AR Gone Wild: Two Approaches to Using Augmented Reality Learning Games in Zoos

Judy Perry, Eric Klopfer, Marleigh Norton, MIT, 77 Massachusetts Ave., 10-337, Cambridge, MA, 02139 USA
Emails: jperry@mit.edu, klopfer@mit.edu, marleigh@mit.edu
Dan Sutch, Richard Sandford, Keri Facer, Futurelab, 1 Canons Road Harbourside Bristol BS1 5UH UK
Emails: Dan.Sutch@futurelab.org.uk, Richard.Sandford@futurelab.org.uk, Keri.Facer@futurelab.org.uk

Abstract: Participants in Augmented Reality (AR) games are equipped with location-aware handheld computers, allowing players to physically move throughout a real world location while simultaneously triggering virtual information based on their physical location. Researchers are only beginning to understand how to leverage the pedagogical strengths of location-based AR games. This paper includes case studies for two separate research projects: Researchers from MIT will present "*Zoo Scene Investigators*: Challenges of Designing a Mystery Themed AR Game for Students Ages 10-14 in a U.S. Zoo". Researchers from Futurelab will present "Crafting mediascapes for a Zoo Setting using Create-A-Scape with Singaporean Primary School Students".

Overview: Augmenting Learning through Augmented Reality

The two projects discussed below were developed independently of each other. Nevertheless, they display common characteristics in design and implementation, further exploration of which might reveal important lessons for future developers of this kind of learning activity. Here, we present a brief overview of the field of mobile learning, a summary of each project, and brief discussion of themes resonating between projects.

The use of mobile devices as tools to support learning (or "m-learning") continues to be actively explored by educators and researchers. As mobile devices become part of everyday life, for learning activities to remain relevant they ought to build on the technological practices that learners are familiar with outside the school environment. Vavoula and Sharples (2002) suggest that learning is itself inherently mobile, claiming that it displays mobility in time (it "happens at different points during the day"), in space (learning can occur "at the workplace, at home and at places of leisure") and across different areas of life (it "may relate to work demands, self-improvement or leisure"). Mobile devices themselves can be well suited for supporting certain learning activities: Klopfer, Squire & Jenkins (2002) identify five properties of mobile devices that make them useful to educators: portability, social interactivity (both face-to-face interaction and data exchange between learners), context sensitivity (through GPS and data networks, but also through video and image capture capabilities, mobile devices can collect and respond to data particular to a certain area), connectivity and individuality (support for different activities can be tailored for different learners). For researchers and educators whose work is informed by sociocultural, constructivist and situated theories of learning, mobile learning is of particular interest. Mobile devices afford learners the opportunity to leave the classroom and situate their learning in different geographic contexts, placing them within an authentic environment and giving them tools with which to support the construction of new knowledge – in a sense, these devices enable any location to become a student's classroom. From this perspective, the authenticity of the context in which the learner is situated is determined by the overarching narrative under which learners' activities are located. This opportunity has resonated with those keen to extend Papert's (1980) notion of the "microworld" (a consistent, self-contained simulation offering learners the opportunity to engage with systemic thinking) beyond a program running on a computer: describing what they term "participatory simulations", Naismith *et al.* (2004) highlight the benefit of having a learner, through a networked device, become part of a dynamic system: "they do not just watch the simulation, they are the simulation".

In this way, the information and data given to learners does more than just *reflect* the reality in which they are situated: it *augments* it, supporting them as they engage with the narrative of the learning experience. This class of mobile learning activity has become known as "augmented reality" (AR), and draws on research into game-based learning as well as work on mobile learning activities. AR games engage participants in activities that combine real-world experiences with additional information supplied to them by handheld computers. As students physically move about within geographic space (e.g., a school campus, an outdoor plaza, a zoo, etc.), their location-aware handheld computers (e.g., Windows Mobile devices equipped with GPS) allow them to collect additional information by interviewing virtual characters, viewing rich media or accessing real or simulated data. Participants in AR games are often tasked with role-playing and collaboratively investigating a problem or issue in a game-like fashion. Previous work on AR (Klopfer, Squire & Jenkins, 2002; Klopfer, Squire & Jenkins, 2003; Klopfer & Squire, 2004; Falk, Ljungstrand, Bjork, & Hannson, 2001; Walz, 2002) indicates that these immersive, interactive experiences are promising for learning.

In this paper, we discuss two separate research projects: "*Zoo Scene Investigators*" which takes place at the Columbus Zoo and Aquarium, located in Columbus, Ohio in the United States. The Tao Nan School's Zooscape AR game was located in the Singapore Zoological Garden. In both projects, investigators sought to explore ways in which zoo settings might provide fertile locations for place-based AR learning games.

Zoo Scene Investigators: Challenges of Designing a Mystery Themed AR Game for Students Ages 10-14 in a U.S. Zoo

Background and Research Objectives
Building on knowledge gained from prior research, the MIT Teacher Education Program and Columbus Zoo and Aquarium collaborated to design and test an AR game designed to teach Zoo visitors about the illegal wildlife trade. The goals and requirements of the project included:

- *Age-appropriate content and pedagogy for middle school students on field trip.*
- *Teams of six students plus one adult chaperone:* Based on previous Zoo field trip models, teams of six students proved manageable by one adult, without requiring too many chaperones of the school.
- *Two-hour time limit*: Factoring in introduction, tutorial and conclusion, this left an hour for game play.
- *Manageable by one Zoo staff:* The Zoo was able to devote one staff member to running the game.
- *Illegal Wildlife Trade Theme:* The illegal wildlife trade is particularly problematic in southeast Asia. The AR game was designed to reinforce this theme, and was located in the "Asia Quest" exhibit.
- *Mapped to existing math and science content standards:* To qualify as an educational field trip, certain educational state content standards must be met. This required incorporating additional material such as the differences between plant and animal cells, quantitative graphs, and predator-prey relationships.
- *High engagement for participants:* If the students are not engaged, they will be unlikely to learn. Furthermore, field trips participants expected an enjoyable experience.

Our investigations centered on the following key research questions: (1) Do students of various backgrounds and ages (ranging from 10-14 years old) find a role-playing AR game in which they investigate a simulated crime while learning about endangered species both appealing and engaging?, (2) Is it possible to have a meaningful AR experience with middle schools students in two hours or less?, (3) How can we create a cohesive game using key existing physical live animal exhibits? (4) What additional steps and/or research would permit us to further develop this approach to using AR in a zoo setting?

Walkthrough
The following description outlines the scenario presented to participants, and reflects the modifications made based on the piloting process (described below). Students arrived at the Zoo having already been divided into teams and assigned a chaperone. They were escorted to a conference room, where the basics of the game were explained. They were then shown a video to explain the story, narrated by a security guard explaining how an anonymous 'John Doe' nighttime Zoo intruder was captured, possibly trying to steal something. You [the players, a.k.a. the famous "Zoo Scene Investigators"] have been brought in to gather clues, and determine what the intruder was up to.

Handheld computers, GPS units, and paper worksheets ("clue reports") were distributed to players, after which all players went outside for a walking tutorial. A Zoo staff member guided the players through the types of interactions required in the game, including interviewing animals, interviewing people, filling out clue reports, and finding clue codes (small signs with numbers on them hidden in the physical space which students enter into their computers to get information).   After the tutorial, the players separated into their teams and played the game as individual groups. Teams returned to the conference room at the appointed time to discuss their findings and to watch a confessional video by the villain.

Methods

Concept Testing
The project began during summer 2007, taking advantage of the Zoo's week long day camp sessions for middle school students (mainly 11 and 12, as well as some 13 year-olds) to gauge the appeal of various game concepts. The students were split into groups of roughly 10 students and were facilitated by a moderator. The moderator read two scenarios to the students, after which students completed a written opinion survey. The moderators then facilitated a focus group in which the students discussed the potential scenarios. The groups took place weekly, across three weeks, with revisions to the scenarios in between. Week One's scenario consisted of reading scenarios on *Zoo Scene Investigators*, a detective game about a crime that had taken place

in the Zoo, and *Death by Cookies*, an investigation into a cookie company which was using illegally farmed palm oil and the ripple effects on the environment. During the testing which occurred during Weeks Two and Three, subsequent revisions to these scenarios were presented for similar feedback.

Handheld Prototypes 1 & 2

A prototype of *Zoo Scene Investigators* was created for GPS-enabled handheld computers. The prototype contained several interaction styles and the interviews were in the form of plain text with still images. Classes were recruited from local schools to send students to one of three sessions. Each session contained three teams of six students and one or more chaperones. The participants in Prototype 1 included two classes (7th and 8th graders) from an inner city school and one class of 5th graders from a rural school. At least one observer accompanied each team to take notes, and written surveys were given afterwards.

Participants in Prototype 2 played a version of the game which was revised based on the results of the first handheld prototype. These pilot tests had the same structure as the first: three sessions with three teams each. The timing of the test—nearly winter and before a major holiday—made it extremely difficult to recruit subjects. This time, two sessions included 8th graders from the same inner city school, and the final group was made up of 5th graders from a suburban school.

Findings and Discussion

Concept Testing

The focus groups provided useful insights into the difficulties of designing for this age group. The range of maturity of the students was wider than expected and was reflected in their tastes. A good indicator was the reaction to the *Death by Cookies* scenario. Most students either liked the idea because they liked cookies, or hated the idea because they thought a cookie game would be for little kids. Since the particular product was not central to the concept, it was changed to soap for the next test.

For the second week, having discovered that cookies were a polarizing theme, the product in the second scenario was changed as reflected in the new title, *The Dirt on Soap*. The students were much more divided on whether they liked the detective scenario or the corporate investigation scenario better. However, *Zoo Scene Investigators* was the preferred scenario, so it was selected as the final concept.

The third and final week of concept testing was used to collect more information on the way to implement the *Zoo Scene Investigators* idea—whether it should be more serious or silly, or should involve talking animals. Talking animals also proved to be controversial. The compromise solution was to have animals talk via a special machine that read the animals' memories. This seemed to satisfy both sides as a way of communicating with animals in a less childish way.

Handheld Prototype 1

As can be expected from initial prototypes, the first handheld prototype test turned out to be a useful source of data, though unsuccessful as a game. There were many issues to address, including:

- *Low literacy:* It was a surprise to the designers to find that participants comprising two of the sessions—the inner city 7th and 8th graders—were not native speakers of English and whose English literacy was extremely low. As this prototype was almost entirely written text, this made the game impossible for the students to play without assistance. The third session—rural 5th graders—were native English speakers, yet they also had difficulty with the amount of reading. After discussion with the Zoo staff, it was decided that low literacy should not be a barrier to playing the game. Adding audio became a high priority revision to the next version of the prototype.
- *Cognitive overload:* Given the already short amount of time for gameplay, the teams were spending a comparatively large amount of time deciding what to do. To focus the students on the content, it was decided to try a completely linear structure for the second prototype: students discover each clue in a predetermined order, and follow this path to solve the mystery.
- *Lack of teamwork:* The game was designed to encourage teamwork by giving different information to each of the three pairs of students on the team, and expecting students to share that information to solve the crime. However, while students were very interested in their own clues, there were not interested in those of their teammates. On some occasions, it was observed that this seemed to be less of a problem when one pair of students received information and the others did not. For the next pilot, it was decided to only give new information to one pair of students at a time. The other two pairs would get notifications to go ask the first pair what they discovered.

Handheld Prototype 2

Generally speaking, observations conducting during the second handheld prototype demonstrated progress in several problem areas identified during the previous round of testing. Replacing the text with subtitled audio improved playability, though there were some problems clearly hearing audio. The linear gameplay helped maintain momentum and shift students' focus on interpreting the clues, rather than merely deciding what order in which to get them. Giving information to one role (one pair of students) at a time also seemed to have its intended effect as students shared information much more freely in this session, though there was some confusion in teams where one student tried to go ahead of his or her peers. Nevertheless, the prototype also introduced new problems that were difficult to see in the previous test, including:

- *Error-prone tutorial*: The tutorial had a walking component in which a single member of the Zoo staff led all 18 students through a series of clues. Keeping that many students' attention was a difficult task, and sometimes the staff member forgot to address certain topics. Also, if the students were not paying attention at a key moment, they may have missed a key instruction regarding the game. Enlisting the help of the chaperones, creating tools for the Zoo staff member in the form of checklists, and some sort of assessment to make sure that all students understand what to do before they leave for the independent portion of the game are all being considered for future iterations of the game.
- *Unclear integration of clue reports and game*: The clue reports were written worksheets given to the students and chaperone as a way of focusing the students on the task. They were intended to be used at the end of each animal section. However, several chaperones forgot they even had clue reports to fill out. Those who did often tried to fill them out *too soon*, such that they were trying to answer questions about clues they had not found yet. Possible fixes include giving clearer cues in the game about when to fill out the clue reports and having checklists of clues for the chaperone to know when they have collected enough information.
- *Animals vs. GPS:* The viewing areas for most animals is often quite small, made smaller by the fact that GPS does not function indoors, so indoor viewing areas were mostly avoided by the game. Further, if the character interview hotspots were placed too close together, a student could stand in a single spot and unintentionally trigger multiple interviews, creating confusion. This prototype tried to strike a compromise between placing characters near an animal enclosure so the animal could be viewed *while* playing the game, and trying to select locations which were likely to be successful with the constraints of GPS. The results were unsatisfactory, with students often ignoring the animals – thus missing a key opportunity for the Zoo. It is unclear how to address this, though a possible solution would be to explicitly build in time to look at animals, with the understanding that animals are sometimes uncooperative and not available to visitors.

Utilizing mediascapes with Singaporean Primary Students in a Zoo Setting

Background

"Mediascape", a software conceptualised and developed for use with GPS-enabled PDAs, is a digital overlay of sound clips, video snippets, etc. on a particular geographic location or hotspot. The GUIs and the underlying software architecture are designed so that mediascapes can be easily constructed and analysed on standard PCs with picture files or video clips. An interesting feature of the software is that it allows users to conduct simulated test-runs of the completed mediascapes on PCs before downloading them into the PDAs for use on the location. These flexibilities allow teachers and pupils to create mediascapes for themselves or others.

The technology that enables the construction of, and participation in, mediascapes was developed by Mobile Bristol, working with HP Labs in Bristol, UK. Initially, the technology was piloted as part of Futurelab's Savannah (Facer, 2004) and Mudlarking projects, and subsequently updated and improved versions were used in collaborations with other partners (for example, 'Ere Be Dragons, and a game set in the Tower of London). Following the success of these projects and the decision to allow public to have access to the software needed to create and use mediascapes, Futurelab and HP Labs, with the support of the Department for Education and Skills, developed the Create-A-Scape website (http://createascape.org.uk/) that contained resources and support for teachers interested in using mediascapes in their teaching. A pilot project which put Create-A-Scape technology to use took place in the UK in December 2006, as part of a pan-European project (PUENTE, an extension of the "La Piazza" project), investigating appropriate frameworks for analysing and designing intergenerational activities in public spaces. The experiences and findings of these previous projects informed the development of the Tao Nan School's mediascape, discussed below.

Tao Nan School's Zooscape

Encouraged by the success of projects conducted in the UK illustrating the potentialities of this locative technology in supporting new and emerging forms of learning, Tao Nan School of Singapore, in collaboration

with HP and IDA, decided to develop a learning experience for its pupils using the Mediascape technology. At the conceptual stage, the research team was mindful of the fact that for an IT-enabled implementation in curriculum to be meaningful to the teachers and the pupils, the use of technology needed to take into account the socio-cultural context of the participating schools and education system: i.e. how the technology would used and when it would be used would influence the outcomes of the implementation. The decision thus was made to locate the use of the mediascape in the Singapore Zoological Garden over a period of two hours, as part of the Primary Six's science enrichment programme during the June vacation. With this arrangement, not only would the use of the locative technology be situated within the larger context of the pupil's outing to the Zoo, but it also minimized the impact the implementation of technology had on the already over-crowded curricular slots.

In designing the curriculum, the research team was interested in developing an understanding of the ways HP Mediascape technology enhanced pupils' learning experience in the Singapore context. More specifically, the research team considered the following areas worth pursuing further: (1) Does the technology promote students' engagement with the learning objectives?; (2) Does the technology foster greater social interaction between learners in the Singapore context?; (3) What teaching objectives are appropriate when using this technology?; (4) What factors contribute to the successful implementation of technology in our schools?

Activities

The project has two broad phases. The first was a planning stage, in which the teachers and students worked with a researcher from Futurelab to develop an understanding of the potential of the technology and the ways in which it might be used meaningfully within the curricular context of Tao Nan Primary School, producing a plan for a set of activities based at Singapore Zoo, incorporating the use of the mediascape technology. The second phase was a practical trial of these activities in the Zoo itself.

Curriculum Development

Developing the curriculum consisted of three segments: planning, testing, and executing. During the planning phase, two science teachers worked with the researcher to extend their understandings of the ways in which the tool might be used to support the science curriculum. Following this early planning work, they proceeded to work with the HP support team in developing a set of activities based at Singapore Zoological Garden that would use the mediascape technology. The testing phase was a technical trial of the technology and it consisted of three stages: First, the teachers, with the assistant of HP support staff, introduced the mediascape and its functionalities to the pupils by having them to try out the technology on the school compound. Second, the teachers and the HP support staff tested the mediascape at the Zoo to ensure that it was technically viable. Third, the teachers, with the help of other science teachers, went through the activities in its entirety at the Zoo so that they could have a sense of what the pupils would be experiencing; and, where necessary to fine tune the activities. The third and final phase involved 30 Primary Six pupils from Tao Nan School. They were divided into two groups of 15 each and these two groups carried out the same set of activities at the Zoo on different days. Within each group, the pupils were organised into teams of three of mixed abilities. Each team was given two PDAs; one for GPS connectivity and the other for capturing audio-video clips as well as taking notes

The Task

During the field trial, the pupils were divided into mixed-ability groups with each group having three members. Each group was assigned one roles: Herbivore (Pygmy Hippo), Carnivore (Otter) or Omnivore (Sunbear); and was given the following storyline (reproduced here in the idiomatic English used in Singapore):

> You were caught by some poachers and had just made an escape. You are heading home to the zoo now but at the same time facing dangers of meeting your predators. Hence, you must avoid certain animals and their enclosures according to your diet. To avoid being preyed on, you need to use your survival tool, the PDA, to strategise your safe return. The team which completes the most tasks and has avoided the most pitfalls wins the game.

The groups were also told to begin their search of their habitats (indicated as hotspot on the mediascape) from a particular tram station and end it at their own habitat (Pygmy Hippo / Otter / Sunbear) within two hours. Each group was expected to visit at least two hotspots plus one compulsory hotspot (excluding their own habitats) in order to complete the game. Within each hotspot, the pupils were required to: (1) From the list, check whether there are any animals that have similar diet as yours, (2) If yes, proceed to do the tasks and take a photo of another animal in the list that matches your diet for your food points, and (3) If no, move on to the next hotspot.

The pupils were told of a bonus hotspot for which double bonus food point would be awarded for every task completed in this hotspot. They were also asked to snap a picture of their prey if they were spotted at the wrong habitat and the prey would lose a food point. The pupils were required to save the completed tasks into

the PDAs. As a penalty for performing the tasks at the wrong habitat, food points would be deduced at the end of the game. All the tasks which were completed needed to be saved into the PDAs. When the pupils reached their own habitats, they were expected to record a short video of themselves at the habitats and end the video by saying, "I am home."

Data Collection

A post-activity survey was conducted among the pupils to identify pupils' attitudes towards the use of handheld computers in the activities as well as the nature and quality of learning that took place. The survey took the form of a Likert-scaled questionnaire with 16 items. A typical question from the questionnaire was "I like handheld computers because of its small size" and the pupils were required to provide their answers on a four-point scale with discreet scores ranging from strong agreement on one side to strong disagreement on the other side, and with no opinion in the middle. Besides quantity data, qualitative data for this project was collected through on-site observation and semi-structured post-activity interviews. For the two days the activities were taking place, a researcher followed two mixed-ability groups, one on each day, to observe how the pupils within the groups interact with each other as well as how these pupils interact with the technology. These pupils were interviewed by the same researcher immediately after the field trial so that a better understanding of their interactions could be developed. The teachers and the technical support staff from HP involved in this project were interviewed within a week from the completion of the activities at the Zoo.

Analysis and Discussion

Effect of Technology

Of the 16 items in the survey administered, six items were about the functionalities of the handheld PDAs. The responses from the pupils for these items showed that the pupils involved in the project took to the handheld PDAs: they enjoyed using the PDAs because it was a "cool-thing" to engage in a wide variety of outdoor activities with a PDA that fitted snugly in one's palm. Many pupils, during the post-activity interview, commented that having the handheld was "fun and nice" and the device was easy to use because the screen layouts looked similar to those on PCs. Many pupils found the camera and video-recording features useful and one boy explained that the video-recording feature allowed his group, "to take note vocally…and in the background we can put the animal we are talking about!"

It was observed on many occasions during the field trial that the use of technology encouraged pupils to perform the assigned tasks in ways that were unanticipated by the teachers or the researchers. For example, when the boy commented that his group used the video-recorder function of the handheld to do note-taking, he had indicated that he and his group were not using the PDA's word processing software, which many would link to tasks like taking notes and recording observations, to record their observations. In fact, he saw the video-recording mode as superior in accomplishing the note-taking task as the video-recording feature of the PDA allowed them to record the animals they were talking about. This example illustrated the affordance of the technology that enabled the pupils to complete a task in ways that are far more innovative and creative than what could be perceived by the teachers or the researchers when they were designing the curriculum. Similarly the massive computational power of the PDA coupled with its integrated functionalities afforded the pupils the ability to attempt a particular task multiple times, selecting the best outcome. For example, the researchers observed that the pupils, when tasked to take a snapshot of a particular animal (e.g., a polar bear), tended to take multiple-shots from various angles and positions instead of just one shot. After taking the shots, the groups would view through these photographs on the PDA's screen, selecting the best shot and deleting the rest. The criteria for selection were observed to be colour and contrast of the photographs as well as the clarity of the image of the animal captured by the PDA's camera.

The field trial showed that it was not just the locative technology that encouraged and supported the effort put in by the group but that more traditional tools were necessary. The paper map of the Zoo was vital during the activities and gave the group a shared purpose; it was large enough for a group of pupils to view it simultaneously. The affordance of coupling pen with map in this field trial had enabled some pupils to actually share their ideas in a concrete manner through creating markings on the map.

Nature and Quality of Learning

It was observed that the use of this locative technology during the activities had allowed greater opportunities for contextualized learning of the subject that otherwise would not be possible in the classroom. One of the teachers involved in the project observed that:

"During classroom teaching, pupils tended to be more passive with lots of spoon feeding taking place, difficult to assess [pupil's understanding,] we wouldn't know [whether] they understand it or memorized the fact. The task in [the] real world stretched them further and

they tended to think and analyse, and through the discussion we know whether they know how to apply the knowledge learned [in classroom]. [In class,] when they have problems they will raise their hand to asked the teacher and the teacher would prompt or tell them the answer. Now they don't have a teacher to help them and were left alone, now they don't know whether their answer was right or wrong but they just have to do it. They have to do it and to decipher for themselves the information around them."

Given that the content and pedagogical approach within the Zoo game differed markedly from their standard classroom practice, some pupils were obviously uncomfortable with such change. During the post-activity interview, a girl commented that she supposed she could learn the same science content in the classroom and it would be much faster and more comfortable to do so in the classroom, especially since the teacher was always there ready to provide help, so doing the activities in the Zoo was not that beneficial to her. Her response echoed that of the survey findings. In the survey findings, the two items among those that had the least percentage of pupils stating they "agree" or "strongly agree" were about the effectiveness of technology as an enabler in learning: (n) I know more about the subject because of the using handheld computer (78%); and, (o) Handheld computer helped me learn better (88%). All the other items of the survey generally have at least 90% of the respondents stating "agree" or "strongly agree".

The researcher observed that there was a relatively high degree of engagement among the pupils in the groups he observed during the field trial. Pupils were deeply engaged in exchanging their ideas, asking for clarification and requesting for confirmation. Similar observation was made by one of the teachers involved in the project who reported during the post-activity interview that the behaviours of the pupils, during the field trial, as compared to that in the science classroom were "very different":

During the [field] trial they actually ask each other questions. 'Is this chimpanzee?' … The other pupils will help by looking at the list... They will prompt each other question and that is how they arrived at the answer, so called answer which they are not very sure of.

The comments the pupils made during the interview about the ways they interacted with each were consistent with those made by the researcher and the teacher. One girl, during the interview, commented that during the field trial she could easily move around to exchange ideas using the resources like PDA, signposts and maps with her peers in the group whereas in the classroom it would be more difficult to do so because of the constraint of space and sitting arrangement.

Discussion points

While there are many differences between the two projects, some core themes resonate in each. The first, and perhaps most obvious, difference is the cultural context: with one project located in the USA and another in Singapore, it might be assumed that users came to the trials with different attitudes towards the technology, grounded in the wider social expectations of and familiarity with mobile technology. Similarly, we might assume that the location itself holds different places in the respective cultural imaginations: the purpose and role of a "zoo" might be expected to have historically different beginnings and to differ still in the present day. And from a more specifically educational perspective it might be expected that different pedagogic experiences and attitudes informed every aspect of each project, from understandings of the roles of teachers and learners to the purpose and value of field trips. Neither trial, however, was undertaken with the aim of furnishing data for a comparative cultural study, so we can do nothing more here than note that these broad cultural differences might exist.

Continuing to view the two trials from an educational perspective, it is clear that the pedagogic aims of each differ sufficiently to make it impractical to compare their relative success or failure in successfully addressing the curricula aims of the teachers involved. The ages of the two cohorts of students differed significantly, as did the way in which each activity was designed. The tasks necessary for the completion of each activity also differed in their focus and approach, making a comparison between the two meaningless. However, there is one important difference between them that is worth highlighting in a discussion of possible approaches to design and pedagogy within learning-focused locative activities. In each project, learners were asked to take on a different identity, in effect playing a role other than "learner" throughout the activity: for the students in the MIT project this role was that of a human unaffiliated with the zoo, while for the Singaporean students the identities they were asked to inhabit were those of various animals resident in the Zoo. In this case, examining the difference in approach might lead to a productive exploration of the role of identity in learning activities of this kind and the degree to which teachers and designers feel this role might need to be tied to the physical location in which the activity takes place.

Perhaps of most interest, given the focus on physical location, was the choice of venue for each: a zoo. This suggests a number of lines of possible enquiry. Firstly, the place a "field trip to the zoo" occupies within the discourse of formal education may be similar in each case: this is an activity about which people involved –

parents, school staff, learners themselves – already hold certain beliefs and understandings. The specifically technological and mobile dimension of the two projects discussed above is thus not taking place in a location that challenges wider notions of what learning consists of. From a practical point of view, it is a safe, regulated location well used to being treated as a pedagogic resource.

Secondly, from a design perspective the zoo affords clearly designated locations that map to the clearly-defined GPS co-ordinates that underpin the activity. "The monkey house" or "the crocodile pool" have more sharply defined boundaries than other, more nebulous concepts of places such as "near the gate" or "just past the playing fields". Even if the real physical location has messy and ill-defined boundaries, the mental models of a zoo provided for visitors (even those not trialing a new location-based technology) and constructed through signs and maps are themselves clear. This may well be of use to designers attempting to represent a location with quantitative methods. Of course, GPS detection itself is not exact, and finding ways to plausibly incorporate a certain "fuzziness" on the ground regarding individual players' locations is a challenge for designers. Exploring the tensions between these two constructions of place would perhaps lead to a greater understanding of productive design approaches for this type of tool.

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