

# Kingdom of the Knights: Evaluation of a Seamlessly Augmented Toy Environment for Playful Learning

Steve Hinske, Matthias Lampe  
Institute for Pervasive Computing  
ETH Zurich  
8092 Zurich, Switzerland  
+41 44 632 0768  
{hinskes, lampe}@inf.ethz.ch

Nicola Yuill  
Department of Psychology  
University of Sussex  
Falmer, UK  
+44 1273 678630  
nicolay@sussex.ac.uk

Sara Price  
London Knowledge Lab  
University of London  
London, UK  
+44 (0) 20 7763 2175  
s.price@ioe.ac.uk

Marc Langheinrich  
Faculty of Informatics  
University of Lugano (USI)  
6904 Lugano, Switzerland  
+41 58 666 4304  
[www.inf.unisi.ch/langheinrich](http://www.inf.unisi.ch/langheinrich)

## ABSTRACT

Ubiquitous technologies offer new opportunities for digitally augmenting children's toys and play experiences. A key question is how augmented toy environments affect children's playful learning, and whether this differs from non-augmented play environments. This paper presents preliminary results of a user study we conducted to evaluate an augmented toy environment that we built – the Augmented Knights Castle – in terms of fun and storytelling, particularly when compared with an identical, non-augmented version. All sessions were observed, video-recorded and further feedback was elicited through small group interviews and questionnaires. Findings suggest ways in which digitally augmented play environments promote different kinds of activity from an equivalent non-augmented play environment.

## Categories and Subject Descriptors

H.5.1. Information interfaces and presentation (e.g., HCI): Multimedia Information Systems. H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces.

## General Terms

Design, Experimentation, Human Factors.

## Keywords

Augmented Knights' Castle, User Study, Augmented Toys, Children, Playful Learning, RFID Technology.

## 1. INTRODUCTION

Augmented toy environments are play environments that combine the physical world with the virtual world. By equipping traditional

toys with modern communication and sensor technology, it is possible to extend the virtual world to real-world objects and consequently offer new play and learning experiences, for children (e.g., [2][3][7][8]). Research suggests the value of features of digital environments for supporting play and learning, e.g. the value of unexpected or unfamiliar events for attracting attention and promoting engagement [7]; the value of tangibles in supporting both exploratory and expressive interaction [6]; and activities that promote diving-in and stepping-out or alternating between immersion and reflection [1].

The Augmented Knights' Castle (AKC) is a digitally augmented play environment designed to enable various forms of context-sensitive audio feedback to take place seamlessly while playing with the characters and scenery in the play set. The audio feedback was tailored to be suitable for a Middle Ages context for children, to enhance their play and storytelling and to foster playful learning of medieval facts and stories.



Figure 1. The two play sets, the KC (left) and the AKC (right), respectively

To determine if the design and implementation process was successful, to investigate the effect on interaction and to ascertain

ways in which children might benefit from the technology-enhanced environment, an evaluation study was conducted. To date, little research in technology-augmented environments has undertaken comparative studies with equivalent traditional environments. The AKC, being built from a traditional toy set, offers the opportunity to explore the differential effect of an augmented compared to a non-augmented play environment. Thus, a comparative study was conducted using the AKC and an equivalent traditional (non-augmented) play set to evaluate the effectiveness of the environment for supporting storytelling and playful learning (see Figure 1). The study also enabled an investigation of the technical success of the environment.

This paper presents preliminary findings with regard to how such an augmented play environment can influence and enhance the playing storytelling of children.

## 2. THE AUGMENTED KNIGHT'S CASTLE

The AKC [4] was developed using Playmobil figures and scenery embedded with RFID technology, and was designed to seamlessly integrate the technology into a traditional toy environment, such that the technology was not obvious, but hidden from view, in order to retain ‘natural’ characteristics and to avoid much effort in learning to interact with it.

The RFID tags are attached to or incorporated into the pieces of the play set to uniquely identify them (e.g., inside the head and the back of figures as well as on the feet and bottom side of figures, see Figure 2, left). The play set consists of nine so-called “active zones”, areas that are aware of figures placed in them (see Figure 2, right). Whenever a figure was placed in one of the active zones, one of the recorded sound files was played: while in most cases it was played randomly, we also included some sound effects that were played at a particular location and/or with special characters (e.g., if the black knight is on the drawbridge, a voice would say “Look out, townspeople, the black knight is entering the castle”). In total we recorded over 200 sounds for 30 figures, with a different voice picked for each figure. In addition, we played a matching background music – this atmospheric but often overlooked [5] music adds to the realistic illustrations of the figures, and objects of the play set, and thus to the immersion.

## 3. METHOD

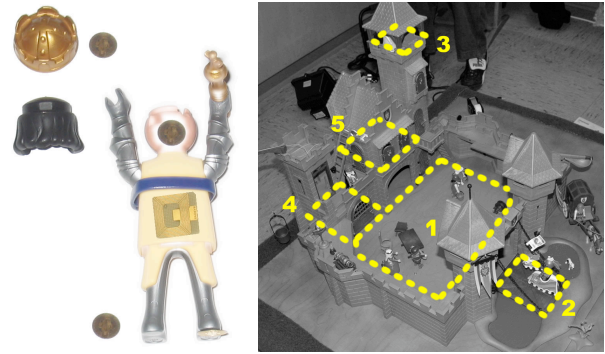
### 3.1 Participants

The user study was conducted in an elementary school in Germany. Participants were 103 children, 55 boys and 48 girls, from the first to the fourth grade (see Table 1). The children in each class were divided into groups of two or three, resulting in a total of 39 groups. Children were grouped with their classmates to counteract any awkward “getting acquainted” phase and facilitate the children to start playing right away.

### 3.2 Procedure

Each group played either with the non-augmented Knights’ Castle (KC), the AKC, or both. The groups that played with both play sets started with the KC and played with the AKC next (KC/AKC), or vice-versa (AKC/KC). Groups were distributed as equally as possible given time constraints by the senior leadership team of the school to fit the children’s curricula (see Table 1).

Children who played with either the KC or the AKC, played for approximately 35 minutes (see Figure 3), followed by group



**Figure 2.** All play figures are multi-tagged to maximize the probability of being read (left). The active zones of the castle: the inner yard of the castle (active zone no. 1) is covered by eight antennas connected to a multiplexer (right).

interviews with the researcher. The children playing with both play sets would play approximately 20 minutes with each set and then participate in the same interview process. The children were not given any particular instructions – we simply told them to play with the play sets as they would at home. Even the children playing with the AKC were only quickly briefed inasmuch that we demonstrated the modus operandi (i.e., how to trigger the audio feedback) to them once at the beginning.

Test type	No. of groups	No. of graders				
		1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	Σ
KC	13	6	6	11	10	33
AKC	12	8	8	8	9	33
KC/AKC	8	2	4	5	3	14
AKC/KC	6	6	6	3	8	23
Σ	39	22	24	27	30	103

**Table 1.** Overview of the grouping of the children. Test type refers to which play set(s) the children played (i.e., “KC” = played with KC only, “KC/AKC” shows the order of play).

In the interview session, children were asked about the kind of stories they had created. This helped us to understand how the children played, but also enabled the children to overcome any shyness. The children were then asked questions relating to our research focus (e.g., “How much did you like playing with the (A)KC?” or “Which play set was better for your stories?”).

## 4. RESULTS

Children generally rated both play sets very highly in the individual ratings (on a scale from 1 to 5, 1 meaning “awkward” and 5 meaning “fantastic”), with means of 4.4 and 4.6 out of 5 for the KC and AKC respectively: ratings for each condition are shown in Figure 4. When asked to compare the two play sets directly, 21 of the 37 who played with both sets preferred the AKC,  $\chi^2(1) = 9.78$ ,  $p < .01$ , with 6 rating them equal and 10 preferring the KC. There was no significant difference in the frequency of children’s preferences between the two sets in supporting storytelling,  $\chi^2(1) = 1.5$ , not significant.



**Figure 3. Children playing with the play set.**

If children had another 20 minutes to play with either set, which one would they choose? 27 out of 37 (73%) chose the AKC, significantly more than choice of the KC,  $\chi^2 (1) = 7.8$ ,  $p < .005$ . Furthermore, 36 out of 37 (97%) liked having background music that fits the medieval scenario.

We also asked the children who played only with the AKC how they liked this form of play compared to traditional toys and computer/video games. 32 out of 33 (97%) said the AKC was more fun than video/computer games, and all (33 out of 33) said it was more fun than traditional toys.

## 5. DISCUSSION

This study is one of the earliest studies in the field that begins to make direct comparisons between digitally augmented and non-augmented equivalent environments. We set a challenging target, since the KC itself is a very engaging toy, and the AKC differs only in augmenting with context-sensitive audio. This is important work in order to understand more clearly the differences that technology-enhanced environments have in mediating interaction, and to enable a clearer understanding of when and how augmented environments can be best exploited to support play and learning.

A key question is how activity and interaction in the two environments might differ from one another. Based on the quantitative data and qualitative analysis of the children's interview data we discovered a number of interesting findings, which suggest ways in which a digitally-augmented play environment promotes different kinds of activity from an equivalent non-augmented play environment. These findings also show important directions for future work.

### 5.1 Fun and Engagement

The statistical results show no significant difference between children's perception of fun between the two environments for those that played with either the KC or AKC. This is perhaps not surprising as both play environments are very appealing, but nevertheless importantly indicates that both environments are valuable in terms of actively engaging children. However, for those who played with both environments, there was a significant preference for the AKC in terms of fun.

While both the statistical analysis and the children's feedback indicated that they mostly preferred playing with the AKC, we were also interested in finding out whether playing with the AKC would change the way they played. In other words, we wanted to know how children actually reacted to the digital augmentations.

Although responses to the digital effects varied, this variation suggests ways in which the digital augmentation influences interaction. Two main groups of augmentation were the talking figures and the background music.

#### 5.1.1 Talking figures

Children responded to the talking figures in a variety of ways:

- Some children just 'cracked up' and laughed;
- Some children directly replied to the figure's utterance (e.g.: Figure: "I'm the golden knight." / Child: "Hello golden knight.");
- Some children responded indirectly, for example by saying, "let's take the golden knight";
- Some children ignored or disregarded it.

One interesting observation that can be made is the choice of perspective-taking in these examples. The verbal responses here take the third-person perspective, whereas frequently in pretend play situations with play figures children take a first person perspective, pretending to be the figure they are holding themselves. One outcome of the verbal augmentation is that the figures, by talking, take on an identity of their own, prompting the children to take a third person perspective. This may be an indication that the AKC encourages the children to act as producers, taking a more metacognitive and reflective approach to their play (also see [6]). Augmented toy environments might therefore encourage different forms of play.

#### 5.1.2 Background music

Again, children had mixed views about the background music in the AKC, with the majority finding it 'fun' and supporting their imagination, while some children found it distracting:

L: It was more fun here [AKC] because of the music...

N: I totally liked the music. That was not so boring. It's more fun.

M: Without music, you cannot imagine everything so well.

K: The music was a little bit too distracting... here [KC] there are not sounds all the time. Here you can play as you want to.

However, it was apparent from observation during data collection that children were able to disregard the sound effects and could therefore choose whether or not to use or integrate them into their play. During play with the AKC (as with the KC) children still made their own sounds to accompany their play. Sometimes children would also mimic the sounds pre-recorded by us.

The fact that children are able to disregard sounds/ narrative suggests that this kind of augmentation need not be distracting or prevent children from making their own stories:

M: "I didn't really pay attention to the background music..."

Thus, children are very positive about the background music and the talking figures in the AKC, and identify these as being a key in making the environment fun: they can also choose to disregard them.

### 5.2 Storytelling

Some found storytelling better with KC whilst others reported it to be better with AKC. This view was individually-based rather than group. For example, when asked which environment they found

better for storytelling one group of 9-10 year olds gave an overall mix of responses relating to their story development:

M: It was more fun here [AKC]... because of the sounds...

V: Here, we focused more on the sounds than on the play...

Question: Which play set was more suitable for your stories?

V: I find over there [KC]... you are not distracted by the voices...

M: I found them equally good...

N: I found it better here [AKC]

One child felt that with the KC “you could play unhurriedly”, while with the AKC they tended to listen to what the figures said, rather than make up their own stories. This is not surprising given the novelty of the environment and the brevity of the sessions. Children’s unfamiliarity naturally promotes exploratory activity to find out what is possible, but future work will develop studies to look at the way that children’s play might develop over time.

Other data suggests that children sometimes actively used the sounds and commentaries for their own stories/play.

L: Over there ... [AKC] with the sound effects... that was better...

Lu: We used the sounds and imitated them...

The fact that some felt they were listening rather than playing their own story suggests that this kind of play set may be useful for children who find developing ideas and creating stories problematic and warrants further investigation. One feasible function of the AKC is as a tool to help children develop imaginative play, for use in children with autism who tend to lack such capacities. The play set could be used to provide support such as sound effects and simple speech on which children might be encouraged to build, in the same way that the design of physical environments can be used to support more social play in this group (e.g. see [9]).

The play set could also be used to support narrative development in young typically-developing children. For example, Marshall et al. describe the PUPPET project, a virtual environment to support playful learning that allowed children to interact with virtual characters [6]. The authors noted that children could act in four different roles: as audience, actor, script-writer, or editor (e.g. recording and re-recording sounds for characters). As we have shown, the AKC seems to prompt all these types of behavior in children, and further development of the environment could be used to support different perspective-taking.

Furthermore, the findings indicate that children, while in general being enthusiastic about the sound effects, verbal commentaries, and background music, sometimes want to focus on their own story-telling. The AKC addresses this issue well, since the technology is integrated in such a way that is almost completely invisible, and the augmentation part can easily be switched off with the press of a button, turning it into a traditional KC.

## 6. CONCLUSIONS AND FUTURE WORK

This paper presented preliminary results of a user study we conducted in an elementary school to investigate how augmented toy environments affect the play experience of children.

The majority of the children really enjoyed playing with the AKC, which was demonstrated not only by the results of the user study, but also by other, more subtle comments received afterwards: for example, children’s parents and teachers would occasionally tell

us that the children were still talking about the “cool” project in school – even weeks after the study.

One was that it could be beneficial if the children could make the figures *stop* talking: in the current scenario, a figure placed on the play set triggers the playing of a sound file which continued until completed. However, if we could allow children to make the sound file stop playing by removing the same figure, the children would have more control over the play. To further extend children’s control an important future extension is to enable children to record their own sounds and commentaries.

Future work will also include conducting a long-term study to evaluate children’s experience of the AKC over time, and with repeated play sessions and also if such an augmented play environment can be used to convey educational content in a playful way: since some teachers – not only at this elementary school – showed interest in using this augmented play set in the curriculum to support playful learning, e.g., for historical content, we also intend to conduct another study in a school to focus on the development and use of educational content.

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