Interaction Design and Architecture(s) Journal - IxD&A, N. 13-14, 2012, pp. 56-63

# Designing Interactive Systems for Discovering and Learning

Oscar Tomico[1], Bart Hengevelt[1]

[1] Eindhoven University of Technology, Den Dolech 2,
5612 AZ Eindhoven, The Netherlands

{o.tomico, b.j.hengeveld}@tue.nl

**Abstract.** Advances in technology have opened up new opportunities for intelligent systems that support learning. Most prominently, we can now move towards contextualized learning by embedding intelligence in our everyday artifacts and environments. However, these new opportunities cannot just be 'old wine in new bottles'; we, designers, are forced to reconsider our design space. In this position paper we present our approach to this reconsideration. The presented projects vary from professional to leisure applications, are situated in different contexts from the public library to the home environment, are aimed at supporting either individual development or group work, and facilitate a range of learning activities. In this paper we present and discuss the results of an expert panel review of bachelor, master and Ph.D. projects, set up to: (1) analyze whether current learning strategies still apply to novel technologies; (2) if so, which ones, and (3) whether new learning strategies have emerged.

**Keywords:** Interaction design, interactive systems, re-contextualitzation.

## 1 Introduction

Advances in miniaturization, network and sensor technology, and material science are enabling us to blend intelligence into our everyday environments with increasing nonchalance, bringing us closer to the realization of what Mark Weiser called Ubiquitous Computing [1]. Multi-touch interfaces are slowly breaking down the common single user/single interface interactions, RFID technology that enables personalization is commonplace and explorations in wearable technologies are yielding increasingly viable results. One field in which these technological advances open up new opportunities for design is that of interactive learning.

Until recently, supporting learning with intelligent products and systems often meant de-contextualizing, i.e. taking apart the trinity of 'learner, task and situation'.

---

[1] Please note that it is assumes that all authors have used the western naming convention, with given names preceding surnames. This determines the structure of the names in the running heads and the author index.

For example, an interactive course in pottery would be reduced to watching an instruction or browsing a forum on the Internet, thus losing the richness of the situated, multi-sensory, master-apprentice setting. The emphasis in such a situation would not be on the transfer of skill and expertise, but on the transfer of knowledge.

Looking at the history of interactive products and systems, we believe that this process was natural, but undesirable. The time has come to re-contextualize learning, now that the possibilities for ‘intelligence supported learning’ have expanded. One thing to realize though is that these new technological possibilities force us to reconsider the boundaries of our design space. At the department of Industrial Design of Eindhoven University of Technology we do this through explorative design projects resulting in experiential prototypes. In this paper we give a cross section of our endeavor through 22 example projects.

## 2 Designing for Discovering and Learning

This paper focuses on the design of intelligent products, systems and services that support learning strategies such as reflection, imitation, abstraction, sharing, exploring and decision making in various fields. Designing for discovering and learning can range from generating conceptual design tools to designing for specific business sectors like tourism, sports or professional support. The projects presented are work by bachelor, master and Ph.D. students at the Industrial Design department from the Eindhoven University of Technology.

The projects were used as part of an expert panel session with seven participants (experts from education, engineering, industrial design and exhibition design) aimed at establishing whether new learning strategies have emerged and whether these can be attributed to novel technologies. In the expert panel participants were asked to classify the projects based on the learning styles they support.

Learning styles, defined by Kolb [2] are flexibly stable learning preferences, which change slightly from situation to situation but maintain some long-term stability. The model of learning styles and its supporting learning strategies during the expert panel session was based on the four-quadrant model of cognitive preferences developed by Herrmann [3]: a logical analytical, fact based and quantitative learning (quadrant A); an organized, sequential, planned and detailed learning (quadrant B); an interpersonal, feeling based, kinesthetic and emotional learning (quadrant C); and a holistic, intuitive, integrating and synthesizing learning (quadrant D).

## 3 Example Projects

In this section we illustrate 12 out of 22 example used during the expert panel session, before presenting the results from the panel discussion at the end of this paper.

Aclock, (Figure 1, left) aims to develop a sustainable energy monitoring system for domestic consumers to become more aware of their energy consumption. By measuring the consumption of individual sources and communicating it to the consumers, they gain the ability to reflect on their consumption behavior.

Swing (Figure 1, left) aims to develop a sitting behavior monitoring system for the office environment to become more aware of the sitting posture. The concept integrates dynamic stimuli - in the form of a swinging motion - and technology that reacts to people's sitting postures.

Where the time goes (Figure 2, left) consists of two parts: (1) a web interface that invites the user to make an estimation of the time needed for certain activities; (2) a physical device that offers a concise overview of the activities. The system can be started and stopped, making time flow from 'remaining' to 'spent'. Afterwards, a confrontation of estimation accuracy can lead to better predictions in the future, as reflection stimulates self-regulation.

Move/Learn/Explore (Figure 2, right) is a tangible interactive learning environment for abstract sound concepts. It consists of objects that can be manipulated to change the pitch, volume or tempo of music.

Re-flex (Figure 3, left) is a system for people with high-functioning autism that can be used to experience, rehearse and retell a story. Puzzle pieces can be used for sequencing and reflecting on the actions taken.

LinguaBytes (Figure 3, right) is a modular play-and-learning system aimed at stimulating the language development of non- or hardly children between 1 and 4 years old. By manipulating and combining tangible materials, children can hands-on read interactive stories and do related games and exercises.

Curious Paths (Figure 4, left) is a system designed to make people curious about specific (hidden) locations in a city environment. Differences in vibration patterns give a small clue about the location, which can be found. The distance to a location determines the vibration frequency and the match value determines the strength of the vibration.

Storytail (Figure 4, right) supports parent and child to create a story together. When the story is finished, the characters, storyline and locations are all combined, showing the 'trace' of the story. In this way the child can reflect on the story, as well as on the values interwoven in the story.

Sense 6 (Figure 5, left) is a system to support learning of physical skateboarding skills, through augmenting the tools used through sound in combination with a platform and communicator to share skills. The skill-data provides information about location, balance and action rhythm during a skateboarding skill.

Omeo (Figure 5, right) is a device that evokes reflection and discussion of memories by linking digital memory triggers to physical artifacts in the real world. With Omeo, children and parents can share experiences and memories together.

Active Explorers (Figure 6, left) is a set of tools, to be used in a group, which stimulate to capture and present a classroom topic from different angles. There are four tools that can be used to collect samples. There is a device that captures audio, one for video (no sound), one for close-up photos and a container for touch or smell.

Ennea (Figure 6, right) is a system that takes real-life data by looking at social contact and interaction between pupils within the school environment. The measurements are done by mobile, networked objects, which can be carried around by the pupils. Knowledge of social roles (represented in the shape of animal icons) allows the pupils to reflect and look back at their social contact of the last week.


**Fig. 1.** Left: Aclock, final bachelor project (FBP) by J. Pieterse. Right: Swing, FBP by F. van der Ven for Ahrend.


**Fig. 2.** Left: Where the time goes, FBP by W. van Dijk. Right: Move/ Learn/Explore final master project (FMP) by S. Bakker for Simon Fraser University.

**Fig. 3.** Left: Re-flex FMP by J. Gillesen for GeorgiaTech. Right: Lingua-Bytes, Ph.D. by B. Hengeveld in collaboration with Radboud Universiteit and Viataal.

**Fig. 4.** Left: Curious Paths, 1st and 2nd year master project (MP) by T.v. Bergen, T. Frissen for Microsoft Design Expo (MDE). Right: Storytail, MP by W. Kersteman, L. Kooijman, R. Magielse, J. Knoester, F. Matthijssen for MDE.

**Fig. 5.** Left: Sense 6, MP by I.d. Boer, J.v. Aart, B. Braat, L. Boer for MDE. Right: Omeo, MP by B. Smit, C. Megens, D. Menting, E. Vegt, M. Pikaart for MDE.

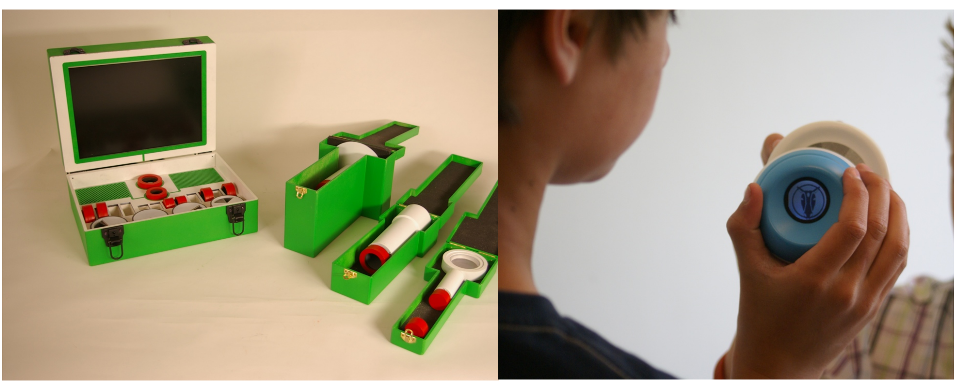

**Fig. 6.** Left: Active explorers, MP by R.v.d. Westelaken, A. Wessels, J. Westerhoff, J. Wang for MDE. Right: Ennea by L. Doesborgh, S. Eerens, J.P. Faber, J. Dekker, J. Gillessen for MDE.

# 4 Expert Panel Session

## 4.1 Set Up

These and 10 other projects were evaluated in a panel discussion with seven participants (experts with a education, HCI, industrial design and exhibition design backgrounds). The aim of the expert panel discussion was to determine whether the aforementioned learning strategies described by Herrmann [3] still applied to novel, interactive learning opportunities and/or whether new learning strategies could be identified. For this the panelists were asked to assign the – in their view – best fitting learning strategies to each project. They could use the strategies defined by Herrmann [3] or define new ones if necessary. There was no limit to the number of 'votes' each panelist could cast.

## 4.2 Findings

In total the panelists assigned 85 learning strategies to the 22 projects. Most of these strategies came from quadrant C or D: 35% and 28% respectively. Only 5% came from quadrant A and 9% from quadrant B. The remaining 23% were new learning strategies. An overview of all assigned learning strategies is given in Table 1.

The main conclusion we can draw from this division of votes is that the 22 example projects capitalize more on interpersonal, holistic and intuitive learning styles rather than on analytical, organized, sequential ones. One could argue that this is due to the nature of the projects we offer our students, but we think this is not entirely true: a major pillar of our educational approach is that students develop their design identity though their projects, which means that their designs reflect to a large extent the students' vision on the societal changes they envision [4].

In addition we find it notable that 23% of the 'votes' are for new learning strategies, which is more than the cumulative 14% of the assigned strategies from quadrants A and B. Only 'organizing and structuring content' and 'acquiring skills through practice' from quadrant B approached the level of relevance of the learning styles from quadrants C and D.

# 5 Discussion

In the introduction we have illustrated that, now that the possibilities for 'intelligence supported learning' have expanded, the time has come to re-contextualize learning. This has resulted in projects that according to the expert panelists capitalize more on interpersonal, holistic and intuitive learning styles rather than on analytical, organized, sequential ones. We believe that this is because the re-contextualization of learning by bringing together again the trinity of 'learner, task and situation'. In quadrant C strategies, learners respond to experiential opportunities, sensory movement, music, people-oriented case discussions and group interaction [3]. In quadrant D strategies, learners respond to spontaneity, free flow, experiential opportunities, experimentation, playfulness, future-oriented case discussions, visual displays, individuality, aesthetics and being involved [3].

**Table 1.** Overview of assigned learning strategies, ordered by Herrmann's learning style quadrants [3].

| Styles | Strategies | Nº |
|---|---|---|
| Quadrant A (Upper left) | Acquiring and quantifying facts | 1 |
| | Applying analysis and logic | 0 |
| | Thinking through ideas | 1 |
| | Building cases | 2 |
| | Forming theories | 0 |
| Quadrant B (lower left) | Organizing and structuring content | 3 |
| | Sequencing content | 0 |
| | Evaluating and testing theories | 0 |
| | Acquiring skills through practice | 4 |
| | Implementing course content | 1 |
| Quadrant C (lower right) | Listening and sharing ideas | 5 |
| | Integrating experiences with the self | 3 |
| | Moving and feeling | 9 |
| | Harmonizing with the content | 4 |
| | Emotional involvement | 9 |
| Quadrant D (upper right) | Taking initiative | 7 |
| | Exploring hidden possibilities | 6 |
| | Relying on intuition | 3 |
| | Self-discovery | 7 |
| | Constructing concepts | 0 |
| | Synthesizing content | 1 |
| Other | Storing into the environment | 1 |
| | Co-discovery | 2 |
| | Social communication | 1 |
| | Re-assurance | 5 |
| | Share an experience in a different modality | 3 |
| | Repetition | 1 |
| | Imitating | 1 |
| | Learning by doing | 1 |
| | Changing patterns | 4 |
| Total | | 85 |

Finally, special mention needs to be placed to the new classifiers that emerged as possible new learning strategies or an specialization of existing ones empowered by the re-contextualization of the learning. Co-discovery and social communication classifiers relate to the listening and sharing ideas strategy but the first two add more emphasis to the communities of practice [5]. Learning by doing, repetition, imitating and re-assurance relate to the acquiring skills through practice strategy, making a stronger link to mastering skills and craftsmanship [6]. Storing into the environment, share an experience in a different modality and changing patterns relate to the harmonizing with the content strategy, but from a perspective related to distributed cognition [7].

## References

1. Weiser, M.: The Computer for the 21st Century, Scientific American, vol. 265, pp. 94--104, (1991).
2. Kolb, D.A.: Experiential learning theory and the Learning Style Inventory: a reply to Freedman and Stumpf. Academy of Management Review, vol. 6, num. 2, 289--296, (1981).
3. Herrmann, N.: The creative brain, Brain Books, The Ned Hermann Group, North Carolina, (1989).
4. Hummels, C.C.M. & Vinke, A.A.: Developing the competence of designing intelligent systems. Eindhoven University Press, Eindhoven, The Netherlands, (2009).
5. Lave, J., & Wenger, E.: Situated learning: Legitimate peripheral participation. Cambridge University, Cambridge, UK, (1990).
6. Sennett, P. (2008).: The craftsman. Yale University Press, New Haven, CT, (2008).
7. Woelert, P.: Human Cognition, Space, and the Sedimentation of Meaning, Phenomenology and the Cognitive Sciences, vol. 10, num. 1, pp. 113--137, (2011).