Available online at www.sciencedirect.com
ScienceDirect
Computers & Education 50 (2008) 125–147
COMPUTERS & EDUCATION
www.elsevier.com/locate/compedu

Applying distributed cognition theory to the redesign of the 'Copy and Paste' function in order to promote appropriate learning outcomes

Michael Morgan [a], Gwyn Brickell [b], Barry Harper [b,*]

[a] *Faculty of Information Technology, Monash University, Melbourne, Australia*
[b] *Research in Interactive Learning Environments Group, Faculty of Education, University of Wollongong, Wollongong, Australia*

Received 14 December 2005; received in revised form 20 April 2006; accepted 20 April 2006

Abstract

This paper explores the application of distributed cognition theory to educational contexts by examining a common learning interaction, the 'Copy and Paste' function. After a discussion of distributed cognition and the role of mediating artefacts in real world cognitions, the 'Copy and Paste' function is redesigned to embed an effective interaction strategy, based on encoding strategies, into the interface. The current affordances of the 'Copy and Paste' interaction derived from its business heritage (speed and accuracy of reproduction) are contrasted with those needed for a learning interaction (the meaningful processing of content for understanding). An empirical study was conducted to test the efficacy of the redesigned function through an experimental treatment. The study examined the impact of an experimental treatment based on changes to the 'Copy and Paste' function in terms of:

(a) changes to interaction strategies employed by learners;
(b) changes in learner familiarity with note taking and summarisation interaction strategies;
(c) changes to the features of the text produced by learners.

The experimental task consisted of participants completing three short written assessment tasks based on multiple text resources using either: (i) Control treatment: standard notepad tools supplemented by a text-based resource outlining note-taking and summarisation strategies; or (ii) Experimental treatment: the modified notepad. The results of the study showed that participants in the experimental group spent significantly more time engaged in activities that indicated higher levels of cognitive processing and produced notes that contained text features that also indicated significantly higher levels of cognitive processing.

Keywords: Human–computer interface; Interactive learning environments, Cognitive tools

* Corresponding author.
E-mail address: Barry_Harper@uow.edu.au (B. Harper).

0360-1315/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.compedu.2006.04.006

1. Introduction

This study examines the effectiveness of the learner's use of the 'Copy and Paste' function to interact with content resources in a computer mediated learning environment. The purpose of the study was to demonstrate that distributed cognition theory (Dillenbourg, 1996; Hollan, Hutchins, & Kirsch, 2000; Hutchins, 1995; Karasavvidis, 2002; Nardi, 1996b; Pea, 1985, 1993; Perkins, 1993; Salomon, 1993) provides a significant insight into how learners conduct activity in computer mediated learning environments and how they interact with content using mediating artefacts (Hutchins, 1995; Pea, 1985, 1993; Perkins, 1993; Salomon, 1993; Vygotsky, 1980). Distributed cognition theory was used to justify the redesign a mediating artefact, the 'Copy and Paste' function, while encoding strategies suggested by schema theory were embedded in the interface to form an interaction strategy thereby addressing fundamental learning issues such as 'depth of processing' of content. The objective of the redesign of the 'Copy and Paste' function was to increase the learners' depth of processing of content and to embed interaction strategies that encouraged the encoding of content to long-term memory through the development of robust and effective schemata (Lutz, 2000; Quillian, 1968; Rumelhart, 1980; Rumelhart & Norman, 1978; Sweller, 1999). A constructivist philosophy (Duffy & Cunningham, 1996; Jonassen, Mayes, & McAleese, 1993) of learning was the basis of the instructional strategy adopted in the study in that it is recognised that in order for learners to 'construct' knowledge they must be actively engaged in 'processing content for understanding'. This approach has lead to the design of computer mediated learning environments that encourage the learner to engage in purposeful activity in products like *Exploring the Nardoo* (1996). This package, for example was designed as a virtual water catchment area in order to allow learners to explore issues of water management, water quality and environmental preservation via a number of embedded investigations. It is a resource rich constructivist learning environment that relates to a complex and 'ill-defined' content domain (Jonassen et al., 1993; Jonassen, 1997). This contrasts strongly with early methods of employing computers in education in which they were used simply as convenient vehicles to transmit content. It is envisaged that the redesigned 'Copy and Paste' function would be applicable to computer mediated constructivist learning environments such as *Exploring the Nardoo*.

Traditionally the emphasis of formal instruction has often been on the internalisation of representations of the external environment by minds working in isolation from others, and often in isolation from real-world contexts (Lave & Wenger, 1991). In contrast to this approach distributed cognition as applied to educational contexts, focuses on the ways in which learners appear to think in conjunction with mediating artefacts that pervade human environments (Perkins, 1993). In this view the internal cognitive resources of learners are shaped by the configuration of the environment at the same time as the individual is acting to re-craft their environment in order to assist in further cognitive activities (Hutchins, 1995; Pea, 1985, 1993), forming complementary components of a distributed cognition system. Bringing the internal cognitive resources of the individual (Atkinson & Shiffrin, 1971) into coordination with the external resources available in the environment is important in order to promote effective learning. The design of effective learning environments therefore depends on the ability of instructional designers to understand the cognitive impact of mediating artefacts (Vygotsky, 1980) on the cognition of learners and to design mediating artefacts with the appropriate configuration of affordances and constraints (Norman, 1990, 1991).

2. Theoretical underpinning – distributed cognition

Arising from the work of Lev Vygotsky in the 1930s, distributed cognition (Cole & Engeström, 1993; Dillenbourg, 1996; Engeström, 1999; Hollan et al., 2000; Hutchins, 1995; Karasavvidis, 2002; Nardi, 1996b; Pea, 1985, 1993; Perkins, 1993; Salomon, 1993; Wertsch, 1985), recognises the role that mediating artefacts play in human cognition. This study looks at the role of a specific mediating artefact, the 'Copy and Paste' function, in guiding or shaping the cognition of learners. Vygotsky (1980) argued two important concepts:

1. That it is a special property of human cognition that humans put between the stimulus and their internal cognitive resources certain mediating artefacts, such as signs, e.g. language, and physical tools, that altered their cognition in fundamental ways, and