The COMPASS Framework for Digital Entertainment: Discussing Augmented Reality Activities for Scouts

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Abstract
Entertainment is challenging to observe, especially with children, due to limited analytical tools. In response, we present a modified framework for entertainment computing, COMPASS – COmbined Mental, PhysicAl, Social and Spatial factors, which we use to analyze augmented reality activities for cub scouts.

Author Keywords
Children-Computer Interaction; Augmented Reality; User Experience; Evaluation Framework.

ACM Classification Keywords
H.5.2. User Interfaces – Theory and Methods, Evaluation/methodology, User-centered Design

Introduction
Advancements in information and communication technologies (ICT) led to its broad use in private domains, including those of children, in the form of digital entertainment. New entertainment would integrate mental and physical presence with social and spatial aspects [5]. We present our augmented reality (AR) activities to demonstrate this integration. We then discuss the activities based on the COMPASS framework, which extends the framework in [5].

Related Work

AR is a promising medium for entertaining activities. However, to assess the quality of entertainment, we need appropriate frameworks for children. From a backpack system composed of a laptop computer, individual sensors and a head-mounted display (HMD), smartphones and tablet computers enable AR experiences in one portable device. Such implementations are limited and questionnaires have been developed to assess the usability of individual applications [8]. Several AR applications have already been applied to tourism [4], education [9], and gaming [10]. Evaluation methods have been demonstrated in these domains; however, entertainment was not explored.

Framing Entertainment Computing

Mobile entertainment commonly refers to using smartphones and tablets as a medium to deliver previously existing multimedia, such as novels, movies, and videogames. These do not represent what Nakatsu et al. [5] consider new media. To explain new media, Nakatsu et al. distinguishes passive experiences (reading a novel, watching movies, etc.) from active experiences where participants react to dynamic situations (doing sports, creating art, etc.) An entertainment experience can fall anywhere between the passive-active continuum. Their framework introduced the term, integrated presence, which refers to the appropriate combination of physical activity and mental imaginations. It differentiates physical presence (hearing sound, looking at an image, etc.) and mental presence which involves higher-order processing of stimulus (listening to music, analyzing a painting, using language, etc.) Nakatsu et al. illustrated the classification of entertainment based on the passive-active experience continuum and three classes of presence, namely, physical, integrated and mental.

Assessing Flow Experience

Several theories have been developed in the fields of communication and media psychology to analyze entertainment. However, having an integrative view of entertainment is still challenging [5]. Research works have leveraged on the concept of flow experience to analyze entertainment [5], [1]. Csikszentmihalyi [2] defines flow as "the state in which people are so involved in an activity that nothing else seems to matter." Flow experience has been observed using surveys and experience sampling methods, both of which rely on the users to be capable of articulating their internal states.

Field Testing with Children

Read and MacFarlane [6] have listed four known concerns with using survey methods with children, namely, satisficing and optimizing, suggestibility, sensitivity to question formats, and language effects. They designed and validated questionnaires and recommended some design guidelines. In the end, they warn that an experiment from one group of children may not be generalizable. Moreover, children's responses are not stable over time. As such, they recommend focusing on general trends and outliers in children's responses.

The COMPASS Framework

Physical presence and mental presence form a scale in the previous work [5]. However, it's possible to make an entertainment activity more mentally challenging without making it less physically challenging, and vice versa. As such, we separate the physical-mental presence scale into two scales:

- Mental Activity Scale - refers to how passive or active an entertainment experience is in terms of mental exertion. E-books, movies, and strategy videogames would score higher in his scale.

Figure 2: The Scouts Cabin (top) and screen view of Meeting Robert Baden-Powell Application (bottom).

- Physical Activity Scale - refers to how passive or active an entertainment experience is in terms of physical exertion. The arcade games Taiko no Tatsujin and Dance Dance Revolution are digital entertainment that would score higher here.

Although mentioned in the work of Nakatsu et al [5], social and spatial factors were not included in their framework. Mental and physical activity corresponds to the interaction between the user and the entertainment system. Current entertainment systems also facilitate the interaction among users, and between the users and their environment. In such entertainment media, interaction with other users and physical environments contribute significantly to the experience. New digital entertainment will have spatial and social factors, as illustrated in Figure 1. The two scales are:

- Social Activity Scale - refers to the extent a digital entertainment activity integrates social factors to the experience. For example, Guild Wars (MMORPG) would score higher because they require cooperation among remote players to accomplish tasks. Another would be augmented team sports, which envisions the use of digital media to create new sports [7].
- Spatial Activity Scale - refers to the extent an entertainment activity integrates physical locations and real objects from the environment. For example, augmented skiing [3] and Pokémon GO would score higher on this scale.

We summarize the four scales into COMPASS - COmbined Mental, PhysicAl, Social and Spatial factors. Currently, we are equipped with digital media, such as AR, that enables us to effectively integrate these four factors into entertaining activities.

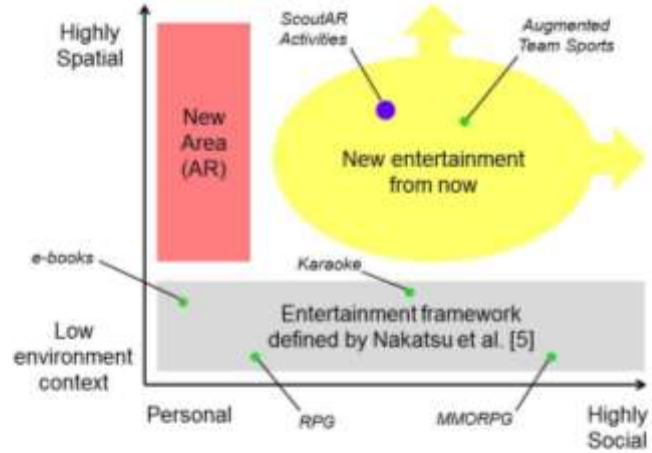

Figure 1: The COMPASS Framework

Development of AR Activities for Scouts

Scout leaders select scouting activities from a list prescribed by the Boy Scouts of America. Most involve teaching some skill or some desirable characteristic. However, when we were brainstorming with scout leaders, we focused on creating technology-enhanced outdoor activities that the scouts would find enjoyable, thus the emphasis on entertainment. We developed four prototype systems using the Unity game development platform and Vuforia AR software development kit. We installed the applications on iPad 2 tablet computers (except Blind walk) and Nexus 5 smartphones (for the Blind Walk). We placed the iPads inside a case with a neck strap, whereas the Nexus 5 was mounted on a Google cardboard forming an HMD.

Meeting Robert Baden-Powell

We set up a cabin for scouts to meet a virtual Robert Baden-Powell (Figure 2), the founder of The Scout

Figure 3: Tree Climbing scenario (top) and screenshots of the system (middle and bottom). The user instructs the climber the direction of the movement. Red cubes indicate where the climber goes next; green shows successfully visited points.

Association. Using simple gestures and dialogue, the virtual Baden-Powell explained facts about the scouting organization. We used this application to quickly introduce mobile AR to the cub scouts.

Tree Climbing
Boy scouts engage in tree climbing exercises to develop physical strength. We prepared a lighter version for cub scouts and made it a team activity. The tree climbing activity requires the cooperation between a climber and a guide who uses the tree climbing application. Through the AR application, the guide sees virtual checkpoints overlaid on the scene, as shown in Figure 3. He instructs the climber where to move next. This activity trains the scouts to construct and to follow instructions.

Blind Walk
The original blind walk is a game where one scout is blindfolded and follows a path of rope. The rope is tied around trees and guides the scouts through challenging obstacles. We transformed the blind walk into a team activity by having one member to be virtually blindfolded, while two to three members act as guides. The blinded member uses a head-mounted application which indicates the location of the virtual checkpoints with distance markers, as shown in Figure 4. The guides ensure that the blinded does not bump into trees, stumble on big rocks, etc. by giving him some warnings and instructions. Similar to tree climbing, the activity trains the scouts to listen to instructions and construct their own instructions.

Memory
The traditional memory game is played with a set of cards laid face-down on a surface. Participants flip open pairs of cards with the goal of finding cards that match. Non-matching cards are laid face-down once again, thus requiring the participants to remember the location of each card. We apply similar mechanics for our AR memory activity. However, instead of cards, we attached markers to trees and display virtual information. Using the memory application in Figure 5, one scout chooses two objects to view and comes back to report it to the group. Memory simulates the experience of remembering the location of physical objects found near the camp. This activity trains the scouts in giving and listening to directions to a place.

Field Testing
We conducted a field test to confirm whether the scouts can operate the system or not, including but not limited to gestures and visualizations; to discover limitations in our activities and suggest improvements for future AR entertainment activities; and to identify behaviors of children that may be indicative of flow experience. For our exploration, we made all activities available in the scouting site from 10:00AM–3:30PM with a 1.5 hour break in between. We conducted a field test with around 40 cub scouts (6 to 12 years old), under the supervision of around 10 boy scouts (13 to 15 years old), 10 scout leaders (adults) and 5 parents. The cub scouts where divided into four groups and they were rotated among the four AR activities. To ensure safety, boy scouts, scout leaders and parents were always on stand-by. To motivate the students, we declared that we will announce the fastest groups for Tree Climbing, Blind Walk, and Memory. Seven people managed the testing: four acted as facilitator-observer; three acted as assistant-observer. The facilitator-observers managed one of the four activities in four hours. They first explain the mechanics of the activity, then proceed to facilitate as the scouts perform the activity.

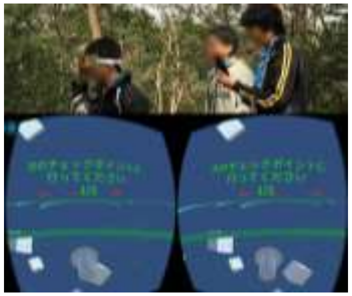

Figure 4: One member wears the Blind Walk application as two members guide him (top). The member sees red markers (bottom) which he needs to visit to accomplish the task.

Figure 5: Location of marked trees (top) and screen view of the hidden object (bottom) for the memory application.

Whenever they observe a difficulty with our system, notice an interesting behavior in the children, or recognize some trend, they report it to assistant-observer who takes notes. The assistant-observers assist the facilitator-observer when necessary. Otherwise, their task is mainly to observe. The assistant-observers rotated among the activities.

Results and Discussion

Although all activities use an AR application, there are differences in our applications based on COMPASS. We summarize these comparisons in Table 1. We judged the Meeting Robert Baden-Powell activity as the most passive. The scouts simply listen to the presentation; the content was easily understandable; and physical exertion and discussion among peers were not necessary to accomplish the task. The purpose of the physical location was for ambience only, without interaction with the environment.

Tree Climbing, Blind Walk, and Memory all require giving and receiving instructions for each team member. However, we think Memory requires the most mental exertion because the participants need to memorize objects and physical locations or directions. As for the physical activity, we rated Tree Climbing to be the most physically challenging because the participants need to climb a tree in a controlled manner to accomplish the task.

All the latter three activities in Table 1 involve cooperation. However, we rated Memory as highest in social activity because it requires strategic thinking and decision making for all team members, as opposed to Tree Climbing and Blind Walk where one person gives instruction and another person follows.

All four activities combine digital information and information from the physical environment. Although it’s easier to see that the Meeting Robert Baden-Powell application combines some virtual objects and real environments in the presentation style, we labeled Blind Walk to be higher in the spatial aspect because the user of the application is actively combining the virtual information he sees with his peer’s instructions and his sensations of the surroundings. Memory is the highest in the integration of the physical space because all users needed to remember corresponding locations and virtual objects, and move around a wider space to accomplish the task.

All the scouts were able to do four activities after some guidance from the facilitator. For the three tablet-based applications, the children easily understood that they need to hold the application steadily in order for the virtual information to pop out. In cases that the tracking is lost, they quickly learned how to handle it by steadily holding the tablet towards the marker and moving it carefully. The scouts did not have problems with holding the application, probably because they did not need to hold the tablet steady for a long time. As for Blind Walk, which uses an HMD, only one group reported dizziness after using the application.

Although we were able to set up and use the applications, we encountered some points of improvement, as follows:

- Tracking for the Tree Climbing activity fails during the activity. This tracking instability increases the physical activity required for Tree Climbing, and resulted to some climbers giving up mid-way.

Activities	Me	Ph	So	Sp
Baden-Powell	L	L	L	L
Tree Climbing	M	H	M	M
Blind Walk	M	M	M	M
Memory	H	M	H	H

L=Low, M=Medium, H=High

Table 1: Using COMPASS framework to compare ScoutAR activities

- Initial tracking for the Blind Walk fails and needs an expert to reset it. This reduces social activity because the group cannot resolve the problem on their own.
- The scouts understood the virtual arrow in the Blind Walk, but they ignored the distance markers, probably because they felt that it was not useful. Our options are removing it, or trying out other distance visualizations and see if they are useful for the activity without adding unnecessary mental burden.

Conclusion and Recommendation

We present the COMPASS framework to discuss the trend in new media which integrates mental, physical, social and spatial factors. Although COMPASS could apply to many user groups, we focused on children. Ultimately, we envision that user evaluation of digital entertainment with children would emphasize on behavior encoding, rather than interviews and questionnaires. A behavior coding protocol should be developed based on COMPASS. This protocol would operationalize and quantify each COMPASS factor.

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