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Factors influencing sociability in educational MMORPGs – a fuzzy AHP approach

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Abstract

Purpose – Sociability is considered to be important to the success of educational MMORPGs. The purpose of this study was to access the relative weights of these sociability factors which the authors garnered from the literature on educational MMORPGs.

Design/methodology/approach – The authors used fuzzy-AHP approach to access the relative weights of these sociability factors they garnered from the literature on educational MMORPGs. To do this, a questionnaire using a pair-wise comparison data input format was administered to 242 school teachers to gather assessments for the factors.

Findings – The authors found five most important factors affecting sociability – cooperation, team-based reward, discussion of strategy, reputation, and social navigation.

Originality/value – Although prior studies have identified various factors that facilitate sociability in educational MMORPGs, the relative importance of these factors has not been determined. The results can not only be used to help educational MMORPG developers focus on the most important sociability factors and propose specific guidelines for designing educational MMORPGs, but can also identify the best design strategy for promoting sociability of educational MMORPGs.

Keywords Sociability, Analytical hierarchy process, Fuzzy theory, Educational MMORPGs, Multi-criteria decision making, Computer games

Paper type Research paper

1. Introduction

Massively multiplayer online role-playing games (MMORPGs) provide cyber-social environments that allow users to engage in various social activities, share social experiences, and learn social skills (Papargyris and Poulymenakou, 2004). The recent use of MMORPGs for learning purposes has received significant attention by researchers. Game developers have begun transforming the essential concept of MMORPGs into educational contexts, hoping to assist learners in achieving learning goals through playing games. Educational MMORPGs are believed to possess the potential for increasing learners' intrinsic motivation for problem solving, team interaction, and role playing activities (Dickey, 2007, 2011; Paraskeva *et al.*, 2010; Jang and Ryu, 2011; Nelson *et al.*, 2011; Hou, 2012). Furthermore, they may facilitate learners' socialization and assist the improvement of teamwork skills, such as cooperation, communication, and coordination by passing through various difficult and complex in-game tasks that require learners to function together (Childress and Braswell, 2006; Kim *et al.*, 2009; Jang and Ryu, 2011; Yien *et al.*, 2011).



Although educational MMORPGs are rapidly developing and are adopting various learning domains extensively, game designers do not always successfully integrate learning contents within the mechanics of the game (Habgood and Ainsworth, 2011). Studies have proposed that sociability, the ability to trigger learners' social interactions, is the most important mechanic that can be effectively integrated with learning content in educational MMORPGs (Jang and Ryu, 2011; Hou, 2012). For example, Hou (2012) indicated that the ability of educational MMORPGs to trigger social interactions is highly correlated to the high level of learning engagement, which increases opportunities for mastery learning through collaboration. According to Jang and Ryu (2011), the richness of the required social interactions for playing educational MMORPGs can improve learners' leadership skills in both the game and real life. Therefore, sociability is critical to the success of educational MMORPGs.

Prior conducted studies for identifying the influences on learners' sociability have discovered that organizational norms facilitate learners' ability to socialize with others in the community (Ryan and Deci, 1996; Ducheneaut and Moorel, 2004; Tulathimutte, 2006; Jang, 2007; Wolf, 2007; Verhagen and Johansson, 2009). Several scholars have argued that MMORPGs should rely heavily on social interaction to support learner-to-learner interaction (Choi and Kim, 2004; Ducheneaut and Moore, 2005; Williams *et al.*, 2006; Jang and Ryu, 2011; Hou, 2012). Other studies have examined the influence of team activity on learners' sociability in the game world (Jakobsson and Taylor, 2003; Ducheneaut and Moore, 2005; Williams *et al.*, 2006; Steinkuehler and Williams, 2006). These studies stated a broad range of factors that influence sociability in MMORPG environments, but they have not provided the whole picture and the relative importance of the factors affecting sociability, which increases the difficulty for decision makers. Determining their relative importance assists developers in focussing on factors with the greatest weight and identifying the best design strategy for improving games' sociability.

The evaluation of these factors can be considered a multiple-criterion decision-making problem. Prior studies (Kahraman *et al.*, 2003; Büyüközkan, 2004; Kim and Nevo, 2008; Nakatani and Chuang, 2011) regarded the analytic hierarchy process (AHP) as an appropriate method for solving these types of issues. The AHP can be used to systematically determine the relative importance of a set of dimensions in a multi-criteria decision problem. When AHP is performed, a decision problem is decomposed into a hierarchical structure model that includes several decision components. The relative importance of each decision component can be determined, which can be assigned a score that is calculated through a pair-wise comparison (Kurttila *et al.*, 2000). This study uses a hybrid methodology that combines fuzzy logic techniques and the AHP approach. This hybrid methodology provides a systematic tool for analyzing learners' sense of importance of the factors that affect sociability and assist decision makers in decomposing the multi-criteria problem into a hierarchical model. This structuralized model represents the top-level goal and the various sub-dimensions of the decision problem. Using the hierarchical model, decision makers can evaluate the relative importance of each game factor by implementing a pair-wise comparison; thus, the mental workloads employed by developers in the multi-criteria comparisons are reduced, and the results are more precise (Miller, 1956). These results are used to assist educational MMORPG developers in focussing on the most important sociability factors and propose specific guidelines for designing educational MMORPGs, but also identify the best design strategy for promoting sociability in

educational MMORPGs. Furthermore, teachers can use these results to determine the sociability criteria for educational MMORPGs.

2. Factors that influence sociability in educational MMORPGs

2.1 Sociability in serious game and social media

Previous studies suggested that serious games and social media such as computer-supported collaborative learning (CSCL) environments, internet forums, weblogs, and micro-blogging have the potential to improve sociability through the increasing cooperation of members and mastery of social skills (Dondlinger, 2007; Dede *et al.*, 2000; Preece, 2000; Kreijns *et al.*, 2002). Kreijns *et al.* (2004) designed and implemented sociable CSCL environments and discovered that the higher the sociability, the more probability that social interactions occur/increase and the more probability that a sound social space emerges. Lane and Hays (2008) used virtual humans and a serious game referred to as intelligent tutoring system for teaching cross-cultural social interaction skills. They discovered that sociability has a central role in the process of learning cross-cultural social interaction skills. Assmann and Gallenkamp (2009) developed a serious game for teaching leadership and discovered that perceptions of leadership trustworthiness were affected by culture, high self-disclosure, and intensive use of communication media. Hämäläinen *et al.* (2008) performed a qualitative analysis of the functions of utterances between players in an online 3D virtual serious game. Players functioned together in a team to resolve problems regarding work safety in a construction-related work environment. Their results show how structured support can be implemented in games to inform players of the next required actions at different phases in the game. Furthermore, Hämäläinen demonstrated the use of serious games for a social activity that would not have been possible in a traditional classroom setting, which may foster users' intentions for socializing with others. The studies comprehensively indicated the importance of sociability in the design of serious games and social media.

2.2 Development of factors that influence sociability in educational MMORPGs

As shown in Table I, a review on relevant literatures is conducted to identify the variables that develop the factors that influence sociability in educational MMORPGs. Thereafter, we performed an in-depth interview with educational MMORPG experts to differentiate and classify these factors. Eighteen educational MMORPG experts (nine male and nine female) participated in the interview. All users were requested to discriminate and classify factors that influence sociability. Thereafter, a hierarchical model was constructed to represent the systematic structure of factors that affect sociability based on the results of the interview (Figure 1).

2.3 Systematic framework of factors that influence sociability in educational MMORPGs

The factors that affect sociability according to the interview results are shown in Figure 1 and are divided into three main dimensions: organizational norms, social networking and interaction, and team activity. Organizational norms refer to the social norms regarding social behaviors that are acceptable within a group, including design factors such as reputation, social norms, and team-based rewards. Social networking and interaction refers to the processes that facilitate the formation of social networks, in which learners can connect with others, including social presence, social navigation, social networking, and character customization. Team

Factors	References studies
Reputation	Tulathimutte (2006), Wolf (2007)
Social norms	Verhagen and Johansson (2009), Jakobsson and Taylor (2003), Ducheneaut and Moore (2004)
Team-based reward	Ryan and Deci (1996), Ducheneaut and Moore (2004), Chiu <i>et al.</i> (2006)
Social presence	Short <i>et al.</i> (1976), Gunawardena (1995), Tammelin (1998), Tu (2000, 2002), Tu and Isaacs (2002), Kreijns <i>et al.</i> (2002)
Social navigation	Laffey <i>et al.</i> (2006), Hutchins (1995)
Social networking	Laffey <i>et al.</i> (2006), Gunawardena (1995)
Character customization	Chou (2003), Dickey (2007), Gee (2004), Lo (2008)
Discussion of strategy	Jakobsson and Taylor (2003), Steinkuehler and Williams (2006), Salas <i>et al.</i> (1992)
Cooperation	Jakobsson and Taylor (2003), Steinkuehler and Williams (2006), Goldstein (1994), Andrews <i>et al.</i> (2002)
Communication	Jakobsson and Taylor (2003), Steinkuehler and Williams (2006)
Coordination	Jakobsson and Taylor (2003), Steinkuehler and Williams (2006), Salas <i>et al.</i> (1992)

Table I
The overview of all factors influence sociability

activity refers to the internal processes that occur as learners integrate into a learner group. These include the discussion of strategy, coordination, communication, and cooperation.

2.3.1 Organizational norms. Reputation refers to the in-game mechanism that encourages learners' behaviors based on the estimation of recognition held by others inside and outside of an organization (Tulathimutte, 2006; Wolf, 2007). The concept of reputation has been commonly adopted in online shopping web sites such as eBay and Amazon.com to increase the reliability of systems, reduce risks between users, and assist users in deciding whether to interact and trust with a user based on other users' experiences with that user. Several MMORPGs such as World of Warcraft (WOW) and Ultima Online use reputation to recognize players that fought with other players of comparable experience levels to obtain special titles and items. Learners' desire for reputation may be considered a motivation for learning because they play harder to increase their reputation in game. Furthermore, reputation facilitates sociability in a game.

Social norms are characterized by an emphasis on control with a focus on the internal environment, revealing a significant emphasis on defining social norms, controlling behavior, and setting punishments for misbehavior (Verhagen and Johansson, 2009). Social norms ensure that the process of social interaction between learners assists learners in constructing the in-game social network and results in higher sociability (Jakobsson and Taylor, 2003; Ducheneaut and Moore, 2004).

Team-based rewards refer to the system that satisfies group members' shared needs, driving them toward participating in group activities (Ryan and Deci, 1996; Ducheneaut and Moore, 2004). For instance, WOW beginner teams receive additional experience and special weapons when they finish a 25-player raid (a specific team quest in-game) and satisfy specific requirements of the game. Reasons for using team rewards include supporting a team-based structure, fostering teamwork among team members, and promoting team productivity, which drives individuals toward

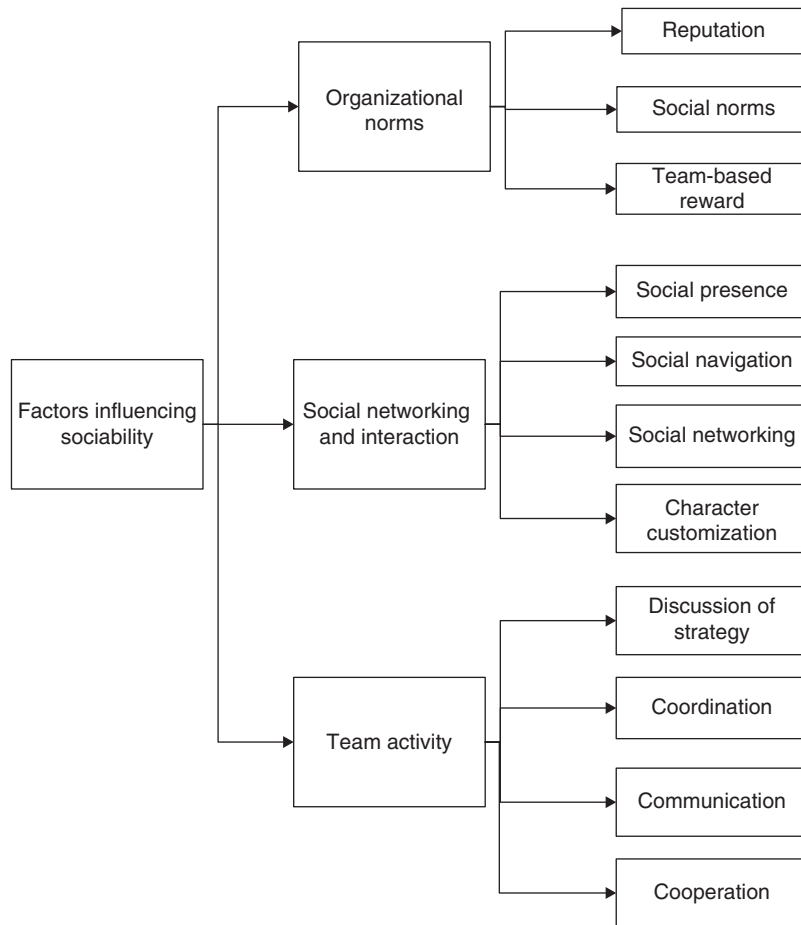


Figure 1.
The hierarchical structure
of the research problem

working together to achieve the same goals. Chiu *et al.* (2006) examined knowledge sharing in a virtual community and discovered that intrinsic team-based rewards (outward praise and respect) and extrinsic rewards (money and virtual items) can improve mutual trust, interaction, and reciprocity among individuals, facilitating sociability in the community. A group receives team-based rewards in educational MMORPGs when they perform well. Team-based rewards increase learners' reliance on team effort rather than their own; thus, team-based rewards bridge a learner with the learner group and motivate learners toward continuing to interact with team members, perpetuating higher sociability.

2.3.2 Social networking and interaction. Social presence is a commonly used term in media studies for referring to how effectively a computer-mediated media conveys the feeling that mediated participants are actually present (Short *et al.*, 1976). Social presence is believed to be another factor that influences sociability because it enhances learners' sense of community and social influence in gaming (Gunawardena, 1995; Tammelin, 1998; Tu, 2000, 2002; Tu and Isaacs, 2002; Kreijns *et al.*, 2002). As learners

play in an environment with a high social presence, they feel more affiliated with others, which improve sociability.

Social navigation is a construct that represents awareness of others' actions as a primary guide for own actions (Laffey *et al.*, 2006). This concept is a social and a frequently collaborative process (Hutchins, 1995). A social navigation goal of online game learners involves using information regarding other learners' behaviors for their own navigational decisions. Therefore, social navigation expands and maintains learners' social networks, facilitating sociability.

Social networking provides a feeling of connection to others (Laffey *et al.*, 2006; Gunawardena, 1995). As learners search for groups and require assistance during gaming, social networking enables them to contact others immediately. Therefore, social networking can be regarded as an important factor that affects sociability.

Character customization is the choice of the amount and multimedia type of information that users (learners and instructors) have assessed for personalizing and distinguishing a user from others (Chou, 2003; Dickey, 2007), which influences sociability because outward attractiveness influences learners' social interactions (Lo, 2008). Gee (2004) suggested that video games should recommend that learners attempt new styles as beginners because different styles are suitable for different people. Most MMORPGs provide various clothes, decorations, and equipment to cater to various individual preferences in appearance. Character customization enhances social interactions as learners begin socializing and chatting with others. Consequently, character customization involves sociability.

2.3.3 Team activity. Discussion of strategy is believed to affect team sociability (Jakobsson and Taylor, 2003; Steinkuehler and Williams, 2006; Salas *et al.*, 1992). Discussing strategy is a pre-planning task that occurs when MMORPG learners organize teams for solving difficult and complex game missions. Team strategies involve mission-related affairs such as the deployment of members, attack and defense tactics, and item distribution. Every learner is encouraged to participate in strategy discussions, decision making, and implementing decisions, which create an agreement among group members and sociability.

Coordination is a managerial factor that can influence team sociability (Jakobsson and Taylor, 2003; Steinkuehler and Williams, 2006; Salas *et al.*, 1992). Coordination is the manifestation of organization, which involves arranging various people or things to work in unison toward a goal or effect for accomplishing desired goals in an organization manner. More coordinated efforts to organize build stronger ties among team members, facilitating sociability.

Another factor that influences sociability is cooperation (Jakobsson and Taylor, 2003; Steinkuehler and Williams, 2006). Cooperation is the act of working together toward a common goal and is essential when individuals are required to participate in certain activities among differentiated tasks. Educational MMORPG learners are normally required to cooperate in games for solving difficult and complex quests that are designed for educational purposes. The cooperation between learners improves the sociability within a game. Goldstein (1994) indicated that playing video games is a social activity, which often involves cooperation between and among learners. Andrews *et al.* (2002) considered cooperative behavior to be highly correlated with good sociability in the community.

Communication is a group function that enables members to share information and exchange messages (Jakobsson and Taylor, 2003; Salas *et al.*, 1992). Learners can

conduct face-to-face, text, or voice chatting communications, and exchange messages to interact with others learners in educational MMORPGs. Communication assists learners in building and maintaining relationships with others, which contributes to game sociability.

3. Assessment of factors that influence sociability

This study uses fuzzy AHP to weigh the relative importance of various factors that affect the sociability in educational MMORPGs. Fuzzy AHP overcomes several shortcomings of AHP (Ayağ, 2005): first, the subjective judgment, selection, and preference of decision makers has a significant influence on AHP results; second, ranking of the AHP method is imprecise; third, the AHP method creates and handles a significantly unbalanced scale of judgment; fourth, the AHP method does not consider the uncertainty that is associated with the mapping of an individual’s judgment to a number; and finally, the AHP method is restricted for use in nearly crisp decision applications. Moreover, Buckley (1985) suggests that another advantage of fuzzy AHP is its simplicity for computations. Therefore, this study adopted the fuzzy AHP approach because it allows a more accurate description of the decision-making process. Table II shows a comparison of the methods, including the advantages and disadvantages of the current fuzzy AHP methods in literature, which have important differences in their theoretical structures. The proposed approach is adopted because it can precisely compute synthesized weight and has a lower computational requirement compared to other fuzzy AHP approaches. The proposed approach

FAHP method	Feature	Advantages	Disadvantages
van Laarhoven and Pedrycz (1983)	Derive fuzzy weights using Lootsma’s logarithmic least square method Adapt Saaty’s AHP method with triangular fuzzy numbers	The opinions of multiple decision makers can be modeled in the reciprocal matrix	There is not always a solution to the linear equations Computational procedure is too complex
Boender, <i>et al.</i> , (1989)	Revise van Laarhoven and Pedrycz’s method Propose new approach for normalization of the local priorities	It allows to model multiple decision-makers’ opinions	Computational procedure is too complex
Chang (1996)	Calculate aggregate weights using entropy concepts Define fuzzy standards	The computational procedure is relatively low	This approach is restricted to probability and possibility measures Entropy only works as probability distribution is known
This proposed approach	Construct the fuzzy comparison matrix using triangular fuzzy numbers Defuzzify weights using Tzeng and Teng’s (1993) center of gravity method	It is easy to extend to the fuzzy case It ensures a unique solution to reciprocal comparison matrix	Computational procedure is still somewhat complex

Table II
The comparison of different fuzzy AHP approaches

contains a questionnaire design, data collection, computational procedure for fuzzy AHP, and results.

3.1 Questionnaire design and data collection

This study developed a questionnaire to gather educational MMORPG teachers' assessments of the relative importance of the organizational norms, social networking and interaction, and team activity factors in a pair-wise comparison data input format. Each item was assessed using a nine-point ratio scale, as suggested by Saaty (1990). An example of questionnaire is shown in Appendix. The response to each items represented ideas, for example, as equally important, moderately important, strongly important, very strongly important, and extremely important. We conducted a survey and recruited 259 Taiwanese teachers who had used educational MMORPG in their courses as participants. After primary data analysis, we deleted incomplete questionnaires and outlier data, leaving us with 242 valid samples for use in this study. The gender distribution of participants was 118 (48.76 percent) males and 124 (51.24 percent) females. Seventy-three (30.17 percent) of the participants were elementary school teachers, 34 (14.05 percent) were junior high school teachers, 70 (28.93 percent) were senior high school teachers, and 65 (26.85 percent) were college teachers. Detailed descriptive statistics relating to the participants' characteristics are shown in Table III.

3.2 Computational procedure for fuzzy AHP

There were seven steps in our proposed fuzzy AHP approach. We first used triangular fuzzy numbers to construct the fuzzy comparison matrix. Second, we integrated the collected teachers' assessments of each decision factors and dimensions using the fuzzy average method proposed by Buckley (1985). Third, we computed the fuzzy weight of each decision factor using the approximation method introduced by Buckley (1985). Fourth, the center of gravity method, a defuzzifying method proposed by Tzeng and Teng (1993), was performed to defuzzify the weight of each decision factor. Fifth, we normalized the weights of all of the decision factors. Sixth, we aggregated each level of the proposed hierarchical model of factors affecting sociability and calculated the relative value of the fuzzy weight for each factor at dimension levels. Finally, we computed the consistency index (CI) and consistency ratio (CR) for each fuzzy comparison matrix.

3.2.1 Constructing the fuzzy comparison matrix. Triangular fuzzy numbers \tilde{M}_{ij} from $\tilde{1}$ to $\tilde{9}$ was employed to represent the results of users' assessments of the pair-wise

Measure	Value	Frequency	%
Gender	Male	118	48.76
	Female	124	51.24
Level	Elementary school	73	30.17
	Junior high school	34	14.05
	Senior high school	70	28.93
	College	65	26.85
Years of teaching experience	< 5	77	31.82
	5 ~ 15	105	43.39
	> 15	60	24.79

Table III
Descriptive statistics of subjects in this study

comparisons between each of the decision dimensions (see Table IV) by constructing a fuzzy positive reciprocal matrix M , which is the outcome of this step, and can be defined as follows:

$$M = [\tilde{M}_{ij}]$$

where M , fuzzy positive reciprocal matrix:

$$\tilde{M}_{ij} = (L_{ij}, M_{ij}, R_{ij})$$

where L_{ij} , the left value of the fuzzy membership function of the collected subject assessments of design factor j of decision dimension i ; M_{ij} , the middle value of the fuzzy membership function of the collected subject assessments of design factor j of decision dimension i ; R_{ij} , the right value of the fuzzy membership function of the collected subject assessments of design factor j of decision dimension i :

$$\tilde{M}_{ij} = \frac{1}{\tilde{M}_{ji}} \quad \forall i, j = 1, 2, \dots, n$$

3.2.2 *Integration of the collected subjects' assessments of each factor.* There are many possible approaches to integrating subject assessments when calculating the triangular fuzzy number. In contrast to some studies that apply statistical parameters such as the minimum, maximum, mean, and mode to represent the fuzzy numbers, this study applied the geometric mean method proposed by Buckley (1985). The computing process is defined as follows:

$$\tilde{m}_{ij} = \left(\frac{1}{n}\right) \otimes \left(\tilde{m}_{ij}^1 \oplus \tilde{m}_{ij}^2 \oplus \dots \oplus \tilde{m}_{ij}^n\right)$$

where \tilde{m}_{ij} , integrated triangular fuzzy numbers; \tilde{m}_{ij}^n , the value of the pair-wise comparison of the collected subject assessments of design factor j of decision dimension i ; n , the number of subjects.

After this computing process, integrated triangular fuzzy numbers is obtained as the outcome.

Table IV
Membership function
and definitions of
fuzzy numbers

Fuzzy number	Membership function	Definition
$\tilde{1}$	(1,1,2)	Equally important
$\tilde{2}$	(1,2,3)	Between equally and moderately important
$\tilde{3}$	(2,3,4)	Moderately important
$\tilde{4}$	(3,4,5)	Between moderately and strongly important
$\tilde{5}$	(4,5,6)	Strongly important
$\tilde{6}$	(5,6,7)	Between strongly and very strongly important
$\tilde{7}$	(6,7,8)	Very strongly important
$\tilde{8}$	(7,8,9)	Between very strongly and extremely important
$\tilde{9}$	(8,9,10)	Extremely important

3.2.3 Computation of fuzzy weight. After integrating the collected data and calculating the corresponding triangular fuzzy numbers, we used the approximation method proposed by Buckley (1985) to compute the fuzzy weight. The formula of the approximation method proposed by Tzeng and Teng (1993) for computing the fuzzy weights is defined as follows:

$$\begin{aligned}\tilde{Z}_i &= (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \dots \otimes \tilde{a}_{in})^{1/n} \quad \forall i = 1, 2, \dots, n \\ \tilde{W}_i &= \tilde{Z}_i \otimes \left(\tilde{Z}_1 \oplus \tilde{Z}_2 \oplus \dots \oplus \tilde{Z}_n \right)^{-1}\end{aligned}$$

where \tilde{Z}_i , the geometric mean value of the triangular fuzzy number; \tilde{a}_{ij} , the triangular fuzzy number of row i and column j in the fuzzy positive reciprocal matrix; \tilde{W}_i , the fuzzy weight of each row of the fuzzy positive reciprocal matrix.

After this computing process, the fuzzy weight of each row of the fuzzy positive reciprocal matrix is obtained as the outcome.

3.2.4 Defuzzification of decision dimensions. The weights of the decision dimensions and decision factors were represented by fuzzy values. The defuzzification process assigned a distinct number to each of the decision factors. We then used the center of gravity method of defuzzification to calculate the center of gravity of the triangular fuzzy number. Given a triangular fuzzy number and its three sides, denoted by $\hat{A} = (L_{ij}, M_{ij}, R_{ij})$, the outcome – defuzzified weight DF_{ij} was calculated using the following formula:

$$DF_{ij} = [(R_{ij} - L_{ij}) + (M_{ij} - L_{ij})]/3 + L_{ij}$$

3.2.5 Normalization of defuzzified weights. To compare the importance of different decision factors at different dimensions, we first normalized the defuzzified weights. The definition of the normalized weights (NW_i) of each decision dimension at each level can be defined as follows:

$$NW_i = DF_{ij} / \sum DF_{ij}$$

After this computing process, the normalized weights (NW_i) of each decision dimension at each level is obtained as the outcome.

3.2.6 Calculation of the synthesized weight for each of the factors at each level. We calculated the normalized weights of each decision factor at each dimension as the outcome. However, to determine the priority of each dimension, it was still necessary to synthesize weights for each decision factor at each decision dimension. The larger the value of the synthesized weight, the higher the priority of the dimension. The definition of synthesized weights of each decision dimension at each level was defined as follows:

$$NW_K = NW_i \times NW_{ij} \times NW_{ijk}$$

After this computing process, the synthesized weights of each decision dimension at each level is obtained as the outcome.

3.2.7 Checking for consistency. CI was employed to designate overall inconsistency for the proposed hierarchy and for each decision dimension. CR was also calculated to

describe the consistency of the pair-wise comparisons. CI and CR is the outcome of this step and the equations for calculating were:

$$Consistency\ index\ (CI) = \frac{\lambda_{Max} - n}{n - 1}$$

where λ_{Max} is the maximum eigenvalue, and n the number of decision component:

$$Consistency\ ratio\ (CR) = \frac{CI}{RI}$$

RI is the average index for randomly generated weights obtained from a table of random consistency indices. To judge the consistency of the pair-wise outputs, if CR was ≤ 0.1 , then the output of the pair-wise comparison was sufficiently consistent. On the other hand, if CR was > 0.1 , then the results of the pair-wise comparison were inconsistent.

3.3 Results

According to the seven steps of the fuzzy AHP calculation step, the output – synthesized weight for each of the factors at each level can be obtained. As can be seen in Table V, is a summary of the final weights for the three dimensions affecting educational MMORPG learners’ sociability. “Team activity” (weight = 0.389) was the most important dimension that contribute the most to teachers’ assessments on sociability in this study, followed by “social networking and interaction” (weight = 0.339) and “organizational norms” (weight = 0.272). For each dimension, the factors with the greatest importance from teachers’ perspective were “cooperation” (weight = 0.314), “social navigation” (weight = 0.302), and “team-based reward” (weight = 0.399), respectively. Reviewing the weights across all dimensions in Table V, we can see that the factor “cooperation (weight = 0.122),” “team-based reward (weight = 0.108),” “discussion of strategy (weight = 0.108),” “reputation (weight = 0.104),” and “social navigation (weight = 0.102)” have the highest rankings. In our study, the CR was $0.083 \leq 0.1$, then the output of the pair-wise comparison can be proven sufficiently consistent.

Dimensions	Weights	Factors	Weights within dimension	Synthesized weight (ranking)
Organizational norms	0.272	Reputation	0.382	0.104 (4)
		Social norms	0.219	0.060 (10)
		<i>Team-based reward</i>	0.399	0.108 (2)
Social networking and interaction	0.339	Social presence	0.173	0.059 (11)
		<i>Social navigation</i>	0.302	0.102 (5)
		Social networking	0.269	0.091 (7)
		Character customization	0.256	0.087 (8)
Team activity	0.389	Discussion of strategy	0.278	0.108 (2)
		<i>Cooperation</i>	0.314	0.122 (1)
		Communication	0.167	0.065 (9)
		Coordination	0.241	0.094 (6)

Table V
Weighted dimensions and factors influencing sociability in educational MMORPGs

4. Discussion

The results indicated that cooperation was one of the most important factors that contribute the most to teachers' assessments on sociability. The potential reason for this result may be similar to that shown in the Ducheneaut and Moore (2005) study, which states that cooperation, is a basic social skill for learners that can facilitate teamwork. As learners initially play a team game, they increasingly cooperate with others while performing various combat roles such as "tank," "healer," "caster," and "melee." This playing strategy demands more challenges and cooperation, which results in an improved flowing experience compared to playing alone (Hsu *et al.*, 2009). Furthermore, these cooperative tasks involve stimulating more social interactions between team members, which improves a learner's sense of sociability within the game. Gee (2004) suggested that cooperation is associated with the learning principle regarding "insiders," in which the learners' experience is customized by permitting them to play the roles of "insiders," "teachers," and producers." Furthermore, learners begin customizing their learning experience as they cooperate with others.

The team-based reward is another important factor that contributes the most to teachers' assessments on sociability. Team-based rewards increase team members' intrinsic motivation, controls their participation behavior, and distracts them from the responsibility of regulating themselves (Ryan and Deci, 1996). Team learners involved in team-based reward-related activities such as accumulating gold and acquiring rare items in MMORPGs form reinforcing team-based reward loops. For example, League of Legends provides learners with additional team-based rewards such as special outward character appearances and items, which are beneficial to their goals of character optimization and fosters their motivation for playing. In educational MMORPGs, team-based reward loops sustain the motivations of teams (Hsu *et al.*, 2009) and results in increased in-game sociability because learners have more opportunities to play together.

The discussion of strategy contributed to teachers' feeling of importance that contributes their assessments on sociability. Most beginners of MMORPGs become more involved in the discussion of strategy and social interaction as they progress (Chen *et al.*, 2008) because they tend to join teams to solve the more difficult and complex quests. The contribution to sociability from the discussion of strategy can be explained by Gee's (2004) learning principle regarding "distributed knowledge," which indicates that knowledge is distributed across learners, objects, artifacts, symbols, technologies, and environments. Discussing strategy allows learners to share knowledge among each other, which facilitates the integration of knowledge. This sharing of distributed knowledge improves learners' interactions, resulting in enhanced sociability.

Reputation was identified as the most important contributing factor to sociability. The higher a learner's reputation in the game, the more potential can be recognized by others. Therefore, the recognition based on in-game reputation motivates learners toward working harder, engaging in teamwork to solve quests, and continuously logging into the game, which facilitates in-game sociability.

Furthermore, social navigation is an important factor that contributes to sociability. Dieberger *et al.* (2000) proposed that future information systems in online environments result in populated spaces where an awareness of other people's activities is present, where people rate and annotate information, and provide guidance either directly or through intermediaries. Therefore, the importance of social navigation grows with the evolution of an educational MMORPG. The function of

social navigation in a game is reminiscent of the principle of “explicit information on-demand and just in time,” in which attempts are made to provide learners with information at an instant where is both understandable and usable by them (Gee, 2004). Being understood by friends and the community, and receiving useful information from group members may increase their sense of belonging, which results in increased game sociability.

These factors can be used by developers to improve the sociability of educational MMORPGs. First, developers may desire creating a team mentor system that can enable low-leveled learners to implement team tasks in cooperation with other high-leveled team members. This team mentor system can assist low-leveled learners in attending to common goals of the group in cooperation with high-leveled learners, facilitating learner-to-learner interaction. Second, developers can create a team-based reward distribution mechanism to ensure the fair distribution of team-conferred reward points. Team-conferred rewards points can encourage learners to play with team members rather than solo. Such a system may quantitate each team member’s contribution. For example, team learners may receive these points when assisting the team or when another team member completes a difficult quest or defeats a significantly challenging monster. Team-based points should be convertible to visible rewards such as gifts or money from the game’s online shop. Third, developers can design a member discussion interface that allows teams of learners to define social norms, mission assignments, resources, and expected team-based rewards before implementing team tasks to support learners’ discussions of strategy. This interface may strengthen learners’ communications regarding missions and role expectations, increasing sociability. Fourth, educational MMORPG developers can design reputation scorecards for team members, which allow learners to compute and publish reputation scores, including metrics such as the exploration progresses of teams, fitness of members’ races, and fitness of members’ classes, their mission progressions, and the number of power gamers in their learner group. This team member reputation scorecard can motivate team members toward investing more time and effort in increasing the reputation of the team. Finally, social navigation may be enhanced if developers provide a friendship channel to assist learners in participating in friends’ in-game dynamics, finding information, receiving useful information based on others’ recommendations, or assisting the learner in deciding whether to join a learner group. This friendship channel may increase learners’ socialization through the conversion of learners’ social relationships into physical and emotional support.

A pattern model for facilitating team sociability in educational MMORPGs emerged from the discussions of these critical factors. Team-based rewards, discussions of strategy, and reputation are relevant to learner to team interaction, which may influence learners’ team performance and eventually contribute to sociability. Cooperation and social navigation involve learner-to-learner interaction, which may improve sociability by increasing a learner’s sense of belonging. Therefore, a relationship may exist between the factors affecting sociability, team performance, sense of belonging, and sociability. Further studies may confirm the relationship between these constructs by using a structural equation modeling approach. Understanding the relationship between these factors and sociability can assist game developers in predicting sociability and manipulating these factors in their design to facilitate sociability. Moreover, this study uses fuzzy AHP to create an evaluation model for assisting developers in understanding the critical factors that facilitate sociability in educational MMORPGs. Future studies can use these results for building

the causal effect model to identify the cause-and-effect relationships between these five factors and improve sociability.

This study has several limitations. A limitation of this study is that the sample only included Taiwanese teachers. Future studies should apply the model to other regions of learners to include cross-national or cross-cultural aspects, as the differences in priority sets can provide a basis for identifying situational effects. Second, the evaluation criteria were selected from a review of literature regarding sociability and we do not suggest the factors represent an exhaustive list. Other possible sociability factors may not include in this study. Future research can use different methodologies, such as longitudinal or qualitative studies to identify other sociability factors.

5. Conclusion

Sociability is the most important mechanic that can be effectively integrated with learning content into educational MMORPGs. As previous studies have mentioned a broad range of factors that influence sociability in educational MMORPG environments, they have not provided the whole picture of the factors affecting sociability. The results not only be used to help educational MMORPG developers focus on the most important sociability factors and propose specific guidelines for designing educational MMORPGs, but can also identify the best design strategy for promoting sociability of educational MMORPGs.

This research has both theoretical and practical contributions. From the theoretical standpoint, this study presented a systematic framework for studying sociability in educational MMORPGs or similar environments. This study not only confirms but also extends the current line of research in sociability. In the practical side, the findings can serve as the reference framework to assist current educational MMORPGs for the future development of sociability designs. Also, the tool used in the study can also be used to evaluate importance along specific sociability dimensions to improve their function and designs.

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Further reading

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Appendix. An example of question items in fuzzy AHP pair-wise questionnaire

Please compare in pairs the relative importance between two given item statements regarding the factors influence sociability. If a criterion (or sub-criterion) on the left is more important than the one matching on the right, put your check mark to the left of the importance “equal” under the important level you prefer. If a criterion (or sub-criterion) on the left is less important than the one matching on the right, put your check mark to the right of the importance “equal” under the important level you prefer. The notations of relative importance are following:

- (1) absolutely – absolutely more important;
- (2) very strongly – very strongly more important;
- (3) strongly – strongly more important;
- (4) weakly – weakly more important; and
- (5) equally – equally important.

	Very Absolutely strongly					Equally					Very strongly Absolutely							
Criterion (or sub-criterion)	9:1	8:1	7:1	6:1	5:1	4:1	3:1	2:1	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	Criterion (or sub-criterion)
Social presence																		Social navigation

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