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Citation: Vasiliou, Christina (2015) Collaborative Learning In An Artifact Ecology. In: Proceedings of the 2015 International Conference on Interactive Tabletops & Surfaces - ITS '15. Association for Computing Machinery, pp. 457-462. ISBN 978-1-4503-3899-8

Published by: Association for Computing Machinery

URL: <http://dx.doi.org/10.1145/2817721.2820987>
<<http://dx.doi.org/10.1145/2817721.2820987>>

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Collaborative Learning In An Artifact Ecology: A Distributed Cognition Perception

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ITS '15, November 15-18, 2015, Funchal, Portugal
ACM 978-1-4503-3899-8/15/11.
<http://dx.doi.org/10.1145/2817721.2820987>

Abstract

This work aims to extend our understanding of how groups of learners collaborate in a learning environment rich in technologies, namely an artifact ecology. For the purpose of this investigation we enriched a postgraduate HCI course with four identical technology rich settings that aimed to support student collaborative activities around a design problem. Following an ethnographic approach, we collected qualitative data from an HCI course over three years resulting in a rich dataset for analysis. Initial studies helped us understand the domain knowledge, context, and learners' needs and experiences. Then, using Distributed Cognition (DC) framework we worked toward understanding the interdependencies of learners, tasks, and technologies in the environment and highlighting aspects of redesign. The findings of these individual studies were then combined in order to provide a holistic understanding of the collaborative activities in an artifact ecology.

Author Keywords

Collaborative learning; distributed cognition; artifact ecology; HCI education.

ACM Classification Keywords

H.5.3. Information interfaces and presentation (e.g., HCI): Group and Organization Interfaces;

Introduction

Technology's evolving nature has brought new possibilities to the design of technology-rich learning environments for collaborative activities. Tablets and smartphones together with personal computers become part of an artifact ecology in which each device acts as a specialized portal into users' personal or shared information space [3]. In a collaborative learning environment these devices may be used for a variety of tasks while each individual may perform a task differently. Therefore, learners, tasks and use of technology in a learning environment cannot be studied independently or in isolation. To design effective technology-rich collaborative learning environments we need to acquire a deep understanding of the complex relations and interactions between collaborators and information technologies. Researchers have identified DC as a powerful tool for understanding the interdependencies of learners, tasks, and technologies in collaborative environments and for highlighting aspects for redesign [5].

Our work focuses on exactly this, using Distributed Cognition (DC) and more specifically Distributed Cognition for Teamwork (DiCoT) as a methodological framework to guide data collection, analysis and interpretation of findings. Through this investigation we aim to understand collaborative learning activities around an artifact ecology, apply and expand DiCoT framework to map them.

Theoretical Framework

As a theoretical framework DC analyses cognition in a distributed manner [4], while it considers an activity taking place across individuals, tools and representations as one cognitive system, instead within an individual's mind.

Researchers in HCI (Human-Computer Interaction) and CSCW (Computer Supported Cooperative Work) communities have identified DC as a valid framework for understanding the interdependencies between users, tools and tasks [2]. In order to design effective artifact ecologies, each tool must allow the distribution of an individual's cognition to the wider cognitive system, e.g. the classroom [7]. Furthermore, DC can provide a detailed identification of issues with existing work practices and mediating artefacts [6], allowing researchers to identify aspects of re-design of the environment.

However, there is no established methodology towards applying DC in the case of collaborative learning environments. In this work, we adopted the DiCoT methodological framework introduced by Blandford and Furniss [1] for collaborative work to extend our understanding of how groups of learners collaborate in a learning environment rich in technologies. This methodology was extensively used in workspace environments and draws together ideas from DC and conceptual design, including 22 principles classified loosely in five models; physical layout, information flow, artefacts, evolutionary and social structures.

Artifact Ecology

We sought to create an artifact ecology, by enriching the classroom environment with various technologies

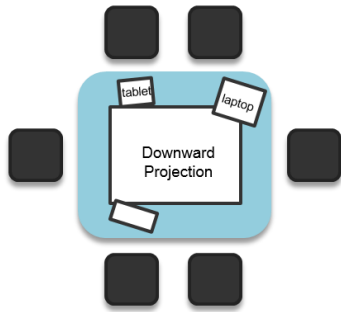


Figure 1: Physical Layout of the artifact ecology where each group of learners' would work.

aimed to support student collaborative activity, particularly brainstorming, researching, reporting or reflecting, both in-class and in distance (in-between the face-to-face meetings). Furthermore, this physical space, together with the problem based learning (PBL) approach aimed to promote openness and flexibility. Students were encouraged to use the technologies as they perceived appropriate for each activity and task. Each group worked in a physical, technological set-up exhibiting three main attributes that we considered important for collaborative learning activity:

- A downward pointing projection was provided as a central focus point to support students' fertile discussions and activities (see Figure 1). This setup would cultivate the blend of physical and digitally projected artifacts, mixing paper and technology, on the same workspace.
- The multitasking nature of the group was invigorated with mobile devices such as tablets, iPods and laptops for concurrent research and record-keeping (see Figure 2). The students were also allowed to enrich the artifact ecology with their own devices.
- A social networking platform (Facebook) was used to strengthen information sharing, coordination and collaboration, both between group members and devices.

Proposed Research Approach

Through the lens of DC, this work aims to extend our understanding of how groups of learners collaborate on design problems in a learning environment rich in physical and digital technologies and blending face-to-face content-and-activity with digital content-and-

activity. Furthermore, through this investigation DiCoT methodological framework will be transferred from workspace settings and applied to collaborative learning environments. Further, we aim to highlighting what is salient in the existing collaborative learning environment design and practices and indicate aspects of redesign of the learning environment.

For the purpose of this work, we enriched a postgraduate HCI course with four identical technology rich settings that aimed to support student collaborative activities around a design problem. Following an ethnographic approach, we collected data from a variety of sources (e.g. field notes, focus groups, interviews, video data) from an HCI course over three consecutive years resulting in a rich corpus of data. Each ethnographic study was extended for a period of three months, waving the novelty effect off the participants, increasing the level of the trustworthiness of the study.

In the sections that follow the progress achieved so far as well as the future plans for the current dissertation are outlined.

Work to Date

Study 1 - Exploratory: "Understanding the domain knowledge and exploring learners' expectations in an artifact ecology"

First study acted as a pilot study with the overall aim to understand the domain knowledge of the dissertation (HCI education, problem based and collaborative learning) as well as explore learners' expectations and attitudes in an artifact ecology [8]. More specifically we aimed at finding answers to the following sub-questions:

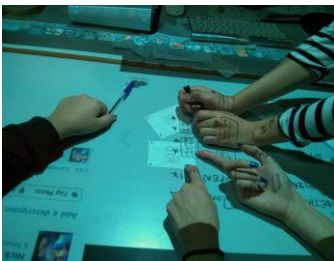


Figure 2. Mobile technologies and downward projection as used in-class.

- What are the current directions and technologies used that already exist in the literature of technology enhanced problem based learning?
- What are the current goals and directions of HCI education?
- What are learners' expectations, attitudes and technology use in an artifact ecology?

Study 2: "Understanding learners' experiences and applying the DiCoT framework for collaborative learning activities in an artifact ecology"

The second study focused on two main research pillars; first on understanding learners' collaborative experiences in the artifact ecology [9] and second to apply DiCoT in a collaborative learning setting. In this context, we showcase learner-learner and learner-artifacts interactions evident in the workspace that support collaboration and coordination during collaborative learning activities. We describe the cognitive system from three different perspectives - physical layout, information flow and artifacts involved - which allows an in-depth understanding of the interactions and interdependencies among learners and artifacts during collaborative activities. Further, the study also focused on illustrating and validating the utility of DC and DiCoT as a tool for modelling interactions and interdependencies during collaborative learning activities in an artifact ecology [10]. More specifically, this study focused on the following sub-questions:

- What are learners' collaborative learning experience and user experience in the artifact ecology?

- How can DiCoT be applied as a modelling tool for collaborative learning activities in an artifact ecology?
- How learner-learner and learner-artifact interactions evident in the artifact ecology support collaboration and coordination during design activities?

Study 3: "Expanding DiCoT methodological framework for collaborative learning activities in an artifact ecology and extracting design guidelines"

Finally, the third study will focus on expanding the DiCoT methodological framework for collaborative learning settings. Through this study we will highlight the affordances of digital and physical tools in the ecology of artifacts that support collaboration and coordination during collaborative learning activities and how they vary across different groups. Further by providing insights on how the affordances of the artifact ecology supported collaboration and coordination, we wish to provide practical guidelines to designers of collaborative spaces and new research directions to researchers. This understanding will allow us to expand the DiCoT framework to explain learning contexts as well as workspaces. More specifically, this study will focus on the answering the following sub-questions:

- What are the affordances of physical and digital tools in an artifact ecology as tools for distributing cognition?
- What are the group characteristics that underpin the use of physical and digital tools in an artifact ecology as tools for distributing cognition?
- How can DiCoT framework be expanded for collaborative learning activities?

- What design implications emerge as guidelines for interaction designers and practitioners for collaborative learning activities in artifact ecologies?

Significance

Our study aims to illustrate the utility of DiCoT methodological framework as a valuable tool for explaining interactions and interdependencies during collaborative learning activities in an artifact ecology. As claimed in the literature, DC is a well suited conceptual framework when dealing with technology-rich collaborative environments. However, DiCoT framework was explicitly used in the workspace, with no known extend to a collaborative learning setting. Therefore, one important contribution of this work is to transfer and apply the DiCoT framework from workspace to classroom environments, and further verifying its validity in a collaborative learning environment.

Looking at both learners' experiences, needs and expectations and understanding the computational ideas and paradigms through distributed cognition, we perceive that our study has a significant contribution in the use of such technologies across HCI, CSCW and CSCL. If we understand how these technologies can distribute an individual's cognition towards the group, we can also find out how to design effective artifact ecologies that can support them. The added benefit of examining a complex system through the lens of DC is that it allows researchers to take a step backwards and see the "big picture", focusing on interactions and actions central to the coordination of work activities. Such an understanding will allow researchers and

practitioners to pin-point where changes should occur or should not occur in the cognitive system as a whole.

Expected Outcomes

The completion of this project is expected to supply researchers a better understanding of how groups of learners collaborate in a learning environment rich in technologies. Furthermore, we aim to enrich and guide technology designers and practitioners on constructing effective artifact ecologies for collaborative learning activities by crafting a set of design guidelines.

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