Jill Watson SA: Design and Evaluation of a Virtual Agent to Build Communities Among Online Learners

Qiaosi Wang
Design & Intelligence Lab
Georgia Institute of Technology
Atlanta, GA 30332, USA
qswang@gatech.edu

David Joyner
College of Computing
Georgia Institute of Technology
Atlanta, GA 30332, USA
david.joyner@gatech.edu

Shan Jing
Design & Intelligence Lab
Georgia Institute of Technology
Atlanta, GA 30332, USA
sjing3@gatech.edu

Ashok Goel
Design & Intelligence Lab
Georgia Institute of Technology
Atlanta, GA 30332, USA
ashok.goel@cc.gatech.edu

Ida Camacho
Design & Intelligence Lab
Georgia Institute of Technology
Atlanta, GA 30332, USA
icamacho@gatech.edu

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Abstract
Despite being accessible and affordable, online education presents numerous challenges for online learners due to the absence of face-to-face interactions. Lack of community belongingness, in particular, negatively impacts online learners' learning outcomes and learning experience. To help online learners build communities and foster connections with their peers, we designed and deployed Jill Watson SA (stands for Social Agent). Jill Watson SA is a virtual agent who can match students with shared identity, defined by similarities in location, timezone, hobby, and class schedule on the Piazza class discussion forum. We implemented Jill Watson SA in two online classes and conducted three short surveys with online students to evaluate Jill Watson SA. Through mixed-methods analysis on the survey responses, we discuss implications for future improvement of Jill Watson SA and present design recommendations for technology aimed at helping online learners build communities.

Author Keywords
Online Learning; Community-Building; Virtual Agent

CCS Concepts
•**Human-centered computing** → **Empirical studies in collaborative and social computing;** *Human computer interaction (HCI);*

Sense of Community
The definition of "sense of community" in online learning environment is vaguely defined. In current work, we use Rovai's [13] definition and define "sense of community" as "mutual interdependence among members, connectedness, trust, interactivity, and shared values and goals. "

Introduction

Online education continues to gain popularity over the years. In 2017, 15.4% of U.S. students from post-secondary institutions enrolled exclusively online, about one in six students [4]. However, due to the lack of face-to-face interactions, online learning also presents numerous challenges for students. Lack of sense of community, in particular, negatively impacts online learners' perceived learning engagement, class satisfaction, and learning outcomes [13, 10].

Sense of community among online learners is hardly uncharted territory. Scholars have explored the relationship between sense of community and other constructs (e.g., learning engagement [17], learning outcomes [16]), and developed instruments to measure students' level of community belongingness [12]. Yet in a technology-mediated learning environment like online education, empirical investigation regarding community-building among online learners is sparse, design of technology in facilitating online learners' community-building process remains unexplored.

Motivated by this gap, we present our evaluation of Jill Watson SA, a virtual agent who can connect online learners with shared identity on the class Piazza discussion forum. In this work, we seek to answer the research question of how to design technical intervention to help online learners build communities. Our contributions are three-fold: (1) we contribute one of the first evaluations of technical intervention in facilitating online learners' community-building process; (2) we identify two goals online learners try to fulfill through community-building and urge designers to be aware of these goals when designing interventions; (3) we provide design recommendations for technology aimed at building communities among online learners, highlighting the importance of shared identity and the need to design for community-building motivations.

Related Work

Early research proposed several theories and frameworks on interactions within problem-solving groups. Among them, Bales' Interaction Process Analysis [1] on problem-solving small groups provides one of the most effective empirical methods to observe group interactions [11]. Underlying Bales' work is the theoretical idea that two processes happen simultaneously throughout group interactions: instrumental process and expressive process [1, 11]. Instrumental process refers to task-oriented group interactions while expressive process refers to the interpersonal relationships among group members [1]. Group attention constantly shifts among these two processes, however, concentrating solely on either one of them will result in strains on the other process [11].

With the rise of online learning in the past decade, group dynamics and interaction patterns have changed when education is being delivered through technical platforms. Yet community-building among online learners was not well-studied until very recently. Existing work found that online learners' community-building practices either originated from discovery of shared identity or deliberately established to fulfill academic or professional goals [15]. Discovering students with common identity (e.g., students who are also veterans) also promoted collective efficacy, the belief in the group's capacity to achieve shared goals [14]. Sun et al. suggested that interventions should be lightweight and make online learners' shared identity visible [15]. Yet to our knowledge, no work has been done to evaluate a technology intervention in facilitating online learners' community-building process. With these insights in mind, we present our design, implementation, and evaluation of Jill Watson SA.

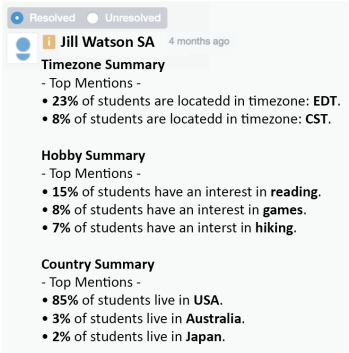

Figure 1: An adapted example of Jill Watson SA's aggregated class statistics post on Piazza.

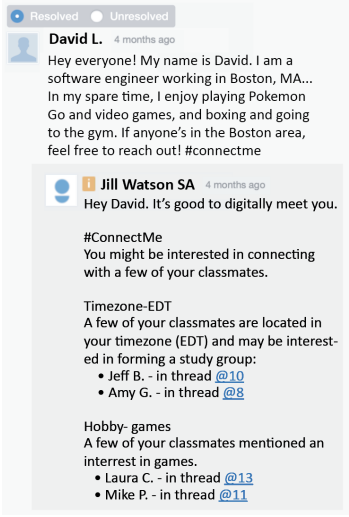

Figure 2: An adapted example of Jill Watson SA's personalized response to an online student on Piazza, based on location and hobby.

Design and Implementation of Jill Watson SA

Design of Jill Watson SA

Jill Watson SA is a virtual agent active on the class Piazza discussion forum to help facilitate online learners' community-building process. Jill Watson SA is part of our Jill Watson project in designing virtual agents to make online learning scalable and personable [6]. We believe that virtual agents can help provide more fun and personable elements in the community-building process for online learners, who often feel like just another number in the system. Existing research also suggested that conversational agents can provide social support [9] and enhance collaborative learning [8], which are the end goals that we are trying to achieve with Jill Watson SA.

Jill Watson SA Functionalities

Jill Watson SA uses natural language processing to extract student information from self-introduction posts, often posted at the beginning of each class on Piazza discussion forums. Jill Watson SA can identify student hobbies, regions, countries, time zones, and classes they are currently taking. The agent has two features— posting aggregated class statistics summarized from each student's introduction post (See Figure 1), and responding to each student (if they opted-in to use Jill Watson SA) with personalized recommendations about others who share common interests, locations, time zones, or hobbies (See Figure 2).

Implementation of Jill Watson SA

We implemented Jill Watson SA in two online classes in Georgia Tech's Online Master of Science in Computer Science program[1]. To avoid pressuring students into reaching out to others, we asked students' consent for Jill Watson SA to collect and share their information to other students. Students consented by including #connectme in their self-introduction posts. Jill Watson SA kept the aggregated class statistics and personalized recommendations updated during the first two weeks of the semester, which is also when the introduction threads are usually active on Piazza.

[1] To learn more about the Georgia Tech OMSCS program and class, see [5, 7]

Methods

We evaluated Jill Watson SA through three short surveys (S1, S2, S3) over the semester (roughly four months) to gather as many students' feedback as we could. Each survey served a different purpose: S1 to understand how online learners currently build communities, S2 to collect qualitative feedback on the agent, and S3 to quantitatively evaluate the effectiveness of the agent.

The purpose of the first survey (S1) is to understand the online learner population. We collected student demographics and asked students to describe how they currently connect with others. We conducted a second survey (S2) to gain students' opinions after their use of Jill Watson SA. In S2, we asked students to self-report their usage of Jill Watson SA and collected their feedback through open-ended questions. Students can always go back to Jill Watson SA's responses and reach out to others throughout the semester. In the third survey (S3) which we distributed at the end of the semester, we thus asked students to report how many students they connected with over the semester based on Jill Watson SA's recommendations.

We received 601 valid responses from S1, 359 valid responses from S2, and 431 valid responses from S3. The survey respondents were from 66 different countries, with more than half of the students coming from the United States (51.41%), followed by India (14.98%) and China (10.98%). Across all the surveys, gender and age distribution remained roughly the same: with 18.10%–19.13%

female, 72.85%–79.70% male, and less than 1% students did not specify; majority of the students were from age 25 to 34 (52.09%–58.40%) and age 35 to 44 (20.19%–21.80%).

Two researchers coded responses on how students currently connect (S1) and student feedback about Jill Watson SA (S2) iteratively using open coding [3]. We started by coding the first 50 responses from each survey. Through initial discussion, we created an initial code book with five codes for S1 and eight codes for S2 responses. Then we evenly divided the remaining data and coded independently based on the code book. The two researchers frequently came together to discuss questions raised during coding and resolved conflicts throughout the entire coding process. We then used descriptive statistics to analyze S3 responses regarding the number of people students connected with through Jill Watson SA over the semester.

Findings

Overall, online students in our study were positive about Jill Watson SA and all believed it was an interesting concept. However, online learners reported mixed opinions on the actual usefulness of Jill Watson SA in fostering communities. In this section, we present online students' diverging opinions on Jill Watson SA and discuss online learners' community-building process as a class-oriented activity.

Jill Watson SA: Making Shared Identity Visible

From student responses in S2, we found online learners formed connections through shared identity highlighted by Jill Watson SA. Some students used Jill Watson SA's responses to connect with others located in the same area, *"It helped me find my classmates in my timezone. As I live in India, only few people live near my timezone. So, we formed a whatsapp group and stayed in touch."* Other students also used Jill Watson SA to form local study groups, *"I was able to connect with a study group in a different part of the state that I am in."*

Highlighting shared identity not only helped online students form connections, but also helped them foster a sense of belongingness in the class. One student said, *"I really find Jill Watson SA posts helpful because of finding similarities with other course participants that develops belongingness to the course."* Another student also pointed out, *"I think the personalized response fosters inclusion and collaboration in the class. It helped me have a sense of belonging."*

Jill Watson SA: Information Not Actionable

Even though online students liked the concept of Jill Watson SA, they also found the information more interesting than helpful because they didn't know how to act on the information provided by Jill Watson SA. One student said in S2, *"It was a good-to-know comment but did not really compel/trigger an action among the participants as much as I had expected."* Some students explained that they didn't know how to use the information provided by Jill Watson SA or didn't know how to start a conversation with those students. One student suggested, *"Perhaps an initial 'forced' interaction between Jill Watson SA's recommended matching students can help break the ice and help start a conversation."*

Some online learners pointed out in their answers to S2 that having limited time prevented them from interacting with Jill Watson SA's recommendations, or even connecting with online students in general. One student simply put *"I didn't really look at the results. It takes time."* Other students also said, *"I work very demanding full-time and I don't have time to check piazza other than look for solution when I am stuck."* When asked about how they currently connect with other students, one student responded, *"I am guilty of not connecting enough with my classmates currently. My*

full time job requires me to travel and work constantly and I find just enough time to get through my assignments."

Indeed, through students' self-report in S3 at the end of the semester, more than half of the students did not connect with anyone through Jill Watson SA. Among all the students who opted-in to receive personalized recommendations from Jill Watson SA (n=191), 53.40% students didn't connect with anyone, 19.90% students connected with five or less students, 7.85% students connected with more than five students, and the rest of the students did not receive valid responses from Jill Watson SA due to the lack of students who shared commonalities with them (18.85%).

Building Communities: Class-Oriented Process

We found that online learners' current communities were either built for class-related purposes or originated from class-related activities (e.g., group projects, discussions about course materials), based on their responses in S1. In our study, online students sought out others almost solely for class-related purposes such as finding students in the same location to form local study groups, or seeking out students they could work together on a group project. Majority of the online learners also said they connected with others either through class-related discussions on Piazza or through group projects. Yet not all students viewed Piazza as their main source of building connections—some students saw group projects as their main and only opportunity to connect with others, *"I have not had any luck connecting with classmates from my past two online classes except some discussion through Piazza. I think a group project will allow me to setup ways to connect via social media."*

From online learners' feedback in S2, we also noticed that most of their evaluations of Jill Watson SA were based on whether the information provided was useful for class purposes. For example, one student said *"It (Jill Watson SA) wasn't very helpful because I didn't feel like she pointed out specific students that I could form a study group with. "* One of the student who was taking the class with no group project also said *"It was good knowledge to have, but this course is more based on independent work, so connecting with other students was not a priority. "*

Discussion

To summarize, we found that online students liked the concept of Jill Watson SA, yet held mixed opinions regarding its actual usefulness in facilitating community-building process. Our findings also showed that online learners' current connections were centered around class-related activities. Below we discuss in detail the design implications for technology aimed at helping online learners build communities.

Design for Community-Building Motivation

Even though Jill Watson SA made the process of identifying similar students more convenient for online learners, we found that merely pointing out those students was not enough—knowing there are other students in the class with shared identity is only a starting point for community-building among online learners. Due to the lack of face-to-face interactions and time constraints, actually reaching out to others with commonalities is still a difficult gulf to cross when the connection goal is not purely academic or professional. The question thus remains on how to design interventions to properly motivate online learners to reach out, connect, and stay connected with their peers?

Promote Shared Identity to Foster Connections

Our findings align with existing work [14] on the crucial role of discovering shared identity in promoting community belongingness among online learners. As detailed in our findings, students found Jill Watson SA useful not only because it helped students form study groups, but also because it

delivered an important message to online learners— that there are others who are from the same region, who share similar career aspirations, who are also juggling between full-time jobs, families and education. As some students said, by making their shared identity visible amongst them, Jill Watson SA helped "develop belongingness" in the class.

Community-Building: Functional Goals vs. Emotional Goals
We found that online learners evaluated Jill Watson SA based on two criteria— its effectiveness in helping them achieve class-related purposes (e.g., form study groups) and its usefulness in providing them a sense of belongingness in the online class.

This finding suggests that community-building among online learners serves two types of goals: functional goals and emotional goals. Functional goals are academic or professional goals that students pursue through building connections (e.g., completion of group projects, greater learning outcomes through group discussions). However, online learning is a rather lonely and intimidating process. Thus having knowledge of students who are similar to them also fulfills their emotional goals— providing emotional support through heightened sense of community in online classes.

While the two goals we identified share some similarities with Bales' instrumental and expressive processes [1], functional and emotional goals focus on end objectives whereas Bales' work emphasizes ongoing processes. We suggest that functional goals can be achieved through instrumental process and emotional goals can be fulfilled through expressive process.

Through our evaluation, online learners' existing communities seem to be solely meeting their functional goals, either driven by or originated from class-related activities. Though the corresponding instrumental process includes identifying students with similar academic interests or skill sets, which could help fulfill students' emotional goals, this process is still largely driven by functional goals.

Given the extremely high dropout rate in online classes [2], which is partially contributed by online learners' low sense of community [13], we are concerned that online learners' heavy emphasis on community-building functional goals might lead to strains in their expressive process, and leads to failure in fulfilling their emotional goals. We therefore call for future research to explore ways to facilitate online learners' expressive process in achieving their emotional goals. We hope these two goals we pointed out will help designers make informed decisions when designing interventions to facilitate online learners' community-building process.

Conclusion and Future Work

We present the design and evaluation of a virtual agent named Jill Watson SA to foster communities among online students. We implemented Jill Watson SA in two online classes and conducted evaluation through mixed-methods analysis on three short surveys. We found Jill Watson SA highlighted online learners' shared identity yet the information provided was not actionable in building initial connections. We also identified online learners' current community-building as a class-oriented process. We urge designers to design interventions that help motivate online learners in community-building, make online students' shared identity visible, and consider which community-building goals—functional or emotional goals—the interventions are designed to fulfill.

In the future, we will design features to help students overcome the initial connection gulf and conduct more in-depth exploration on the impact of virtual agents acting as community-building facilitators in online learning environment.

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