Legitimate Peripheral Participation and Value Creation in Online Knowledge Sharing Communities

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Abstract

Online knowledge sharing communities require contributions and active participation to thrive, yet all participation is not equal. Community members well-socialized in the community are more likely to make stronger contributions. In this paper, we theorize about how legitimate peripheral participation of new online knowledge sharing community members can drive different types of contributions and potentially generate value for the community. We conduct an agent-based simulation analysis of different configurations of legitimate peripheral participation to explore our theoretical arguments. We find, in general, that increased requirements for legitimate peripheral participation of new members drive quality contributions and generates value for the community. However, we also find that there is an inflection point where too many such demands may stifle contributions and impede value creation in these communities.

1. Introduction

Online knowledge sharing communities are collective spaces where community members exchange and create knowledge. In such communities, participants focus their interactions on sustaining knowledge flows [12]. Online knowledge sharing communities can take a variety of forms including open problem-solving communities such as Stack Exchange, online encyclopedias such as Wikipedia, open-source software communities, and organization-specific communities such as those associated with knowledge management systems. Regardless of the form of community, the goal inevitably involves creating value for their members by integrating and sharing their knowledge.

However, the mere presence of an online knowledge sharing community does not ensure successful value creation. Different design decisions will increase and decrease the likelihood of quality participation [12,22,24]. Quality participation requires both (1) participation, and (2) quality. The collective knowledge of community members grows overtime because of the exchanges and interactions in the community. Members in online communities dedicate valuable resources to participate. On the other hand, community members who participate a lot may create a tension in the community by excessively influencing the knowledge collaboration process [11]. For example, in Wikipedia, articles may fluctuate in edit wars between members who are driving their own knowledge perspectives [2,17].

Thus, in designing and governing online knowledge sharing communities, it is important to encourage quantity of participation but not at the expense of quality participation. One process that increases the quality of participation is the practice of "legitimate peripheral participation" [4,5]. Communities of practice employ the process of legitimate peripheral participation to enable newcomers to get introduced to community norms and practices before becoming active, full participants [19]. This practice is widespread in many knowledge or craft learning situations, and often involves some sort of master-apprentice arrangements [30]. Online communities too have been conceptualized as communities of practice [4,29]. Prior studies suggest that legitimate peripheral participation is valuable because it enables the transition of newcomers to participants and leverages their valuable contributions during that transition [13,23]. Building on prior work we ask the question: *what is the value of legitimate peripheral participation in online knowledge sharing communities?* We propose here that while legitimate peripheral participation is valuable, designs with stringent requirements for legitimate peripheral participation can stifle knowledge creation.

To explore this question, we adopt an agent-based modeling approach. We inform the model with assumptions associated with the impact of legitimate

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peripheral participation on online knowledge sharing communities throughout the processes of knowledge flow. We find that increasing the requirement for legitimate peripheral participation is associated with increased percentage of quality contributions. However, there is an inflection point beyond which the percentage of quality contributions decrease. We perform several post-hoc analyses and find that percentage of quality contributions increase further when legitimate peripheral participation is coupled with an increased propensity to start new threads rather than building on existing ones.

2. Legitimate Peripheral Participation in Online Knowledge Sharing Communities

The concept of "legitimate peripheral participation" finds its roots in apprenticeship processes [19]. Such processes involve socialization into a community by learning about how work is done by full-fledged and productive members of the community. It is a learning process, whereby a new participant who is outside of the community becomes an insider [4], typically by participating in peripheral but productive tasks that contribute to the overall goal of the community [6]. In order to become an insider in the community, it is not just about understanding explicit rules and canonical information of the community, but also the unspoken, implied, or tacit aspects of what passes for appropriate action. This legitimate peripheral participation process is less about learning objective information, and more about learning how to function within the community [4].

Although the process finds its roots in face-to-face communities of practice, various scholars have applied this notion of legitimate peripheral participation to online communities. For example, Wikipedia, as an online knowledge sharing community, exhibits many of the key aspects of legitimate peripheral participation found in other communities [6,13]. There is mutual engagement among the members, who actively negotiate with each other on aspects of the community, and exhibit a shared repertoire of practices. As members become socialized in online communities their goals change and they take on broader responsibilities. Reading is the key way for members to become socialized in an online knowledge sharing community [1]. Transparency into the practices of other community members is also key to socialization in the community [23].

3. Legitimate Peripheral Participation and Value Creation in Online Knowledge Sharing Communities

According to Antin and Cheshire's study of Wikipedia [1], the process of legitimate peripheral participation in online knowledge communities proceeds as follows. The first step to involvement is reading. The more active the readers, the more likely they will make minor, incremental contributions (such as fixing errors or minor edits). Minor edits increase the likelihood of major edits and new contributions. With more reading, new community members learn more about the community and get invested in the community. As members become socialized in online communities their goals change and they take on broader responsibilities [6].

Initially there is little cost to participating in terms of reading or lurking, but over time this low cost breeds interest which sometimes results in active contribution – a process described as conversion of viewers to contributors [13]. Halfaker and colleagues [13] found that the design of communities can influence conversion. Also, they found that actively soliciting contributions from new participants results in no increase in the likelihood of quality submissions. This indicates that, without adequate socialization of new participants, quality of contributions will suffer.

Legitimate peripheral participation can act as a filtering mechanism. It filters low quality contributions by ensuring members are well qualified to contribute before they do so. This suggests a quantity-quality tradeoff. With increased legitimate peripheral participation, an online community will get fewer contributions but the ones it gets are of a higher quality. The value created by the community depends on such high-quality contributions. On the other hand, any requirements for legitimate peripheral participation reduces volume. If this volume is too low, this can destroy value in the community. At one extreme, if all members participate only peripherally there will not be any created knowledge.

Therefore, in the design of a knowledge sharing community it is important to understand that requirements for legitimate peripheral participation can impact value in the community both positively and negatively and the goal of the paper is to explore this relationship. We start this exploration by proposing the following assumptions we bring to an exploration of the role of legitimate peripheral participation in knowledge sharing communities:

Assumption #1: Requirements for legitimate peripheral participation will reduce the number of contributions.

Assumption #2: Requirements for legitimate peripheral participation will increase the quality of (the fewer) contributions.

Thus, requirements for legitimate peripheral participation conceivably both increase and decrease value in knowledge sharing communities. There will be a tradeoff in designing platforms for knowledge sharing communities, and these tradeoffs will likely involve characteristics of community participants, as well. In this paper, we will explore this tradeoff to gain insight into how encouraging legitimate peripheral participation in online knowledge sharing communities will impact value in communities. To do so, we draw on knowledge sharing processes and agent-based modeling approach.

4. Knowledge Sharing in Online Communities

Knowledge has been viewed as a duality by many researchers [8,14,25]. The duality perspective acknowledges that knowledge has a component that is less tangible and more implicit and social. Tacit knowledge is difficult to represent in knowledge artifacts such as books and articles. It also spans multiple sources and is not represented in a single artifact. Furthermore, tacit knowledge is context specific and difficult to communicate to others.

Under the duality of knowledge perspective, knowledge evolves overtime [18,25]. This evolution follows repetitive phases at different levels. Knowledge can be explicit or tacit. Explicit knowledge is easy to formalize and transfer whereas tacit knowledge is personal, context specific, hard to formalize and difficult to communicate. Knowledge creation is the transformation of tacit knowledge into explicit knowledge. Online communities are a place in which such knowledge transformation happens [12]. Through communication and interaction afforded by the online community platform, the tacit knowledge of individual members is leveraged and (in part) transformed into an explicit knowledge in different forms such as articles in wikis and code in open-source software communities.

In particular, it is important to note that online knowledge sharing communities embody the four knowledge exchange processes that are found in organizations more broadly: internalization, externalization, socialization and combination [11,18].

In the discussion below, we define an online knowledge sharing community as a growing collective of members. Exchanges are modeled in threaded discussions where members contribute posts to threads. Members are characterized with their tacit knowledge and can perform three actions: reading a thread, starting a new thread and posting to an existing thread. Posts have associated explicit knowledge that is in part determined by the tacit knowledge of their contributing members. A thread's explicit knowledge is the aggregation of the explicit knowledge of its posts.

Different processes of knowledge flows in online communities stem from the actions of community members. Internalization is realized by reading existing threads which represents the growing stock of explicit knowledge in the community. This flow depends on members' interpretation and understanding of the explicit knowledge represented in the thread. This knowledge is then refined and incorporated with a member's own tacit knowledge. Wenger [30] refers to this process as "reification" which is a way of making an abstract and concise representation of what is often a complex and frequently messy practice.

The opposite knowledge flow process is externalization, whereby members contribute their understanding to a community, typically through writing. Sometimes, this process is conveyed by other means than writing such as committing code in open-source communities or sharing other artifacts such as designs and music in remixing communities. In some situations, this newly created explicit knowledge must be integrated and combined with existing knowledge in the community. For example, when editing a Wikipedia article, a member must integrate the newly added content with what exists before. This requires additional processes of reconfiguring existing information through sorting, adding, re-categorizing, and re-contextualizing [24]. In other situations, the newly created explicit knowledge stands on its own, for example, when a member creates a brand-new thread. In this case, the process of combination comes later when other members build on this knowledge.

The fourth process, socialization, enables the transfer of tacit knowledge among people without its explicit representation. This process happens in apprentice-mentor interactions where apprentices learn from their mentors not through language but by observation, imitation, and practice [24]. In contrast to craftsmanship, socialization in online communities depends on language, which is the primary and most often the sole medium of communication. Yet, online communities develop their own linguistic norms that enables socialization [12]. For example, members encode their experiences by exploiting language and other means already at hand in the community. Online communities also develop linguistic norms that enables efficient communication of experiences of ways of doing [9,16]. To get acclimatized into the community, new members need to learn how to play the language game which is essential for knowledge creation [3]. Therefore, not only does reading existing threads contribute to expanding the tacit knowledge of members through externalization but also it expands tacit knowledge through socialization and learning the community norms, values and practices.

In summary, legitimate peripheral participation is the process through which newcomers gain experience and become core members in communities of practice. This process relies on newcomer involvement in low-risk tasks and observation of experienced members in order to understand the practices, vocabulary, and organizing principles of the community's practitioners [19]. In online communities, legitimate peripheral participation is achieved by reading other members' contributions and observing the community norms and practices [1]. Legitimate peripheral participation stands in opposition to active participation where members contribute to discussions and the creation of knowledge in online communities. Whereas legitimate peripheral participation is a core characteristic of communities of practice, it is not necessarily the case for online communities. Some online communities operate as network of practice where members interact by exchanging information pertaining to their work [5]. Online communities also make design choices in requiring peripheral participation through building social capital [20]. For example, Stack Exchange uses a reputation system through which members earn reputation by answering and voting on others' questions. Reputation is needed to post new questions. This enforces a degree of peripheral participation on newcomers. In communities where no such rules are implemented, different members can still vary in their propensity of peripheral participation. Some members may shy away from posting and prefer to observe others for a while. Others will want to contribute and participate immediately.

Regardless whether legitimate peripheral participation is a community design decision or a member's personal choice, the process has implications on the collective value creation of the community. The basic trade-off is between the quantity and quality of contributions. Legitimate peripheral participation fosters building the stock of tacit knowledge via socialization and internalization of existing knowledge, norms and practices in the community. On the other hand, time spent observing other members can be put to use by contributing new knowledge to the community. Of course, there is a feedback loop that makes this relationship far from clear. If new members do not build an adequate stock of tacit knowledge, then the explicit knowledge value of their contribution will be low. This will subsequently affect the tacit knowledge of other members, who are internalizing these low-quality contributions. Another indirect consequence of low quality contributions is the decreased welfare of the community. Low quality contributions can either lead other members to leave the community or to kick out the low-quality contributing members by enforcing moderation if available [7]. Because of all of these complex interactions, thinking through the process requires an approach that is well-suited to thinking through complexity – such as agent-based modeling.

5. Modeling Approach

Agent-based modeling is a computational methodology that enables one to model complex systems [26,27]. Agent-based models are composed of interacting agents: computational entities that have properties and rules of behavior [31]. In our context, the agents are members of online communities who have among other properties tacit knowledge. The agents interact and out of this interaction they create and share knowledge. One goal of agent-based modeling is to generate the macro system behavior out of the micro agent behavior. This is done by creating multiple agents and simulate their behavior over multiple time periods.

There are two main ways in which agent-based modeling can be used in human-computer interaction research: First, to advance theories related to multiuser systems and second, to inform the design of these systems as well as interventions, policies, and practices surrounding them. The former corresponds to the use of agent-based modeling to explain mechanisms, processes, or conditions that lead to certain behaviors and the latter corresponds to the use of agent-based modeling to prescribe actions to obtain desired outcomes [26] (p. 398).

In the context of online communities, value creation emerges out of the repeated interactions, contributions and exchanges among members over time [12]. The community-level outcome is determined by the actions and behaviors of members. Yet, members' actions and behaviors are interdependent and are also influenced by the collective welfare of the community. For example, linguistic norms in online communities emerge from early members' interactions but then influence late members norms [9]. Theoretically, there are several processes that lead to knowledge creation in online communities. For example, Nonaka's four processes of internalization, externalization, combination and socialization [12,24]. Because these processes are interdependent and mutually constitutive (e.g. internalized knowledge is externalized and then combined and so forth), the community-level outcome of created knowledge cannot be easily predicted.

We outline below the pseudo-code of the model. We implement this mode using NetLogo [31]. The full source code is available at (people.terry.uga.edu/hanisaf/LPP_HICSS.nlogo). We refer to legitimate peripheral participation as "LPP" in this analysis.

```
For each day
 With probability proportional to community growth
  Add a new member to the community
 For each member
  With probability proportional to LPP
   EITHER Read a thread OR Contribute to a thread

Read a thread
 With probability proportional to reading propensity
  Select a random thread
   T1=Internalize the explicit knowledge of the thread
   Increase the member's tacit knowledge by T1
   T2=Socialize the tacit knowledge of other members
   Increase the member's tacit knowledge by T1

Contribute to a thread
 With probability proportional to contrib. propensity
   EITHER start a thread OR join a thread with
probability proportional to joinORpost propensity

Start a thread
 E=Externalize the member's tacit knowledge
 Set the thread explicit knowledge to E

Join a thread
 Select a random thread
 E1=thread current explicit knowledge
 E2=Externalize the member's tacit knowledge
 E=Combine E1 with E2
 Set the thread explicit knowledge to E
 If E > E1 increase good quality posts

Externalize(tacit)
 Return log(tacit + 1)

Internalize(explicit)
 Return log(explicit + 1)

Combine(explicit_1, explicit_2 … explicit_n)
 Return mean(explicit_1, explicit_2 … explicit_n)

Socialize(tacit_1, tacit_2 … tacit_n)
 Return mean(tacit_1, tacit_2 … tacit_n)
```

5.1 Model Parameters and Transfer Functions

We elaborate here on the model details including transfer functions and other parameters. We validate these choices in the robustness checks section below.

First, we choose a logarithmic function to transfer tacit to explicit knowledge and vice versa. This choice stems from the property of human perception known as the Weber–Fechner law which states that perceived intensity is proportional to physical stimuli on a logarithmic scale [28]. Recently, this property has been extended to other cognitive functions and a neurological basis of it was discovered [10].

Second, we choose a linear scale when combining explicit knowledge and also when integrating tacit knowledge (in the socialize process). Because these combinations occur in the same domain (i.e. mental for tacit and physical for explicit knowledge), we have no reason to use a logarithmic function. However, we assume here the knowledge is additive and we use the average function. This allows the explicit knowledge of a thread to increase when a new post that carries a higher value is contributed or decrease when the post contains a lower value. This process allows for mimicking the remixing effect in online communities.

Third, we think of LPP as a design choice parameters that a community may employ to enforce members' behavior. We further assume members vary in their propensities to perform the three actions of reading, starting a thread and joining a thread. For example, Stack Exchange's reputation system forces members to contribute a minimum number of posts before enabling them to start a thread. Other communities bestow privileges based on tenure. However, even when a member can perform a certain action, s/he may or may not want to perform it. For example, a reputable member on Stack Exchange who is an expert in one domain may not participate new questions but rather answer other members. An introvert member will be reading much more than posting. Modeling LPP independent of members' behaviors allows us to accommodate variability of members' behaviors and also understand how such behaviors and community design decisions interact.

We model members' propensities to perform the three actions with three variables: reading propensity, contributing propensity and start/join thread propensity. We consider the two actions of starting a thread or joining a thread to be two instances of contribution because they both involve creating a new post (i.e. either in a new thread or an existing one). When contributing, the third variable (start/join thread propensity) determines whether the contribution is to a new thread or an existing one. Every day (i.e. time step in the simulation), all members will be asked to either read or contribute depending on the value of LPP. Every member will respond differently depending on his/her values of the three propensity variables. These values are initialized randomly from a Gamma distribution $\Gamma(\alpha, 100/\alpha)$. This distribution is selected to have same population mean but different shapes. This ensures that in the resulting communities will have the same overall propensities but with different distributions over members.

We vary the shape and scale with five configurations of α that all have the same mean (Figure 1). Increasing α results with more members having higher propensities than others'. A low α results in a more uniform distribution of the propensity parameter.

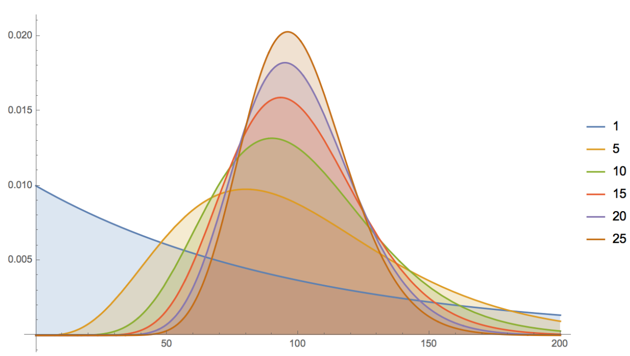

Figure 1: Five configurations and associated distributions of propensity variables

6. Results

We simulate the model using NetLogo BehaviorSpace. We vary the propensity of legitimate peripheral participation (LPP) from 10% to 90% with 10% increments. This results in 9 configurations. We run the simulation 10 times per configuration which results in 90 runs. Each run goes for 1000 time steps. Each time step represents a day. Therefore, each run simulates a growing online community for three years, which is an adequate duration for the growth of knowledge sharing communities [16]. As outcomes, we examine the total number of posts (TP) contributed by members, the total number of good quality posts (TGP) and the percentage of good quality posts (PGP=100*TGP/TP). Figures 2, 3 and 4 plot these three outcomes respectively.

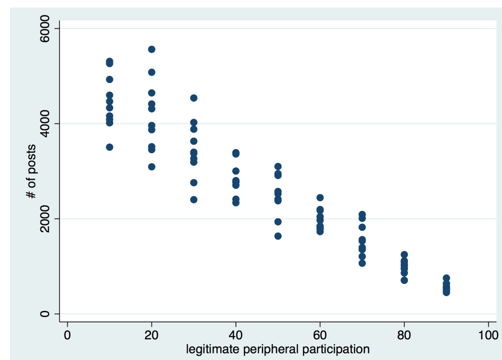

Figure 2: Legitimate peripheral participation propensity and the number of posts in the simulated communities

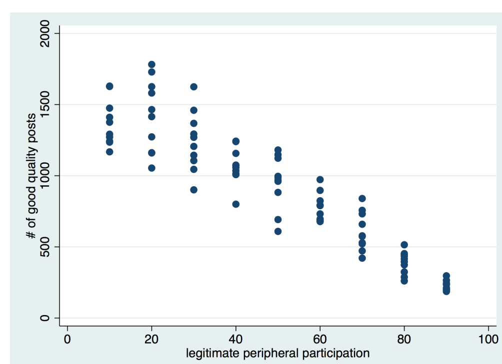

Figure 3: Legitimate peripheral participation propensity and the number of good quality posts in the simulated communities

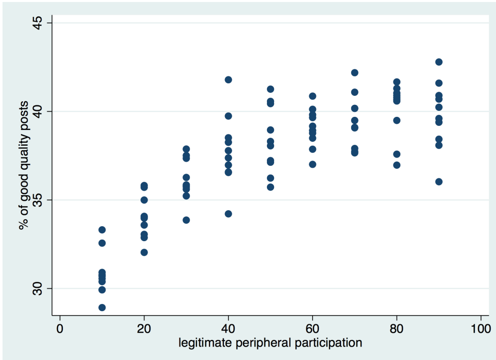

Figure 4: Legitimate peripheral participation propensity and the percentage of good quality posts in the simulated communities

From a quantity perspective, increased LPP is associated with decreased contributions including both the total number of posts and the number of good posts. This result is expected because LPP is associated with favoring reading over contributing. However, interestingly, the total participation (TP) and total good posts (TGP) have different rates of decline with LPP. From a quality perspective, the relationship between LPP and TGP is not linear as Figure 4 shows. Visually, the scatter plot hints to a quadratic relationship. To confirm this interpretation, we run two regression models with linear and quadratic specifications. The results in Table 1 clearly show the quadratic specification to have a superior fit. The fit equation $PGP=0.303*LPP-0.002*LPP^2$ is maximized at LPP=76. This means that increasing LPP is associated with better quality up until 76%. Increasing it any further results in declining quality.

Table 1: Results of regressing the percentage of good quality posts on legitimate peripheral participation (1) and its squared value (2)

	(1)	(2)
LPP	0.104***	0.303***
	(0.008)	(0.029)
LPP^2		-0.002***
		(0.000)
Constant	32.099***	28.451***
	(0.446)	(0.624)
N	90	90
RMSE	1.940	1.551
R^2	0.660	0.785
R^2 adjusted	0.656	0.780
F	171.031	159.127

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

6.1 Robustness checks

We validate the results in a larger sample of communities by varying the propensity α which results in different distributions of members' propensity to read and contribute to new and existing threads. For each distribution, we vary α from 1 to 25 with 5 steps. This results in 11250 configurations (5×5×5×90).

The regression results (1 & 2) in Table 2 validate the prior results. Both the effects size and their statistical significant are in line with the prior results, which indicates the model is robust to the value of the chosen parameters.

Furthermore, we now examine the interaction effect between the propensity parameters and LPP. Increasing the propensity α parameter results in a community where some members have much higher propensities than others (more variance). The results of model 3 (main effects) indicate that the three actions are equally associated with the dependent variable: quality (note again that the contributing propensity α leads to either starting or joining). On the other hand, only start/join thread propensity α has a positive interaction with LPP. Reading propensity α has a marginally significant and small interaction effect.

This suggests that increased peripheral participation works better when members tend to create new threads because they will have a better chance of creating good quality threads increasing their overall ratio (i.e. the dependent variable).

7. Discussion and Conclusion

In this paper, we developed an agent based model to investigate the impact of legitimate peripheral participation on both the quantity and quality of participation. Although we did find what we expected – that legitimate peripheral participation influences both quantity and quality, our analysis clearly indicates an inflection point. Beyond a certain point, online knowledge sharing communities with stringent requirements for legitimate peripheral participation may eventually begin hurting both the quality and quantity contributions. This is because of the complex feedback cycle involving fewer exemplar contributions that are examples for subsequent participants as well as base contributions that would require further elaboration. It takes contribution to drive subsequent contribution.

In addition, while the three actions of reading, starting and joining threads are valuable to generate quality posts, the requirement of legitimate peripheral participation yields better outcomes when coupled with an increased propensity to start new threads. The tacit knowledge gained with peripheral participation is better put to use in creating new discussions rather than elaborating on existing ones.

Table 2: Results of robustness checks (1 & 2) and moderation effects (3 & 4)

	(1)	(2)	(3)	(4)
LPP	.108***	.301***	.301***	.294***
	(.001)	(.006)	(.005)	(.005)
LPP^2		-.002***	-.002***	-.002***
		(.000)	(.000)	(.000)
Reading propensity α			.212***	.226***
			(.004)	(.008)
Contributing propensity α			.034***	.033***
			(.004)	(.006)
Start/join thread propensity α			.212***	.166***
			(.004)	(.008)
LPP × Reading propensity α				-.0003+
				(.000)
LPP × Contributing propensity α				.000
				(.000)
LPP × Start/join thread propensity α				.001***
				(.000)
Const.	34.8***	31.3***	26.3***	26.6***
	(0.076)	(0.128)	(0.125)	(0.176)
N	11250	11250	11250	11250
RMSE	3.721	3.545	2.834	2.828
R^2	0.361	0.420	0.629	0.631
R^2 adj.	0.361	0.420	0.629	0.630
F	6342	4065	3817	2400

Standard errors in parentheses
+ <0.1, * p<0.05, ** p<0.01, *** p<0.001

This research has implications for the design of online knowledge sharing communities. For example, organizations typically have problems with the quality of contributions for their online knowledge sharing communities [15,21]. Encouraging legitimate peripheral participation through some sort of reading and mentoring program would work to involve and socialize new members in the community – to drive their investment in the community. However, it is critical that this required activity avoid being too onerous.

Further, for existing and active communities it is critical to keep them in control. Online knowledge sharing communities that have enjoyed some success must encourage socialization through processes such as legitimate peripheral participation to maintain a high percentage of quality posts. As our analysis indicates, low quality posts can have detrimental effects on the community. Faraj et al. describe this as domestication of the community [12]. After an initial period of growth where a community is well-seeded, it is important to be sure that contributions remain high quality from new participants. There are a variety of tactics for implementing legitimate peripheral participation in online knowledge sharing communities. For example, Wikipedia requires that new contributors review a significant number of materials and strongly encourages them to edit existing articles before attempting to generate new ones. Further, there is a quality control function in the community whereby well-established members assess and approve some contributions. In other contexts, such as corporate knowledge management systems, where there is often significant problems getting participation of any sort [22], complementary practices would be in order. Such complementary practices include status markers such as badges and ratings, as well as various seeding strategies to build critical mass of content in the community [20].

Finally, as with all complex models, agent based modeling is a thought amplifier – enabling researchers to explore the ramifications of their assumptions in complex scenarios. Future research will involve validating these insights with empirical data.

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