Augmenting Distributed Activity for the Developing Mind

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Abstract
This PhD evaluates how learning is contingent on the environment, to achieve frameworks for the design of applied learning technologies for Infant (Key Stage 1, 4 to 7 years) education. The research is working towards a hypothesis that an enactive approach to interaction design, coupled with a detailed understanding of daily school life, can produce a foundation for more rewarding and empathic applications of ICT in Infant education.

Keywords
Collaborative learning technologies, distributed cognition, distributed interaction, enactive design, learning through play.

ACM Classification Keywords
H.5.2 User Interfaces – Theory and methods, User-centered design; H.5.3 Group and Organization Interfaces - Collaborative computing, Synchronous interaction, Evaluation/methodology; K.3.1 Computer Uses in Education - Collaborative learning.

Introduction
In the UK, the Government's positive endorsement is evident in the ever-increasing investment in technology [5]. Consequently, schools have been hit with a huge wave of new digital equipment and networked services, particularly in the past 5 years. There was clearly an

initial assumption that the application and integration of new digital technologies would be obvious to the educator, seamlessly shifting into the curriculum and show much improved results and productivity. State educational departments are however, beginning to realize this radicalization of teaching practice is more complex [3, 5].

This research attempts to be pragmatic about the role of technology in Infant education. The design practice aims to critically investigate the potential and the pitfalls of this emerging pedagogical shift in everyday teaching, in order to move forward. There are many well cited research projects which have shown positive outcomes for technologically assisted learning for this audience [1, 2], but there is little evidence they reach the classroom, and thus often fail to accommodate the logistics and culture of everyday educational processes and institutional needs.

To understand how learning occurs, this research project has taken the psychological stance that cognition is a consequence of engaging in a social and material world. Distributed and embodied theorists hold that thought and knowledge does not occur separately, but take place within the context of our semantic knowledge of, and interaction with, our environment, objects and other people [4, 7]. This perspective provides a theoretical and conceptual framework for the design and evaluation of learning environments, and the culture of education. The study is drawn to parallels between theories of distributed cognition (DC) and the distributed interaction and communication in learning.

The design practice has focused on sociodramatic play, as it provides an ideal vehicle to study the role of others, objects and the environment in the active development of cognitive and social skills. Play, while not the predominant feature of childhood development, is a leading factor of cognitive and social growth [6].

Research Questions

Throughout the research, the DC model has been applied to the structure of learning and technologically assisted learning processes. Within a DC framework, the research critically investigates teaching methods and the current role of technology in schools. Exploring for the influence of technology on the dynamics of learning and teaching, whilst reflexively considering the value of distributed cognition model to understand socio-technical systems for learning.

There has been a waterfall approach to the research progression, as the outcomes of the preliminary research are applied to design solutions. The aim is to locate areas where ICT can support existing teaching practice, and where the design can incorporate or generate new educational experiences. This process aims to develop socio-technical systems where agency is placed with the learner, without being problematic for the educator.

In an attempt to locate productive avenues for technology, the project moved to consider the potential of enactive design in collaborative learning environments. The design practice aims to explore the creation of environments for physical, collaborative and emotional engagement with technology for learning through play.

Methodologies

The researcher has a good working relationship with three Infant schools in the Plymouth area, which have provided an environment for observing and testing theories and technologies in use. The study has adopted a mixed approach to methodology, utilizing Ethnographic techniques, Participatory Design (PD) and usability testing. This varied approach was required to satisfy the broad remit of the research criteria and the iterative design practice. Qualitative data from the field spans observations and recordings of classrooms, lessons, meetings and collaborative activities, photographs of learning spaces, interviews and discussions with children and teaching staff.

Multiple directions for the design practice have been pursued though series of PD workshops. In addition to observed behavior, data included work produced by the children and peer observations of task. Workshop activities often use using low-tech equipment, prototypes, and other technical systems (including Logitech Video Effects, Kidpad, iChat). Attention was paid to the use of shared workspace, use of artifacts and how activity was organized and maintained through action and language. This included working with interactive whiteboard, screen based technologies and mobile devices to capture, display and interact with digital media.

Conceptual and usability testing is conducted iteratively through the design process. Evaluation of data looks for responsiveness to media content or modalities of interaction, most notably kinesthetic and verbal responses (e.g. appropriate bodily movement). In usability terms, aside from workflow issues, moments of conflict and collaboration were marked out.

An enormous benefit to working with users during iteration of design was that it enabled a dialogue about how to develop new technologies. Children, and teaching staff, can find it difficult to comprehend abstracted technical solutions, and prototypes can generate alternative contexts for the same technology. Prototype development, in participatory design, therefore provided the increasing area of common ground to reduce the gap between designer and user.

Design Practice

From an ongoing formative evaluation, the research project has developed the following criteria for design of systems to support collaborative play:

- Physical modalities of interaction. This is to counter concerns over passive engagement with media, or extend the narrow scope of point and click interaction.
- Create shared representational states that can help maintain situated awareness in the group.
- Creative use of artifact. Activities should be able to work with new themes within the curriculum, and therefore enable more cross-curricular engagement with technology.
- Integrate the use of found digital media to enable ease of use. There is a lack of basic understanding about digital media production among teaching staff as a result of very little time to train.
- As with the individual work distributed throughout the school (i.e. poster displays), children should be able the see their own work to make cognitive and emotional connection to the content.
- Distribute interaction, partly as conflict often emerges when there is only a single point of

interaction. Also to support natural group behaviors. When free to roam, the dynamics of the children's groups continually shift from collaborating as a whole, to small groups, dyads, and even to solo play. Collaborative interactive systems therefore need to provide for parallel activity, where points of interaction that are distributed throughout the physical space.

- Opportunities for immediate engagement. Children need no instruction when told to play, and societies of play are often ephemeral [6] as they fit into short timeframes. Research found when the play activity required a drawn out set up procedure, the children commented this was "not play". Too much adult assistance also meant to group did not have time to generate autonomy
- Hidden technology. This proved an effective measure against hindering children's expectations of experience.

The design practice has developed a suite of prototypes; their primary function was to serve as research tools for refining and challenging the design criteria. These tools use motion tracking with dynamic graphical and audio effects, to mix live data captured from physical locations with representational media (audio, image, video), and create collaborative Mixed Reality environments.

Future Work

In additional to an ongoing review of data collected in the field, the project has yet to complete its investigation of suitable channels of communication for remote learners. Mediating communication for distance learners is a key issue for this study, partly as it is well cited in ICT potential. In preliminary research this has proved to problematic, as relationships in the classroom are intimate and they have the advantage of sharing the same physical environment for reference. In the absence of this common ground, communication can be inefficient, and thus difficult.

Contribution

The infrastructure and resources for ICT in schools are in place, but there is still a gulf between execution and aspiration. Design solutions within this research project look to offer enactive and social experiences, to reduce the ghettoization of ICT in Infant education.

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