*Chapter*

# COLLABORATION, COOPERATION, AND COMPETITION: TOWARD A BETTER UNDERSTANDING OF CONCEPTUAL DIFFERENCES IN MOBILE LEARNING GAMES.

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## ABSTRACT

With the rapid development in mobile communication devices, recent trends suggest that the use of mobile games in learning is on the rise. However, scant attention is given to the design and application of collaborative, cooperative, and competitive mobile gaming activities in classrooms. Cooperation and collaboration are two concepts that have often been used interchangeably and inaccurately in teaching and learning. Evidence from the literature suggests that cooperation and collaboration differ significantly in relation to teacher role, student role, and communication type between group members. Therefore, the principle objective of this chapter is to provide an overview and analysis of the conceptual differences between collaboration and cooperation in the context of mobile gaming. Second, we will discuss the integration of the element of competition in learning and mobile gaming activities and its impact on learning performance. Lastly, for each of the three teaching strategies, we will discuss current research trends and developments of mobile gaming in learning by summarizing empirical case studies and their key findings.

**Keywords**: Mobile games; collaboration; cooperation; competition; game-based learning

## INTRODUCTION

In recent years, mobile games have gained increasing attention compared to other gaming platforms such as console, PC, and arcade games due mainly to several factors, which include mobility, accessibility, networkability, and simplicity of mobile devices. Additionally, the advances in mobile hardware and the greater smartphone adoption among consumers has offered mobile users the advantage of multi-functionality and flexibility in using these devices. Along with the enhancement of features and content in mobile devices, mobile games have

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recently shown explosive growth rates in today's game market. In fact, Deloitte (2016) expect that smartphones and tablets will be the leading games platform regarding software revenue. Specifically, they expect that revenues will increase 20 percent from 2015 compared to only five and six percents for PC and console games respectively. Without a doubt, the increasing popularity of mobile games is directly related to the fact that users can play these games without limitation of time and location. From a marketing perspective, the market for mobile games is low barriers to entry (Deloitte, 2016). In other words, mobile games can be created within hours and with low marketing costs, whereas console and PC-based games may take several years to develop, not to mention their substantial production and marketing costs.

Given the different definitions and terminologies of mobile games, a narrow definition is needed to diverge the functions of mobile devices from those of other devices. Jeong and Kim (2009) point out that portability and networkability are two key elements to consider when defining mobile games. That is, mobile games are played in handheld mobile devices that include wireless communication functionality, and these games can be either embedded, downloaded, or networked. However, the mobility or portability characteristic of a mobile device is perhaps what attracts users the most to mobile games, particularly the light users. This category of users, according to Jeong and Kim (2009), comprises players of different ages, including many women, who prefer to play mobile games in their spare time and for short periods of time. Hence, it is within reason to argue that the success of mobile games stems from their ability to appeal to users from different gamer demographics.

Recently, there has been a growing acceptance among educators that games provide a platform for active learning in that they contain certain vivid and challenging features that are absent in conventional learning materials. Mobile game users can experience total immersion in the game for hours while being unaware of their surroundings (Shaffer, 2006). The higher levels of engagement that students experience with mobile games have prompted a widespread acceptance of mobile game learning among educators who are eager to see similar outcomes applied to learning curricular subjects. Consequently, game-based mobile learning has gained increasing popularity since mobile devices can now support multimedia content, location awareness, connectivity, and augmented reality (Parsons, Petrova, & Ryu, 2011). Further, mobile learning games offer ample informal opportunities for learners to explore topics of interest, network with other users, and share information. In a sense, mobile learning games represent a combination of mobile learning and game-based learning, which can actively engage younger people in learning while taking their digital culture into account (Facer et al., 2004). Research into the effectiveness of digital games supports the link between mobile games and engagement in curricular subjects. The use of mobile location-aware games contributes to engagement and meaningful learning in different academic subjects such as history (Admiraal, Raessens, & Van Zeijts, 2007) and science (Squire & Klopfer, 2007; Squire, 2008). Another key element in a sustainable learning experience is motivation. Games, in general, can distribute learning content in a motivating and engaging manner (Gee, 2003). Motivation theorists have long argued that individuals who are more interested and engaged will show better learning and achievement outcomes (see Deci & Ryan, 1985). Undoubtedly, mobile learning games that incorporate motivational design can be effective learning tools that can increase the levels of engagement and achievement.

The crux of mobile learning is not simply an individual's interaction with a mobile device. It is supporting an array of cognitive and social skills through different tasks such as exploration, content generation, problem-solving, and navigation in space (Spikol & Milrad,

2008). Concerning the latter task, using mobile technologies in learning allows more flexibility in an outdoor educational environment. Players are now allowed to move physically through open space while being able to navigate through the virtual worlds (Grüter, Mielke, & Oks, 2005). Mobility opens the possibility of situated learning in different physical settings. Ardito and colleagues (2012) and Loiseau and colleagues (2013) designed mobile applications to teach students about the history of cities and geological sites while they were walking around them. In the case of Pokemon Go, for instance, players can explore the real world and virtual worlds simultaneously. Although this mixed reality game was not designed as an educational game, arguments are emerging lately about its educational potential, especially in regard to the social knowledge construction that takes place among users in a growing community of practice, which is similar to that of Minecraft users (Farber, 2016). Simply put, the implementation and use of mobile games in educational contexts allow more flexibility to adapt to different situations, contexts, and accommodating different numbers of students (Kuts et al., 2007).

Likewise, the introduction of mobile games in classrooms can impact the teaching techniques that teachers adopt to promote active learning and improved performances. For example, collaborative, cooperative, and competitive learning are instructional approaches that have been widely used in the field of education. Competitive learning occurs when one or a group of students achieve their goals, but others fail to reach that goal (Johnson & Johnson, 1991) and can be interpersonal (between individuals) or intergroup (between groups). Conversely, the goal of cooperative and collaborative learning environments is to work together toward a common goal with an emphasis on social interactions among members of the groups. However, collaborative and cooperative learning seem to be used somewhat interchangeably even though some important conceptual differences exist. In this chapter, we will identify and highlight some of the key differences between collaborative, cooperative, and competitive learning. More specifically, we will discuss their definitions, principles, and current applications in the context of mobile game-based learning activities. This examination provides some insight into how to effectively design and implement mobile game-based classroom activities to help educators attain learning outcomes that correctly align with one of the three teaching strategies mentioned earlier.

# DEFINITIONS OF TERMS

## Collaboration

Collaboration can be defined as “a philosophy of interaction and personal lifestyle where individuals are responsible for their actions, including learning and respect the abilities and Ácontributions of their peers” (Panitz, 1999, p.3). In a collaborative environment, the actions of individuals are directed toward a common goal (Beznosyk et al., 2011). According to the Oxford English Dictionary, the term “collaborate” originated in the late 19th century from the Latin word “collaborat”, which means “worked with” and from the verb collaborare (from col “together” + laborare “to work”). Thus, the word “collaborate” means to work with each other towards the same goal, but not necessarily cooperatively on the same tasks (Davidson & Major, 2014).

## Cooperation

Cooperation is defined as "a structure of interaction designed to facilitate the accomplishment of a specific end product or goal through people working together in groups" (Panitz, 1999. p.3). When interacting cooperatively, individuals act on the same objects simultaneously in a shared environment (Beznosyk et al., 2011). Cooperation also involves assigning subtasks by distributing the common goal among different members (Altin & Pedaste, 2013). According to the Oxford English Dictionary, the term "cooperate" originated in the late 16th century from the Latin word "cooperat", which means "worked together", and from the verb "cooperari" (from co "together" + operari "to work"). In other words, "to cooperate" is to work together jointly to complete an educational operation, such as activity or a project (Davidson & Major, 2014).

## Collaborative Learning

In literature, the definitions of collaborative learning have described the importance of both students working together in groups and the group working together with the teacher to develop knowledge, thereby transforming the nature of authority in the classroom (Davidson & Major, 2014). From this perspective, collaborative learning refers to the variety of educational approaches, which involve collective intellectual efforts by students, or students and teachers together (Smith & MacGregor, 1992).

## Cooperative Learning

Cooperative learning can be defined as students working together in a group that is small enough for everyone to participate collectively in a task that has been clearly assigned. Additionally, students involved in a cooperative learning are expected to carry out their task without direct and immediate supervision of the teacher. Cohen (1994) contends that any study of cooperative learning should not be confused with small groups that teachers form for the purpose of delivering intense and direct instruction-e.g., reading groups. Johnson and Johnson (1991) clarify this aspect by stating that cooperative learning involves the use of small groups in which students not only work together to maximize their own learning, but also each other's learning as well. Another definition of cooperative learning was put forward by Felder and Brent (2007), which refers to team members being held individually accountable for the completion of content in an assignment or project.

## Competitive Learning

Competitive learning takes place when one student or a group of students achieves a certain goal that another fails to reach (Johnson & Johnson, 1991). Depending on the setting, competitive learning can be interpersonal (between individuals) or intergroup (between groups). This type of learning may be more appropriate to help students review already learned materials (Griffiths & Podirsky, 2002). A concept that has been discussed in management literature is called coopetition, which refers to a hybrid behavior that comprises both competition and cooperation (Dagnino, 2002). Simultaneous cooperation and competition

between firms, which has become increasingly popular in recent years exemplify the concept of coopetition (Gnyawali, He, & Madhavan 2006, 2008).

### Mobile Learning

More recent definitions of m-learning identify how mobile technology is used for educational purposes. For example, Ally (2009) defines m-learning as a process that involves the use of mobile devices for the purpose of accessing and studying learning materials as well as communicating with fellow students, teachers, or institutions.

## PRINCIPLES OF COLLABORATIVE AND COPPERATIVE LEARNING

Collaborative learning and cooperative learning are two terms that are commonly used in discussions of how and why to use group activities in learning. While both motivational and cognitive theories support the achievement benefits of collaborative learning, a noncognitive outcome of a collaborative experience in a classroom is that students will become more altruistic (Slavin, 1995). Collaboration and cooperation are two terminologies that have become so entangled that they are often used interchangeably and in some cases applied inappropriately. Davidson and Major (2014) argue that cooperation and collaboration in learning come from different origins and follow along distinct disciplinary lines. They contend that collaborative learning is an approach that has been used mostly applied in the field of humanities, whereas cooperative learning is an approach that has been used mainly in fields that include mathematics, sciences, engineering, social sciences, and professional programs. With respect to origin, Bruffee (1995) states that collaborative and cooperative learning are two approaches that were originally developed for people of different ages, experience, and levels of mastery of interdependence.

Many educators have asked questions about the similarities and the differences of collaborative and cooperative learning. Some of these questions include whether collaboration is a sub-form of cooperation or vice versa. According to Davidson and Major (2014), such questions are important in that they question the underlying philosophies, goals, and methods of collaborative and cooperative approaches. To help distinguish between collaborative and cooperative learning approaches, Brody and Davidson (1998) identify eight important questions that teachers should ask from the perspective of cooperative learning:

1. How do we teach social skills?
2. How can we develop self-esteem, responsibility, and respect for others?
3. How does social status affect learning in small groups?
4. How do you promote problem-solving and manage conflict?
5. Are extrinsic or intrinsic rewards more effective?
6. How can we prove that cooperative learning increases academic achievement?
7. How do we teach children to take on various roles?
8. How do we structure cooperative activities? (p. 8)

Similarly, there are eight questions that educators should ask from a collaborative perspective, according to Brody and Davidson, which are as follows:

1. What is the purpose of the activity?

2. What is the importance of talk in learning?
3. To what extent is getting off topic a valuable learning experience?
4. How can we empower children to become autonomous learners?
5. What is the difference between using language to learn and learning to use language?
6. How can we negotiate relevant learning experiences with children?
7. How do we interact with students in such a way that we ask only real questions rather than those for which we already know the answers?
8. How can we use our awareness of the social nature of learning to create effective small group learning environments? (p.8)

It is important to note that not all cooperative and collaborative approaches are successful. Simply putting students together does not guarantee positive outcomes regarding knowledge construction or academic achievement (Barron, 2003). Some researchers have highlighted the concept of "free-rider" as a factor that makes collaboration less efficient. This idea refers to how some group members do all or most of the work while others go along for the ride (Slavin, 1995). To adequately address this issue, Slavin (1995) suggests the diffusion of responsibility (a fundamental principle of cooperative learning) in that each group member is responsible for a unique part of the task. Other important requirements that should be met for effective collaborative learning include active roles, a common group goal, individual performance, and assessment of each group member (Stump et al., 2011).

Compared with traditional instruction, mobile learning seems to be a more attractive way of learning that can trigger the interest and motivation of learners in collaborative environments. Formative assessment, which is the process of providing feedback and support during instruction, is one of the teaching components that can be enhanced through the use of mobile learning. For example, the study by Hwang and Chang (2011) shows that students who used a guiding mechanism called Formative Assessment-based Mobile Learning (FAML) in a mobile learning environment experienced higher motivation and better learning achievement. This mechanism provides individual support and guidance to students in a real-world learning environment. In fact, similar mechanisms that are implemented in mobile games may enhance individual performances in the collaborative and cooperative learning environments, while also assessing the performance of each group member. Moreover, these systems can be effective in lightening teachers' workloads especially when dealing with larger groups of students. Nonetheless, some concerns regarding the benefits of combining real world contexts and digital world resources have been raised. For example, Chu (2014) investigated the possible negative effects of mobile learning and suggested that improper learning design may lead to heavy cognitive load. This aspect is particularly important in both collaborative and cooperative learning environments where mobile learning games are used, and where learners are required to simultaneously interact with the device, content, and peers, consequently exhausting their mental load efforts.

The literature includes numerous studies that attest to the benefits of collaboration in game-based learning, and to the role of games play in improving collaboration skills. Sánchez and Olivares (2011) found that the use of Mobile Serious Games (MSG) contributed to higher perceptions of collaboration skills and problem-solving skills among Chilean 8th-grade students. In another study that compares solitary and collaborative modes of game-based learning, Chen, Wang, and Lin (2015) concluded that learning science concepts that are supplemented with collaborative learning can enrich the learning experience and collective problem solving. Overall, a large body of empirical evidence shows encouraging signs that

games, in general, can positively foster collaborative behaviors while increasing motivation and engagement.

Johnson and Johnson (1991) were among the first to define cooperative learning, and based on their research proposed five principles of cooperative learning, which are also applicable in cooperative game-based learning environments. The principles that should be included in cooperative learning models are described as follows:

1. *Positive interdependence*- Refers to the belief that each member of the same group has a unique contribution to make to the joint effort and that all members are dependent on one another to achieve a goal. The shared goal can only be attainable by working with one another. Johnson, Johnson, and Holubec (1998) contend that this particular pillar is the most important and the most challenging to implement in a teamwork learning environment.
2. *Individual accountability*- Refers to the awareness that all students in a group should be their individual share of work and be held accountable for their individual performances and mastery of the content learned.
3. *Face-to-face promotive interaction*- While some of the group work may be divided up and done individually, interactions with other group members are necessary to provide feedback, support, and encouragement to reach the goal. Johnson et al. (1991) maintain that a meeting in person is crucial for it to be effective, which could be a challenge in some game environments where students interact in the virtual world but not in person.
4. *Appropriate use of social, interpersonal, collaborative and small-group skills*- This includes students' ability to interact smoothly with other group members. Students are also encouraged and supported to develop and practice trust-building, leadership, decision-making, communication, and conflict management skills. In some cases, teachers should provide training and basic information at the beginning of the activity, such as laying out basic etiquette rules.
5. *Group processing*- Refers to the exchanges among group members to identify what member actions are helpful or not to assess the group's productivity and progress toward the common goal. Based on this assessment, the group decides on the changes they will make to be more effective as a group in the future.

Similarly, there are five theoretical principles identified under the collaborative approach as put forward by Panitz (1999), which are described as follows:

1. Individuals who work together gain a greater understanding than those who work independently.
2. Verbal and written interactions contribute to this increased understanding.
3. Classroom experiences present opportunities group members to become aware of relationships between social interactions and increased understanding.
4. Some components of this increased understanding are idiosyncratic and unpredictable.
5. Group members participate voluntarily in a collaborative activity and must enter into it freely.

## COLLABORATIVE AND COOPERATIVE ACTIVITIES IN GAME-BASED LEARNING

Collaborative learning is a situation where group members, more or less at the same level, can perform similar actions and work together toward a common goal (Dillenbourg, 1999). Perhaps the most obvious distinction between a collaborative learning and competitive learning environments is the nature of the goal. That is, students who work collaboratively are expected to have common goals, as opposed to students in a competitive environment where conflicting goals exist. While collaboration and cooperation are often used synonymously, scholars who have used these terms distinctively highlighted a fundamental difference in term of the degree of division of labor among group members (Dillenbourg, 1999). In other words, students in a cooperative learning environment split the workload, solve sub-tasks individually, and later assemble these partial results to formulate the final product. In a collaborative environment, however, team members simply work together often synchronously to achieve the common goal. Additionally, a significant difference between collaboration and cooperation in the context of teaching and learning resides in the role of the teacher in the process. A cooperative approach seems to require more interventions from the teacher about structuring groups and learning activities, whereas in a collaborative environment the teacher acts more as a facilitator (Dillenbourg, Baker, Blaye, & O'Malley, 1995; Johnson & Johnson, 1999).

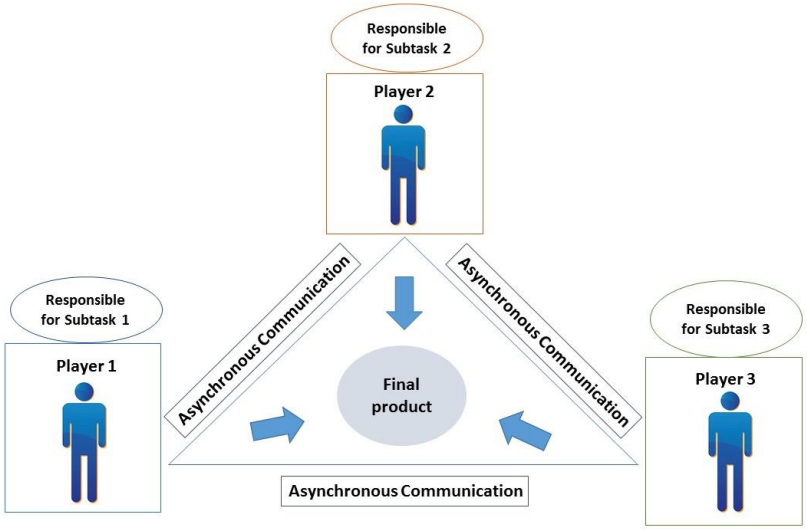


**Figure 1.** Cooperation in game-based learning

Dillenbourg (1999) discusses the type of communication between group members as a key criterion in differentiating between collaborative and cooperative conditions. From this perspective, it is argued that students in a collaborative environment are communicating synchronously while doing something together, which is different from cooperation where asynchronous communication is often the case. To illustrate this point and other key differences between collaboration and cooperation, let us assume the case of a cooperative activity in the game of Minecraft. In this example, a group of four students is assigned to design a commercial building. As a cooperative learning activity, each student in the group can assume a different role within the activity. One student may oversee the design of the building; a second student can be the bookkeeper who ensures that the project stays within budget, while the other two students can be the builders and divide tasks accordingly. In this example, each user's

participation and contribution are unique in that players rely on each other, while holding personal accountability for contributing their parts. Teacher intervention is needed in this case to ensure effective group structuring while students work to solve different sub-tasks individually. An important aspect to point out is the level of synchronicity in group interactions. In other words, group members will mainly interact after the production of individual sub-tasks, though occasional discussions may occur throughout the process.

Dillenbourg (1999) identifies three key criteria to describe the situation in which students interact in a collaborative way: interactivity, synchronicity, and negotiability. To further illustrate how collaboration in game-based learning differs from cooperation in light of these criteria, let us consider another scenario in Minecraft where students work collaboratively this time. In this example, a group of three students are assigned to work together in the virtual world of Minecraft to build and ultimately replicate the Pyramids of Egypt. Group members participate in synchronous joint problem solving while arguing their standpoints, negotiating, and trying to convince other members about specific task details. More importantly, they perform similar actions-i.e., building the pyramids- to achieve a common goal. Certain group discussions and negotiations could be about the dimensions or the locations of the structures in the virtual world. In any case, negotiation in collaboration is not only important to develop shared goals, but also to become aware of any goal discrepancies, which could result from disagreements in actions (Dillenbourg, 1999). Lastly, we argue that this degree of negotiability and interactivity in a collaborative learning environment is what limits the level of teacher intervention. That is, since members in the group perform similar actions and collaboration is quite interactive, group members are more likely to exhibit supportive behaviors and guide one another in the learning process, keeping teacher's help to a minimal level.

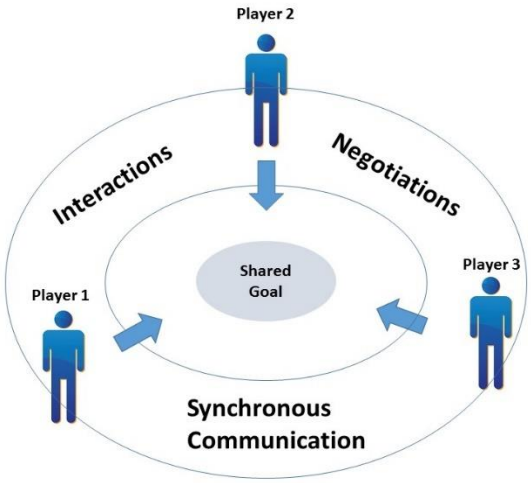


**Figure 2.** Collaboration in game-based learning

## Studies and Cases of Collaboration in Mobile Game-Based Learning

The advances in communication technology in recent years have paved the way for more research and development in Collaborative Virtual Environments (CVE). Newly released and successful commercial games such World of Warcraft implement a multiplayer component to

allow collaborative play. In literature, the term "third place" was used to describe the neutral ground where online players meet each other in the virtual world (Wadley et al., 2003). According to Preece and Maloney-Krichmar (2003), "third places" can encourage players to display their personality, individuality, and sociability since they provide playful mood and audiences. In collaborative gaming environments, players can use pseudonyms and nicknames and use voice or text to communicate with others. In fact, the implementation of voice over IP technology has become increasingly used as a rich communication medium, particularly in environments with vibrant and realistic 3D graphics (Wang et al., 2014). In recent years, virtual world environments such as Second Life or Role-Playing Games including World of Warcraft have emerged as a learning arena for game-based learning (Leidl & Ling, 2007; Whitcomb, 2008).

Although research on collaboration in mobile game-based learning is an area that is still emerging, the early evidence tends to link the activity design to students' behaviors in collaborative multiplayer settings. In the section that follows, we have summarized the key findings from two cases of collaborative mobile learning gaming activities that address game design, students' behaviors in a collaborative mobile gaming setting, and grouping strategies.

The first case is the study by Tan, Reddy, and Tewari (2009) who sought to explore the feasibility of creating multiplayer mobile games based on a traditional multiplayer real life game called *Colour Colour* played by children in rural India and ESL (English as a Second Language) students in California. The mobile version of this game, which is designed for ESL students, requires players to move and collect objects of a particular color. The shared goal of this activity is to collect items of the correct color as a team. In fact, players are given scores based on whether they can pick the correct items and the time it takes them to collect item while also being penalized for picking up items of the wrong color. In this game, students are provided with individual scores as well as group score to track their progress. Important observations emerged from this study, notably how students understood the game to be competitive despite its collaborative design. For example, the scores and time of completion were important aspects of the game design that promoted competitive behaviors among students. Concerning the level of communication between group members, long periods of silence were observed in this activity. In fact, despite the finding that students in California were more communicative than their Indian counterparts, Tan and colleagues (2009) maintain that making the game more challenging would have made students take the game more seriously and thus communicate more and display a more collaborative behavior. Overall, this experiment leads Tan and colleagues to suggest that how the game is introduced to students plays a significant difference in students' attitudes and the level of collaboration they produce.


**Figure 3.** Screenshots of the mobile game *Colour Colour* (copyrights to Tan et al.)

As mentioned previously, a collaborative learning environment requires that group members participate voluntarily and freely. However, this raises concerns of how teachers should assign students to groups in collaborative game-based activities while considering students' freedom to work with their preferred partners. Flexible grouping, for instance, is a classroom strategy that allows students to work together in a variety of ways. This grouping arrangement is temporary and frequently changes, thus it allows teachers to avoid the static nature of commonly known grouping practices. This brings us to the second case, the study by Wong and colleagues (2013). Using a mobile-assisted Chinese character forming game (Chinese PP-game) with primary students who were learning Chinese as a second language, Wong and colleagues (2013) investigated how flexible grouping methods can affect collaborative patterns. In this learning game, students needed to identify their partners to collaboratively compose the components into an eligible Chinese character. Two gaming modes were introduced in this study: 1- Mode SGM - which only allows students to join one group at a time and 2- Mode MGM- in which students could join multiple groups at a time. As the game advances, the existing groups are disbanded, and a new set of components are assigned to individual players for the next round. To examine the link between game behaviors and academic achievements in the formal Chinese class, Wong and colleagues divided study participants into three bands- high achievers, medium achievers, and low achievers. In all, researchers report positive results about social and collaborative behaviors that students displayed as a result of using the flexible grouping strategy in a mobile learning game. First, students showed high energy levels as they walked around and carried out quick discussions about what combinations would be viable in constructing eligible Chinese characters. Second, peer coaching emerged in groups where medium achievers and low achievers worked together, thus narrowing the gap between them and high achievers. Despite the emergence of some competitive behaviors as the result of implementing individual scoring, researchers observed a healthy balance between competition and collaboration. For example, despite the pressure of

forming complex characters or multiple characters in less time, students did not hesitate to help peers from other groups, even if that puts the latter in a competitive advantage. Further, based on the observations from this study, students did exhibit gender shy-behaviors in the first two sessions but by the last session they seemed to overlook gender or personal affiliation. Lastly, Wong and colleagues conclude that collaboration is most effective when the feature of "distributed resources" in integrated into the mobile learning game. In other words, ownership of a piece of the resource (one Chinese character in this case) ensures that each group member makes an equal contribution and is equally valuable to the group. Wong et al. further note that introducing two modes of grouping options-i.e., SGM and MGM- has led students to figure out strategies to maximize their winning chances, which researchers maintain did not share with students at the instruction phase (before gameplay).


**Figure 4**: Screenshots showing *My Character* interface (left) and *My Group* interface (right) (copyrights to ETS)

## Studies and Cases of Cooperation in Mobile Game Based Learning

An important characteristic of a cooperative learning environment is promoting positive interdependence. By allowing each player to hold a single piece of information or knowledge, each group member provides a valuable contribution toward achieving the common goal. The heterogeneity of resources can positively impact not only the quality of interactions (Fidas, Komis, & Avouris, 2005) but also prevent a single person from taking control of the group (Wendel et al. 2010). When it comes to designing cooperative activities, the jigsaw learning method seems to be suitable for the affordances of augmented reality and an integral component of several mobile games used in educational contexts. A good example is a game called *Alien*

*Contact* (Dunleavy, Dede, & Mitchell, 2009), which was designed to teach math, language arts, and scientific literacy skills. In this game, as students move to a physical location, a map on their mobile devices displays digital objects and virtual people in an augmented reality world superimposed in real space. When students are within a proximity of the digital artifact, the software triggers video, audio, and text files that provide narrative, navigation, and cooperation hints. In this setting, each team has four roles: Chemist, Cryptologist, Computer Hacker, and FBI Agent. Depending upon each role, students can see different and incomplete pieces of evidence. But, to successfully navigate the environment and solve various puzzles, students are required to share information with their teammates. In their study using *Alien Contact*, Dunleavy and colleagues (2009) show that the size of the group impacts the contributions of each member. They found that students in larger groups tended to rely on one or two members to do most the work, while some of the students with similar roles were ignored because the information they possessed was not unique.

The second case we provide in this section is a game designed by Lee and colleagues (2016), which depicts the application of jigsaw learning strategy in mobile game based learning. In this game, players in the role of business consultants navigate different locations and investigate the problem presented to them. As they navigate different departments and watch interview videos with department managers, they gain perspectives on the problems facing the fictional manufacturing company. They then must gather, analyze and reflect in pairs after they individually visit all the locations. The joint decision they make together is what determines the outcome of the game. This includes a summary report and a presentation to the CEO of the manufacturing company.

The game in this case can be played in two modes: single and pair-player . In a single player mode, players can visit all five departments. In the pair-player mode, however, each player can only visit four departments; one player does not visit the marketing department, and the other does not visit the research and development department. Hence, the pair will have a knowledge gap that can only be addressed by working cooperatively. From this study, Lee and colleagues (2016) conclude that self-interest should align with collective interest for the success of interactive cooperation. They also noted that asymmetry in subtasks (i.e., different roles) is a crucial component in designing future cooperative learning games.

We mentioned earlier in the example of *Alien Impact* how the size of the group in mobile game-based learning could influence the outcome of interactions and communication between group members. To further examine this specific detail, we provide another example of a game called *QuesTInSitu: The Game*, a location-based learning game designed by a secondary school art teacher (Melero, Hernández-Leo, & Manatunga, 2015). This game is somehow similar to jigsaw puzzles and can be played in a contemporary art museum. In this study context, students were assigned to 3-member, 4-member, and 5-member groups to see how the size of the group may have impacted the level of engagement, enjoyment, and overall interactions. However, only one student in each group had a smartphone, while other members assisted with collecting the necessary information to solve questions. The results from this study also suggest that group size impacts students' attention and participation within the group. In fact, this study showed that the smaller groups experienced higher levels of concentration and enjoyment because it was easier to reach agreement on the answers.

## Collaborative Versus Cooperative Activities in Mobile Game Based Learning

The breadth of the outcomes affected using mobile games in cooperative and collaborative learning activities is impressive. However, designing group activities where all group members make equal contributions is challenging. In literature, it has been argued that assigning students interdependent tasks can help students feel accountable and will force them to speak for themselves (Marfisi-Schottman & George, 2014). While this strategy of assigning different roles to students has been increasingly integrated into the design of collaborative mobile game-based learning activities, it has become difficult to differentiate between cooperative and collaborative activities as both learning models are overlapping. As a result and despite the conceptual differences between the two learning approaches, cooperation and collaboration are used interchangeably in mobile game-based learning settings, particularly in relation to the distribution of roles and interaction synchronicity. Unfortunately, very few previous studies have explicitly investigated and compared the performance outcomes in both collaborative and cooperative conditions in game-based learning. One notable exception is a study by Beznosky and colleagues (2011). These authors provide a comparative analysis of user performance and enjoyment in a collaborative and a cooperative virtual environment. Although this research does not address collaboration and cooperation in mobile a game setting, we believe that most of the findings can be relevant in the context of mobile learning game development. Another important observation is how Beznosky and colleagues have used the term “collaboration” in lieu of cooperation and vice versa. Nonetheless, we treat the example they provide for a cooperative activity to depict collaboration and the collaborative activity to illustrate cooperation instead.

During the experiment by Beznosky and colleagues, groups of three people were asked to play a basic 3D game with the shared goal of collecting 20 digits and calculating the sum of these digits. Specifically, this game consists of two virtual houses containing 20 cubes, but only half of the cubes had a digit on one of their sides. The game concludes when participants collect the digits, calculate their sum, and select the correct answer from one of the four options in the screen.

To explore the virtual environments, participants in this experiment had to manipulate the objects under different conditions depending on the session. In a cooperative session, the objects could be moved only by one person. Thus, each player was collecting digits individually. In the collaborative session, required manipulation by two users was needed meaning that participants had to simultaneously move a cube and collect the digits. In both conditions, voice communication and a text messenger were made available to participants. Results of this experiment revealed that participants enjoyed collaborative conditions more-i.e. joint manipulation of objects- regardless of their levels of experience in the virtual environment. Beznosky and colleagues argue that the main advantage, in this case, was that players could achieve a joint goal concurrently. The authors further found that the manipulation of objects in collaborative conditions, which required more effort and cohesive work compared to single manipulation, as well as the length of task completion, did not impact the level of enjoyment. Whereas, in cooperative conditions, longer task completion time seemed to be an influencing factor on player enjoyment. While the results from this experiment may suggest that collaborative learning environments provide more enjoyable experiences to students, further research is needed in mobile game-based learning using collaboration and cooperation conditions that align very closely with the theoretical principles of each approach.

## COMPETITION-BASED LEARNING

Digital games comprise various motivational elements to enhance student learning such as goals, cooperation, and competition (Prensky, 2001). Competition in learning has long been regarded as an effective strategy to stimulate learner's progress. Fulop (2002) argues that collaboration and competition exist simultaneously in learning activities. For example, while students work together to carry out a group task, they can also implicitly compete for the role of "best collaborator." The relationship between cooperative learning and competitive learning can be further explored in the context of intergroup competition. That is, when groups are competing, students are under pressure to maximize their individual performance to help the group succeed (Slavin, 1990). As discussed thus far, cooperative behaviors allow the group to achieve better than if students worked separately. But with the presence of competition, individuals are provided with the motivation to make more efforts to improve (Cosier & Schwenck, 1990). This argument can be supported by empirical evidence, which found that intergroup competition contributed to increased productivity and decreased inefficiency (Mulvey & Ribbens, 1999) and that cooperation increases in response to intergroup rivalry (Van Vugt, De Cremer, & Janssen, 2007). It was also shown that individual contributions are significantly higher in intergroup competition conditions as opposed to no competition conditions (Mulvey & Ribbens, 1999).

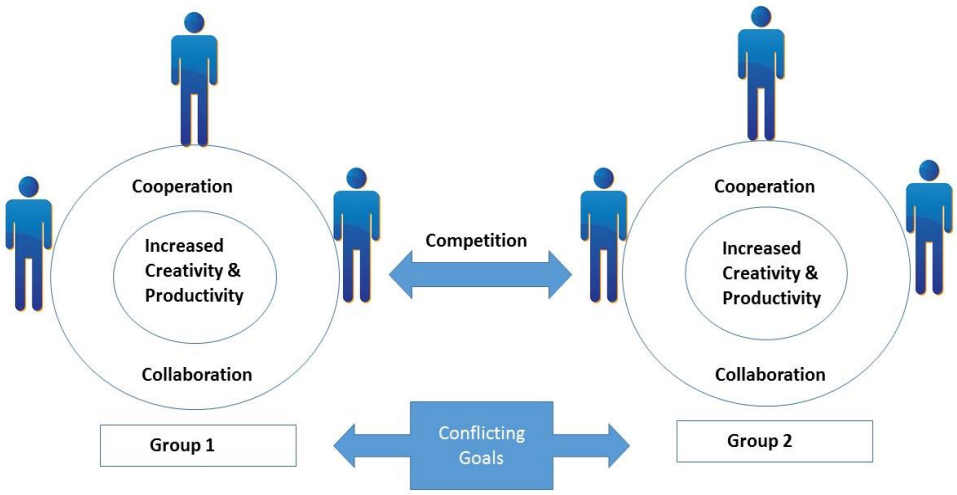


**Figure 7**. Intergroup competition in learning

Thus far in this chapter, the discussion has focused on group work in a collaborative and cooperative learning activities. As such, we continue to focus on intergroup competition rather than competition between single individuals. In literature, Baer and colleagues (2010) define intergroup competition as "a social situation in which the goals of different groups are linked in such a way that goal achievement by any one group reduces the ability of other groups to reach their respective goals" (p. 830). Earlier, we have mentioned the flexible grouping strategy

in a game-based learning setting (see Wong et al., 2013), and how it allows grouping arrangements to change frequently. While empirical evidence points out to positive results about social and collaborative behaviors, opposite results have been shown in intergroup competitive settings. For example, the study by Baer and colleagues (2010) found that group performance and creativity increase in conditions of intermediate competition in closed groups (i.e., groups with stable membership) compared to open groups (where membership changes). This is consistent with a line of a theory called Structural Adaptation theory, which suggests that it is harder for groups to shift from competitive to a cooperative way of thinking (Johnson et al., 2006). According to Baer and colleagues (2010), this can be illustrated by the case of a group that exchanges one of its members with a rival group. As suggested by structural adaptation theory, the two groups are more likely to experience disruptions to collective performance as the result of the difficulty of overcoming their past competitive attitudes toward the newer members, consequently undermining collaboration among group members. Overall, while research seems to support the idea that open groups in noncompetitive environments have an advantage over closed groups in relation to performance and creativity (Choi & Thompson, 2005), the inclusion of new members from rival groups may potentially compromise performance and overall in-group collaboration.

Notwithstanding the evidence that competition in intergroup settings increases productivity and creativity, empirical findings have pointed out to the negative effects of competition particularly on learning motivation (Butler & Kedar, 1990) and learning preferences (Yu et al., 2002). Additionally, since competition emphasizes social comparison by which students' performances are compared and exposed, such exposure may negatively impact confidence (Chan et al., 1992) and self-efficacy (Stapel & Koomen, 2005). From one perspective, making mistakes and experiencing failure are part of the learning process; however, in a competitive environment, students are often penalized for making mistakes, which explains why students tend to evaluate themselves more negatively in these conditions. Further, when introducing competition in a learning activity, learning is no longer a task with intrinsic value. The study by Deci et. (1981) for instance compared students' motivations while solving puzzles in competitive and noncompetitive settings and found that students' intrinsic motivation decreased during competitions.

Slavin (1990) argues that competitive learning situations can be devastating for students who are low achievers since negative feedback can be a poor motivator for them. To mitigate the potential negative effects of competition, researchers have proposed certain conditions for both constructive and healthy competition where one's learning in one area does not prohibit other students' learning in the same area (Sheridan & Williams, 2006). In a constructive competition learning context, group members have mutual respect for each other's knowledge, opinions, and ways of thinking. Competitors should also feel that they have the same level of knowledge and that each member feels that he or she can make unique contributions (Williams & Sheridan, 2010). However, despite the amount of research on competition and collaboration, constructive competition conditions are an area that is underinvestigated, particularly in game-based learning. In literature, Shindler (2010) proposes the following principles to help educators distinguish between healthy and unhealthy competition in learning when designing competitive class activities:

*In Healthy Competition*

1. The goal should be fun.

2. The competitive goal is not valuable or real, and should not be characterized that way.
3. The learning goal is clearly characterized as valuable.
4. The duration of the competition activity is short but involves high energy.
5. There is no long-term effect from the activity.
6. All individuals and groups involved see a reasonable and equal chance in winning.
7. Some examples include Trivia contests, short -term competitions with a symbolic reward, or challenges between groups where there is no reward.

*In Unhealthy Competition*

1. The activity feels real, and the winners and losers will be affected.
2. The goal/reward of the competitive activity is valuable/real.
3. Winning the competition characterizes the learning goal.
4. Winners can use their reward as a social or educational capital later.
5. Advantaged students are rewarded implicitly or explicitly in the competition.
6. Students develop an increasingly competitive mindset over time.
7. Some examples include long-term point systems, competition for grades, playing favorites, and the award for skill-related performance.

## Cases of Competition in Game-Based Learning and Mobile Contexts

Compared to other social situations, video games comprise a clear body of rules and predefined goals, which makes them less equivocal competitive settings (Vorderer, Hartmann, & Klimmt, 2003). However, there is a lack of consensus regarding the importance of integrating the element of competition in games. Some researchers argue that competition is a dispensable game component (Shaffer, 2006; Prensky, 2001), while others consider it to be an essential part of gaming (Alessi & Trollip, 2001; Michael & Chen, 2006). From one perspective, it has been argued that competition functions differently depending on the type of competition implemented in the activity (Van Eck & Dempsey, 2002). In other words, regardless of the game genre, it is whether the player competes against himself or against others that is likely to impact behaviors and motivations. In game-based learning, the game design and interactions in virtual worlds allow researchers to investigate different conditions of competition. However, most research on competition seems to focus on competition between peers and less on situations where students compete with themselves. An example is a study by Vandercruysse and colleagues (2013) who investigated students' perceptions in a game-based learning environment by comparing students' perceptions in four different conditions: a competitive game environment, a non-competitive game environment, a competitive learning environment, and non-competitive learning environment. Using the single player fantasy role playing game called *Divine Divinity* where students competed with each other, it was found that the presence of competition had no effect on students' motivation regardless of whether students were in learning or gaming environment. Students in both competitive environments, however, reported higher perceived competence, invested efforts, and task value. Compared to students in a learning environment, students in a gaming environment reported higher interest, enjoyment, and perceived competence. They also attributed more value to the task they completed. Thus, the overall findings suggest that behaviors and motivations differ not only based on the type of competition but also based on the context of competition (i.e. virtual vs., non-virtual world). This is important to highlight since, in mixed-reality mobile games, competition could take place in both virtual and the real world.

The research available on competition-based learning using mobile games is scarce. Similar to collaborative and cooperative activities discussed earlier, the design of competition-based mobile activities revolves around field observations and explorations. The first case we discuss in this section is the mobile learning system developed by Hwang and Chang (2015), which is a learning interface that presents a map with each location associated with real-world learning targets. Using a peer competition strategy, students throw a dice to determine the number of steps they need to make and as soon as they reach a certain location. Players need to carefully observe learning targets (e.g., objects in a museum) or interview personnel to acquire knowledge. This system also incorporates supplementary materials to assist them when they fail to answer a question correctly. The gaming activity ends when students complete all the learning tasks. They can also score additional points when they seek information on the web. When using this system in their study to compare the use of a competitive approach versus conventional approach (no competition), Hwang and Chang (2015) found that peer-competition improves students' learning interest, attitudes, and local cultural identity when compared to conventional methods of mobile learning. Interestingly, Hwang and Chang (2015) reveal that incorporating the element of competition decreased students' cognitive loads.

The study by Hwang and colleagues (2014) is another case that illustrates the application of a mobile competitive game approach. In this study, the game used contains a board game interface that consists of sequences each representing a game mission. The fifth graders who participated in this study used a location-aware mobile learning environment in a butterfly garden with different species of butterflies. After rolling the dice, each student can proceed to the next location based on the number shown by the dice. At each location, students are asked to observe real world targets and answer questions correctly. If they fail to respond the question the first time, they are provided with supplementary materials. After a second failed attempt, the interface provides students with the correct answer along with explanations. When students arrive at a location labeled "an opportunity to win," they can play either a matching game or a first shooter game. The matching game aims to help students comprehend the relationships between butterflies and host plants, while the first shooter helps students recognize predators and natural enemies of butterflies. At different stages of the game, students who answer questions in less time get a higher score. The board game interface presents students with their gaming status. The game ends when students answer all the questions or when the time ends. Like the other case we have discussed earlier, Hwang and colleagues (2014) also considered conventional mobile learning methods in their study to compare their findings. Specifically, they found that students in a competitive mobile gaming context showed significantly higher flow experiences and more positive learning attitudes compared to learners in a conventional mobile learning environment.

The two cases we discussed in competitive mobile gaming provide excellent examples of healthy competition in mobile game-based learning where one student's learning does not prohibit other students' learning in the same area of instruction. The game design in both activities allows students to get equal opportunities to interact with the learning targets and answer questions at their own pace. Thus, it important design competitive learning games that allow students to catch up before the end of the game after falling behind. Another important aspect worth mentioning is integrating the element of luck in the game design (i.e. rolling the dice). Although it is unclear what impact the element of luck had on the level of competitiveness in the two studies we have discussed in this section, we beleve that luck in this case was more

about randomizing game missions or locations to explore rather than putting one player in a competitive advantage over the other.

With studies on competitive mobile game approach still emerging, designing a game interface that shows student's individual score in relation to others' can make students more competitive. However, when students' have their names displayed publicly this can cause negative damage to their confidence when they are underperforming. To mitigate similar negative influences, some researchers (Chen & Chen, 2013) propose the concept of surrogate competition in virtual worlds. This refers to an indirect competition between individuals in that each player assigns a substitute and thus the competition takes place between the substitutes. For example, the reasoning behind the use of surrogates or virtual characters is that direct competition usually leads students to associate failure and game outcomes to their own identities. When using a virtual surrogate, however, students may attribute failure to lack of effort rather than ability (Chen & Chen, 2013).

## CHAPTER SUMMARY

In this chapter, we discussed the concepts of collaboration, cooperation, and competition and their applications in mobile gaming activities. Collaborative learning and cooperative learning have often been used interchangeably and applied inaccurately in the learning context. With the growing popularity and acceptance of mobile games in academic settings, we feel that it is crucial to analyze the three teaching approaches in the context of mobile games in hopes of providing an avenue for better design of mobile gaming activities with clear goals and concisely defined student's' and teacher's roles. Based on the review of the literature and the arguments we presented earlier, we categorize the difference between collaboration and cooperation into three key areas: teacher role, student role, and type of communication. Regarding the first aspect, teacher role, a cooperative approach seems to require more teacher intervention than the collaborative approach. We have argued earlier that the similarity in students' tasks in a collaborative activity leads students to provide instant support to one another. Thus, less intervention from the teacher might be needed. The second key area is student's role within the group. In a cooperative learning setting, the degree of division of tasks is more dominant compared to collaborative learning environments. In other words, students who work cooperatively in a group split the workload (often assume different roles), work individually, and later piece together their individual products to create a final product. In the case of collaborative learning, students often have similar roles and work together (not individually) towards the common goal. The third aspect refers to the type of communication (i.e., the synchronicity of communication). As explained earlier, students who work collaboratively and perform tasks together communicate synchronously. While it has been argued that face-to-face meetings are required in collaborative learning environments, the use of mobile devices in group learning activities can change this dynamic. In other words, students in a collaborative learning activity may be at different physical locations during the learning activity but can still use some features on their mobile devices (e.g., Face Talk Chat) to communicate synchronously. Thus, the physical co-presence of learners is no longer required in collaborative mobile game activities since mobile devices provide different options for instantaneous communication. On the other hand, the nature of cooperative learning activities does not require students to communicate synchronously since subtasks are performed individually under different roles.

A more consistent finding about collaboration in mobile-game-based research is the emergence of competitive behavior. The introduction of individual scoring and time pressure elements can lead students to display competitive behaviors despite the collaborative design of the game. While a healthy balance between competition and collaboration can result in successful learning, in many cases this balance is hard to achieve. In cooperative settings, we have discussed the importance of role asymmetry in that each student's contribution to the group should be unique otherwise some members with similar roles or subtasks may not be actively involved in the collective work and decision-making process. There is also some evidence that the size of the group may impact the ease of negotiations and reaching agreements. In other words, the smaller the group, the easier it is for group members to reach consensus. This applies to both collaborative and cooperative mobile game-based environments.

In this chapter, we also discussed the positive and negative effects of competition in learning. Competition plays an important role in an intergroup rivalry in that it leads group members to maximize their individual performances to benefit the group. Unfortunately, exploring intergroup competition in mobile game-based learning is an area that is underinvestigated. The available research so far seems to focus on comparisons between competitive game-based environments and conventional environments with students competing with each other to achieve higher scores. Nonetheless, the empirical evidence presented in this chapter suggests that scoring elements and pressure of time completion may lead to competitive behaviors in collaborative and cooperative game-based activities. Thus, future designs of group activities that emphasize collaborative work should carefully consider these elements and how they may trigger competitive behaviors. Lastly, another important aspect to point out is the flexibility of grouping arrangements (closed vs. open) in both collaborative and competitive settings. There is evidence to suggest that flexible grouping in collaborative environments may lead to positive outcomes; however, this strategy may be ineffective in competitive settings where closed groups (i.e. stable membership) are shown to foster more creativity and performance.

## SUGGESTIONS FOR FUTURE RESEARCH

Overall, mobile learning game is still in its infancy. Research on the specific effects of cooperation, collaboration, and competition on learning and behaviors is even more scarce. While very few studies have explicitly explored and compared performance and learning outcomes in both collaborative and cooperative conditions in mobile game-based learning, we highlight the following areas and issues for future research to investigate:

- Comparison of collaboration and cooperation with and without competition. This may include exploring factors such as performance, enjoyment, and learning outcomes.
- Effects of competition on students' cognitive loads. Early evidence points out that integrating peer-competition may decrease student cognitive loads. However, an examination of this area is needed in collaborative and cooperative conditions.
- Exploring competition within situation where students compete with themselves. Current research on competition seems to pay more attention to competition between peers.
- Design elements of effective collaborative and cooperative mobile gaming activities. Introducing individual scoring features for instance may disrupt the collaborative

design of an activity by introducing competition. Thus, unveiling the design elements that make mobile activities collaborative or cooperative is needed.

- Teachers' roles and perceptions in collaborative and cooperative conditions. We have discussed this aspect from a theoretical perspective; however, to the best of our knowledge, there is no empirical evidence that examines the level of teacher intervention in both conditions.
- Effects of grouping strategies (closed vs. open) on engagement and performance. Specifically, examining how introducing members from rival groups to collaborative groups could provide important insight into its impact on in-group collaboration and performance.
- Lastly, it is yet unclear which curricular activities are most suitable for the application of mobile games. Future research should focus on examining which curricular subjects may benefit the most from mobile games. This can provide invaluable insight to both game designers and teachers who intend to integrate mobile games in their classrooms.

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