of my research is to apply the theoretical foundations of KM to better understand how technological systems could be designed to support knowledge sharers' needs in the process of sharing. The aim is to improve the quality and ease of engagement in the sharing experience. Changes to the modern workplace as a result of COVID-19 means that individuals are now more likely to be remotely located from each other. As such, identifying and addressing the barriers individuals face when engaging in knowledge sharing practices can support users to better learn about implicit know-how, essential practices, and maintain social connections with their community over the course of their professional development.

II. UNDERSTANDING THE BARRIERS TO KNOWLEDGE SHARING FOR SPREADSHEET USERS

We focus on the spreadsheet software to better understand how to design for knowledge sharing in a specific end-user programming context. Spreadsheets are used by millions of users around the world, and can be extremely vulnerable to errors [13]. Thus, supporting users' expertise development in spreadsheet use is crucial. In addition, as spreadsheet work is often highly collaborative [14], there are frequent opportunities for knowledge sharing interactions which makes it suitable for study [15].

I began my research by first exploring and identifying the potential barriers users face when engaging in general spreadsheet collaboration activities, such as sharing spreadsheets and allocating work to other users. Previous research shows that spreadsheet users often discover new features and practices through the natural course of collaboration with other users [5], thus, barriers to engaging in such collaborative activities not only deter opportunities for learning and discovery, but likely also have implications for engagement for intentional knowledge sharing activities as well. To explore this, I conducted a thematic analysis on two sets of interview data, one of which I had previously collected, to explore spreadsheet usage, learning, and collaborative practices for spreadsheet users from different professional domains. We found that spreadsheet users were often inconsistent in their

definition of what constitutes ‘spreadsheet expertise’, often expressing confidence in using spreadsheets in their work, but nevertheless concluding that their overall software proficiency or practices were deficient, or downplaying the validity of their specific spreadsheet practices. This tendency towards negative evaluations of expertise indicates lower self-efficacy - defined as an individual’s belief or cognitive appraisal of their own ability to accomplish a particular outcome [16] - which is typically associated with decreased knowledge sharing intention [17], [18]. We also found that users were reluctant to engage in collaboration due to normative beliefs about when, and with whom, sharing would be most appropriate, a desire to maintain images of independence and individual responsibility over one’s spreadsheet, and concerns of other users’ interference in their spreadsheet. These barriers to sharing and collaboration not only limit opportunities for learning and discovery for recipients, but also related to common barriers in knowledge sharing literature as well.

In order to validate whether the issues identified in the interview study had a measurable impact on intentional knowledge sharing, we mapped the themes from the interview study to established factors in existing theories of knowledge sharing [17], [19]. We then conducted a survey and multiple regressions analysis to explore whether the factors identified in the interview study could be used to measure and knowledge sharing intention specifically in the spreadsheet context (e.g. sharing spreadsheet-related resources, writing spreadsheet documentation). This allowed us to identify five predictor variables: spreadsheet self-efficacy; perceived reputational gains from sharing; effort associated with codifying knowledge for sharing; reliance-based trust in colleagues’ abilities, and disclosure-based trust in colleagues’ reception of potential feedback, challenges, and criticisms.

We found that individuals with higher levels of spreadsheet self-efficacy and perceptions that sharing resulted in reputational gains were also more likely to self-report higher levels of spreadsheet-related knowledge sharing intention, while greater codification knowledge predicted lower sharing intent. We further found that users generally reported high levels of self-efficacy in their ability to use spreadsheets in their work, this did not translate into high self-efficacy when evaluating their overall spreadsheet expertise, and this gap in users’ self-perception of expertise was observed across user groups from different occupations and expected spreadsheet skill levels. We hypothesise that this tendency towards conservative estimations of one’s overall spreadsheet expertise also has a negative impact on knowledge sharing. Overall, this study provides evidence that, much like the physical effort of codifying knowledge, which has previously been identified as a key challenge which spreadsheet authors can face when supporting recipients with comprehension in spreadsheet sharing [20], social incentives - such as concerns relating to one’s image and presentation - as well as personal factors, such as how an individual evaluates their own expertise, can also have a significant role on users’ willingness to engage in any form of sharing practice.

III. FUTURE WORKS

My research thus far has identified how personal, social, and software-related factors manifest and affect sharing intention in a specific context, namely, the spreadsheet software. Following these studies, my plan is to test through experimentation how different aspects of users’ interaction experiences in the spreadsheet may exacerbate the issues identified, and how systems could be designed to support strategies to mitigate these challenges.

One challenge identified from my interview study is that users have very little frame of reference for identifying what constitutes ‘spreadsheet expertise’. Since an individual’s self-efficacy, unlike their self-esteem, is a belief which individuals develop from intentional, cognitive appraisal of their previous experiences [21], [16], interventions could target the appraisal process by supporting positive reflection [22]. One approach is to support users in tracking and framing past successes, which is an important factor in informing self-efficacy, for example, having the spreadsheet interface visually highlight the features which users have successfully applied in the past. Another approach is to reframe people’s understanding of expertise by placing greater emphasis on job-related expertise, which our study suggests people tend to have greater confidence in. User interfaces could label different features according to relevance in a particular task domain, and then visually highlight successfully used features within these task domains in order to accentuate users’ job-related spreadsheet expertise.

While previously, feature usage tracking or alternative task-based interfaces may have been used to improve feature awareness, adoption, and learning (e.g. [23], [24], [10]), my research would compare and evaluate the utility of these designs in promoting beneficial outcomes beyond learning, and whether there are implications of these designs for encouraging knowledge sharing intention. Understanding the contributors to low spreadsheet self-efficacy, and exploring methods to improve this will not only be beneficial for knowledge sharing practices, but is also associated in past literature with desirable spreadsheet use behaviours, such as tinkering and exploratory learning [25].

IV. DISCUSSION

Learning in the workplace can be challenging, so ensuring that users have access to different venues for acquiring knowledge is essential. Through my research, I hope to further our knowledge of how best to support the needs of users we expect to fulfill the roles of knowledge sharers, and to explore how best to translate our theoretical understanding of sharing barriers into practical and effective interventions in the context of spreadsheet users.

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