Chapter 14
Interactivity[3] Design and Assessment Framework for Educational Games to Promote Motivation and Complex Problem-Solving Skills

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14.1 Introduction

Digital game-based learning has been receiving increasing attention from educational researchers in recent years (cf. Gee, 2003; Prensky, 2006, 2007; Shaffer, 2006). Among many genres of digital games, massively multiplayer online role-playing games (MMORPGs) are especially touted. MMORPG is a genre of role-playing video games that can be described as a "persistent, networked, interactive, narrative environment in which [large] number of players collaborate, strategize, plan and interact with objects, resources, and other players within a multi-model environment [of a virtual game-world]" (Dickey, 2007, p. 254). These unique affordances of MMORPG make it an ideal candidate to serve as an open-ended learning environment that support contextualizations (Cordova & Lepper, 1996; Parker & Lepper, 1992), situated cognition (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991), intrinsic motivation (Rieber, 1996), and social communication (Gredler, 2004; Wideman et al., 2007). Hence, the proponents of MMORPGs strongly argue for their potential in promoting students' motivation and complex problem-solving skill development (e.g., Gee, 2007; Greenfield, 2010; van Eck, 2006, 2007; Yanuzzi & Behrenhausen, 2010).

However, little empirical research exists to support these assertions. Based on their review of empirical literature published in the past 20 years, Eseryel, Ifenthaler, and Ge (2010) conclude that the potential of digital game-based learning is unrealized due to lack of empirically validated instructional design frameworks to support

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students' motivation and complex problem-solving skill development. In order to address this gap, for the past few years, we have been engaged in design-based research (DBR) that aim at eliciting educational MMORPG design principles to facilitate students' motivation and complex problem skill development (cf. Eseryel & Ge, 2010).

The goal of this book chapter is to present the Interactivity[3] design and assessment framework that has emerged from this DBR effort. Special attention is paid to bridging three levels of interactivity that were identified in our study as having crucial importance for effective educational game design: (1) interface interactivity, (2) narrative interactivity, and (3) social interactivity.

In the remainder of this chapter, we first introduce the details of our DBR initiative that was launched by carrying out a series of studies in a rural high school in the Midwest United States. Then, we explicate the design model and the accompanying evaluation framework to help guide the development and testing of different levels of interactivity in educational game design. We then present a study that shows the validity of the Interactivity[3] design and assessment framework for MMORPGs. We conclude with the discussion of the findings of the setting an agenda for future research.

14.2 Design-Based Research Framework

In order to arrive at design principles for effective educational MMORPGs to promote students' motivation and complex problem-solving skill development, we investigated with *McLarin's Adventures*, an educational MMORPG that was being developed by the K20 Center at the University of Oklahoma.

McLarin's Adventures is an educational adventure MMORPG, in which middle and high school students collaborate to solve complex problems that call for cross-disciplinary learning (mathematics, literacy, science, and social studies) (see Wilson & Williams, 2010 for details). When students first enter *McLarin's Adventures*, they are presented with a news video reporting on eccentric trillionaire Jonathan McLarin's dream of interplanetary and interstellar travel. His company, McLarin International, has finally produced a vehicle capable of traveling one light year in a single day. In this news video, Mr. McLarin announces the plans to send a team of experts to explore and survey Earth-like planets outside of our solar system. To select a team who will receive this great honor, McLarin International is holding a competition for mathematicians, scientists, and journalists. Each team will have to prove their abilities to survive while meeting the specified goals. Then, McLarin International's Chief Operating Officer appears and invites potential applicants to apply and the game begins.

This background game narrative calls the students to play the role of mathematicians, scientists, and journalists competing to prove their capabilities to McLarin International. The game narrative divides the overall complex problem-solving task into several whole-task problem scenarios including locating water resources, determining the quality of water supplies and purification, settlement planning and

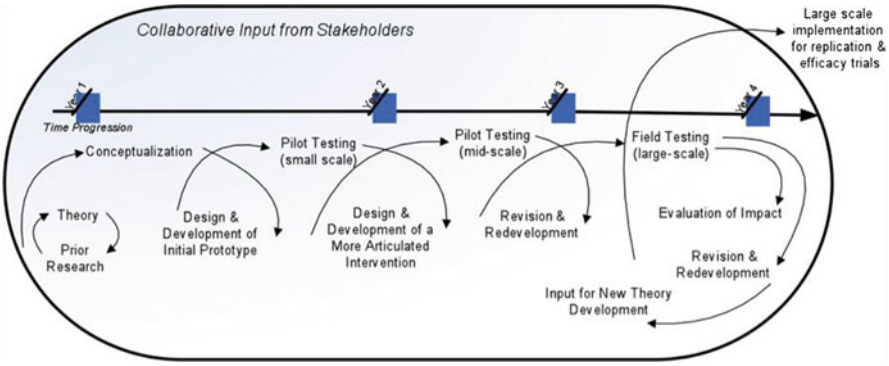

Fig. 14.1 Design-based research framework

building of shelters, locating food sources for colonization, creating an inventory of supplies and requirements for additional supplies, building a sanitation system, and so on. The competencies required to solve these problem scenarios are aligned with the learning standards outlined by the State Department of Education.

In the game environment, whole-task scenarios are presented through a communication kiosk. After student teams complete each task, they submit their reports to McLarin's International through the system, receive automated confirmatory feedback from the system, and proceed to the next kiosk for the next task. In order to assist students during their game play, the game interface includes navigation support tools, in-game applications (journal, spreadsheet, e-mail, etc.), and research instruments (pH meter, thermometer, pedometer, etc.) that allow the students to authentically collect, organize, analyze, and report data while in the game. In addition, a chat client is included to support the interteam communication of the students.

Figure 14.1 depicts the DBR framework that guided our investigation with *McLarin's Adventures* MMOG. The study presented here reports the findings at the end of the third year during the mid-scale pilot testing.

14.3 Interactivity³ Design Model for Educational MMORPG

Crawford (2010), who have been developing commercial games since 1978, summarizes our findings best when he said

> If the entire thrust of my career could be reduced to a bumper sticker, it would read, "It's the interactivity!" Interactivity—not graphics, not animation, not sound—is the essence… (p. 334)

Salen and Zimmerman (2004) identified four modes of interactions in commercial games in terms of player's level of engagement: (1) functional interactivity which means the interaction with the material part of the system, such as how sticky the

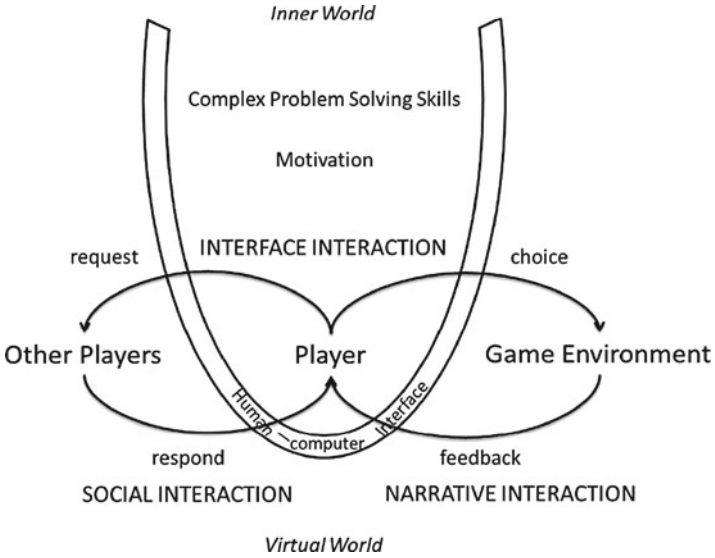

Fig. 14.2 Interactivity[3] game design model

keys feel; (2) explicit interactivity, which refers to the actual play motion, like clicking and hitting keys; (3) cognitive interactivity, which is "the psychological, emotional, and intellectual participation between a person and a system" (Salen & Zimmerman, 2005, p. 70); and (4) cultural participation, which is the participation beyond the in-gameplaying, and construction of the game culture in the real world.

Salen and Zimmerman's (2004) model provides a good blueprint to describe interactions in commercial games; however, in order to design an educational game, we need to pay special attention to the functionality, game play, referentially, social, and pedagogical issues (Konzack, 2002; Liarokapis, 2006). In educational settings, especially when we target learners' motivation and complex problem-solving skills, we take the explicit interaction between players and games as a persistent cycle of making choices through the game play. Hence, the findings of our DBR effort point out to three levels of interactivity that are important to the success of the educational game design to support both learning and motivational outcomes: (1) interface interactivity; (2) narrative interactivity; (3) social interactivity. Figure 14.2 depicts the Interactivity[3] game design model, which integrates these three levels of interactivity for designing educational MMORPGs to support student motivation and complex problem-solving skill development.

Interface interactivity is a super category of functional interactivity in Salen and Zimmerman's (2004) terms, which includes both player's device input and system's visual output. Because other levels of interaction are conveyed through the interface, the effectiveness the interface design either enhances or impedes all other levels of interactivity.

Narrative interactivity is a subconcept of what Salen and Zimmerman (2004) refers to as cognitive interaction. Narrative interactivity refers to learner's cognitive interaction with the game's complex storyline. Role-playing games rely heavily on storytelling, where players construct their mental game space and make sense of game play. This is where most of the high-order cognitive activities occur. Therefore, it is the foremost important level to consider when designing educational MMORPGs to support acquisition of complex problem-solving skills. Social interactivity is a salient feature of educational MMORPG that was not addressed by Salen and Zimmerman's (2004) modes of interactivity. Nevertheless, in commercial games, cultural participation occurs spontaneously outside the game environment without game designers' prescription. Therefore, it is not a designed feature of commercial MMORPG. Instead, in educational MMORPG, designers need to pay special attention to social interactivity that occurs among learners during game play. Hence, our game design model emphasizes social interactivity instead of cultural participation. Social interactivity brings dynamic human interactions throughout game play and interacts with the game narrative to provide learners' with ever-changing storyline and endless decision-making possibilities.

The three levels of interaction are also aligned with the evolution of video games in terms of their gradually increasing complexity: Back in the era of Pac-man, the players had hardly anything to learn except for smartly dodging from the ghosts, which focus on the functional interactivity. When role-play games (RPGs) dominated video games 2 decades ago, the players were able to immerse themselves into the story with multiple characters and complex storyline. Hence, narrative interactivity becomes more important, through which players learn complex relationship of time, location, characters, events, and rules in the game. With the advancement of the Internet, MMORPGs emerged by pushing the interactivity requirements to a more complex and advanced level, emphasizing the participation of, and communication among real people behind game avatars.

In the following sections, we further describe these three levels of interactivity and then elaborate on how they influence learners' motivation and acquisition of complex problem-solving skills in educational MMORPGs. This by no means indicates that these three levels are distinct and separated. Instead, it is separated in three levels for the convenience of the designers with different types of expertise. For example, graphical designers and programmers may focus on the level of interface interaction while content experts and storytelling experts can focus on narrative interaction and social interaction.

14.3.1 Interface Interactivity

Interface interactivity refers to the direct interaction between players and game systems. Like in a learning environment, where designers cannot directly design the learning experience but design artifacts and activities to elicit desired learning experience, game designers cannot directly design the interactive experience that the

player would have during game play. Rather, through carefully designed interface, designers can manipulate players' game experiences and help them achieve the desired interactivity. Therefore, we focus at the features that facilitate effective and engaging interface interactions such as navigation (Dondlinger & Lunce, 2009), data visualization, and interface metaphor (Fullerton, Swain, & Hoffman, 2004).

Navigation refers to the wayfinding in the game. In real world, people find their ways by recognizing land marks, street signs, asking the way, and so forth. In virtual world, in addition to these elements, game designers also need to provide maps and depth cues, which can help players locate desired objects and places, hence focus on what is important in the game to avoid cognitive load caused by unintuitive navigation. In understanding way-finding affordance, Dondlinger and Lunce (2009) stated: "the challenge for the virtual environment designer is to provide navigational affordances without cluttering the information landscape" (p. 2). We adopted their criteria of successful navigation in an educational MMORPG, which includes audio, maps, landmarks, depth cues, signs or pathways, and avatar perspective. Adjustable avatar perspectives enable player to flexibly explore the game environment and therefore support navigation in the game space and facilitate way finding.

Visualization refers to presenting quantitative data by graphics and charts, which allows players to know the approximation of game-related data at a glance. For example, the health status of avatars in a game is represented by a color-coded bar in the dock of the game interface. When an avatar's health is in good condition, the bar is full and is green. When an avatar is attacked by enemy, the bar dwindles and changes color into red to alert the player to avoid further injury. Good visualization also evolves in ways in which data is organized; the consistency of screen layout and clear data hierarchy are all helpful design elements to help players' quick retrieval of data.

Interface metaphor or the theme of the interface can affect the mental status of the players (Fullerton, Swain, & Hoffman, 2004). For example, in science adventure games, the high-tech look control panel and the dark color scheme create immersive atmosphere for the players to engage into the scientific game play and make them believe that they are scientists or commanders and their decisions matter much. While in some life simulation games, the cozy look control panel and warm color scheme elicit emotions of love and care.

Interface interactivity is a layer through which all other levels of interactions are realized. The design quality of this layer directly affects the overall success of the game in different ways: good design helps to set up the tone of the game play and to optimize clear transmission of information from other levels of interaction; flawed designs impede and block such interactions, which will cause players frustration.

14.3.1.1 Interface Interactivity and Motivation

An interface consists of sensory stimuli including visual, auditory, or tactile stimulation. These elements can create a sensory curiosity as a motivator (Malone, 1980). They are also used to distort players' perception and to create temporary acceptance

of an alternate reality (Wilson et al., 2009). Such make-believe traits or physical fidelity (Crawford, 1984) enable video games to present a designed virtual immersive environment and make players feel the environment and the tasks in such environment are authentic. Brown et al. (1989) argued that learning outcomes can be optimized when learners acquire knowledge and skills or solve problems in authentic situated learning environments. Therefore, the ability to represent an authentic environment gives MMORPG the affordance of enhancing learners' immersion, which in turn positively affects learners' motivation.

14.3.1.2 Interface Interactivity and Complex Problem-Solving Skills

People have difficulty with solving complex problems because the factors that affect a complex problem situation can be numerous and a change in each factor may cause a chain of changes in many other factors (Dörner, 1987). Problem solvers often neglect some minor cues, which are actually important factors in problem-solving processes. Blumberg, Roshenthal, and Randall (2008) found that game players relied on different cues in problem-solving during gameplay. The success of the problem solvers depends on the accuracy of the mental model they build to depict the cause-and-effect relationships among the factors affecting the complex problem situation.

An MMORPG is an ideal environment to present complex problems in that designers can naturally incorporate all the factors and their effects naturally in a game environment. Well-designed interface interactivity allows players to access every details of the game environment through different navigation and visualization tools so that they can discover factors that help them discover the causal relationships among problem constituents. In a complex problem situation presented by an MMORPG, players need to have a good interface to lead them to identify the problem, collect necessary and all the resources that they need.

14.3.2 Narrative Interactivity

In a RPG, players are engaged in a higher cognitive level of interaction beyond interface interaction, which is the interaction with the narrative. Narrative is the story that players experience during game play. Game narrative "strings together the events of a game, providing a framework and what can alternately be called a justification, a reason, or an excuse for the gameplay encounters" (Dansky, 2007, p. 5). Game narrative is prescribed by the game designers in order to give players the information to advance the plot. Well-designed narratives can clearly state the goal of the game, naturally define rules of the game, sets the player's role, and provide meaningful choices to the players to proceed for further play.

To design good narratives, we adapted the design principles of Goal-Based Scenarios (Schank, Berman, & Macpherson, 1999). A goal-based scenario "is a

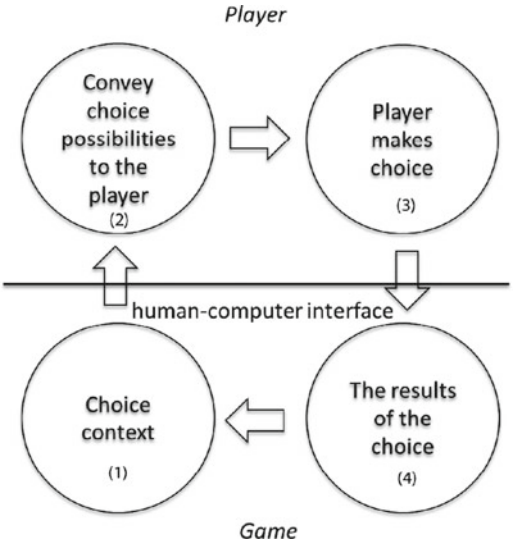

Fig. 14.3 Cycle of choice

learn-by-doing simulation in which students pursue a goal by practicing target skills by using relevant content knowledge to help them achieve their goal" (Schank et al., 1999, p. 165). Game narrative and goal-based scenarios share important features such as highly goal-oriented tasks, a movie-like plot with settings and protagonists, and the activities that require target skills to be applied to achieve the ultimate goal. The concept of learning by doing also matches well with game-based learning in an MMORPG, where players are given authentic tasks situated in a context of a story that call for complex problem solving.

Well-designed narratives present consistent and fully developed choices to players. In order to assess the quality of the choices provided by the narrative, the following five questions should be asked for each choice point (Salen & Zimmerman, 2005): (1) What happened before the player was given the choice? (2) How is the possibility of choice conveyed to the player? (3) How did the player make the choice? (4) What is the result of the choice? How will it affect future choices? (5) How is the result of the choice conveyed to the player? In order to make meaningful choices, the context of the choices should be clearly perceived by the players. By assessing the situations they are in, as well as hints or guesses they are given during the play, players make choices. We argue that question five can be combined with question four (Fig. 14.3) in that conveying the result of a choice to the player can be the same process of presenting "what happens before the player's *next* choice is given." Moreover, in complex problem-solving situations, some consequences of player's choices may not be immediately available to the player, imitating the time delays seen in real life in those situations. Instead, the consequences of these choices may have some prolonged effects on the overall storyline. This adds to the complexity of the problem that players are attempting to solve since it makes it harder for the

problem solver to build the mental model of the complex problem. Therefore, the human–computer interface also separates question (2) and (3), which happen to the player, from questions (4) and (1), which happen inside the game narratives.

14.3.2.1 Narrative Interactivity and Motivation

Narratives can be a significant intrinsic motivator if the storyline incorporates well-designed elements such as fantasy (Malone, 1980), uncertainty, and inevitability (Eifferman, 1974; Kagan, 1978; Malone, 1980; Salen & Zimmerman, 2005). Fantasy is the make-believe setting of the story; uncertainty means the ambiguity of the result or the winning of the game play; inevitability refers to the imminent results such as nonrenewable resource or irreversible processes, which add to emotional tension of players. Dempsey, Haynes, Lucassen, and Casey (2002) found that incorporating challenges, clear goals, and sufficient feedback into narratives are important for players gaming experiences. Ideally, the narrative can bring player into the state of *flow* (Csikszentmihalyi, 1991), in which player completely focus on the task at hand, and forget about self, about others, about the world around themselves. Players also lose track of time, feel happy and in control, and become creative and productive (Csikszentmihalyi). In contrast, if the game narrative is not well designed, the game can at most serve as a brief extrinsic motivator or merely a shell to link discrete tasks together. Under such circumstances, players would soon lose interest in the game because they are not intrinsically motivated. Furthermore, a poorly designed narrative can also confuse, frustrate, and turn players away from a game.

14.3.2.2 Narrative Interactivity and Complex Problem-Solving Skills

The narrative in an MMORPG is a complex and ill-structured problem space that provides players ample opportunities to be engaged in higher order thinking. Players usually do not know how the story develops; therefore, they need to constantly evaluate their current surrounding environment and emerging incidents to define the problem they need to solve. MMOROG usually provide players with small quests, in which players can refine certain areas of their skills and then proceed to more advanced quests. This complies with the processes of solving complex problems: articulating the problem domain and constraints, identifying alternative opinions and perspectives, generating possible solutions, assessing alternative solutions, monitoring problems representations, implementing and monitoring solutions, and adapting the solution approaches (Jonassen, 1997).

As interface interaction provides physical fidelity, which is the make-believe traits at interface level, good narrative interaction provides psychological fidelity, which means players should feel that the story is authentic and real. Studies suggest that students could be benefited from authentic learning environment (e.g. Ge, Thomas, & Greene, 2006). In their meta-analysis of problem-based learning, which allows students to learn in an authentic environment, Dochy, Segers, van den

Bossche, and Gijbels (2003) also found that students exposed to problem-based learning are better in applying their knowledge. Narrative in a game allows authenticity to be emerged through the participation of players (Barab, Squire, & Dueber, 2000), which is a more natural way to engage players in authentic learning.

14.3.3 Social Interactivity

Social interactivity in game-based learning environments refers to the communication and collaboration between human players. Social interactivity is a salient characteristic of MMORPG because players do not only interact with the game environment but they also interact with other players via their self-created avatars (Steinkuehler, 2004). Players in the game world can carry on a text or voice chat when their avatars are physically close to each other. Alternatively, they can use distance communication tools such as in-game emails or pagers to contact their partners. Through social interactions, players learn and solve problems together replicating real-life complex problem-solving situations. In contrast to predesigned narratives, the social interactivity with players is live, dynamic, and may happen spontaneously if the scenarios within a game are designed to promote communication and collaboration. Therefore, social interaction constantly changes the game content and presents players a slightly different game play experience every time they play. Such features give social interaction strong affordance in support of social learning, collaborative learning, and players' engagement in a context-rich virtual world.

Amory (2007) suggested the use of social capital theory as a lens to understand the collaborative behaviors in games. Social capital is defined as "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet & Ghoshal, 1998, p. 243). Nahapiet and Ghoshal (1998) applied the theory in organizational settings to suggest social capital can facilitate the creation of intellectual capital, which is a form of learning. In an educational game context, it means players learn from other players.

Drawing from Granovetter's notion of embeddedness (Granovetter, 1985), Nahapiet and Ghoshal (1998) suggested three dimensions in social capital: (1) structural, (2) relational, and (3) cognitive. The first dimension of social capital is the structural dimension which concerns with the network structure as a whole. In an MMORPG, it will be whom a player can contact, and in what ways they can contact with others. In order to have social interaction, a player has to be able to contact other players. However, the presence of ties among players is not enough. The strength of ties, which refers to the frequency of contact among the players, is also important. An effective MMORPG would provide an easy mechanism through which communication among all players is made easy so that a dense communication network can be formed to support social interactivity.

The second dimension of social capital is the relational dimension, which describes the personal relationship among the players (Nahapiet & Ghoshal, 1998).

Relationships among players can be demonstrated by the trust among them, approval among each other, and norms and identification seen in the community. To the contrary, negative relationship elements can be demonstrated by the relational conflict among the players.

The third dimension of social capital is the cognitive dimension, which refers to the shared interpretation of the meaning among the players (Nahapiet & Ghoshal, 1998). The shared languages and narratives among the players provide them common ground to exchange ideas and create new meanings (Nahapiet & Ghoshal).

14.3.3.1 Social Interactivity and Motivation

Social interactivity during gameplay, such as competition and collaboration with others who are also playing the game, plays an important role contributing to learners' motivation. Existing research findings suggest that social interaction fosters learners' motivation. For instance, Chen, Dun, Phuah, and Lam (2006) stated that positive social interaction in an MMORPG, such as pro-social behavior, trading, and collaboration can enhance players' engagement while negative social interaction behaviors, such as begging, politics, scamming, and leeching impede engagement. The studies conducted by Sweetser and Wyeth (2005) and Yee (2006) concur that social interactions that allow players to compete, collaborate, and connect lead to game flow experiences. Therefore, the collaborative tasks and the three dimensions of social interactivity should be carefully designed in educational MMORPG to make the gaming experience more motivating and more authentic.

14.3.3.2 Social Interactivity and Complex Problem-Solving Skills

Good social interactivity in games not only leads to players' engagement but also supports players' complex problem skills development. Cognitive flexibility theory (cf. Feltovich, Spiro, Coulson, & Feltovich, 1996) suggests that multiplicity, such as multiple representations of problems and multiple methods to solve problems, is important in solving complex problems. Through productive discussions and argumentation among each other, well-designed opportunities for social interactions in game-based learning environments allow learners to realize that there are multiple interpretations of the complex problem scenario of the game and there are multiple solution alternatives. Azevedo, Winters, and Moos (2004) examined how students learned environmental science concepts collaboratively. They found that students learned significantly more about ecology after working collaboratively. In another study, Uribe, Klein, and Sullinvan (2003) also found that student pairs outperformed students who worked alone in solving ill-structured problems. Therefore, designing MMORPGs to promote social interaction at all levels is essential for players' complex problem-solving skill development.

14.4 Assessment Framework

Based on the Interactivity[3] MMORPG design model, we developed a framework to assess educational MMORPGs. This framework has three dimensions, which capture different salient aspects of educational games: (1) interface interactivity, (2) narration interactivity, and (3) social interactivity.

Each dimension involves several elements that must be carefully integrated into the overall game design. Each of these elements is assessed on a rubric that measures the level of interactivity design from *level 0* to *level 3*. Level 0 indicates the lowest level of each element, which in general refers to a negative impact on learning goals or learning approaches. For instance, level 0 on *sound* means the audio in the game is confusing to the players and/or it is uninteresting, which makes it harder for the players to understand the context, negatively impacting learner engagement. Level 1 indicates the absence of such interactivity. For the *sound* category, it means audio is absent from the game. Level 2 indicates an adequate level of interactivity. Level 3 indicates a good level of interactivity. For instance, a level 3 of *sound* means that the audio provides clues to the players in a meaningful way. In the following sections, we explicate how we evaluate three types of interactivity in an MMORPG.

14.4.1 Assessing Interface Interactivity

Drawing from Dondlinger and Lunce (2009), there are six elements that can help with navigation: sound, map, landmark, depth cue, signs or pathways, and avatar perspective. The rubric to assess interface interactivity is presented in Table 14.1.

Sound should relate to the environment in the same way it does in the real world. Nevertheless, it does not have to be realistic. Actually, controlling the amount and variety of sound in the game can give players clues without taking up needed cognitive capacity for puzzle solving. Carefully timed and placed audio cues can tell players how close they are to a location or give them useful feedback as to if they are making the right decisions in the game. Conversely, arbitrary use of audio would distract and confuse the players.

A map should be built in the game and include landmarks that visually connect the objects in the 3D space. Referencing the map by the users should minimally affect their flow of the game. In some cases, the issues of flow can be solved by integrating use of the map into the story line and characterizing the map in a way that it belongs to the story. Augmenting a quick reference *bird's eye view* onto the screen can also be a way, in which a map can help users navigate without disrupting game play.

Rendering an object in a 3D program is not the only way to create a 3D experience. In some virtual environments, navigational elements rendered as 2D or 2½D objects can more effectively convey crucial navigational data than 3D objects (Dodlinger & Lunce, 2009; Komerska & Ware, 2003). Other artistic techniques such as color treatments and horizon lines can also contribute to the depth information. Making clever use of depth cues can help the player focus on what's important in the game as well as minimizing the load time for the computer. No matter what

Table 14.1 Rubric for assessing interface interactivity

Categories	Criteria	3 Good	2 Fair	1 Lack	0 Negative
Navigation					
Sound	Sounds are timed to give clues about proximity to a location within the plot of the game. For example, train noises get louder as player gets closer to the train station or the music becomes tenser as player approaches a pivotal moment				
Map	Map is directly related to the space it refers to. Map also integrates into the story, game play, and can be accessed without interrupting the flow of the game				
Landmark	Landmarks are naturally integrated and serve specific purposes within the overall goal of the game				
Depth cue	Depth cues employ a number of illusion techniques in order to serve specific purposes within the overall goal of the game. This may take form of 2½ dimensions and dramatic shading to emphasizing certain objects and subdue others. These tools can be used to simplify and control the user's navigation experience				
Signs or pathways	Signs and pathways are naturally integrated into the story and the environment. They are visually designed in a way that creates curiosity and adventure for the player as he follows them				
Avatar Perspective	Avatar perspective is simple to use and enhances the player's spatial knowledge. Avatar perspective allows player to feel emotionally or physically attached to the events of the game and enhances the mood and goals of the overall game				
Visualization					
Consistency	All data and buttons are always in a consistent location				
Grouping of data	Data is grouped in such a way that related information can be quickly compared and common tasks that require menus can be completed without interrupting the flow of the game				
Interface metaphor					
Interface theme	The metaphor should be consistent with the goal and the player's role throughout the game				

techniques are used they should be done in a way that there is no confusion about where objects are in the game space.

Street signs, sidewalks, and stepping stones are tools that humans are accustomed to making and using. These tools can help game designers direct the players when designed carefully. There are other aspects to include such as avatar perspective. Data visualization category consists of consistency, grouping of data, hierarchy of data, and interface metaphor. Not all tools are necessary for a successful virtual experience. However, allowing players to be successful navigators in different ways is advantageous because each player may have a different personal style of navigation. More importantly, any counterproductive navigation or visualization tools could lead to frustration and rejection of the game by the players.

14.4.2 Assessing Narrative Interactivity

The elements of the assessment of narrative interactivity (Table 14.2) are driven from the design principles of Goal-Based Scenario framework proposed by Schank et al. (1999). It consists of seven essential components: goals, mission, cover story, role, scenario operation, resource, and feedback.

Goals in this scenario are the learning goals that the players are supposed to achieve during gameplay. The mission is the tasks through which they can achieve the goal. The cover story is the background story that expresses the need to go on to the mission and to achieve the goals. The role is the player's identity in such missions. The scenario operations are the sum of activities, including all the choices players make towards the goal. Feedback is the just-in-time information of players' progress during their activities.

The cover story can be revealed at the very beginning of the game or while playing by cut scenes, which are also referred as in-game movies. Cut scenes can take many forms such as video clips, emails that the players receive in the game environment, and so forth. These cut scenes serve as an indication of the accomplished goals, giving information or hints of the mission that the players are about to go through, and push the plot to go forward by setting up new goals. For example, when a player first enters the game environment, the cover story, which may take a form of a video clip, could be played to define the roles of the players and their missions. After the player achieves some goals, in order to advance the plot to a new stage, a cut scene may be presented through a nonplayer character (NPC), who may direct the player to new quests. Well-designed narratives clearly state the goal of the game, define the rules as well as the player's role, set the mood, and motivate the players to move forward in their game play.

Scenario operation needs to ensure that the activities players are given directly contribute to the realization of the goals by utilizing the target knowledge and skills to be learned by the players. The causal connection between players' action and the system's reaction should be clear. The system should also provide rich possibilities for players to make meaningful choices. In addition, the game environment needs to provide carefully organized information resources that players should access in

Table 14.2 Rubric for assessing narrative interactivity

Categories	Criteria	3 Good	2 Fair	1 Lack	0 Negative
Mission					
Goal distinction	Both the overall goal and the subgoals are clearly stated; the goals are in great consistency; the criteria for achieving each goal is clear to students				
Goal motivation	The goals of the game are in accordance with those that the students already have or are appealing to the players so that they are willing to adopt these goals. The goals are intuitively challenging but attainable				
Target skill dependence	The process of achieving goals foster and require both domain specific and generic ability of the players. Players achieve the goals depending on the target skills that they are supposed to acquire in the process of playing				
Situativity	The environment in which the goal is embedded is authentic and appropriate so that it facilitates transfer. Players may freely interact with the environment				
Flexible completion criteria	Players could have multiple paths to accomplish the mission. Each path will ensure the players to experience all the cognitive process that are required to accomplish the goal				
Backstory					
Consistency	The cover story clearly conveys the mission background, the role of the player, and the mission itself to the player. It provides evidences for players to predict the boundaries of and the relationship in the game play. It gives the player plot hooks and uncertainty to motivate the player to go on with the game. It is neither too short nor too long				

(continued)

Table 14.2 (continued)

Categories	Criteria	3 Good	2 Fair	1 Lack	0 Negative
Grouping of data	They appear right in time to provide information such as strategic prompts of upcoming tasks or give hints of navigation; They also reinforce the mood and tune of the game				
Roles	The roles of the players are consistent with the mission. Avatars accumulate experience and skills to enable them to accomplish high-level tasks. The characters of the avatars have both strength and flaws, which changes during the game				
Scenario operations	Tasks and quests should contribute to goals and mission. Provide ample opportunities for player to make choices and should have clear consequences that either have a immediate or long-term impact on the game play				
Resources	Information and tools that are necessary to achieve the mission and the goal must be provided and is well organized for easy access. Should be embedded naturally in the storyline.				
Feedback	Situated in the game play, give player just-in-time feedback and customized information support to help advance the game				

order to successfully achieve their goals. Contextualized and just-in-time feedback is also crucial in scaffolding learners during gameplay (Schank et al., 1999).

14.4.3 Assessing Social Interactivity

To evaluate the social interactivity of a game, we suggest rating the game in four dimensions: (1) the degree of collaborative activities, (2) the structure dimensions of the game, (3) the cognitive dimensions of the game, and (4) the relational dimensions of the game. The rubric is presented in Table 14.3.

Table 14.3 Rubric for assessing social interactivity

Categories	Criteria	3 Good	2 Fair	1 Lack	0 Negative
Collaborative task	Players need to collaborate most of the time to complete the tasks				
Structural dimension	Players can reach all other players and communicate with them easily				
Cognitive dimension	Share representations and meaning, such as shared stories and language, generated from the game can be found in many occasions				
Relational dimension	Relational evidences, such as respect, trust, obligation, identification, and norm, that are generated from the game can be found in many occasions				

In order to have meaningful social interactivity among the players, a game should incorporate meaningful collaborative tasks, which allow them to interact naturally. As a result, each of the players can share their expertise or workload to solve problems together. Therefore, we first evaluate the degree of collaboration in the task, ranging from level 0, which indicates collaborative activities having a negative impact on the goal of the learning exercise, to level 3, which indicates that the game requires (or strongly encourages) learners to collaborate most of the time.

Drawing from social capital theory (Nahapiet & Ghoshal, 1998), we also include in our rubric a structure dimension, a cognitive dimension, and a relational dimension to measure social interactivity in MMORPGs. The structural dimension of social capital refers to the structured embeddedness of a social system (Nahapiet & Ghoshal). It can be measured by the interconnectivity among the players in a game. A highly interconnected game allows any players to connect to other players all the time. In addition, communication among players should be ubiquitous.

Another dimension in social interactivity is the cognitive dimension. This dimension is concerned with shared meaning of the players, which requires shared representation and a common language and knowledge base (Nahapiet & Ghoshal, 1998). A zero score refers to the situation where players do not understand each other to the point that players are confused about each others' meaning. A low score means that the players do not have any shared representation nor a common language. It is possible that players share their understanding and interpretations before they play the game. We still consider that they have shared representations. However, we give higher ratings to educational games only if shared representations are generated and cultivated through game design; in order words, good educational games should be designed to promote shared representations.

Finally, relational evidences are defined as any actions among players, which show trust, approval of each other, and norms and identification seen in the community (Nahapiet & Ghoshal, 1998). A zero score refers to poor relationship among players to the point that they distrust and do not want to work with each other. A low relational score means that the players have not so good relationship, but they may still be able to work with each other. It is possible that players already have had a good relationship before they play the game. We still consider that the game support this dimension. However, we give higher ratings to the educational game only if the relational evidences are generated from the game.

14.5 The Present Study

In this section, we summarize the results of the studies conducted at the end of the second and third cycles of our DBR (Fig. 14.1) to investigate the effect of *McLarin's Adventures* on student motivation (cf. Eseryel, Miller, Ge, Ifenthaler, Law, & Guo, 2010; Miller, Eseryel, & Ge, 2009) and complex problem-solving development (cf. Eseryel, Ge, Ifenthaler, & Law, 2011). We also present the evaluation of the design of *McLarin's Adventures* MMORPG based on the assessment framework described in Sect. 4 to demonstrate the utility of the Interactivity[3] game design model (Fig. 14.2) in guiding the design of educational MMORPGs when coupled with its assessment framework.

14.5.1 Participants and Procedure

A rural high school in the Midwest of the United States was used as a test bed for the experimental studies conducted at the end of the second and third cycles of our DBR (Fig. 14.1) to investigate the effect of *McLarin's Adventures* on motivation and complex problem solving.

Three hundred and forty-nine ninth-grade students participated in the first study conducted at the end of the 2nd year design cycle. These 349 students were randomly assigned to one of the 19 classes; of which ten of them were then randomly assigned to treatment (game group) condition and nine classes were randomly assigned to control (no game group) condition. The data reported here were from 251 students, from whom we received both parental consent and student assent forms. Of these 251 students, 156 were in the experimental group and 95 were in the control group. There were 47% males and 53% females.

The study at the end of the third year design cycle was conducted with the incoming ninth grade students during the following school year at the same high school. Three hundred and forty-three ninth grade students participated. These students were randomly placed into 16 classes. Out of these 16 classes, eight were randomly assigned to treatment (game group) condition and eight were randomly assigned to control (modeling

group) condition. The data reported here were from 280 students, from whom we received both parental consent and student assent forms. Out of these 280 students, 137 (48.9%) were in the treatment group and 143 (51.1%) were in the control group.

The data collection procedures in both studies were the same. Following the pretest data collection, students in the experimental group played the *McLarin's Adventures* MMOG 2 days a week for 16 weeks during the 50-min class period. At the same time, the students in the control group participated in a class that was specifically developed to facilitate students' interdisciplinary STEM learning and improving their leadership, management, and decision-making skills. In this sense, both the game-based learning environment and the traditional class curriculum attempted to facilitate, in their own ways, complex problem-solving skill acquisition in an interdisciplinary STEM curriculum. At the end of the 16 weeks students in both groups took the posttest, which was the same as the pretest.

In addition to these studies, at the end of second and third design cycles, a team of game researchers, graduate students who specialize in educational games, and students played with the *McLarin's Adventures* game and evaluated it on the assessment rubric presented in Sect. 4.

14.5.2 Data Analysis Framework

In order to track the changes in students' developments in their *complex problem-solving* skills as a result of gameplay, each student's *structural knowledge* of the complex problem-solving domain was elicited in both pretest and posttest by asking the student to build a causal representation of the problem-solving domain that served as the situated context in the *McLarin's Adventures* MMORPG (Eseryel et al., 2011).

Each student's annotated causal representation was compared with the expert causal representation on six measures as suggested by the Highly Integrated Model Assessment Technology and Tools (HIMATT) (Ifenthaler, 2010; Pirnay-Dummer & Ifenthaler, 2010): (a) *surface matching*, which compares the number of propositions (concept—relation—concept) within two causal representation; (b) *graphical matching*, which compares the diameters of the spanning trees of the causal representation, which is an indicator for the range or complexity of conceptual knowledge; (c) *structural matching*, which compares the complete structures of two causal representations (expert and subject) without regard to their content; (d) *gamma matching*, describes the quotient of terms per concept within a causal representation; (e) *concept matching*, which compares the sets of concepts within a causal representation to determine the use of terms (semantic correctness); and (f) *propositional matching*, which compares only fully semantically identical propositions between two causal representation.

In order to measure student motivation, during pretest and posttest in both studies, all students were provided with a packet of motivation instruments related to self-determination theory (Ryan & Deci, 2000). The instruments were retrieved

from the Basic Needs Satisfaction Survey (http://www.psych.rochester.edu/SDT/measures/needs.html):

- The Autonomy subscale (seven items)
- The Competence subscale (six items)
- The Relatedness subscale (eight items)

Cronbach alphas for our instruments were: autonomy = 0.57; competence = 0.47; pretest relatedness = 0.74; and relatedness = 0.82.

14.6 Results

Tables 14.4 and 14.5 present the evaluation of the *McLarin's Adventures* after the second and third design cycles. After the second design cycle, out of the three interactivity dimensions, *McLarin's Adventures* scored relatively well in the narrative interactivity dimension with a good storyline and a clear mission, although the subtasks and feedback were not well designed. The scores on the roles, scenario operations, resources, and feedback measures were also low. In addition, the game scored quite poorly in the interface interactivity dimension, where navigation and visualization have relatively poor scores. The score for social interactivity dimension was also low, where the tasks in the game were not collaborative in nature. Despite the fact that the backstory announced that each player would be hired in different roles, the avatars of the students were still the same and did not reflect any differences in their roles or in appearance. All subtasks during the game still had to be completed individually by each player. The players could use the chat function in the game to communicate with each other and share strategies but that distracted the players from the game and added to their cognitive load.

Upon the improvements in the overall game design on the third design cycle, the evaluation scores after the third design cycle also improved. In general, interface and narrative interactivity scores visibly improved. The evaluation results suggested that *McLarin's Adventures* provided an exciting backstory, a clear mission, clearly defined roles, and a lot of resources, which provided initial motivation. The interface also fitted nicely with the backstory of a scientific fiction. However, the navigation supports and visualization supports still needed improvement to eliminate distractions.

Despite the improvement in the social interactivity scores, the score for collaborative task was very low. The backstory of the game called for players to assume different scientist roles to complete the tasks while playing the game as teams of four. Each player was able to customize their avatars based on the roles they assumed. However, the tasks in the game still required to be completed by each player individually. In addition, it was hard for each team member to locate other team members in the game. Although a map function was provided, it was not easy to use. However, some tasks were very difficult to understand and these caused the players to seek other players to help them figure out the tasks and the functionalities

Table 14.4 Aggregated evaluation results of *McLarin's Adventures* after second design cycle

Elements/rating	Comments
Interface interactivity	
Navigation 1.14 pts	The navigational cues in the game were rather weak. There was some clipping, which might distract the player from taking the game seriously. For example, avatar could walk through objects that should be solid. Also, the environment is a vast space. It is hard for the players to determine which way to go, etc. Some buildings, roads, trees, etc. could be placed appropriately to help situate the player and give them additional navigational cues
Visualization 1 pts	There was a lack of visualization of data in the game. Players had to dig deep in menus to find their health status. Overall, the interface did not invoke a sense of hierarchy, curiosity, not do they emphasize any objects over others
Interface metaphor 2 pts	The interface of the game is appropriate given the context of the game. However, the user interface requires some time for the players to figure out where all the tools are. It can be improved to make it more visible to the students
Narrative interactivity	
Mission 3 pts	The mission of the game was clearly defined
Backstory 3 pts	The backstory set the tone of the game play; it was motivating and allowed the players to naturally enter the game environment
Roles 1 pts	The players took on the role of researchers and needed to conduct a series of experiments on the island to examine the environment for survival. However, in the game environment, all the player avatars were the same and did not help distinguish different roles players assumed
Scenario operations 1 pt	Although the tasks required target skills to be accomplished, the individual tasks did not contribute to the overall goal. The individual tasks also did not have strong casual or logical relationships among themselves that could help the player to build a mental model required to solve the overall complex task (mission) in the game
Resources 1 pts	Formula and charts of mathematical calculations were available in players' backpacks. However, there was no cue to help players relate the problem they encountered in the game to those resources
Feedback 1 pt	The game environment did not provide immediate or long-term feedback to players' operation, which usually confused and frustrated players. The only feedback they could get was at portals when they finished a task. A nonplaying agent appeared and gave a summary and then assigned a new task when players finished a task
Social interactivity	
Collaborative task 0 pts	Although *McLarin's Adventures* is claimed to be an MMORPG, collaborative activities could not be found in the game
Structural dimension 1 pt	Finding other players in *McLarin's Adventures* was not supported. There was chat function for players to communicate but it is not sufficient and distracted players from the game and contributed to added cognitive load
Cognitive dimension 1 pt	During the problem-solving tasks, the players could understand each other easily, but there was no evidence that the shared representation or meaning was generated from the game
Relational dimension 1 pt	The relationships among players were built up unintentionally. The first task was designed poorly, so it took the players a lot of effort to find the answer. As a result of the collaboration, trust and respect were built

Table 14.5 Aggregated evaluation results of *McLarin's Adventures* after third design cycle

Elements/rating	Comments
Interface interactivity	
Navigation: 2 pts	The navigational cues in the game were mostly OK supported by a map. Objects placed in the environment gave a sense of situatedness to the players so they could figure out which direction they should be moving. However, the map function could be improved. It is not easy to read the map to figure out where everything is
Visualization: 2 pts	The game environment provided appropriate visualization tools. However, it was not always easy to figure out where they are. So, the user interface could be improved to make it easier for the players to find visualization tools
Interface metaphor: 3 pts	The interface metaphor fitted nicely with the story. Most of the pages have a consistent high tech science fiction feel
Narrative Interactivity	
Mission: 3 pts	The mission was clearly defined and it was motivating for the players
Backstory: 3 pts	The backstory set the tone of the game play allowing the players to be immersed into the game plot smoothly
Roles: 2 pts	The players took on the role of researchers and needed to conduct a series of experiments on the island to examine the environment for survival. Although the game provided four different avatars for the players to choose from, no avatar possessed distinctive ability than others to fit specific tasks
Scenario operations: 2 pt	Although the tasks required target skills to be accomplished, the individual tasks did not contribute to the overall goal. The individual tasks also did not have strong casual or logical relationships among themselves that could help the player to build a mental model required to solve the overall complex task (mission) in the game
Resources: 2 pts	A detailed resource guide is included in the game. However, it is not apparent to the players when they can consult the resource guide to help with their game play. Automated feedback from the game could prompt players to consult the resource guide when they fail to complete specific activities
Feedback: 1 pt	Although the players were collecting points as a result of their game play, it was not apparent when and how they were collecting these points. Also, the point structure was not tied to their winning or losing the game. It was more of a counter that did not mean much in the context of game play. The game environment did not provide immediate or long-term feedback to players' operation, which usually confused and frustrated players. The only feedback they could get was at portals when they finish a task. A nonplaying agent appeared and gave a summary and then assigned a new task when players finished a task
Social interactivity	
Collaborative task: 1 pt	Each player is expected to complete each task separately even though players play in teams of 4 comprising different scientist roles
Structural dimension: 2 pts	Finding other players in *McLarin's Adventures* was supported by the map but it was not easy to use. Chat and voice chat allow players to communicate seamlessly

(continued)

Table 14.5 (continued)

Elements/rating	Comments
Cognitive dimension: 2 pts	The game tasks were not set up to promote shared representation or meaning to be generated among game players who play in the same team
Relational dimension: 2 pts	The game was not designed to support relationships among players. However, the unclarity surrounding some of the tasks and interface features led to some players communicate to figure them out together. However, this communication happened outside the game, where students sought each other face to face in the classroom. As a result, a sense of community, collaboration, and trust was built among players. It would be great if an external virtual learning community is designed to support players share tips and experiences related to the game

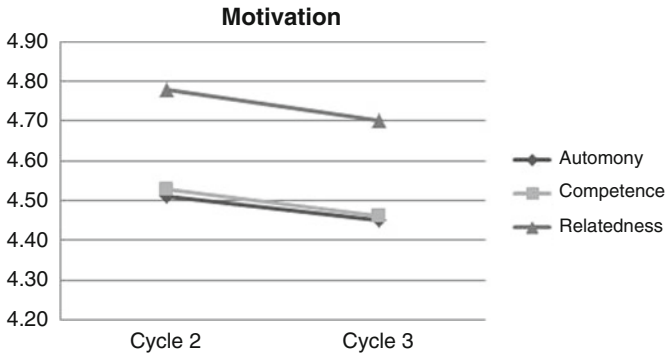

Fig. 14.4 Comparison of student motivation between second and third cycles

within the game. In general, this led players to develop trust and respect during the game. Voice chat function made it easier for players to communicate during game play but players also relied on face-to-face interactions in the class to seek out help from other players in the class during game play.

Figure 14.4 depicts the comparison results of student motivation after the second and third design cycles. Students' motivation was measured with the self-determination constructs: autonomy, competence, and relatedness. Although the results showed a small decrease in motivation, the differences in motivation between cycle 2 and cycle 3 were insignificant ($p > 0.05$).

On the other hand, significant improvement was observed in students' complex problem-solving skills from the second design cycle to the third design cycle ($p < 0.01$; effect size for the gamma dimension is $d > 0.05$; all other dimensions $d > 0.20$). Figure 14.5 depicts the comparison of the results along the six dimensions of the *structural knowledge* variable that measured their conceptualization of the complex problem in which the game was situated. This shows that the improvements made in interface and navigation interactivity were effective in promoting students' complex problem-solving skills despite the lack of major improvements in

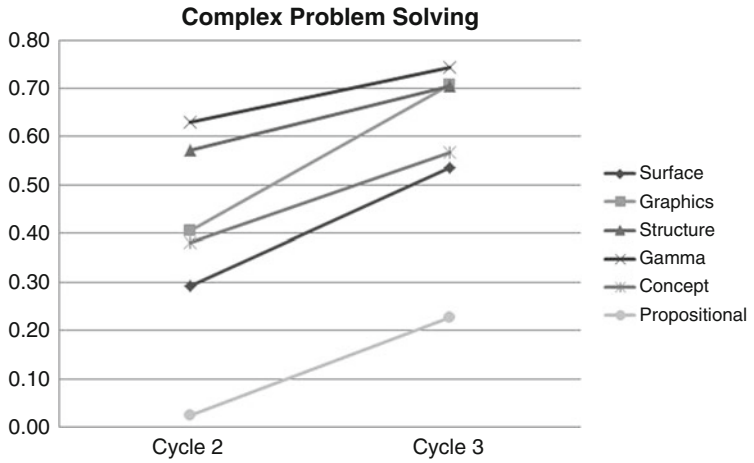

Fig. 14.5 Comparison of student complex problem-solving skills between second and third cycles

the social interactivity dimension. However, further studies (see Eseryel et al., 2011) spoke to the importance of the social interactivity dimension by including tasks in the game narrative that are complex enough to require a teams of players, each of whom possess a different skill set. Dynamic modeling feedback was also identified as having crucial importance in helping player teams to build shared mental models of the complex problem domain in the game narrative by scaffolding teams' cognitive co-regulation (Eseryel et al., 2011).

14.7 Conclusion and Future Directions

In this chapter, we presented the Interactivity[3] model for designing educational MMORPGs in addition to its assessment framework. This design and assessment model resulted from a 4-year DBR study. Interactivity[3] model highlights three levels of interactivity that were found to be crucial for the educational MMORPGs to promote student motivation and complex problem-solving skills: (1) interface interactivity; (2) narrative interactivity; and (3) social interactivity. This design model is not meant to provide exhaustive guidelines in the design processes. Rather, it serves as a heuristic model that is intended, together with its accompanying assessment framework, to support educational game designers to connect the three levels of interactivity and direct their attention to the most important points when designing each level of interaction.

Although commercial game literature emphasized the importance of interactivity in game design it is not highlighted and integrated in educational game design. Drawing from our findings and from the commercial game literature (e.g., Fullerton et al., 2004; Salen & Zimmerman, 2004), we argue that interactivity is one of the

most salient characteristics to which educational game designers should attend, especially in the context of educational MMORPGs.

In this chapter, in order to illustrate the utility of the Interactivity[3] design and assessment framework, we also presented the findings from the second and third design cycles of our design-based research study that guided the design of an educational MMORPG called *McLarin's Adventures*. The findings of this study confirmed the importance of all three levels of interactivity in promoting student motivation and complex problem-solving skill development. When the interface and narrative interactivity scores were improved during third design cycle, the students' complex problem-solving skills also showed improvements.

However, after the third design cycle, there was still room for improvement, especially in the social interactivity dimension. The detailed findings of the experimental studies after the third design cycle (cf. Eseryel et al., 2011; Eseryel, Miller, et al., 2010; Miller et al., 2009) confirmed that student motivation and complex problem-solving skill development was still not at the desired level when compared with the control group. This highlighted the importance of social interactivity dimension and the need for the interface and narrative interactivity to seamlessly support the social interactivity during game play. Indeed, one of the affordances of MMORPGs that make it more unique when compared with other types of games is its ability to support multiple players to collaborate together in a situated learning environment to solve complex problems situated in the game narrative. In the *McLarin's Adventures* MMORPG, even though the mission of the game constituted a complex problem, it was divided into arbitrary subtasks that represented simpler problems. In addition, the backstory of the game called for players to assume different roles and play as a team of four scientists. However, each player is expected to complete the game individually and received individual scores. This is identified as one of the main reasons contributing to less-than desired improvements in student motivation and complex problem-solving skills. In the fourth design cycle, the improvements in the game design included redesigning subtasks to cultivate social interactivity with interface and narrative interactivity enabling social interactivity ubiquitously.

In commercial MMORPGs, we see that when the social interactivity is intentionally cultivated in the game design, it usually contributes to the popularity of the game (and its market share). *Star Wars Galaxies* is one of these highly popular commercial games. Upon their analysis of *Star Wars Galaxies*, Ducheneaut and Moore (2004) identified three major design instruments that educational game designers can use to encourage or even force social interaction: (1) difficult quests, (2) complex ecology of professions, and (3) exchange of goods or ideas. Difficult quests are small missions that are impossible for one individual player to achieve. Like in the real world, the complex ecology of players' professions provides diversity and the need for collaboration in MMORPG. In Star Wars Galaxies, not all players are warriors. Instead, many of them chose to take professions such as entertainers or healers. The difference of profession determines the difference of the skillset that a player has. Everyone has his or her strength and weakness. Therefore, they have to work together to take advantage of others' strengths and to cover their weaknesses. In the case of an educational MMORPG, players can chose to be a mathematician,

a geologist, or a physicist according to their interest in real life. Then, the game design should require for them to team up and bring their individual expertise on the table to solve complex problems collaboratively. The difference of profession results in the differences of resources that the players own. Hence, the exchange of resources is made inevitable, which provides players valuable opportunities to communicate and to socialize. Designated places such as a bazaar or a market where players can meet, talk, and trade would be helpful devices in enhancing social interaction. In an educational MMORPG, in addition to trading goods, players can also exchange information such as the data collected by scientists from different disciplines. Places that can host such communications can be a lab or even a tent in the wild.

This leads to another requirement for game designers: To extend their game design by designing and cultivating online learning communities, in which players could come together and share their experiences. In successful commercial games, such as *World of Warcraft*, we see the power of such virtual learning communities that exist outside the game environment. Educational game designers should consider designing and cultivating such virtual learning communities in addition to the game environment to enhance learners' engagement and complex problem-solving skill development.

Despite the popularity of educational games in today's discourse, its research base is still at its infancy. We do not know how to design effective educational games, especially MMORPGs, so that they can fulfill their unique affordances as situated learning environments to support higher order thinking and problem-solving skill acquisition while maintaining high student motivation. To facilitate the design of educational games, validated assessment models are crucial. However, there are very few game evaluation models available for the educational game designers. Sweetser and Wyeth (2005) focused on enjoyment and developed an evaluation model to evaluate players' enjoyment in games. Nevertheless, in educational games, enjoyment is only part of the picture. We need to ensure learning occur among the players. Drawing from ARCS motivational model, Gagne's events of instruction, and Piaget's ideas of schema, Gunter, Kenny, and Vick (2008) developed a more comprehensive game evaluation model for educational game. Nevertheless, it is a generic game evaluation model, which does not explicitly account for salient features in MMORPGs, such as the narrative of the game and the interactions among the players. The interactivity[3] design and assessment framework presented in this chapter is intended to bridge this gap in the literature. It is our sincere hope that the Interactivity[3] design and assessment framework would be beneficial to educational game designers and that other educational researchers would build on it with further empirical support.

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