Potential Challenges in Collaborative Game Design for Inclusive Settings

Abstract
Inclusive educational setting is normally characterized by groups of children with disparate intellectual abilities. This paper discusses the potential challenges associated with the design of effective collaborative games within such groups. We highlight case study observations gleaned from two collaborative games and share some cooperative design patterns that were observed to be effective with mixed-ability groups.

Keywords
Inclusive education, multi-touch interaction, tangible user interface, cooperative design patterns

ACM Classification Keywords
H5.2 [Information interfaces and presentation]: User Interfaces. – Interaction Styles; K.3.1 [Computers and Education]: Computer Uses in Education – Collaborative Learning.

General Terms
Design, Human Factors

Introduction
The design of collaborative games in an inclusive setting with children of varying intellectual abilities has unique challenges that are not normally encountered in
game play among homogenous ability groups. Piaget’s theory of equilibration emphasizes that knowledge construction during collaborative problem solving occurs when intellectual exchange between equals during social interaction allows resolution of cognitive conflict [4]. On the other hand, Vygotsky’s model focuses on the scaffolding of knowledge provided by collaborating with a more skilled partner [8]. In his view, the more skilled person is necessary to support a learner develop expertise; making this is a more suitable collaborative learning model for inclusive settings. However, in practice, many challenges have to be addressed in designing effective collaborative games for groups of mixed-ability children. This paper discusses this issue and puts forward some game design patterns that may address this challenge.

**Related Work**

The work of Tse et al. [8] suggests that collaborative interactions can be enhanced using co-located interactive modalities such as multi-touch tabletops and tangible user interfaces (TUI). However, recent studies by Fleck et al. [3] and Rick et al. [6] showed that such multi-player interfaces themselves do not necessarily promote effective collaborative learning as each user can end up doing their “own things”. Additional cooperative design patterns such as enforced turn-taking [5] and enforced collaboration [1] may be needed to promote joint attention on tabletop environments. El-Nasr et al. [2] presented a set of cooperative patterns identified from numerous commercial cooperative games. Zagal et al. [9] explored cooperative patterns within board games and summarized observations, design lessons and pitfalls that can be translated to computer games. However, these works do not take into account the diverse gaming abilities of members within inclusive settings.

**Potential Design Challenges**

Observations were triangulated from field notes and video analysis of multiple trials of the two games (see Figures 1 and 2) played in mixed-ability groups. We highlight four potential design challenges that HCI designers should consider when designing collaborative games for inclusive setting and suggest some design ideas to address these challenges.

**Maintaining Motivation to Engage**

Motivating children to continue to play a game requires a careful balance of challenging goals to maintain interest but not dishearten the user. Observations of collaborative game play in inclusive settings suggest other dimensions of the motivation issue exist. For example, while having their intended benefits, the use of cooperative design patterns such as enforced collaboration (EC) [1], shared goals [2] and distributed roles [9] can infuriate stronger players when the required cooperation needed of their slower partners is not forthcoming, leading to missed opportunities or slow progress. This may reduce their motivation to further engage in the collaborative activity and even increase their level of resentment. As such, the design of shared and enforce collaborative goals should be reconsidered. One such design strategy is to use *Accommodative Enforced Collaboration (AEC)*. Game play goals with AEC are attained in a more forgiving manner. This means suboptimal progress in the game is made possible even without the explicit forgiving manner. This means suboptimal progress in the game is made possible even without the explicit forgiveness of the slower players. To achieve this, there could be a multiplicity of solutions and the penalty of limited collaboration between players is not “no reward” but...
“less reward” such as in delayed goal attainment or reduced score. In the KORC game, the team can save a drowning cat by either pulling or pushing (multiplicity of solution) and if one player is not cooperating, the cat still moves towards the bank but slowly (see Figure 3).

Creating Incentives to Help
Another challenge is to create intrinsic incentives for a stronger partner to help the weaker one. This task is challenging in a team that is unfamiliar with each other. Typical strategies involve the use of team-based scores to motivate team work. More effective are design strategies that are incorporated into the game play itself. These could include appropriate distribution of roles among members and creating inter-dependant functions for these roles. Situations that explicitly reduce the opportunity cost of helping others can also create effective incentives. For example, player #1 was observed to be willing to help #2 collect the present only when his own bin was full (see Figure 6). Another design pattern is Sequentially-Dependant Roles. Incentive to help one another can be created by ensuring that functional roles are distributed and the completion of one role function is needed before the next can begin. Figure 4 shows how the PAP game uses the sequential process of cutting planks to achieve this. The pair controlling the conveyor needs to MOVE the uncut plank into position before the next pair can start the SAW plank action and so on. Sequential dependency means that helping others allows you to get your own sub-task done.

Tempering the Competitive Nature
The competitive disposition in children during game play is not all bad as it provides them with the intrinsic motivation to engage in the activity in order to improve performance. However, too much competition in a collaborative setting may lead to reduced team rapport and negative social behavior such as hoarding. A fine balance between competition and collaboration needs to be considered. Game design goals should include game play outcomes that encourage positive social behavior such as turn taking and discourage hoarding. One such strategy could be the progressive reduction in the worth of an item as one collects more of it instead of sharing them with others to increase team score.

Leveling the Playing Field
Games can degenerate into situations where the most capable player dominates the game play. Zagal et al. [9] suggested that different players be given different roles and abilities so that the best outcome depends on the coordination of all players. This strategy alone may not be effective when one or more of the players are not intellectually as capable of quick reasoning and decision making as the rest. The required close coordination within the large group may hinder game progress, resulting in frustration in the team. In our opinion, the differences in game play ability may be better addressed by creating different coupled-role pairing. We define a coupled-role as one that can be realized only when the pair works together. An example of this strategy is shown in Figure 5 where both players have to do circular motion gestures with their TUI to move the conveyor belt. The identical actions for both players help the weaker player learn passively through visual imitation [8]. This close coupling and scaffolding can contribute to a more level playing field since both the strong and weak players are highly dependent on each other’s action. In addition, we observed that coupled-roles may also provide more incentive for the stronger partner to help the weaker one in order to get
his assigned coupled-role function to work so that he is able to fulfill accountability to the entire group.

Another method of leveling the playing field is to use the Asymmetric Spatial Advantage provided by co-located interaction spaces such as multi-touch tabletops. Different positions in the interaction space can provide varying game play advantage. An informed teacher can take advantage of this characteristic to locate slower players in advantageous positions. Figure 6 shows how a slower player #1 in the KORC game is placed closer to where the desired items first appear for collection. Being closer to the item, his advantageous position helps offset the better ability of the player #2. Being more capable, it is more likely that player #2 can establish equity by verbally persuading player #1 to share the next present coming down the river.

Conclusions
Our observations in inclusive game play settings suggest that the needs of stronger team members should be addressed if they are to fulfill their roles as enablers and helpers in the Vygotsky’s collaboration model [8]. These needs include motivation to engage in collaborative activity without experiencing too much loss of control due to a weaker partner. We addressed this challenge using collaborative design involving role coupling, sequential role dependency and enforced collaborative activities that are more accommodating to weak cooperation between players. Albeit preliminary, these observations and design patterns do provide a good starting point for the HCI community to begin a much needed discussion regarding the effective design of inclusive gestural TUI and tabletop based collaborative educational games.

Acknowledgements
This research is funded by the Singapore National Research Foundation IDM for Education grant (NRF2008-IDM001-017) and the Lee Foundation.

References