

# Stimulating Collaborative Behaviour in Design Education

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## Abstract

This paper discusses the potential of CSCW tools to monitor and motivate collaborative behaviour of students in design projects. After a brief review of theories on collaborative learning and collaborative behaviour, the paper presents the author's observations of issues experienced by students in collaborative design projects. These issues are compared to the capabilities of the various categories of CSCW tools, in order to find ways to offer support to both students and teachers in detecting and resolving these collaboration issues.

## Keywords

Collaborative Design, Design Education, Collaborative Behaviour, Team Building, CSCW.

## 1 Introduction

The objective of this short paper is to discuss the potential of CSCW tools for stimulating collaborative behaviour in design teams. This discussion is based on a comparison of collaboration issues, as observed in an educational context, with the capabilities of existing Groupware tools.

In educational contexts, collaborative activities have a dual learning objective. The first is to use collaboration to facilitate learning: when working together in groups, students learn more effectively as their actions are continuously observed and criticised by their peers; they also learn more efficiently since they can naturally share knowledge and experiences with each other. The second objective for collaborative activities in education is to prepare students for collaboration projects they will be working on in their professional life. Professional collaboration requires a set of competences that can be acquired explicitly through education. This is a mix of technical competences and more personal competences; examples are: team management, assuming various team roles, effective meeting techniques, task management, time management, group decision-making, group creativity, document management, workflow management, etc.

The paper first provides a review of theories and aspects of collaborative behaviour, as found in literature. It then summarises the authors' observations over multiple years of the collaborative behaviour of design teams composed of students. From these observations an inventory is made of the problems that students encounter when working in collaborative projects over several months. This inventory of problems is then matched against the capabilities of the various categories of CSCW tools that currently exist. This matching exercise provides insight in which problems can actually be supported with CSCW tools and which are the issues that require other ways of addressing in educational as well as practical contexts.

## 2 Aspects of Collaborative Behaviour

Collaborative behaviour can be regarded as the collection of aspects of behaviour that team members manifest, that enable them to effectively and efficiently work together on the tasks assigned to the team.

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Bonk and Cunningham (1998) present psychological factors of collaborative activities: (1) *cognitive and metacognitive factors* – e.g., according to the nature, context and goal of the learning process, (2) *motivational and affective factors* – e.g., how the learner feels motivated according to his emotional states, (3) *developmental and social factors* – e.g., learning is influenced by social interactions, and (4) *individual differences* – e.g., learning strategies, diversity, etc.

Wasson and Mørch (2000) define collaboration patterns as sequences of interaction among members of a team. These patterns involve (i) *interdependency* – e.g., shared information, task division; (ii) *coordination*; (iii) *mutual learning* – sharing experiences; (iv) *shared feedback*; (v) *adaptation* – learning to work together; (vi) *coordinated desynchronisation* – coordinating individual activities; (vii) *constructive commenting*; and (viii) *informal language*.

Harvey and Koubek (2000) carried out an extensive review of the literature and identified cognitive, social and environmental attributes that must be considered to determine the necessary support for collaborative engineering. The cognitive attributes refer to the individual design process (the problem-solving process), the design representation (e.g., the sketches made to arrive at a design solution), and the cognitive resources (e.g., a designer's working memory). These attributes were integrated into a model for distributed engineering collaboration which was divided into three categories: (i) *task characteristics* (complexity and intellectual process phase), (ii) *collaborative technology* (communication medium and conversational properties), and (iii) *individual/group development* (group vocabulary schema, individual cognitive resources and group tasks cohesion).

### 3 Experiences from Teaching Collaborative Design

Collaboration is one of the key competences that students of undergraduate and graduate programmes in various areas of design and engineering will need to acquire. In many programmes, collaborative design or collaborative engineering is explicitly given a place in the curriculum, while in other programmes it is implicitly taught in team-assigned projects. The difference between these two approaches is evident when looking at the focus of the learning activities and of the assessment criteria as well.

In courses with an explicit focus on collaboration issues, the students will tend to be more aware of the various implications of having to work in a team, often an interdisciplinary team. These students are expected to better anticipate the complications that come with working in a team. As a consequence, these students will focus less on the quality of the design decisions and the outcome of the design process, but rather on the activities in the process and on the quality and management of their communication and decision-making process. The utilisation of CSCW in this type of course is generally taught explicitly, and students are assessed on the correct and efficient usage of these tools in their collaborative design work.

In courses where collaboration is not an explicit issue but included as a secondary learning objective, students are generally confronted with the complications of teamwork while working on the collective design tasks. As a result, students will be much more focused on the content of the design process and the quality of their decisions, with only subconscious awareness of the collaboration issues for as long as the process goes well. Once they experience problems in the collaboration their attention is often completely reversed, with full attention for the collaboration issue at hand and a blocked design process as a result.

Experience with teaching both types of courses have been gained by the first author over the past six years. At Eindhoven University of Technology, a Collaborative Design course is taught as part of the MSc curriculum in the Department of Architecture, Building and Planning, in the period 2002-2006 under responsibility of the first author during four consecutive academic years. (van Gassel et al, 2004; van Leeuwen et al, 2005). At the University of Madeira, the undergraduate Design curriculum does not include a course dedicated to collaborative design;

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however, the final year includes a Design Project that is assigned to teams of design students where collaborative design is an implicit component of the learning activities and an explicit part of the assessment. In the period 2006-2008, this project was taught to two generations of students. Table 1 presents an overview of the teaching of these courses, the observed number of design teams that experienced collaboration issues, and the number of teams that failed to come to a successful collaboration.

	<i>Academic year</i>	<i>Number of teams</i>	<i>Number of students per team</i>	<i>Total number of students</i>	<i>Teams with collaboration issues*</i>	<i>Of which considered failures**</i>
Collab. Design course	2002-3	3	6	19	2 (67%)	0
	2003-4	6	6	35	3 (50%)	1
	2004-5	10	4	41	3 (30%)	1
	2005-6	12	4-5	52	4 (30%)	1
Design Project	2006-7 (1 <sup>st</sup> sem)	5	3	14	1 (20%)	0
	2006-7 (2 <sup>nd</sup> sem)	4	4-5	18	2 (50%)	1
	2007-8	7	3-5	30	2 (29%)	1
<b>totals</b>	<b>2002-2008</b>	<b>47</b>	<b>3-6</b>	<b>209</b>	<b>17 (36%)</b>	<b>5 (11%)</b>

\* All teams encountered problems with the collaboration, but the teams indicated in this column have clearly struggled longer, had more difficulties with more issues, were less alert about these issues and did not manage to deal with all of them.

\*\* In these teams, the collaboration was unsuccessful and the team either failed to present a complete design, or did so with some members missing from the finally presenting team. In particular, these teams failed to react adequately to the collaboration problems. In some cases, an individual team member attempted to resolve the problems, but appeared unsuccessful.

Table 1. Student teams in two courses that were subject of observation

Observations made while teaching these courses allow drawing a number of conclusions that are to some extent surprising. The observations concern, in sum over these years, 42 design teams with a total number of 173 students, with teams varying in size from 3-5 students.

Some of the observations in these project teams, regarding collaborative behaviour, are:

1. 11% of the design teams encounter serious problems in the collaboration;
2. Problems in the collaboration have two types of causes: miscommunication and lacking involvement of one or more team members;
3. Problems generally start half-way through the scheduled project time: the moment when group decisions have been made and tasks are assigned to individual students;
4. Students are often incapable of reacting adequately to collaboration problems. The general reaction is based on increasing stress in team members;
5. There is no significant difference between the two types of courses, when it comes to the chances of group failure.

#### 4 Inventory of Problems in Collaborative Behaviour

Table 2 lists the problems that were most commonly observed in teams of students that were collaborating on design projects. Although these observations are made in design courses, the authors suggest that they are actually to be expected in collaborative learning situations in general.

A. Commitment issues:	A1. Being late or absent in group meetings
	A3. Failure to deliver work in time or with quality
	A2. Not reading or responding to communications, e.g., emails
	A4. Intolerance towards other team members' difficulties
B. Task division issues:	B1. Unequal division of tasks
	B2. Insufficient benefit of available skills
	B3. Failure to take missing skills into account
C. Management issues:	C1. No effective leadership: <ul style="list-style-type: none"> <li>a. None of the team members takes responsibility</li> <li>b. Effective leadership is not accepted by all members</li> </ul>
	C2. Failure to agree upon or adhere to the design process and activities
	C3. Failure to determine or adhere to decision-making procedures
	C4. Failure to document the design process: proposals, agreements, decisions, etc.
	C5. Failure to inform absent team members
D. Personal issues:	D1. Colliding personalities
	D2. Existing (previous) conflicts
	D3. Incapability to assume a collaborative attitude: <ul style="list-style-type: none"> <li>a. Failure to listen</li> <li>b. Not open to comments and feedback</li> </ul>
	D4. Authoritarian behaviour: unwillingness to discuss and build consensus
E. Team preparation issues:	E1. Lacking experience with, e.g., digital communication tools
	E2. Failure to recognise such deficiency and take action on this
F. Practical issues:	F1. (Software) tools not available to all members
	F2. Failure to agree upon exchange formats

Table 2. Observed issues in the collaboration of student teams in design projects

## 5 Addressing Collaborative Behaviour in Education

Various theories and accompanying models have been proposed to address the afore-mentioned behaviour issues with collaborative work and collaborative learning. Some models have inspired the development of software tools, known as Groupware, to provide support for collaborative work. Groupware can be divided into three categories depending on the kind of collaboration: communication tools (e.g., synchronous conferencing, e-mail, etc.), conferencing tools (e.g., internet forums, on-line chat, video-conferencing, voting, etc.) and collaborative management / coordination tools (e.g., systems for group management, workflow management, knowledge management, awareness, task management, tool management, etc.). Many of these tools, however, are not able to detect or treat most of the occurring problems due their particular nature (psychological, emotional, cultural, etc.). Awareness tools in particular (Rodríguez Peralta and Silva, 2006) are useful for supporting team members in increasing the cohesion and collaboration in teams. Such tools can be used not only to support resource management, but also to support session management, ensuring that team members have access to identical resources and software tools when collaborating in a session.

Our review included tools offering support for the following aspects of collaboration:

- Group management

- Awareness
- Conferencing
- Task management
- Workflow management
- Voting
- Document management
- Knowledge management
- Tools management

Table 3 indicates which of these categories of tools can actually be applied to address the observed collaboration problems. It distinguishes the tools' capabilities to detect (or help to detect) problems and the capabilities to actually address the problems, either by providing support in taking action when problems are detected, or by providing support to avoid such problems altogether.

	<i>Problem</i>	<i>Treated</i>	<i>Detected, not treated</i>	<i>Not detected</i>	<i>Groupware tool</i>
A1	Being late		X		Group manager, Awareness tool
A2	Failure to deliver				
A3	Not responsive		X		Conferencing tool
A4	Intolerance				
B	Task division issues	X			Task manager, Workflow system
C1	Leadership issues		X		Conferencing tool, Awareness tool
C2	No process management	X			Workflow system
C3	No agreement on decision-making	X			Voting tool (decision-making)
C4	Failure to document		X		Document/Knowledge management
C4	Failure to document,		X		Awareness tool
C5	Failure to inform absentees				
D1	Collision		X		Conferencing tool
D2	Previous conflicts			X	
D3/4	No collaborative attitude		X		Conferencing tool
E1	Lacking experience	X			Group manager
E2	Failure to recognise deficiencies			X	
F	Practical issues	X			Tools manager

Table 3. How groupware tools can be applied to meet learning collaborative needs

## 6 Conclusions

As table 3 illustrates, the tools mentioned are not able to actually solve (or support solving) many of the problems experienced by students in collaborative work. However, the tools do offer ways to detect many of the issues if they are applied as a support to monitor the process and the individual contributions of team members. This monitoring can be done by students as well as teachers. Being applied this way, a secondary but important effect is that the tools can become a

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motivation factor and support the students to gain insight in the group process, making the collaboration issues negotiable and a clearer subject of evaluation.

Another conclusion that we draw from our observations and teaching experiences is that it is not always feasible in the educational context at hand to make effective use (if at all) of the available Groupware tools. While such tools potentially have a high value for the collaboration, they also have a relatively high learning curve, which does not always suit the learning objectives set for the particular educational activities. In other words, not for all design courses using complex Groupware tools is not an option. As a consequence, there is little support to address or even detect the issues that are likely to arise in these courses and it will be important for teachers as well as students to be aware of them and take other effective measures for detection and resolution of these problems.

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