The Effects of Young Children’s Knowledge Acquisition using Tangible Blocks

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Tangibles can be used to created novel learning environments, which have the potential to make learning playful and pleasurable through engaging children.

(S.Price, 2003)
Background

Traditional learning has emphasized the input and outputs of learning environments: how the instruction of content is structured and what was learned.
Active involvement in learning, in the sense of being engaged, interacting and taking part, is central to its effectiveness.

Tangibles have the potential for providing innovative ways for children to play and learn, through novel forms of interacting and discovering.
The goal of our research is to investigate whether children can better memorize and engage with learning on tangible interfaces as opposed to traditional books. Also, this paper explores the differences in knowledge acquisition when using tangibles individually or collaboratively.
Related Work


Comprehension  Social interaction
Related Work

Lesley Xie et all (2008)  
Enjoyment & Engagement

Nesra Yannier et all (2015)  
Improving learning (prediction & explanation)
Related Work

Collaboration

Izzle C. Olson et al (2011)  
Managing Conflict
User Study

We designed a longitudinal user study to assess differences in information learning when using two different platforms.

Experimental 3 different conditions
(1) Individual Book
(2) Individual Tangible Blocks
(3) Collaborative Tangible Blocks

We collected and analyzed
(1) the accuracy for newly acquired knowledge.
(2) engagement with the content.
(3) comparing how children interact with tangibles when alone or in team.
User Study: Learning Contents

6 animals in Africa

crocodile  hippo  leopard  lion  zebra  giraffe

Contents

1) Korean name
2) English name
3) The color/textures of the skin
4) Living habits
   (e.g., ground VS water)
5) Unique characteristics
   (e.g., giraffes are the tallest)

Book

24 illustrated pages
Prototype: the head of animals

- Arduino Mini Pro
- 1.8” Color TFT LCD Display
- RFID Reader (ID-12LA)
- Li-po battery
- A magnet (diameter 0.7 cm)
- Wood box (33*70*47 mm)
Prototype: the body of animals

- Magnet (diameter 0.7 cm)
- Capsule RFID tag
- Animals maximum dimensions 16.5*8*3.6 cm thick
Prototype

Not Connected

Correct Connection

Digital Book
To determine the age of the target, 12 children between age of 4 and 10 years old tested using book and tangible blocks.

We found that the material was too difficult for children of 4 years (38% correct answer) but too easy for those with age of 7 or more years (96% correct).

We determined the age of participants of this study is 5 and 6 years old children.
Experiment

Participants

- 36 kindergarten children (12 children * 3 conditions)
- 5-6 years of age (μ: 5.3, σ: 0.4)
- All received education (private or public kindergarten)

Evaluation Method

- 30 minutes
- 3 conditions groups: book, tangible, and tangible team
- Prologue, a learning session, memory test, and an epilogue
- 2 weeks later, a follow up investigation took place
- Video taping
Measurement

Memory

• A printed quiz with 30 pictorial questions

Engagement

• Classifying children’s actions in 5 groups
  1) Engagement with questions
  2) Focus
  3) Content engagement
  4) Body feedback
  5) Language Feedback

Collaboration

• Extracting actions about collaboration
  1) Conflicts (e.g., blocking, complains)
  2) Collaborations
  3) Request for control
  4) Pointing and helping
Results: Memory

- ANOVA and post-hoc tests with Bonferroni CI adjustments

We found a main effect of learning environment (F(2,66)=11.6, p<0.01, $\eta^2_p=0.26$) and post-hoc analysis indicated that the book condition performed worse (4.6 points lower on average) than the tangible and team conditions (p<0.01).

The results that learning through the usage of tangible blocks leads to higher quizzes scores than the traditional method based on top-down teaching with a book.
Results: Engagement

The number of absolute occurrences of proactive and passive actions.

A  Passive (light tint) and proactive (dark) actions groups for each learning environment (book, tangible, team) in 5 categories and on average.

B  Normalized average percentage of proactive/passive actions. (p<0.01)
Results: Qualitative data in tangible team

Children using tangibles together.
Two children perform together an action A one or B two blocks. C means establishing rules for turn and sharing of control D.
Results: quantitative evaluation in tangible team

A diagram represents collaborative patterns for each team. **White** / **Black** areas are individual children actions. **Red** areas show conflicts. **Green** areas mean collaborations. Sessions lengths are indicated on the right.
Discussion

**Blocks**

- Higher quizzes scores than the traditional book
- The ratio of proactive actions is significantly higher than book

**Tangible Team**

- The passive actions decreased
- Few conflicts arose and children were capable to autonomously deal with them

The higher level of engagement provided by tangibles is a powerful tool when learning new contents

The potential of tangibles for collaborative learning
In conclusions, this paper presented that a learning environment based on tangible blocks can lead to better knowledge acquisition, engagement.

Also, tangible tools allows children to readily and autonomously deal with conflicts and to reduce the overall passive behavior.
Thank you!

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