The Many Faces of Mentoring in an MMORPG

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Abstract—Mentoring refers to the phenomenon where a more skilled or knowledgeable person helps a less skilled or less knowledgeable person gain skill in a particular domain. In this paper we study the phenomenon of mentoring in a massive multiplayer online role-playing game (MMORPG). We identify four different types of mentoring, which map to several important motivational features. We then measure the social networks of mentors and apprentices at multiple levels, and propose a network model to describe the emergence and evolution of mentoring.

Keywords: Mentoring, Social Networks, MMORGP, Mentoring Networks

I. INTRODUCTION

Answering questions and sharing expertise in online communities is commonplace, but it is unclear what motivates users to help one another, or what the actual social processes resemble. While researchers hail the benefits of mentoring in online settings [6], we know little about how often it occurs or what motivates users to act as mentors. People can have a variety of reasons for mentoring; however the main goal of mentoring is usually the advancement of the apprentice. In this paper, we examine the extent to which players of massive multiplayer online games such as World of Warcraft, Final Fantasy, Eve or EverQuest spend time mentoring other players. Given the fact that it is often tedious to collect data about mentor-apprentice relationships in the real world, these virtual world offer an excellent venue to study this phenomenon. We identify several motivations for engaging in a mentoring relationship, including those that focus on mentoring friends or guildmates, or those who focus on their own advancement. We also measure the social networks of mentors and apprentices across multiple levels, and develop models that study mentorship exchange in MMORPGs.

This work contributes to our understanding of knowledge-sharing and mentorship in large-scale organizations or online settings, and demonstrates the importance of modeling social behavior at multiple levels. This is one of the first studies of the phenomenon of mentoring and the characteristics of mentoring in MMORPGs. Observation and insights gained from this study can be used to improve mentoring systems in online games, improve user experience and understand how mentoring in online gaming contrasts with mentoring in the offline world.

II. RELATED WORK

Literature on mentoring finds the relationship present in a variety of contexts [4,5] including studies in organizations [8], educational settings [16], and in close impersonal relationships. These mentoring relationships often facilitate the professional advancement of protégés or provide desired emotional support [8]. Furthermore, they can be expressed through formal relationships or informal linkages [15]. The diversity of potential mentoring relationships poses a challenge for researchers aiming to predict the development of mentor pairs among a heterogeneous population.

The problem of analyzing mentoring in MMORPGs is related to the problem of socialization in such games – namely each construct is driven by different motivations and produces varied outcomes. Shim et al [13] discuss the problem of inferring performance of players in games, Huffaker et al [11] studied expert behavior. Earlier studies of networks in MMORPGs have also looked at Trade [1], how can MMORPGs be used to foster learning [18], hence the connection with mentoring. The work that is most relevant to the current paper is a study on a generative model of a mentoring network in MMORPGs [2] which shows that such mentoring networks have certain characteristics which are not present in many other social networks. The current work can also be conceptualized as an extension of [2].
The mentoring network can be constructed by considering the mentoring apprentice pairs. Thus a directed edge in the network represents a relationship from the mentor to the apprentice. The mentoring network that we use in this paper is from one of the servers (guk) from EQ2 and consists of 23,207 nodes, 93,079 edges, 4,935,602 instances of mentoring, 11,632 mentors and 21,256 apprentices. Notice that there is an overlap between the players who are mentors and who are also apprentices at some period of time. While the same player can have multiple characters, it is not possible for the same player to mentor another character that he or she has using the same account. The majority of the players, more than 97 percent are part of the largest connected component (LCC) even though there are a total of 316 components in the networks. The second largest connected component has only 6 nodes.

The plots in Figure 1 give two characteristics of the network and player activities. Figure 1(a) plots total number of activities versus total number of mentoring activates. The figure shows that for the majority of the players mentoring activities are a small percentage of the total number of activities that they perform. Figure 1(b) gives the distributions for time span for the difference as defined by the time between the first game activity and the last game activity recorded for a player and the corresponding difference for mentoring activities. The main thing to notice here is that the observed data points cover almost all of the possible data points in the curve. The main implication here is that the player exhibit a wide range of behaviors in terms of time allocated for mentoring.

While it is possible for a player $A$ who was mentored by another player $B$ to later on mentor $B$, it is quite rare as the level difference between the players usually persist over time. Thus out of the total of 93,079 edges only 804 edges are reciprocated which implies that the network is nonreciprocal. Just like in the real world, mentors have different motivations for mentoring. Based on extensive experience with game play in EQ, we suspect that the various categories for mentoring which have been identified in the offline world are also applicable to the online world of EQ2. These are also borne out by various clusters of mentors that we obtained based on the mentoring data. Players can have the following motivations for mentoring in EQ2:

- **Instrumental**: A player may mentor another player in order to gain achievement points.
- **Friend-Focused**: A player may mentor another player in order to help his or her friend quickly gain in level.
- **Guild-Focused**: A player may mentor another player in his or her guild as an obligation to help other guild members and foster stronger relations.
- **Veteran (Low Participation)**: There may be many instances of mentoring where a player tries mentoring but after only a few instances decide not to pursue mentoring.

It should be noted that in some cases there may be overlap between the various groups or reasoning for mentoring e.g., a player may be mentoring because of helping her friend and also for gaining achievement points.

### III. MENTORING IN EVERQUEST II

EverQuest II (EQ2) is a massively Multiplayer Online Role Playing Game developed by Sony Online Entertainment. While there are a large number of activities that players can be involved in, we concentrate on mentoring in this paper. Just like many other games the characters in EQ2 have various “levels,” and when a player mentors another player the effective level of the mentor becomes equals to the level of the apprentice [17]. The mentoring player is always the more experienced player with respect to the apprentice. The game is designed such that player who is being mentored ‘levels’ up faster as a result of mentoring. In EQ2 a player can mentor another player by clicking on the other player and then agreeing in a dialog box that their effective level will be lowered.

The mentoring network can be constructed by considering the mentoring apprentice pairs. Thus a directed edge in the network represents a relationship from the mentor to the apprentice. The mentoring network that we use in this paper is from one of the servers (guk) from EQ2 and consists of 23,207 nodes, 93,079 edges, 4,935,602 instances of mentoring, 11,632 mentors and 21,256 apprentices. Notice that there is an overlap between the players who are mentors and who are also apprentices at some period of time. While the same player can have multiple characters, it is not possible for the same player to mentor another character that he or she has using the same account. The majority of the players, more than 97 percent are part of the largest connected component (LCC) even though there are a total of 316 components in the networks. The second largest connected component has only 6 nodes.

### TABLE 1. MEANS OF MENTOR CLUSTERING VARIABLES

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Instrumental</th>
<th>Friend-Focused</th>
<th>Guild-Focused</th>
<th>Veteran (Low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster Size</td>
<td>1,685</td>
<td>2,985</td>
<td>5,354</td>
<td>1,608</td>
</tr>
<tr>
<td>Num. Mentored</td>
<td>13.49</td>
<td>5.18</td>
<td>21.54</td>
<td>1.26</td>
</tr>
<tr>
<td>Play Concen.</td>
<td>0.19</td>
<td>0.33</td>
<td>0.34</td>
<td>0.004</td>
</tr>
<tr>
<td>Num. Guildmates Mentored</td>
<td>3.77</td>
<td>0.34</td>
<td>4.33</td>
<td>0.26</td>
</tr>
<tr>
<td>Guild Play Concentration</td>
<td>0.13</td>
<td>0</td>
<td>0.37</td>
<td>0</td>
</tr>
<tr>
<td>Mentoring Instances</td>
<td>659.55</td>
<td>205.39</td>
<td>1439.083</td>
<td>343.43</td>
</tr>
</tbody>
</table>
As described in the previous sections, people have different motivations for mentoring and these should be mirrored in partitions or clustering of the mentoring data. We applied the Weka [10] implementation of the EM clustering algorithm to discover the clusters. The EM algorithm was used since the number of clusters do not have to be pre-specified. Additionally the characteristics of the individual clusters are similar to the mentoring archetypes described before. The variables for clustering were selected based on domain knowledge of the game and the familiarity of the authors with the game play. The list of the variables which were used for clustering are given as follows:

1. **Number of Characters Mentored**: The number of characters that this character has mentored over the course of the time span under consideration.

2. **Number of Mentor Instances**: The number of unique instances of mentoring, where an instance is defined as gaining experience points in the game. Thus a same character can mentor another character over hundreds of instances. We used number of mentoring records instead of time spent on mentoring because that the information about time spent on mentoring is not available from the game logs.

3. **Play Concentration**: This quantity is defined as the Gini Coefficient of a mentor as computed with respect to the number of mentoring instances for all the other players that he or she has mentored. Given a variable \( X = \{x_1, x_2, \ldots, x_n\} \), the Gini Coefficient can be computed as follows:

\[
g = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |x_i - x_j|}{2n^2 \mu}
\]

4. **Number of Guild-mates Mentored**: The number of characters that this character has mentored in his or her guild over the course of the timespan under consideration.

5. **Guild Play Concentration**: This quantity is defined in an analogous manner to Play Concentration but with it is computed with respect to only players within the guild.

6. **Average Diff Level**: This is the average level difference between a mentor and all of its apprentices, averaged over the number of instances of mentoring.

The four clusters of mentors and the corresponding characteristics of these clusters are given in Table 1. While there is some overlap between the characteristics of the various clusters, some differences stand out more than others so that they can said to belong to different clusters e.g., both Instrumental and the Guild-Focused clusters have higher values for number of guildmates mentored, the guild focused cluster has a much higher value for guild play concentration.

### Social Characteristics of Mentors

After the four types of mentors are identified, it allowed us to see how they might differ in terms of social networks, especially since some mentors might be altruistic while others are self-serving. We investigated these social networks at multiple levels—between the mentor-apprentice dyads and more complex grouping such as triads.

We began with three popular individual-level measures of social capital within the mentor-apprentice networks. These include: (a) *closeness centrality*, which measures how ‘close’ mentors are to all other players in the network based on their direct and indirect ties; (b) *structural holes*, which measures the extent to which a mentor connects with two players who don’t connect with each other; and (c) *clustering coefficient*, which measures how often a player creates cliques or clusters with other players.

As shown in Table 2, we found that instrumental players demonstrate the highest closeness centrality, followed by veterans, friend-focused and guild-focused mentors using one-way analysis of variance, \( F(3,10563) = 288.29, p<.001 \). Tukey’s HSD revealed significant differences across all four types, \( p<.001 \). We also found that guild-focused mentors demonstrated the highest structural holes, followed by friend-

### Table 2. Means and Standard Deviations of Social Network Measures for the Four Types of Mentors.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Instrumental</th>
<th>Friend-Focused</th>
<th>Guild-Focused</th>
<th>Veteran (Low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closeness Centrality</td>
<td>.24 (.02)</td>
<td>.22 (.03)</td>
<td>.21 (.05)</td>
<td>.23 (.03)</td>
</tr>
<tr>
<td>Structural Holes</td>
<td>.10 (.10)</td>
<td>.17 (.13)</td>
<td>.30 (.30)</td>
<td>.15 (.20)</td>
</tr>
<tr>
<td>Clustering Coefficient</td>
<td>.09 (.11)</td>
<td>.07 (.12)</td>
<td>.09 (.17)</td>
<td>.06 (.10)</td>
</tr>
</tbody>
</table>

Figure 2. Structure of 16 possible triads

![Figure 2. Structure of 16 possible triads](image)

Figure 3. Behavioral signatures of mentoring intensity for four mentor clusters.
focused, veterans and instrumental, $F(3,10563) = 444.62$, $p<.001$. Tukey’s HSD post-hoc tests revealed significant differences across all four types ($p<.001$), except in the mean difference between friend-focused and veteran mentors ($p = .07$). Finally, guild-focused mentors showed the highest clustering coefficient, followed by instrumental, friend-focused and veteran mentors, $F(3,10563) = 25.29$, $p<.001$. Tukey’s HSD revealed significant differences across all four types ($p<.001$), except in the mean difference between guild-based and instrumental mentors ($p = .83$).

**Table 3: Frequency of dyadic and triadic network relations for the four types of mentors.**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Instrumental</th>
<th>Friend-Focused</th>
<th>Guild-Focused</th>
<th>Veteran (Low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indegree Edges</td>
<td>4863</td>
<td>6471</td>
<td>10824</td>
<td>3134</td>
</tr>
<tr>
<td>Outdegree Edges</td>
<td>11760</td>
<td>7703</td>
<td>9587</td>
<td>9937</td>
</tr>
<tr>
<td>Ind/Out Ratio</td>
<td>41</td>
<td>84</td>
<td>1.13</td>
<td>.32</td>
</tr>
<tr>
<td>Homophilous Dyads</td>
<td>1712</td>
<td>1224</td>
<td>2675</td>
<td>985</td>
</tr>
<tr>
<td>Homophilous Transitive Triads</td>
<td>101</td>
<td>36</td>
<td>59</td>
<td>35</td>
</tr>
</tbody>
</table>

**Figure 4: Triadic census of various Triads in the Mentor Clusters**

It is interesting that instrumental players or veteran players (who rarely enter into mentoring exchanges) show the highest closeness centrality—a popular measure of overall influence in a network. One explanation is that because instrumental and veteran players are more focused on their own achievement and don’t confine themselves to a particular guild or small friendship circle, which allows them to spread out throughout the network.

The finding that these mentors bridge structural holes is not surprising if we think about them in terms of a teacher within a group that helps various pupils who are not ready to help each other yet. In other words, these mentors are spreading their time among several other guilds that are likely at small levels and not ready to serve as mentors in their own capacity. A second explanation is that guild-focused mentors might occasionally branch out to help players in other guilds who would not interact with players in the mentor’s guild.

The finding that both guild-focused and instrumental mentors show higher values in the clustering coefficient suggests that these types of mentors are forming their own smaller networks, whether it is reflective of the guild or of a selection of teams. These more complex network structures are discussed in more detail below.

In order to gain further insight into the individual-level network measures, we can examine the presence of dyadic relationships. The closeness centrality of instrumental and veteran players is supported by their low ratio of indegree to outdegree relative to the other groups. Since outdegree in this network indicates mentor-to-apprentice relations this indicates players in these groups wield influential network positions.

Oddly, the reverse pattern may explain why the guild-focused and friend focused clusters are highest in structural holes. As frequent apprentices, these individuals may serve as brokers to parts of the network that would be redundant ties for more focused instrument and veteran players. Additionally, the presence of cliques among guild-focused and instrumental players is further suggested by the high number of homophilous dyadic and triadic relations in the two groups.

In addition to the individual-level, and dyadic network measures, we were interested in more complex structures such as triads. A triad is a graph consisting of 3 nodes, which can create up to sixteen configurations (the set of all possible Triads on a directed graph are given in Figure 2). The differences between the network structures of the various clusters that constitute the mentoring network can be gauged by looking at the logarithm of triadic census of the triads given in Figure 4. The x-axis in the figure corresponds to the various triads given in Figure 4. The distributions of the triads for the clusters are similar except the case of Friend-focused clusters, which demonstrate less of 11 and 14. Interestingly Triad is also observed to a lesser extent in the case of Guild-Focused clusters. Intensity of Mentor Exchange.

In this section we describe a novel way to visualize the various mentoring clusters. Given that the corresponding temporal data is available for all the mentors, we can visualize each cluster by graphing the average intensity of mentoring activity in the span of a day. Thus consider the visualizations in Figure 3 where the rectangular plotting area is divided into 24 hours and the colors represent the intensity of mentoring. Here the intensity of mentoring is plotted based on the visible color spectrum from blue to red i.e., blue represents low levels of intensity, red represents higher levels of intensity and the composite colors in between represent intermediate levels of intensity.

From Figure 3 it is possible to see the differences in the various mentor clusters just by looking at the levels of intensity of mentoring at various time periods during the day. Thus mentoring activity is more spread out during the day in the case of friend-focused cluster and it is most concentrated in the case of Guild focused cluster. It is also evident that in general mentors are less active earlier in the day as compared to the later in the day. The key insight from these visualizations is that it is not just the individual level attributes.
of the mentor clusters which distinguish them from one another but the spread of activity throughout the day is also a distinguishing factor between the mentoring clusters.

A. LIFE CYCLE OF MENTORSHIP

From the perspective of the apprentice the primary goal of mentoring is to increase the level of the apprentice. A soon as the level of the mentor equals to the level of the mentor then it is no possible for the mentor to mentor the apprentice. Thus there is a limit to when a mentor can mentor an apprentice in EQ2. However the same mentor may mentor other people who are at a level lesser than her level. An additional constraint in the game is that a player can be mentored by up to four players simultaneously but a player cannot mentor multiple players at the same time. Since for most player mentoring instances are only a small fraction of total activities performed, mentoring instances are spread out over time. Additionally the overlap between active nodes in the mentoring network is relatively large as compared to the overlap in edges. A comparison of Adjacency Correlation and the Jaccard’s Coefficient for the nodes over time reveals this difference clearly [2].

Thus it is the case that while the same mentors mentor over a span of time, they are less likely to mentor the same people after a certain amount of time. One possible factor could be because the apprentices advance to greater levels and thus have a less need for mentoring. Many of the apprentices in turn mentor other players. Table 6 shows the percentage of players that a player from one cluster mentors in another cluster. The table shows that instruments are more likely to help other instrumental classes. While the distributions for all the other classes are similar but everyone is more likely to mentor players in guilds. While the number or the percentage of apprentices from one cluster to another cluster appears to be the same the intensity of mentoring is not the same. Thus consider the case of veteran players who mentor less than all the other clusters but their percentages of mentoring are comparable.

V. A NETWORK MODEL OF MENTORING

Based on the observations and the discussion in the previous section, we propose that a model for the formation and evolution of the mentoring network in the current setting should satisfy the following characteristics:

1. Lifespan of nodes i.e., after the lifespan of the nodes has expired they can no longer participate in the network.
2. The propensity of nodes to be active at a certain time period.
3. The global network characteristics of inter-cluster and intra-clusters for the various mentoring archetypes.
4. External constraints in the environment i.e., limit on the maximum number of mentors and apprentices at any given time.

The first and the second criteria in the model are based on observations reported by Ahmad et al [2] regarding mentoring networks in MMOs where only certain parts of the network were active at any given time. An additional reason is that players are not active in mentoring all the time but rather mentoring is a subset of activities performed by the players as described in section 3. It should be noted that the clusters described here are the clusters based on the player characteristics and not on the characteristics of the graph structure of the network. More than 98 percent of all the nodes in the network belong to the same largest connected component and given the density of the network a criteria like modularity [14] would reveal one large graph based community. Thus based on the criteria just described and empirical observations described in the previous section, we describe the following model for the phenomenon of mentoring and the characteristics of the various associated clusters observed for mentors.

1. The model is initialized with a set of \( n_0 \) nodes each of which belongs to one of the four archetypes or none at all which are assigned uniformly at random. Each node is additionally assigned a guild id uniformly at random or none at all.
2. At each instance a node is chosen for mentoring from the nodes already present in the network. A node can only be selected if it is not already mentoring.
3. When a new node arrives it is assigned at random one of four archetypes of mentoring behaviors or none at all.
4. Associated with each archetype is a bimodal distribution for its lifetime. The newly arrived node samples its lifetime from the corresponding bimodal distributions \( d_e \) depending upon its archetype. Each node is assigned a guild id uniformly at random or none at all.
5. If \( l(.) \) is the function which describes the label of the node as one of the four clusters then the mentoring node and the apprentice node establish their relationship based on the following probabilities:

\[
p(m \rightarrow a) = 0.75, l(m) = l(a) = \{Inst.\} \\
p(m \rightarrow a) = 0.4, l(a) = \{Guild Based\}, l(m) \neq \{Inst.\} \\
p(m \rightarrow a) = 0.25, l(a) = \{Friend Based\}, l(m) \neq \{Inst.\} \\
p(m \rightarrow a) = 0.15, l(a) = \{Veteran Based\}, l(m) \neq \{Inst.\} \\
p(m \rightarrow a) = 0.15, l(a) = \{Inst.\}, l(m) \neq \{Inst.\}
\]

6. The mentor node then samples the lifetime of its mentoring relationship with the apprentice node from the distribution \( d_e \).
7. Repeat Steps 2-5 by selecting a node from the set already present instead of newly arrived nodes.

Since the lifetime of the nodes are chosen based on the distributions obtained from the data it ensures that the first two requirements of the model are met i.e., the lifetime of the

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**Table 5: Cluster overlap from the model**

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Inst. (A)</th>
<th>Friend (A)</th>
<th>Guild (A)</th>
<th>Veteran (A)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inst. (M)</td>
<td>77</td>
<td>11</td>
<td>5</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>Friend (M)</td>
<td>15</td>
<td>26</td>
<td>41</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>Guild (M)</td>
<td>14</td>
<td>25</td>
<td>44</td>
<td>17</td>
<td>100</td>
</tr>
<tr>
<td>Veteran (M)</td>
<td>17</td>
<td>26</td>
<td>42</td>
<td>15</td>
<td>100</td>
</tr>
</tbody>
</table>
nodes is limited this as a result at any given time only a certain number of nodes are active. Additionally the cluster overlap for model is given in Table 4 which agrees with the observations from the data given in Table 5 since the probabilities of connectivity are based on the observed data.

VI. DISCUSSION

In this paper we analyzed various aspects of mentoring in a large scale MMORPG called EverQuest II. We found that mentors have different motivations for helping others: some are focused on helping friends and guildmates, while others use mentoring as a way to receive additional rewards and achievement in the game. Using cluster analysis, we were able to disentangle the various types of mentors based on play behaviors such as the amount and diversity of mentoring exchanges. We then examined social network measures between dyadic mentor-apprentice relationships, as well as more complex triadic exchanges. We found that these clusters differ in social network behaviors. Guild-focused mentors show higher brokering positions, while instrumental mentors show more centrality in the network. We argue that this is because those focused on their own achievement tend to be diverse in their connections, and thus have more opportunities to influence others, while those focused on helping their guildmates tend to form repeated clusters.

Second, the network formed by the mentoring relationship in itself is a novel network. In this regard the current paper extends the work by Ahmad et al [2] by proposing a network model that explains how mentoring emerges and evolves. By taking into account the lifespan and intensity of mentoring exchanges, we are able to highlight the uniqueness of this type of model. Future studies of mentoring in games and organizations can take these rules into account when modeling social behavior. To the best of our knowledge this is the first work on the social aspects of mentoring in MMORPGs. Overall, our paper contributes to computational social science by distinguishing several types of mentoring motivation and showing important differences in the social networking behaviors.

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