Interactions and Innovation in Educational On-line Communities

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Abstract: Participating in on-line social networks gives people the opportunity to collaborate with others regardless of geographic locale. Social networks were initially developed with entertainment in mind, as opposed to collaboration and productivity. The research team developed a social network for the purpose of collaboration and productivity. After the social network (3Helix.org) was created, the researchers studied the groups, value, gender, trust, and innovations that developed in the on-line community.

Introduction

Social networks give individuals the opportunity to bridge gaps between physical locations, disciplines, and organizations (Granovetter, 1973). Therefore, social networks offer affordances to those with communities. Since society is built around relationships, the behavior of people can only be understood in context with the behaviors and actions of others (Granovetter, 1973). The Internet brought new possibilities for social networks, as on-line communities gave people a new modality in which they could collaborate and socialize.

On-line social networks allow people to "(1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system." (boyd and Ellison, 2007). Many on-line social networking sites were originally developed with entertainment as the primary goal. Due to its popularity and extensive reach, many researchers from both academia and industry are interested in their affordances and possibilities (boyd and Ellison, 2007; Hoover and Foley, 2009). Since many social networking sites offer collaboration tools such as messaging, wikis, blogs, profiles, and continuous updates, users from various fields are able to utilize them to solve complex problems (Greve and Salaff, 2001). Thus, social networking tools and platforms present an opportunity for distributed knowledge creation.

Even though several collaboration tools are available for social network users, many people join social networks for a variety of reasons. Individuals typically join social networks for information, social support, friendship, and recreation (Ridings and Gefen, 2004). Even though they join on-line communities for these reasons, Baym (2004) speculated that approximately 90% of users are lurkers, as they only read content, but do

not contribute. Therefore, many people only create bridging ties that are typically information driven (Ellison, 2007). Those that participate can create bonding ties that are emotionally close relationships.

Social Networks in Higher Education

Many higher education students participate in social networks throughout their educational endeavors. Recently, higher education researchers conducted studies on a variety of areas including cultural differences (Hendrickson, Rosen, & Aune, 2011; Rienties, Héliot, & Jindal-Snape, 2013), educational engagement (Lu & Churchill, 2014; Xie, Yu, & Bradshaw, 2014), and achievement (Il-Hyun, Kang, & Meehyun, 2014; Romero, López, Luna, & Ventura, 2013). Hendrickson et al. (2011) studied connectedness of international students' to co-national and host-national students. In their study, international students had a higher connectedness to host-national students. They posited that this connection may have been based on their participants' comprehensive amount of friends. Rienties et al. (2013) researched the difference between international and host students' social networks in a large class setting based on cultural background. Their findings differed from Hendrickson et al.'s findings, as students from large cultural groups formed close networks with co-national students. However, those from smaller national groupings integrated with both the host-group and students from other countries. They further suggested that class size may have had an impact on the findings, as Hendrickson et al.'s study used a medium class size, while Rienties et al. used a large (207 students) class.

Recent research on engagement includes Xie and Bradshaw's (2014) study of formal role assignments in on-line courses. They assigned students the official role of moderator for discussion groups, as opposed to allowing natural roles to emerge. When formal leadership roles were assigned, moderators began improving their communication and participation in classes by posting more frequently, staying on-line for longer durations of time, and interacted more diversely with students. These improved communication practices also increased student communication to the moderators. Lu and Churchill (2014) took a slightly different approach, as they closely followed 13 undergraduate students in an on-line class. The researchers found student communication to be "short-lived, individual-centered, and casual" (p. 1). In many cases, conversations ended when the content stopped being focused on the original author. Messages in this environment were typically short, casual, and rarely focused on course content. Based on their social network, social engagement increased, while cognitive engagement did not improve.

Even though Lu and Churchill were not able to demonstrate a greater degree of cognitive engagement, increased achievement is possible when social networks are used in classes. Il-Hyun et al. (2014) studied 63 undergraduates in an educational technology course, where those with a high level of social network competence were better able to participate on-line, which was correlated with higher learning outcomes. They also confirmed the importance of trust, as it facilitated knowledge sharing as shown in Social Capital Theory (Il-Hyun et al., (2014); Misztal, 2001; Nahapiet & Goshal, 1998; Wasko & Faraj, 2005). Romero et al. (2013) also studied student achievement in an introductory

computer science course, where those who had high levels of activity in their on-line forums, both in quantity and quality, were more likely to pass the course. Those who did not pass the course typically had the lowest levels of participation in the forum.

Even though higher education social networks have been studied, the researchers were interested in studying several areas together, such as the formation of on-line communities, interactions, trust, and innovations amongst students. The research team created their own social network for the study to ensure nodes, contacts, and survey data could be matched to users. For the study, the term *innovation* refers to a new idea or concept developed in the 3Helix.org community.

The researchers posed the following questions:

1. What types of groups naturally emerged within the on-line community based on nodal contact?
2. How was the perceived valuation of the 3Helix.org on-line community correlated with the amount of time spent performing activities on-line?
3. How did perceived gender impact interaction in the 3Helix.org on-line community?
4. How was trust related with nodal contacts on the on-line community?
5. How was trust related with total number of innovations developed based on participation in the on-line community?

Methods

The study was completed in four phases: Phase 1 - Building the on-line community, Phase 2- Data collection tools and procedures, Phase 3 – Participant Recruitment, and Phase 4 - Analysis.

Phase 1: Building the On-line Community

The 3Helix.org on-line community was built by a team of graduate research assistants using the Ruby on Rails web framework. The research assistants did not create the entire code base from scratch, as the Prometheus codebase was used as the basis for the web framework. The Prometheus codebase was a port of the disCourse and HNLC.org codebase to Ruby on Rails by Joseph, that was written in PHP/MySQL (Suthers, Chu, and Joseph, 2008). The general framework included features for collaboration and community. However, access to these features was limited to registered users. Users who were not registered for 3Helix.org could access stories and the public resources database. Stories were news posts (similar to blog posts) that were posted to the homepage by the site administrator. The public resources database included files that participants posted to the resources database. Both the stories and the resource database were publicly available and searchable.

Members of the 3Helix.org on-line community were able to access many more tools once they logged in to the site (see Figure 1). Members who logged in to the on-line community could access profiles, discussions, wikis, private messages, and workspaces.

Profiles included additional information, such as, e-mail address, telephone number, interests, and recent activities of each member. Therefore, viewing a profile could identify whether the member is currently active or not. Discussions were Web-based threaded forums and were available for all members to view. Individuals did not need to be invited to discussions to participate or to view the content. Private messages were available to all members and allowed participants to converse with other members of the on-line community without the message being available publicly. Workspaces included a main wiki page, discussions, and resources. Members became a participant of a workspace by invitation or by requesting an invitation. Workspace members had the ability to edit the main wiki page, reply to discussions, and upload resources while non-members could not edit the wiki page or resources.

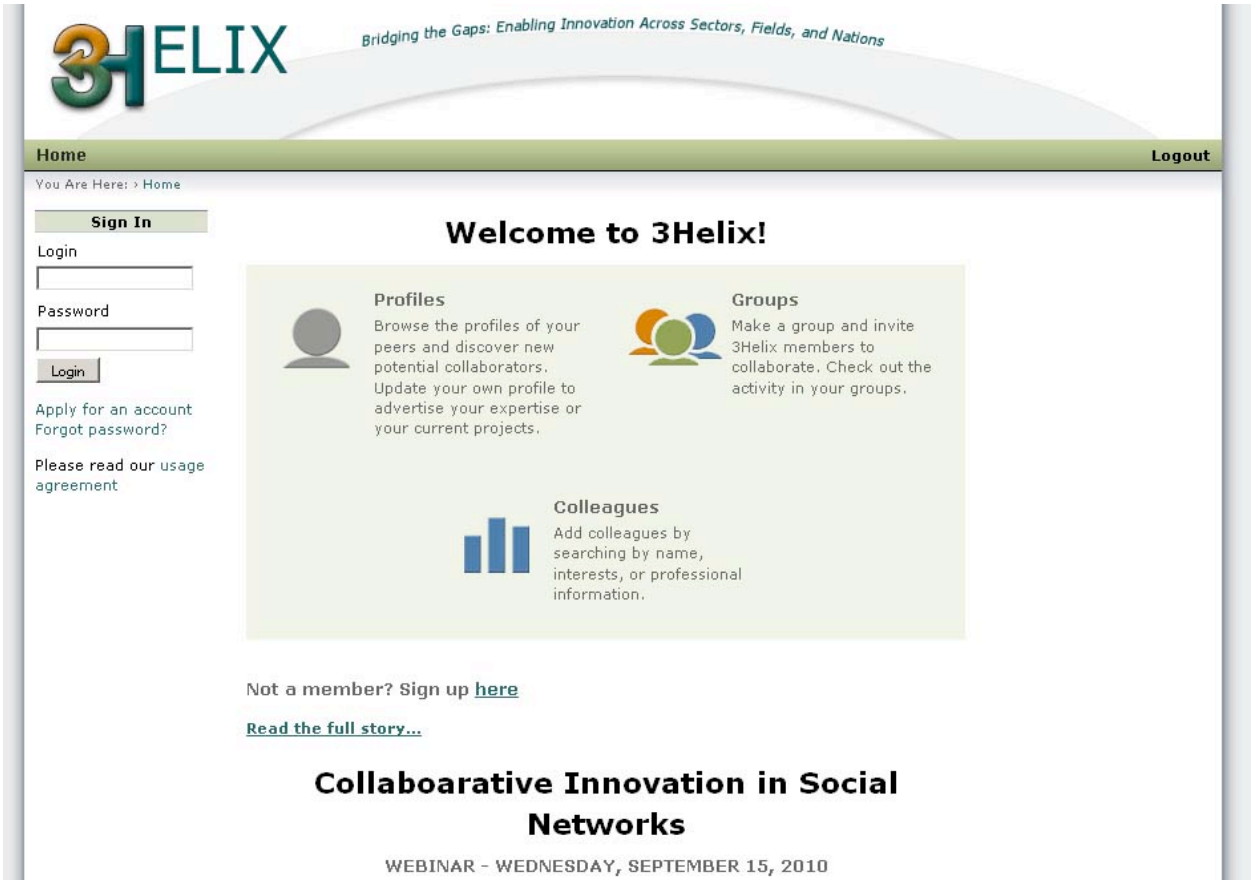

Figure 1. 3Helix.org home page.

Phase 2 - Data Collection Tools and Procedures

After the 3Helix.org community was created, the researchers developed the assessment instruments and procedures. The assessment instruments included two components: 1) actions for each member were collected and stored on the 3Helix.org server and 2) surveys were developed. There were three surveys: 1) an initial, 2) periodic, and 3) final survey. The initial survey focused on the demographics of the participants. The periodic survey included the benefits of 3Helix.org, time spent, innovations developed, and contacts with other members. The final survey included questions about trust, multiple aspects of value, attitude towards the on-line community, participation, and ease of use.

The initial survey was given upon joining the 3Helix.org on-line community, the periodic survey was given after one month in the community, and the final survey was given two weeks after the periodic survey. After the data collection tools and surveys were prepared, the research team invited select individuals to participate in the study.

Phase 3 - Participants

After the data collection tools and procedures were developed, the research team invited undergraduate students to join the 3Helix.org community because social network sites are seen as a vital resource for them (Bigge, 2006). A majority of the participants were enrolled in an introductory computer science course, which implemented the 3Helix.org on-line community as a part of the course structure. The researchers, instructors and teaching assistants of the course collaborated to collect feedback and develop the implementation.

All students, enrolled in the introductory computer science course in the fall 2009 and spring 2010 semesters, were offered the opportunity to participate in the study for extra credit. Those who chose not to participate in the study were offered an alternative method to attain extra credit. Although 729 students participated in the study; only 258 completed all aspects of the study and could be used for the data analysis.

The participants ranged in age from 18 to 66 years old, had a variety of experiences with technology and came from 67 different majors (see Figure 2).

Phase 4 - Analysis

Data from the SQL database were analyzed using UCInet for social node analysis. Self-report questionnaires were matched to the SQL database. Actions and self-report questionnaires were analyzed using the SPSS software tool for statistical analysis.

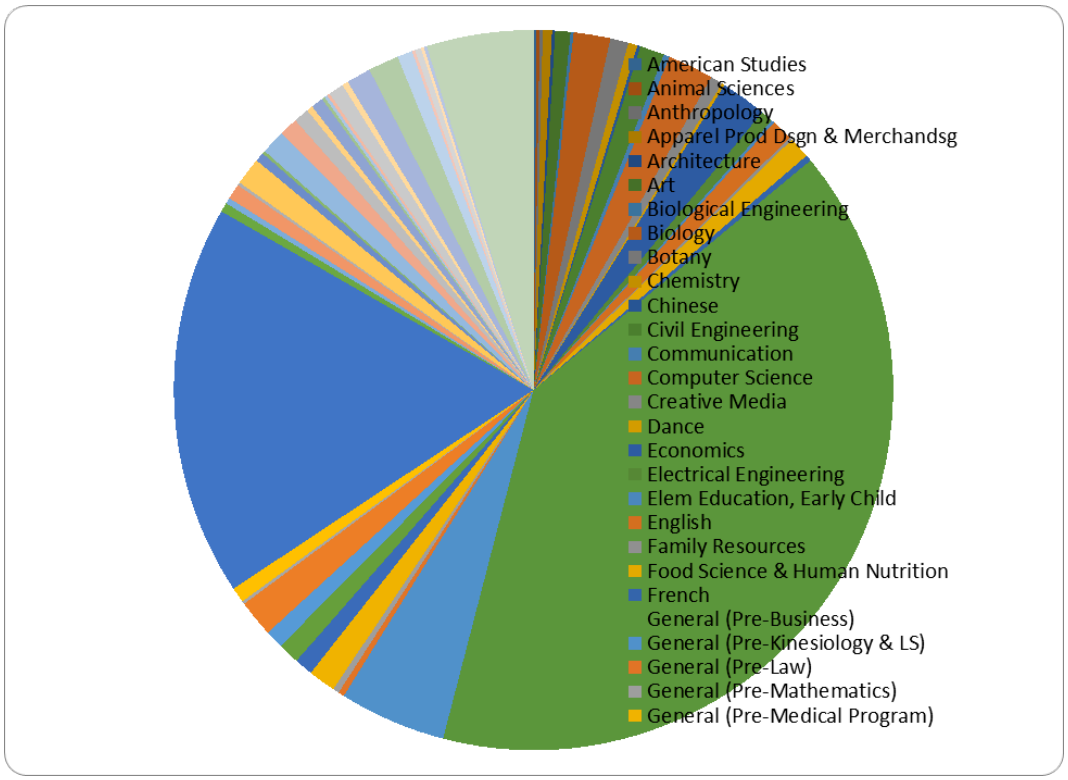

Figure 2. Pie chart with the different university participant majors.

Results

RQ1: What types of groups naturally emerged within the on-line community based on nodal contact?

The research team used a cluster analysis in UCInet to determine the different types of cluster groups that naturally emerged within the 3Helix.org on-line community. Interestingly, eight subgroups naturally clustered based on nodal contact (see Figure 3). The groups varied in participation amounts from being highly participatory to being on the periphery. The size of each node in figure 3 indicates how many other members each participant was linked to based on communication. For example, two nodes are linked together if one participant responds to a post of another participant. Nodes also appear larger as the number of connections to each node has increased. Each of the numbers next to each group indicates the semester which the university students participated in the 3Helix.org on-line community. ICS 1 members particiapted in the fall 2009 semester, while ICS 2 members participated in the spring 2010 semester. ICS 1/2 groups included participants from both semesters. Lastly, Knoweldge Clusters refers to professional participants that did not complete the study. Therefore, data for them was not available for RQ2 through RQ5.

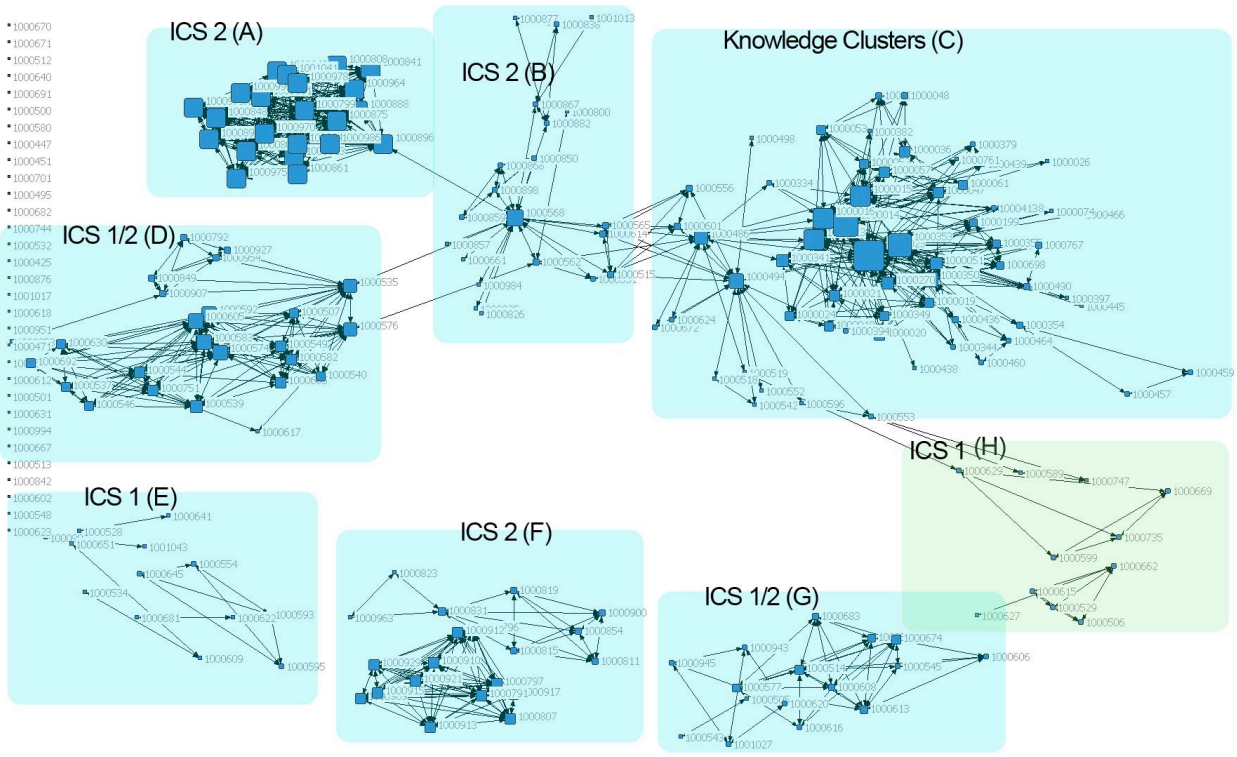

Figure 3. Cluster groups in the 3Helix.org on-line community.

The first group, ICS 2 (A), was highly participatory in nature, as many of the students had nodal contact with one another. The students in this group appeared to have a similar amount of nodal contacts on-line with each other during the semester.

The second type of group that emerged was core periphery. ICS 2 (B) and Knowledge Clusters (C), were core periphery, as many participants were linked to one or a few members. It appears that one member of the ICS 2 (B) group contacted or was contacted by many other members. Knowledge Clusters (C) included a few key members that had nodal contact with many other members of the group. Therefore, Knowledge Clusters (C) was also considered core periphery.

The third type of group that emerged was a mix between highly participatory and distributed. Both ICS 1/2 (D) and ICS 2 (F) were a part of this cluster grouping. It was interesting to note that even though ICS 1/2 (D) included students from the fall 2009 and spring 2010 semester and ICS 2 (F) only included students from the spring 2010 semester, similar structures emerged for both groups.

The fourth type of group that emerged was distributed in nature. Groups ICS 1 (E), ICS 1/2 (G), and ICS 1 (H) were all distributed. These groups were classified as distributed, as their nodal contacts were dispersed and did not include members with a high level of participation.

Overall, four distinct group structures emerged within the 3Helix.org on-line community. Even though similar instructions were given, students naturally created their own structure to participate on-line.

RQ2: How was the perceived valuation of the 3Helix.org on-line community correlated with the amount of time spent performing activities on-line?

To determine how each member's valuation of the 3Helix.org on-line community and the time spent performing activities on-line, the researchers calculated the overall value of each member based on the composite value of the three questions on the survey that indicated how much each member valued the on-line community. Next, the researchers correlated the value for each member with the amount of time that each member indicated that they spent on the on-line community and the total number of actions. Both the perceived time spent and the total number of actions were used, as perceived time spent and actual time spent were different.

Both total number of actions and perceived time spent on the on-line community were statistically significant ($p < .05$) and positively correlated with overall assessment of the 3Helix.org on-line community (see Table 1). Since both actions and perceived time spent were correlated with overall value, both performing actions and spending time on the 3Helix.org on-line community contributed to the overall value of the on-line community.

Table 1. Correlations between nodal contacts, perceived time spent, and overall value

		Actions	Perceived Time Spent	Overall Value
Actions	Pearson Correlation	1	.047	.132*
	Sig. (2-tailed)		.454	.038
Perceived Time Spent	Pearson Correlation	.047	1	.153*
	Sig. (2-tailed)	.454		.017

RQ3: How did perceived gender impact interaction in the 3Helix.org on-line community?

To determine the impact of perceived gender on interaction in the 3Helix.org on-line community, the researchers compared the interactions between males and females. The interactions were split into artifact and no artifact interactions. Artifact interactions include interactions that leave a trace on-line. For example, a discussion posting in response to another person creates an artifact on-line that can be read by other members of the on-line community. Private messages were also classified as artifact interactions, as the receiver was able to read the message that was sent. No artifact interactions include clicking on a discussion post by a member, as the original poster does not know that the posting was read by the other member. Tables 2, 3, and 4 include MM (male to

male interaction), FF (female to female interaction), MF (male to female interaction), FM (female to male interaction), GenderS (same gender interactions), GenderD (different gender interactions), M Initiate (male initiated interactions), and F Initiate (female initiated interaction).

Based on artifact interactions, participants female participates had more same sex interactions than males (see Table 2). However, males had more artifact interactions with participants of the opposite sex than female participants. Overall, there were more same sex interactions than opposite sex interactions and females initiated contact more often than males.

Table 2. Artifact Interactions

MM	FF	MF	FM	GenderS	GenderD	M Initiate	F Initiate
18	87	53	18	105	71	71	105

Based on no artifact interactions, female participants also had more same sex and opposite sex interactions than males (see Table 3). There were more same sex no artifact interactions, as opposed to opposite sex interactions. Females initiated no artifact interactions more often than male participants.

Table 3. No Artifact Interactions

MM	FF	MF	FM	GenderS	GenderD	M Initiate	F Initiate
670	770	399	498	1440	897	1069	1268

Based on both artifact and no artifact interactions, female participants had more same sex and opposite sex interactions (see Table 4). Participants had more interaction with the same sex. Female participants were also more likely to initiate interactions than males.

Table 4. All Interactions

MM	FF	MF	FM	GenderS	GenderD	M Initiate	F Initiate
688	857	452	516	1545	968	1140	1373

As anticipated, the female participants interacted more often than male participants, with the exception of artifact interactions. It appears that females were more participatory than males.

RQ4: How was trust related with nodal contacts on the on-line community?

Three questions in the survey asked participants how much they trusted members of the 3Helix.org on-line community based on the frequency of communication from low to frequent. The correlations were statistically significant for all three levels of communication; infrequent communication, moderate communication, and frequent communication (see Table 5). Based on the correlations, the relationship between

Table 5. Correlations between nodal contacts and trust.

		Nodal Contacts	Trust Frequent communication	Trust Moderate Communication	Trust low Communication
Nodal Contacts	Pearson Correlation	1	.255*	.248*	.269**
	Sig. (2-tailed)		.011	.013	.007

frequency of communication and nodal contact appears to be bimodal, as the highest levels of trust are with frequent and infrequent communication. The student participants tended to trust those that they were in contact with the least and most.

RQ5: How was trust related with total number of innovations developed based on participation in the on-line community?

To determine how trust was related to the total number of innovations, the researchers correlated the total number of innovations reported with the level of trust that participants had with on-line community users (see Table 6). Trust was significantly and positively correlated with innovations. Therefore, trust with the on-line community members promoted innovation.

Table 6. Correlations between trust and innovations.

		Network Trust	Total Innovations
Total Innovations	Pearson Correlation	.167**	1
	Sig. (2-tailed)	.008	

Discussion

On-line communities allow students to interact with their classmates in a variety of ways. In this study, four types of groups naturally emerged: 1) highly participatory, 2) core periphery, 3) a mix of highly participatory and distributed, and 4) distributed. The researchers believed that the diverse groups may have emerged based on the different dynamics of each of the in-class laboratories, as each of the laboratory sections was led by a different teaching assistant. Since teaching assistants had different teaching styles, it may have impacted the way that students participated in the 3Helix.org on-line community. While participating in the community, participants' perceived time spent and actions on 3Helix.org were positively correlated with perceived value of the on-line community. Therefore, the researchers believed that designers should consider methods of promoting actions and time spent on on-line communities, as they were both positively correlated to valuation of the social network.

When reviewing the interaction data, the researchers found that female participants were more likely than males to initiate artifact and no artifact interactions, except for cross gender interactions. Since female participants were more active than male participants, designers should consider methods of increasing participation for male participants. The researchers were intrigued that males only participated more than females when cross gender interactions were calculated and would like to conduct future research to determine why this occurred in the 3Helix.org on-line community.

It was interesting to consider how trust had the highest correlation for participants with the greatest and least interactions. It appears that higher correlation for greater amounts of participation may be due to the knowledge of the person that one interacted with. If a participant interacted with another member frequently, it was possible that he/she learned a great deal about the other person and developed trust. The highest level of trust with those with the least interaction may be due to multiple reasons. The first reason was the idea of family and close friends. Even though a person may not speak with a close friend or family member often, he/she may have a high level of trust. The second reason was that people whom participants interacted with a few times had fewer opportunities to break the trust. Therefore, the researchers believed that if trust was broken, those with moderate amounts of interactions may have stopped communication before getting to high levels of exchanges.

Trust was an important factor to consider in the 3Helix.org community, as it was correlated with innovation. This finding demonstrated the need for trust in an on-line community to promote innovations and further expands on the finding that mutual trust is necessary for knowledge sharing (Il-Hyun et al., (2014); Misztal, 2001; Nahapiet & Goshal, 1998; Wasko & Faraj, 2005). If there was a lack of trust between members of the community, it would be less likely that they will share information and generate new ideas. Likewise, increased interactions and trust could lead to greater amounts of innovations.

Implications for Future Research

This study gave brief insights into the inner workings of the 3Helix.org on-line community. The researchers are left with many opportunities for future research. Since this study focused on general aspects of the on-line community, such as groupings, value, gender role, trust, and innovation development, the researchers would like to conduct qualitative studies to learn about these aspects in more detail. The researchers would like to interview core periphery members of the cluster groups to determine how and why they were key members of their groups. They would also like to interview male and female participants to get a deeper understanding of their roles in the on-line community and why each was likely to initiate different types of interactions. The researchers are also interested in interviewing participants to determine how trust impacts their innovation development and participation in the on-line community.

Overall, the 3Helix.org on-line community was rich and included many possibilities for research. We hope that we are able to explore the different aspects to gain a better understanding of on-line communities.

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