# Chapter 8.2
# Formula Editors and Handwriting in Mathematical E-Learning

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## ABSTRACT

*Teaching and learning mathematics at university level is increasingly being supported by Learning Management Systems. In this chapter, we report from the e-learning initiative, DELTA, and in doing so we aim to describe how formulas, drawings, and other mathematical representations influence student communication. We describe a practice that combines handwriting and discussion forums facilitated by a Learning Management System (LMS). We have experienced lack of student activity in the discussion forums and introducing a new LMS (Moodle) with improved formula editor capabilities into the environment, does not seem to considerably improve the situation, whereas a scanner-based handwritten communication seems to successfully support the assignment communication between the students and the teacher.*

## INTRODUCTION

Teaching and learning at university level increasingly takes advantage of online technology, such as Learning Management Systems (LMS), because they provide a number of advantages such as flexibility regarding time and place, easy distribution of information and support of collaboration among students (Engelbrecht and Harding, 2005, OECD, 2005).

As mathematics is a worldwide and comprehensive topic at undergraduate level (Carlson and Rasmussen, 2008) it is highly relevant to look into specific problems concerning teaching and learn-

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ing mathematics online. This is the purpose of this chapter. The empirical basis of our discussion here is the distance learning program DELTA that has been running since 2005. Our focus is on the relation between technology for writing mathematics and the students' communication. We address the role of handwriting in mathematical e-learning, and how mathematical text is produced and distributed online through a LMS. We also explore the students' communication situation and how the technological environment supports or hinders this communication. More specifically, we address how teachers and students in DELTA cope with the many representations used in mathematical texts and describe the challenges this poses to e-learning of mathematics.

## BACKGROUND

When teaching mathematics fully online, there are a number of aspects of mathematical communication that is worth considering. Firstly, the extent to which the employed interface (i.e. keyboard and mouse) and programs support or hinder mathematical communication. Some of the formulas, drawings and other types of representations are more difficult to create using a computer than it is to write them by hand. Secondly, technological challenges to mathematical notation could prompt students to describe mathematics in words rather than in the established mathematical notation or in other ways affect the types of representations used in mathematical work. Hence, we find it relevant to consider the implications of the multimodal (i.e. uses many types of representations) nature of mathematical text, and how this relates to learning and communication.

### E-Learning and Mathematics

In 2005 OECD published a report surveying the use e-learning in tertiary education across the globe (OECD, 2005). The main results are that technology is increasingly available and used in tertiary education, but that the impact on classroom teaching and pedagogy is sparse. The only notable pedagogical impact is that the idea of a learning object has gained some momentum in supplementing classroom teaching. But the overall picture is unclear in the sense that a number of both positive, (for example flexible access to materials and resources and use of pedagogical techniques dependent on ICT) and negative (for example usability problems with digital tools and loss of face to face contact) effects of e-learning is laid out in the survey. The report points to lack of research evaluating the pedagogical value of e-learning.

A lot of literature, on the other hand, points to innovative or sensible practices and potentials of using e-learning (Jaques & Salmon, 2007, Hiltz & Goldman, 2005, MacDonald, 2008, Rattleff, 2008). The institutional culture seems to play some role; institutions with a long history of distributed teaching shows more potential for pedagogical development taking advantage of new technology (OECD, 2005).

The state of the art of communication technology is a persistent issue in e-learning of mathematics. This is reflected in a conference panel report (Descamps et al. 2006), which describes the current challenges of e-learning in mathematics. The report highlights that 'Tutor-student oral communication' is very important, and one of the reasons is that when writing down one's concerns the students must overcome a technological barriers that makes it a difficult task to write down a mathematical sign in a computer (Descamps et al., 2006).

There is no consensus about the importance of this technological barrier. In a report on Italian use of e-learning in mathematics, Osimo (2002) points out that writing mathematical formulae does not pose a serious threat to the possibility of creating online learning environments in mathematics. It should be noticed that the focus of this report is on the use of e-learning technology as