A Framework of Environmental, Personal, and Behavioral Factors of Adult Learning in Online Communities of Practice

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Abstract

Adult learning is a complex phenomenon that takes place over an adult's lifetime and is not limited to a particular age. It includes a set of activities to enhance life through improving skills, knowledge and capabilities. The foundational theories of adult learning, such as andragogy theory, place the individual adult centre stage and differentiate adult learning from formal learning. They also shift the focus from the individuals to the environment in which adult learning takes place. In line with this movement, online communities of practice (OCOPs) have evolved from being considered as online environments for learning to specialised forums that allow practitioners to collaborate around a project of mutual interest. The principles of adult learning are directly applicable to engagement in OCOPs because they include practical methods founded on the belief that adults are self-directed, autonomous learners and that learning is most effective when the environment plays the role of a facilitator, rather than being just a supportive and traditional setting for learning. However, how individual adults engage in OCOPs and benefit from them is not well understood. This paper draws on social cognitive theory to examine: how environmental, personal and behavioural factors shape engagement in OCOPs. To answer this question, twenty-one interviews were conducted with members of GitHub, a large online community of practice for IT professionals. The findings revealed that adults' engagement in OCOPs involves project-based activities on mutual interests and willingness to help others. The findings also show that engaging in online communities does not only satisfy intrinsic, well-defined, expected outcomes and shape adults' engagement, but also has an impact on adults' lifelong learning achievements, such as professional experience and credit recognition. Based on these findings, a revised framework for adults' engagement in OCOPs is presented and discussed.

Keywords Adults' engagement in online communities of practice · Adult learning · Online communities of practice · Social cognitive theory

1 Introduction

Adult learning is part of a continuous learning practice that takes place over an adult's lifetime and is not limited to a particular age (Cocquyt et al., 2019; Johnson, 2017). Before the Internet and social media, adults could improve their skills and acquire knowledge through books, newspapers, magazines and other traditional face-to-face channels. Yet, social media has changed the ways in which adults share experiential knowledge (Stewart & Abidi, 2017), connecting individuals through an online environment and functioning as knowledge creators and consumers (Guan et al., 2018). Therefore, to some extent, the focus has shifted from individuals to the environment in which adult learning occurs. Within these settings, social media, and specifically, online communities of practice (OCOPs), provide an essential way for adults to acquire knowledge and learn in situations whereby they can apply previous knowledge and experience (Hopstock, 2008; Johnson, 2001).

OCOPs refer to groups of people who engage, learn together and experience a sense of belonging due to mutual interests in an online environment (Grangeia et al., 2019; Kumi & Sabherwal, 2018; Tang & Chung, 2016). Despite

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several advantages of online communities of practice, such as improving access to knowledge exchange (Guan et al., 2018), providing learning materials (Panigrahi et al., 2018) and improving skills, retaining adults' community engagement remains a crucial challenge (Guan et al., 2018) as interest may vary over time (Shapiro et al., 2017).

Extant research already shows the link between engagement and learning outcomes in online environments (Guo, 2018; Kumpas-Lenk et al., 2018; Kurucay & Inan, 2017; Post et al., 2019; Panigrahi et al., 2018; Rajasulochana & Senthil Ganesh, 2019; Sanatkar et al., 2019). However, most research on adults' engagement in online environments concentrates on websites such as Twitter, Facebook and YouTube (Guan et al., 2018). Instead, our study focuses on OCOPs where content generated by individuals is presented as knowledge of common interests. Moreover, existing literature on adult learning primarily focuses on traditional learning contexts and overlooks adults' engagement in online contexts (Klug et al., 2014). Thus, we draw upon social cognitive theory (Bandura, 1986) and the notion of sense of community and social impact theory (Latane & Nida, 1980) to develop a framework for adults' engagement in OCOPs. Our research focuses on the following research questions:

(RQ) How do environmental, personal and behavioural factors shape engagement in online communities of practice?

This paper fills an important gap in the literature by proposing a revised framework for adults' engagement in OCOPS, while also providing useful insights for researchers in this field that could assist in identifying suitable theoretical frameworks for further studies.

The paper is organised as follows: Section 2 presents the research background, Section 3 describes conceptualisation of the study framework, Section 4 presents the research method and Section 5 provides the findings. Section 6 discusses findings and presents the revised conceptual framework of adults' engagement in OCOPs, and Section 7 explains study implications for theory and practice. Lastly, Section 8 presents our conclusion and direction for future studies.

2 Research Background

2.1 Adult Learning

Adult learning is a lifelong process, referring to "all learning engagement activities started after the end of traditional education" (Cocquyt et al., 2019, p. 142). Knowles (1980) initiated an adult learning model called andragogy theory, based on defining characteristics that distinguish mature adults from pre-adult learners through four basic principles: (1) adults must help plan and evaluate their instruction; (2)

experience provides the basis to learn; (3) adults seek to learn subjects with immediate relevance to their job/personal life, and (4) adult learning is problem-centred rather than content-oriented. Two additional principles were suggested by Merriam (2008): (5) adult learners possess powerful internal motivations, and (6) adult learners must have a clear reason to engage in learning. Andragogy is criticised for assuming that all adult learners are autonomous and for ignoring cultural differences, contextual factors and past experiences (Baumgartner et al., 2003). Nevertheless, practitioners who work with adults have applied andragogy's characteristics and translated them into suggestions, learning plans, instructions and evaluations (Merriam, 2008).

2.2 Online Communities of Practice

Communities of practice are informal groups formed by a common practice or interest that collaborate to share ideas, exchange information, seek advice and help each other in a specific domain (Kumi & Sabherwal, 2018; Cho, 2016; Gunawardena et al., 2009; Zhang & Watts, 2003). Online communities of practice (OCOPs) use computer-mediated communication to facilitate interactions among members (Kumi & Sabherwal, 2018). Similar to traditional communities of practice, online communities provide valuable forms of engagement and interaction activities. OCOPs allow members to collaborate and access online resources that may not be available locally (Jesionkowska, 2020). These communities also mitigate barriers of distance, time and member isolation (Jesionkowska, 2020), increasing opportunities for knowledge sharing and engaging in collaborative activities on a sustainable basis (Pesare et al., 2017). According to Sherer et al. (2003), online communities of practice have three main characteristics: (1) involvement requires some knowledge of the domain, (2) members interact and learn together by helping each other and sharing information, and (3) members build a shared collection of online resources such as stories, experiences and ways of addressing recurring problems.

It is important to clarify what is meant by 'learning' in the context of adult learning. The 'learning' in adult learning is not referring simply to training or education. Traditionally, training takes place for the purpose of improving student or employee (Merriam & Caffarella, 1999). The concept of training is rooted in the industrial context when thousands of people had to be trained in mostly routine tasks to meet the needs of the industry. Although there is some shift occurring in the conceptualization of training, the concept remains rooted in its behaviourist beginnings (Senge, 1990) and is more suited to the learning of the repetitive, routine tasks that are associated with static processes rather than learning processes in dynamic environments. The kind of learning required to create an online community of practice is the opposite of the traditional view of training. In online community of practice, members continually

Fig. 1 Model of reciprocal interactions (Schunk & DiBenedetto, 2020)

Personal Processes

Behavioral Processes ⟷ Environmental Processes
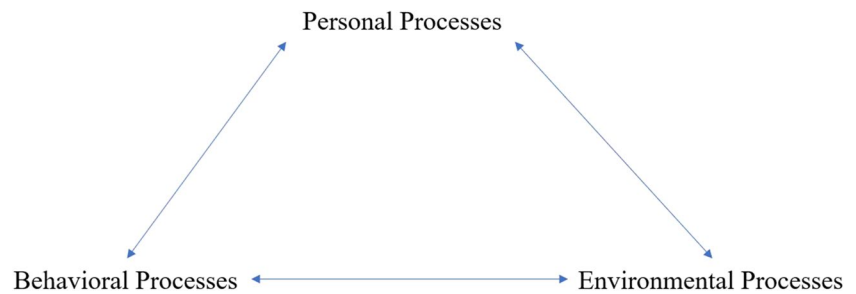
expand their capacity to create the results they truly desire, where new patterns of thinking are created, and where people are continually learning to see the whole together (Gordon, 2021). While bureaucratic models of learning served the needs of the industrial era, they are not suited to modern societies in the digital era when individuals started to engage in learning process based on their needs and at their own pace (Gordon, 2021; Merriam & Caffarella, 1999).

2.3 Theoretical Underpinning

The social cognitive theory (Bandura, 1986) seeks to explain human functioning by emphasising the learning environment's critical role, influence of others, and self-regulation. This theory is broadly applied within learning disciplines (Lowry et al., 2017; Schunk & DiBenedetto, 2020) and other fields such as business, health and education (Erfani et al., 2013; Granziera & Perera, 2019; Plotnikoff et al., 2013). Although different social cognitive theoretical perspectives exist (Schunk & DiBenedetto, 2020), this discussion will focus on the social cognitive theory provided by Wilroy et al. (2018), made up of five constructs: (1) self-regulatory efficacy, (2) social support, (3) outcome expectations, (4) self-regulation and (5) task self-efficacy. Central to social cognitive theory is the reciprocal relations model (Fig. 1), demonstrating that human functioning depends on three interacting sets of factors: environmental, personal and behavioural. Each set affects the others and is, in turn, likewise affected (Schunk & DiBenedetto, 2020). For example, a reciprocal effect exists between self-efficacy (a personal factor) and interest (a behavioural factor) over time (Lent & Brown, 2019). All three factors and their constructs significantly impact our understanding of OCOPs (see Section 3).

Although the social cognitive theory basic principles and definitions aimed to be generic, some improvement may be required for OCOPs. Following social cognitive theory, this study argues that adopting a particular online community is influenced by an individual's developing behaviour and personal factors. Therefore, in this paper we consider that engagement is influenced by social characteristics of the environment, impact from other members, and the sense of community that the individual experiences.

3 Conceptualisation of the Framework

Understanding adult learning engagement through social cognitive theory directly relates to the environmental, personal and behavioural factors described above (Lent & Brown, 2019). These are interactive determinants that influence each other bidirectionally (Wang et al., 2019). Adults' cognitive processes are influenced by their perceived task self-efficacy and outcome expectations, and within the context of environmental factors that subsequently mediate whether and how certain behaviours are exhibited.

3.1 Environmental Factors

We posit that the social impact that community members impose on one another, together with the sense of shared community, are key environmental factors. Social impact refers to an individual's thinking or behaviour reflected in others' actions (Latane & Nida, 1980). Perceived social impact is one main factor behind the social benefit of using OCOPs (Kim & Cho, 2019). The term 'sense of community' has received limited attention in adult learning in OCOPs. According to Kim and Cho (2019), it is a feeling among members that they matter to others in the group. These sentiments are shaped by engaging in OCOPs with shared interests and goals (Abedin et al., 2010). Also, adults' efforts to build a sense of community are essential to ensuring a significant improvement in online communities (Cochran et al., 2016). Abedin et al. (2010) defined sense of community in opposition to a sense of isolation, claiming that awareness of others and sense of cohesion are two underlying dimensions when talking about sense of community in online environments. Moreover, a strong sense of community in online settings is a more important factor for learning achievements and outcomes than seen previously. It is stressed that learners with a strong sense of community are more likely to succeed than those who feel separated from the community (Abedin et al., 2010; Agrawal & Snekkenes, 2017).

3.2 Personal Factors

One personal factor is task self-efficacy. This concerns individuals' confidence in activity engagement (Strachan et al., 2017). Previous research mostly focused on examining self-efficacy in traditional face-to-face settings (Alghamdi et al., 2020). Additionally, little attention is directed to adult learning settings, even though task self-efficacy can explain the nature of the relationship between adults' confidence to perform a task and actual engagement (Wilroy et al., 2018). Adults who have low task self-efficacy believe it is above their capacity and that they lack the necessary skills to accomplish it (Hopstock, 2008). Another personal factor is self-regulatory efficacy, representing the confidence to achieve control over activity participation. This is a critical element for successful OCOP engagement (Lee & Desjardin, 2019). A third personal factor is outcome expectation, referring to beliefs that task accomplishment leads to predicted outcomes (Tsai & Cheng, 2010). Participation in achievement-related and skill-based activity types, such as engaging in a project in OCOPs, primarily depends on one's expectations of success (Schwarzer, 2001).

3.3 Behavioural Factors

The social cognitive theory holds that behavioural factors are influenced and controlled by personal and environmental factors (Zhao & Zhou, 2021). Behavioural factors interact with personal and environmental factors in the bidirectional process, whereby adults learn to repeat beneficial behaviours and avoid harmful ones (Lowry et al., 2017).

One key behavioural factor is social support, the degree to which an individual's essential social needs such as affection, approval and belonging are met through interaction with others (Chen et al., 2020). Social support is significantly correlated with engagement activities across OCOPs

(Jansson et al., 2019), and considered an essential element in learning activities. According to Lin and Bhattacherjee (2009), social support is a significant value that holds an advantage for OCOPs. Though social support research is historically conducted within the context of face-to-face relationships, increasing evidence suggests that individuals use online communities of practice to derive social support comparable to face-to-face settings.

3.4 The Conceptual Framework

Considering the triadic reciprocal model, adults' engagement through OCOPs is an important aspect that represents shifting the focus from individuals to the environment wherein adult learning occurs. Observing how adults engage in OCOPs and factors shaping adults' engagement shows an interplay among environmental, personal and behavioural factors. These communities also increase opportunities for knowledge sharing and engaging in collaborative activities on a sustainable basis. To validate our specific interest in characterising adults' engagement in OCOPs, we highlight that in the literature, several factors are proposed and discussed. Therefore, identified factors from the literature are categorised under three sets to focus on OCOPs, placing emphasis on characterising adult learning and exploring how these factors shape adults' engagement in these communities (Fig. 2).

4 Research Design

There are several methodologies in qualitative research including observations, interviews, and focus groups that may be used to collect data (Rosenthal, 2016). Also previous adult learning research used a variety of methods,

Fig. 2 Social cognitive theory and reciprocal process
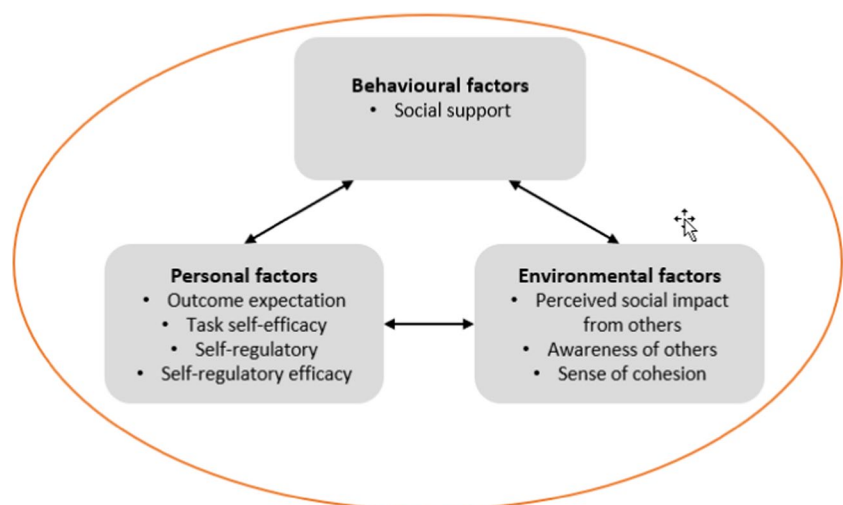
including conducting questionnaires (Rennie & Williams, 2006), case studies (Li & Baker, 2018), surveys (Alhabeeb & Rowley, 2018) and mixed research methods (Yilmaz & Yilmaz, 2019). In-depth interviews involve the posing of open-ended questions and follow-ups designed to obtain an understanding of participants' experiences, perceptions, opinions, feelings, and knowledge.Interview research designed to capture the experiences of respondents (Rosenthal, 2016). Based on our review of literature about justifying sample size of interview participants, we justify sample size through demonstration of saturation within a dataset (Marshall et al., 2013). In this sample size we have assumed that there is a point where data is most often saturated in our study about 20 interviews. Given the exploratory nature of the present study and the need to elicit in-depth knowledge, we conducted qualitative research using interviews for data collection, and analysed the data with the latent semantic analysis (LSA) technique. The strength of a qualitative research methodology using interviews depends on study design quality, including carefully composed research and interview questions, and also rests on the ability to generate new insights and reveal unexpected findings (Broom, 2005).

4.1 Environment Under Study: GitHub

GitHub is a social collaborative coding platform on which software developers not only engage in software development practices, but also share knowledge through comments and notes using GitHub features (Yan et al., 2017). With around 28 million users and 79 million repositories, GitHub integrates several features for collaborative coding (Borges & Tulio Valente, 2018). GitHub's popularity is due to its various features and functionalities available to members (Hu et al., 2018; Li et al., 2017) with which to engage and share past experiences. GitHub not only provides a traceable collaborative project repository, but also acts as an online setting for interested parties, supporting online communities of practice (Zagalsky et al., 2015). Recently, scholars have seen the potential in GitHub's engagement features for improving and perhaps even transforming the online adult learning experience (Zagalsky et al., 2015). We selected GitHub for this study for several reasons. First, it is a highly popular global community for IT professionals. Second, real-world engagement activities and ongoing projects are at the core of GitHub participation (Qi et al., 2017). Third, GitHub offers accessible mechanisms of member communication that are useful in facilitating the interview process (Marlow et al., 2013; Blincoe et al., 2016; Vasilescu et al., 2013).

4.2 Data Collection

A total of twenty-one interviews were conducted with professionals. Research ethics approval was obtained from the University Ethics Committee for this study. GitHub members received an email invitation requesting their study participation. A reminder was distributed two weeks after the initial invitation. Moreover, the research topic and a brief background were announced in a 2018 GitHub community conference in Sydney, with two participants directly recruited from this event. Next, we used a snowball sampling method to recruit more participants (Miller, 2017).

Before taking part in an interview, participants received an introduction to the topic of adults' engagement and a general study description, alongside research background information. Participants provided informed consent prior to being interviewed. The interviews were conducted either face to face (for local members) or online (using Skype or other tools chosen by participants). Some also chose to answer questions in writing. After introductions, interviewees were asked to describe their own GitHub experience. Following this, interviewees could enquire about interview questions, theories and general research topics. They could also share feedback and suggestions concerning the interview process. In the case of email interviews, the researcher sent questions to participants. Compared to those obtained via phone and Skype, email interview responses tended to be better composed and less spontaneous, as interviewees had more time to reflect on their answers (Wu, 2019). To achieve a similar level of data richness, the researcher and interviewees exchanged multiple email messages with follow-up and clarifying questions.

Formulation of the interview questions was guided by the selected theories and corresponding constructs (Appendix Table 1). We examined question validity and readability through a round of seven pilot interviews (five academics and two professionals). Corresponding feedback was applied to create the final study questions.

From June 2017 to January 2019, study participation requests were posted on GitHub education forums, with invitations emailed directly to active members. The researcher was able to recruit twenty-one participants. All participants were male and aged between 18 and 46. Fourteen of them had been members of the community for more than six months, and the rest had been members for more than two years. Of these, ten were interviewed face-to-face or via Skype. The average interview length was approximately 30 min. Interviews were recorded, transcribed automatically (https://transcribe.wreally.com/) and manually reviewed. Some face-to-face interviews were transcribed professionally. In a few cases, follow-up emails were sent requesting clarification or additional details. The remaining interviews were conducted

via email as insisted upon by those participants. Therein, participants provided detailed answers to a list of open-ended questions that the researcher had provided.

4.3 Data Analysis

We used LSA to analyse interview transcripts with the following objectives: (i) qualitatively identify and illustrate the existence of influence in adult learning engagement within OCOPs, and (ii) identify the adults' engagement characteristics. LSA is a computational model of meaning that closely mimics human interpretation of language contextual usage, commonly used for data retrieval, text device comprehension, and applications such as automated essay scoring. Unlike standard keyword-based methods, LSA detects subtle aspects of semantic content (Nicodemus et al., 2014). LSA uses a range of mathematical dimension-reduction techniques to estimate linear combinations of term and concept meanings through its unique ability to reveal conceptual content within unstructured data (Hutchison et al., 2018; Visinescu & Evangelopoulos, 2014). Also, Kwon and Park (2018) mentioned that LSA is widely applicable to extensive analytical scope, including essay grading, text categorisation and, most importantly, theme detection. We used LSA to extract themes from interview transcripts, allowing the researcher to find primary themes using text-mining techniques to ensure all are systematically recognised (Yalcinkaya & Singh, 2015). Key themes are identified for analysis, characterisation, description and labelling, and validated through both the relative strength of each one and resulting coverage of the full text dataset. Themes arose from the data collected about the experiences of engaging OCOPs.

We followed Yalcinkaya and Singh (2015) in undertaking the LSA coding. Firstly, we applied the following text-mining process including tokenisation, stemming, stop word filtering and N-grams:

- Transcripts were tokenised with non-letter separators such that each interview question was aggregated to singular words that transformed the answer into an individual word-bag.
- All the letters in the word-bags were transformed to lowercase.
- Stop words in English such as 'and,' 'the' and 'so' as well as project/company names were pre-defined and removed.
- Word tokens of less than two letters were excluded because they were a grammatical necessity; however, they do not add any meaning.
- Term stemming techniques were applied to the word-bags, whereby variations equivalent to grammatical root words were removed and considered as a simple token. (For example, the words 'collaboration,' 'collaborating' and 'collaborative' were transformed to a single token 'collaborat-'.)

- Lastly, the N-gram model was applied. N-gram is a contiguous sequence of text or speech, which creates word groups that are considered as an individual token in the word-bag. For example, the phrase 'sharing collaborative environments' is aggregated to tokens 'shar-', 'collaborat-' and 'environment-.' This analysis initially performed a three-worded (trigram) and then two-worded (bigram) N-gram analysis.

In the second step, transcripts of raw data were analysed with trigram tokens to derive entities. If the number of tokens discovered through trigram analysis was not sufficient for theme extraction, the results were augmented with additional tokens through bigram analysis. We then sorted the term occurrences in all interview answers in descending order to find the most frequent themes.

To examine the reciprocity of the automatic LSA coding, we selected a set of two interview transcripts and compared the tokens with those generated automatically. The initial Cohen's Kappa value for each category was 0.76, and disagreements were resolved after the same LSA rules were applied (including removing stop words etc.). To further assess analysis validity, a draft report of findings was distributed to other researchers. Their feedback confirmed accurate data interpretation, thus preventing a need to alter themes resulting from the research.

5 Findings

GitHub member responses were selected according to the selection criteria, including at least six months' experience as a member in projects/learning activities and experience in engaging with other members in OCOPs. All research participants were male, which was unplanned and partly related to the demographic makeup of the software development industry and, subsequently, GitHub. Participants were aged 18–46 and hailed from Australia, Canada, China, India, Malaysia, South Africa and the UK.

Social cognitive theory has seen wide applicability within learning, business and health disciplines (Schunk & DiBenedetto, 2020). The theory's predictions have been tested in many studies (Schunk & DiBenedetto, 2020), but this study's discussion centres on the role of adults' engagement in OCOPs. Using social cognitive theory as the theoretical basis of our research, we found and explore factors which presents adults' engagement characteristics and how these factors contribute shaping adults' engagement in online communities.

While prior work has already found a strong link between engagement and learning outcomes in online environments (e.g.Boulton et al., 2018; Guo, 2018; Kumpas-Lenk et al., 2018; Panigrahi et al., 2018; Post et al., 2019), most of the past research was conducted in formal learning settings (e.g. students in higher education, employees' work-related

learning), leaving adults' engagement in OCOPs and its characteristics largely neglected. However, this study addressed this void by characterising adults' engagement in online communities of practice and, more specifically, presenting how these factors shape this engagement.

After analysing themes that emerged from the data, we were able to draw important conclusions on what is the characteristics of adults' engagement in OCOPs and how these factors contribute shaping engagement in OCOPs. These findings enabled us to develop and propose a conceptual framework of adults' engagement in OCOPs. In presenting the findings, we applied emergent themes to each aforementioned construct (see Appendix Table 2 for details), all of which are listed and discussed below according to their respective factor groups (i.e. environmental, personal and behavioural).

5.1 Environmental Factors

5.1.1 Perceived Social Impact from Others

The term "perceived social impact from others" was defined as the effect on an individual's emotions, thoughts, or actions that results from the presence or actions of others, whether real, implied, or imagined.. In addition, findings revealed that perceived social impact from others manifested itself in two forms: (1) perceived social impact from others through engaging in someone's project, and (2) perceived social impact from others in terms of willingness to make an effort and spend time with others in OCOPs.

First, the perceived social impact from others through engaging in someone's project means that online community members are actively influenced by others while working on a project. This is illustrated by a quote from one participant, who stated: *"I need to engage with the person that I'm engaging with [on this project]."* Second, the perceived social impact from others in terms of willingness to make an effort and spend time with others in OCOPs is illustrated by the following participant quote: *"I think that GitHub is all about other members, …. what I have put on GitHub and how much effort I have put on my repos [repository/project]; [and helping others on my free time] I would say [is] a lot."*

In short, these findings reveal the social impact from others occurs through a two-way combination of (1) contribution to project-based activities of mutual interest, and (2) member willingness to help others in their learning process.

5.1.2 Sense of Cohesion and Awareness of Others

The concept of sense of cohesion pertains to an individual's emotional connections with fellow group members, such

as feelings of fondness, concern, and belongingness Most participants believed that there is no strong sense of cohesion and awareness of others between OCOP members. As an example, *"We all can engage for fun once in a while, but you're not going to constantly be there,"* while another stated that the sense of awareness of others was *"not as good as I like it to be, to be honest, mostly because some people abandon their project."* Nevertheless, we detected themes that reveal a sense of cohesion, such as 'caring about code' and 'sense of actual contribution.' These themes reflect that online members actually care about other members through contributions to mutual projects, an important finding that shows how adults engage in reflection through social interaction with others (Nixon & McClay, 2007).

Moreover, results showed that awareness of others in OCOPs was mainly limited to a sense of awareness about the level of other members' contributions to projects. Indeed, little interest was detected for social relationship development between members, as GitHub members do not actively participate in social activities and avoid using personal information due to privacy or security reasons. Listed below are some participant quotes that illustrate this phenomenon:

> "[engagement is] not as good as I would like it to be, mostly because some people abandon their repos/project and never check again for issues/pull requests."
> "I have zero engagement with other members, as I always used GITHUB in private mode but have had some efforts with colleagues on different projects."
> "[Engagement] can be much more efficient in networking and keeping users motivated to check their account regularly."

5.2 Personal Factors

5.2.1 Task Self-efficacy

As anticipated, the themes that arose when participants were questioned about their competence or confidence in carrying out a task were found to be associated with task self-efficacy. For instance, one participant stated, *"I would be confident in performing those same steps to engage with that committer or whatever,"* while another explained, *"I feel well confident, in terms of the fact that I can review Code Changes and Commits as well as having a pipe on Changes to be documented as Change management and Approval process."* And another participant mentioned *"My expectation is that once you are engaged in a project and you are a committer for a project in GitHub, then your task management or your contributions to those projects are generally beneficial rather than people who are going just to make trouble."*

Furthermore, some participants believed that adults who engage in OCOPs have a clear vision and understanding of

how to contribute to a project. We also found that, in general, when adults set their outcome expectations, they tend to increase their contribution towards task completion, thus increasing task self-efficacy.

5.2.2 Self-regulatory Efficacy

Self-regulatory efficacy refers to an individual's level of confidence in their ability to set goals, schedule tasks, and overcome obstacles to participate in an activity. Findings revealed that individual preference for contributing is a critical factor behind engaging in OCOPs. It is important to emphasise here that this belief in self-regulatory efficacy exists in relation to member contribution to common interests.. For instance, one participant mentioned, "*I was working on technical resources like code samples or something like that to help solve a particular problem,*" while another noted, "*We used GitHub to have discussions about projects, solve algorithmic problems, coding problems and even planning projects.*"

5.2.3 Outcome Expectation in Online Communities of Practice

Outcome expectation is the belief that completing a task will result in a specific anticipated outcome. For instance, one participant stated, "*Well, it's been a positive outcome. It's been positive because they've assisted me with problems,*" and another mentioned their outcome expectation as "More to learn, more code quality, and faster doing of large projects." Importantly, findings revealed outcome expectation as a significant contributor to OCOP engagement. Also results showed, that outcome expectation can be divided into two dimensions: personal ("professional experience" and "credit recognition") and community-related expectations ("contribution to a large and interesting project").

5.2.4 Self-regulation

Self-regulation allows adults to set future goals and plan imminent actions and anticipate likely consequences. Related to the self-regulation construct, one participant mentioned: "*I'm going to [engage] with this project to have that kind of opportunity.*" Given the varied participant experiences of engaging in OCOPs, member ability to self-regulate actions might vary from person to person. For example, another participant stated: "*As I choose projects that I really eager to see the outcome I put as much as I can to get the result by engaging [sic].*"

Consistent with the aforementioned self-regulation definition from social cognitive theory, participant responses suggest that self-regulatory abilities are central to controlling personal actions, such as choosing a particular project to contribute to or focusing one's attention on best practice standards that other members provide. This factor is especially prominent when

there is a future goal that directly depends on professional skill improvement. In short, we found that although online members' ability to self-regulate actions might vary, these actions strongly affect, shape and control engagement levels.

5.3 Behavioural Factors

5.3.1 Social Support

Social support refers to the extent to which an individual's fundamental social needs, such as the need for affection, approval, and a sense of belonging, are satisfied through social interactions. Results showed that OCOP contributors are mainly professionals willing to share their skills or provide support to less experienced members. What this could mean is that online members intentionally choose to share their experience to provide social support, or do so whilst seeking a specific outcome. Related to the construct of social support, one participant stated: "*As I like to get results and enjoy my time on a project, I always try to encourage other members by asking their issues or applauding them on their good works. It tries to communicate with other peers [in a friendly way] and encourage them in any situation.*" Social support was also crucial to the following participant: "*[I] usually spend some time to check what happening to other feature branch and activities as a learning resource to see how others' works are going on [sic].*"

Contrary to expectations, we found only one instance that receives a lack of social support: when a member sets a goal he or she is seemingly uninterested in. One plausible explanation is that in OCOPs, the level of contribution to a voluntary project is mostly related to the mutual interests of both parties (i.e. contributor and help seeker) and the contributor's amount of available time. We further illustrate this aspect of the social support factor with the following participant statement:

> "I'm talking about people as well. So maybe you have got two options to say. One is how you are going to engage with GitHub as a tool of collaboration. The second is how you are going to collaborate with people using GitHub. So anything that you think of should be beneficial for us."

Overall, participants believed that members should spend a significant amount of time engaging in OCOPs and, by doing so, provide social support to other members. Also, they reported that it is especially common for more experienced members to ignore simple questions and avoid answering those posed by younger and less experienced members. For example, one participant stated: "*The [dumbest] questions, they're going to get the answer. [….]. They're just going to probably block you. Because they don't want to [answer] you there.*"

We found that, eventually, some of the most experienced members tend to decrease their level of engagement in the

community which, in turn, causes the less experienced members to also reduce their level of engagement due to the lack of social support. These results thus confirm the findings of Jansson et al. (2019), who stated that social support is significantly correlated with engagement activities across OCOPs.

5.3.2 Information Exchange

In order to encourage and facilitate the information exchange process, OCOPs choose to invest in engagement features. Namely, 'engagement features' refers to the use of OCOPs to accomplish activities related to information exchange, such as searching, sharing and publishing experience. Indeed, such communities encourage the sharing of ideas in a free-flowing manner, as well as in the form of structured repositories. One of the participants commented that information exchange activities offer two things: (1) a common understanding of the real-world problem, and (2) an idea of a practical solution in their professional life. For example: "*As I like to get result[s], I always try to encourage other members by asking to share their experience and the issues on their good works.*" Thus, information exchange is not merely a sufficient behavioural factor, but a necessary one that shapes engagement in OCOPs.

However, it is only in an ideal world that members participating in OCOPs are all enthusiastic about information exchange behaviour. The reality is quite different. Namely, there is extensive research that considers the lack of information exchange as a social problem (Matschke et al., 2014). Considering the importance of information exchange, we categorise it as a behavioural factor of engaging in OCOPs and we include it as such in our revised framework.

6 Discussion

One of the main aims of this study was to characterise adults' engagement in OCOPs. Using social cognitive theory as the theoretical basis of our research, we explored factors which shape this engagement and found that environmental, personal and behavioural factors reciprocally shape adults' engagement in online communities.

While prior work has already found a strong link between engagement and learning outcomes in online environments (e.g.Boulton et al., 2018; Guo, 2018; Kumpas-Lenk et al., 2018; Panigrahi et al., 2018; Post et al., 2019), most of the past research was conducted in formal learning settings (e.g. students in higher education, employees' work-related learning), leaving adults' engagement in OCOPs largely neglected. However, this study addressed this void by characterising adults' engagement in online communities of practice and, more specifically, presenting how environmental, personal and behavioural factors shape this engagement.

6.1 Primary Results

Findings of this study contributed to earlier literature (e.g. Figure 1) by showing that characterising adults' engagement in OCOPs provided unique insight into an OCOP's features with an explicit focus on the importance of shifting from individual-centred to environment-centred research. Although, it is widely described in the literature that adults' engagement can shape learning processes through its distinctive project-focused and result-oriented approaches, However, the differences between offline and online adults' engagement have pointed to the necessity of re-examining the meaning of adults' engagement in OCOPs, as well as its components. That is why, based on our findings, we propose and discuss a revised framework for adults' engagement in OCOPs. Namely, as was discussed earlier, this revised framework (see Fig. 3) addresses the various issues identified in the previous research. A significant difference from the earlier findings is that some studies have stressed traditional learning process goals (Galikyan & Admiraal, 2019) and teaching–learning practices (Rubenstein et al., 2018) as essential factors. Our study, however, excludes these two factors and focuses on explaining why focusing on online environments where an engagement takes place is important and how environmental, personal and behavioural factors are essential components that shape adults' engagement in OCOPs.

Environmental factors show that adults experience social impact from others. Namely, we found that members of OCOPs feel a sense of community through the actions associated with achieving expected outcomes, rather than through a feeling or sense of cohesion and awareness of others. This failure to detect a sense of cohesion in OCOPs can be explained by the dynamic nature of adults' lives and the self-directed characteristics of adult learning (Gorges & Kandler, 2012; Pacanowski & Levitsky, 2019). Moreover, instead of caring about individuals, we detected that caring about projects was more prominent. Therefore, these results must be interpreted cautiously, as it is difficult to conclude that one component of adult learning activities increases social support and the perceived social impact from others without directly affecting the sense of community.

Personal factors reflect adults' confidence in taking control over their engagement as members of an online community of practice, whether in terms of contributing to their own projects or to those of other members. For example, the results show that, across online communities, adults with self-efficacy are generally better prepared and likely to be more engaged in all sorts of activities, including contributing to the projects of others. Thus, our results have confirmed that greater engagement enhances adults' contribution as both knowledge producers and knowledge consumers (Guan et al., 2018). Namely, they are knowledge producers through practices such as sharing their own
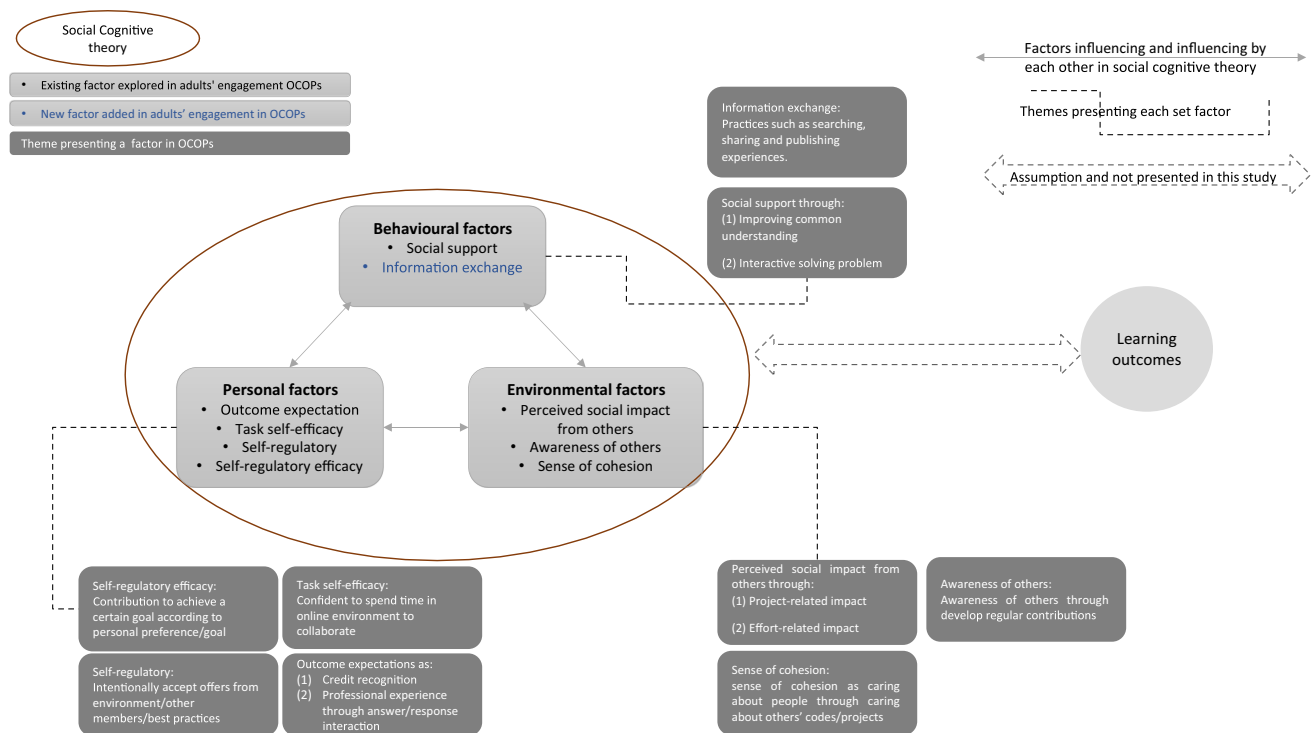
Fig. 3 Adults' engagement in online communities of practice

opinions, while they are knowledge consumers through their engagement as help seekers. Importantly, our results extend the previous research by systematically and empirically demonstrating how personal factors contribute to shaping adults' engagement.

Behavioural factors shape specific actions of adults' engagement in OCOPs (Wang et al., 2019). Our results demonstrate that behavioural factors, which include information exchange and social support, have a significant effect on outcome expectations. These findings are consistent with those of Cocquyt et al. (2019), providing additional evidence in support of the assumption that adults generally expect to use information exchange in OCOPs for the purpose of increasing their skill and competence. Contrary to our expectation, information exchange and social support (see Section 5.3.1) do not have a direct effect on the sense of cohesion and awareness of others. Our findings are, thus, in contrast to some prior studies (e.g. Lin & Chang, 2018), which have shown that a higher level of information exchange practice will enhance interpersonal relationships between members of online communities. One possible explanation may be that adults require common indications to determine whether the other member they are interacting with is trustworthy. Hence, a sense of cohesion and awareness of others may not be developed and, consequently, a shared understanding may not be established.

According to Diep et al. (2017), it is engagement in OCOPs that creates a learning opportunity through interaction with

other members. Indeed, we found that it is exactly this engagement practice that produces learning opportunities among similar-minded adults, potentially leading to a higher level of learning outcomes. Namely, by providing useful information and learning opportunities on various topics, both new and existing learning skills may easily spill over into the busy lives of numerous adults in OCOPs. How engaging in these online communities leads to learning outcomes is best explained by one of our participants: *"Then through that process I've further understood what the library was trying to do and how the library was trying to solve that problem that I'd just solved."* Of course, the volume of learning gains from these interactions depends on the quality of the other members' skills and engagement features provided by OCOPs.

In short, our revised framework shows how environmental, personal and behavioural factors shape engagement in OCOPs, thus providing important guidelines and implications for designing more active and effective OCOPs.

6.2 Theoretical Implications

Social cognitive theory provides the framework for a considerable body of research over the past four decades, producing evidence of mechanisms that support human behaviour change. However, amidst the recent focus shift from individuals to the environment and increased interest in adult learning, it seems appropriate to revisit and refine some

factors of the existing conceptual framework. What follows is a comprehensive description of how this study contributes to the relevant literature.

Firstly, it supports and confirms the importance of three contributing factors (i.e. environmental, personal and behavioural), proposing that the *information exchange* factor be included in the aforementioned framework (see Fig. 3) as a behavioural factor that shapes engagement in OCOPs. Prior studies argued that information exchange allows individuals to leverage the collective wisdom of others, helping them to obtain first-hand insights to improve their knowledge and skills (Lin & Chang, 2018). We therefore argue that information exchange capability is a highly effective type of behavioural factor, as individuals actively exchange information to either discuss interesting topics (Lu & Yang, 2011) or build a social connection with others. Moreover, social support is considered a vital predictor of information exchange practice in adults' engagement (Lee & Jean Yeung, 2019). This is included in our revised framework, because our research confirmed that it can reflect feelings or responses of other members when engaging in OCOPs (i.e. contributing to others' projects), and perceptions of how fast and frequently others contribute with comments or code updates (Eastin & Larose, 2005).

Secondly, the existing literature argues that *outcome expectations* be divided into various types according to environmental settings (Lowry et al., 2017). Reisi et al. (2016) defined outcome expectations as (1) the confidence to overcome barriers, and (2) individual motivation to perform particular behaviours if beneficial consequences are perceived. In addition, our revised framework suggests that information exchange can facilitate an adult's outcome expectations.

Thirdly, *self-efficacy* represents a person's belief in their capability to perform a given activity and improve their personal skills (Beauchamp et al., 2019). According to literature in this field of study, using OCOPs is a useful way for adults to increase self-efficacy (Lent & Brown, 2019). Namely, with enhanced self-efficacy, adults can employ a variety of behaviours to increase lifelong learning achievements (e.g. by using OCOP capabilities, engaging in exciting projects and improving their professional skills). As mentioned above (see Sections 5.2.1 and 5.2.2), in relation to member engagement and mutual interests, we found that the self-regulatory efficacy factor significantly contributes towards achieving outcome expectations.

Fourthly, it is important to emphasise that *information exchange* through member engagement is crucial to growing an online community (Chung & Chen, 2018). Indeed, our revised conceptual framework is based on reciprocal relations of individual factors, largely considering member engagement and a willingness to share information. Furthermore, information exchange practice is mostly facilitated by OCOPs' features such as discussion boards, joint projects and forums. Our current study extends the existing literature by adding the information exchange factor separately in the behavioural factor group. In summary, we found that adults learn from those they interact with and OCOPs grow by participant engagement.

Lastly, perhaps the most significant study implication is that it deepens our understanding of what characterises adults' engagement in OCOPs. Although participants responded with mixed perceptions about their experience in different online communities of practice, their perspectives provided unique insight into features that explicitly and empirically emphasised the importance of shifting from individual member centred to environment-centred research in this field. Moreover, their views revealed the importance of various online setting and OCOP features, including the ways in which adult learning takes place, rules of engagement towards solving problems, special professional needs, reasonable engagement practices, and a sense of community. Regarding the importance of shifting from the individual to the environment, one participant mentioned, "*I usually spend some time to check what happening to other feature branch and activities as a learning resource to see how other's works going on[sic],*" while another stated, "*I know [how much] time it'll take to programme feature[s] and commit to the repository, but this estimate is not true for each time especially when you are working on things which you haven't done before.*" Therefore, our study extends much of the existing literature by focusing on online environment factors along with other factors, and by defining and further clarifying engagement in OCOPs. We in turn argue that it is necessary for future OCOP research to consider experts' responses to define adults' engagement characteristics and their special engagement rules. We contend that this is the most effective way to improve adult learning outcomes.

To summarise theoretical study implications, we suggest that adults' engagement in OCOPs should be considered an adult-centred and community-related activity for promoting information exchange within the various lifestyles and unique circumstances of busy adults. Thus, classifying adult learning as an adult-centred activity and including engagement as a crucial element (Lin & Chang, 2018) supports the existing literature on adult learning while reflecting research participant responses about OCOP engagement features.

6.3 Practical Implications

From a more practical perspective, this study provides several suggestions to enhance adults' engagement in OCOPs. First, our results show that personal, environmental and behavioural factors shape and impact this engagement. Thus, to enhance

adults' engagement perceptions, OCOPs should devise practical strategies to strengthen these factors, for example, by encouraging members to enrich their profiles with their professional backgrounds and experience and to express their personality and qualifications, all for the sake of increasing interpersonal interactions. Second, an online community of practice can improve the compatibility of adults' engagement through various interactive features. These should address all relevant factors that shape adults' engagement in order to encourage two-way engagement between members.

In summary, our paper not only expands the reciprocal process model, but also provides practical implications for OCOPs' practitioners, designers and adults willing to participate effectively in these communities. We summarise the practical finding applications of this paper as follows:

(1) Practitioners should clearly define an online community of practice as a location for information exchange and knowledge transfer through engagement. Also, members should identify and encourage the forms of social support they generally expect from other members to encourage information exchange behaviour in their online communities.

(2) Self-directed learning communities should facilitate member engagement through mechanisms that encourage interactivity between information exchange practitioners, such as commenting, thanking, following, etc. Also, OCOPs should improve community-based member relationships and adult engagement efficiency by facilitating collaboration and cooperation. This work aims to inspire potentially extensive future literature that will use measures of adults' engagement, such as the frequency of engagement practice with others, to explain self-directed learning performance.

A vital contribution of the present study is that it allowed a closer look at adults' engagement characteristics in OCOPs. Building on this study, there are some important directions for future research. We suggest that future studies could empirically test the research propositions derived from our framework to understand better how personal, environmental and behavioural factors shape adults' engagement in OCOPs. Ideally, those studies should rely on experimental research designs (i.e., studies to understand better the mechanisms of shaping adults' engagement) or investigate adults' engagement in OCOPs using other relevant theories.

6.4 Limitations

Although this study has produced several important findings, limitations are also noted. First, findings might be influenced by selection bias, as participants were limited to active GitHub members who had experienced and contributed to a recent project. Members who had ceased using GitHub or experienced other OCOPs might reveal different perspectives. Second, the present work's participants were all male and active GitHub members. Attitudes and beliefs held by participants in the present work may differ from other population subsets. Further studies are required to examine whether results can be generalised to other communities and disaffected participants. Third, although our study suggests that information exchange and social support do not significantly affect the sense of cohesion and awareness of others, other important factors may exist. Fourth, the OCOP environment could be classified into several different types based on applications and technologies, such as specific (e.g. StackOverflow) or general professional interests (e.g. LinkedIn). Given that the study data was collected from one online community of practice, further research is necessary to test the generalisability of results across other OCOPs. Finally, several considerations arise when deciding whether to apply LSA to interview result research. (1) Although LSA requires fewer resources to evaluate text compared to human coding, the research team must still record and transcribe interview answers and format texts for computer analysis. (2) Results interpretation depends on semantic study themes, and so generalisation across studies must be done with caution. This limitation may be obviated by sharing semantic themes across the same studies. (3) In LSA, meaning is derived from the co-occurrence of words in each text, without regard to their order, punctuation or proximity. However, meaning lost by not considering word order may be minimal (Vrana et al., 2018).

7 Conclusion

This study presented a framework for characterising adults' engagement in OCOPs and understanding the factors shaping this engagement. Benefits of doing so are to gain a more reliable picture of how adults interact through an online community of practice and, in turn, to advance our understanding of how OCOPs might be improved for adult learning. To achieve these goals, twenty-one interviews were conducted with members of GitHub, a massive online community of practice for IT professionals. Findings revealed that adults' OCOP engagement involves project-based activities founded on mutual interests and a willingness to help others. Also, our results showed how personal, environmental and behavioural factors shape adults' OCOP engagement. To conclude, this article aimed to expand our knowledge on what shapes adults' engagement and, in particular, highlight the importance of the changing focus from individuals to the environment wherein adult learning occurs. Further research could be used to examine practical steps regarding OCOPs' design to facilitate and encourage adults' engagement in these communities.

Appendix

Table 1 Interview questions

#	Theory	Construct	Description	Interview question
1	Social impact theory	Perceived social impact from others	"defines social impact as any influence on individual feeling, thoughts or behaviour that is exerted by the real, implied, or imagined presence or actions of others. " This reflects situations where beliefs, attributes or behaviours of an individual are influenced by those of others around (Nettle, 1999)	How your activities in GitHub may have been influenced by other members?
2	Social cognitive theory	Self-regulatory efficacy	Self-regulatory efficacy was defined as how confident the individual feels towards setting goals, scheduling and managing barriers to engage in an activity (Wilroy et al., 2018)	How confident are you about setting goals, scheduling and managing barriers to engage in an activity in GitHub?
3		Social support	Social support was defined as how much social support the individual believes friends and family are providing for them (Wilroy et al., 2018)	How much social support are you receiving from your peers in GitHub?
4		Outcome expectations	Outcome expectation was defined as how positive or negative the individual believes the result for engaging in an activity will be (Wilroy et al., 2018)	How positive or negative do you feel the result of engaging with other members in GitHub is?
5		Self-regulatory	It is the level of control the individual exerts through intentions, planning, and goal setting for engaging in an activity (Wilroy et al., 2018)	How much effort do you intentionally make to engage with other members in GitHub?
6		Task self-efficacy	Task self-efficacy is defined as how much confidence the individual has for completing specific tasks associated with engaging in an activity (Wilroy et al., 2018)	How confident do you feel about completing your tasks in GitHub?
7	Sense of community	Sense of cohesion	Sense of cohesion addresses individuals' emotional ties with the group members such as liking, caring, and connectedness (Abedin et al., 2010)	How connected are you with your peers in GitHub in terms of caring about them?
8		Awareness of others	Awareness of others represents an individual's perception of the degree to which he/she is sensitive to the actions created by other individuals in the community (Abedin et al., 2010)	How much you are aware of other member activities in GitHub?
9			Engagement result or outcome	What else would you like to share with us in regards to your engagement with your other members in GitHub?

Table 2 LSA thematic analysis results

Construct	Description	Tokens	Theme(s)
Perceived social impact from others	"Defines social impact as any influence on individual feelings, thoughts or behaviours that is exerted by the real implied, or imagined presence or actions of others." (Nettle, 1999)	"few project actual" "becaus it free" "good for project" "have some project"	Perceived social impact from others through: (1) Project-related impact (2) Effort-related impact
Self-regulatory efficacy	Self-regulatory efficacy was defined as how confident the individual feels towards setting goals, scheduling and managing barriers to engage in an activity (Wilroy et al., 2018)	"allow to share" "ask question most" "contribut code to" "contribut in other" "contribut that way" "contribut to your" "set myself goal" "set of goal" "set up in"	Contribution to achieve a certain goal according to personal preference/goal
Social support	Social support was defined as how much social support the individual believes other members of community are providing for them (Wilroy et al., 2018)	"about your code" "are answer stack" "common languag s" "for solv proble" "learn will happe" "lots of interac" "not their problem"	Social support through (1) improving common understanding (2) Interactive solving problem
outcome expectations	Outcome expectation was defined as how positive or negative the individual believes the result of engaging in an activity will be (Wilroy et al., 2018)	"get straightforward answer" "question and answer" "straightforward answer within"	outcome expectations as (1)credit recognition and (2)professional experience through answer/ response interaction
Self-regulatory	This is the level of control the individual exerts through intentions, planning, and goal setting in engaging in an activity (Wilroy et al., 2018)	"what github offer" "either your profici" "industri accept best" "see somebodi influenti"	Intentionally accept offers from environment/other members/best practices
Task self-efficacy	Task self-efficacy is defined as how much confidence the individual has for completing specific tasks associated with engaging in an activity (Wilroy et al., 2018)	"collabor tool basic" ""climb the ladder" "dont have time" "more time again"	Confident to spend in online environment to collaborate
Sense of cohesion	A sense of cohesion addresses an individual's emotional ties with group members such as liking, caring, and connectedness (Abedin et al., 2010)	"About the code" "don't care about people"	Sense of cohesion as caring about people through caring about others' codes/projects
Awareness of others	Awareness of others represents an individual's perception of the degree to which he/she is sensitive to the actions created by other individuals in the community (Abedin et al., 2010)	"care our develop" "point you build" "sens regular contributor"	Awareness of others through develop regular contributions

Data Availability The data that support the findings of this study are available from the corresponding author upon request.

Declarations

Conflicts of Interest None.

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Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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