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Published in:
International Journal of Knowledge and Learning

DOI:
10.1504/IJKL.2009.031198

Published: 01/01/2009

Document Version
Peer reviewed version

Citation for published version (APA):
Figl, K., Derntl, M., & Kabicher, S. (2009). Visual modelling and designing for cooperative learning and development of team competences. *International Journal of Knowledge and Learning*, *5*(3&4), 235 - 253. https://doi.org/10.1504/IJKL.2009.031198

Figl, K., Derntl, M., Kabicher, S. (2009). Visual modelling and designing for cooperative learning and development of team competences. International Journal of Knowledge and Learning, 5 (3&4), 235-253.

Visual modelling and designing for cooperative learning and development of team competences

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Abstract: This paper proposes a holistic approach to designing for the promotion of team and social competences in blended learning courses. Planning and modelling cooperative learning scenarios based on a domain specific modelling notation in the style of UML activity diagrams, and comparing evaluation results with planned outcomes allows for iterative optimization of a course's design. In a case study—a course on project management for computer science students—the instructional design including individual and cooperative learning situations was modelled. Specific emphasis was put on visualising the hypothesised development of team competences in the course design models. These models were subsequently compared to evaluation results obtained during the course. The results show that visual modelling of planned competence promotion enables more focused design, implementation and evaluation of collaborative learning scenarios.

Keywords: cooperative learning, visual learning design, design languages, Unified Modelling Language, teamwork

Biographical notes:

Dr. Kathrin Figl is an assistant professor in the Institute for Information Systems and New Media at the Vienna University of Economics and Business. She received a doctoral degree and two master's degrees (information systems and psychology, both with honours) from the University of Vienna. Most of her applied research and teaching focuses on the intersection between information systems and psychology, including research on media psychology, e-learning, human-computer-interaction and cognitive aspects of modelling. Kathrin Figl has authored 32 papers, including 3 best paper awards, in peer-reviewed journals and conference proceedings.

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1 Introduction

In today's knowledge society the university graduates are expected to be able to work in teams, communicate effectively in interdisciplinary work groups, and collaborate with co-workers both face-to-face and online (Motschnig-Pitrik, 2008). While most higher education curricula still have a strong focus on promotion of technical skills and factual knowledge, more recent developments such as the Bologna Process (European Commission, 2007) accommodate the new qualification requirements in the knowledge society and promote a shift of focus towards developing *competences* of students based on a desired target competence profile for graduates. Competence refers to the ability to *use* knowledge, skills and personal, social and/or methodological abilities (European Commission, 2008). One set of highly job-relevant competences are those related to teamwork, and one effective way of facilitating the development of those teamwork competences is provision of collaborative learning environments. However, introduction of effective collaborative learning, as will be argued in the following section, is a demanding and non-trivial endeavour. Collaborative learning may introduce a considerable amount of uncertainty, it requires more flexibility, and it generally follows a non-linear flow of events and activities; therefore, planning for those settings is particularly difficult.

To overcome these obstacles, we adopt a visual-language approach (Botturi & Stubbs, 2007) to designing for collaborative learning with particular emphasis on planning for the promotion of team competences. We build upon an existing UML-based design language (Derntl & Motschnig-Pitrik, 2007) and extend it with visual icons that allow the explicit representation of (a) the social setting of an activity and (b) the hypothesised promotion of team competences within a learning activity. The distinction of different types of team competence supported by learning activities is adopted from (Cannon-Bowers, Tannenbaum, Salas, & Volpe, 1995), who differentiate teamwork knowledge, skills and attitudes. The benefit of thoughtful design of cooperative learning becomes obvious when courses are planned and subsequently evaluated and improved with the help of visual design models.

The paper is structured as follows. In Section 2 we introduce relevant background work on cooperative learning and team competences. In Section 3 we describe how team competence promotion can be included in course design. We propose the visual extensions needed to include cooperation and team competence promotion in the design models and give a short introduction on evaluating the effectiveness of the designed team-competence promotion. In Section 4 we present a case study in which we compare the hypothesised competence promotion during course design with the actual perceived competence shifts as rated by students after the course. The final section concludes the paper and gives an outlook on further work.

2 Promotion of Team Competences

How can team competences training, "in which individuals enhance knowledge, skills, and attitudes that applied in a team context result in improved team effectiveness" (Ruiz & Adams, 2005), be incorporated in courses within the time frame of one single term? The following section will give an overview of the status of previous research related to this question.

2.1 Defining Team Competences

Designing for the training or development of a specific competence requires a thorough understanding of the concept of competence. Parry (1998, p. 60) defines competences as "a cluster of related knowledge, skills and attitudes that affects a major part of one's job (a role or responsibility), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved via training and development." Team competences are a main factor for team performance at work or in a learning environment; on the individual level they are the characteristics a team member has to possess to successfully engage in teamwork (Baker, Horvarth, Campion, Offermann, & Salas, 2005). They are team-generic, held by individuals and can be transported to other teams. According to Cannon-Bower et al. (1995) there are three important types of team competences: *knowledge competences*, *attitude competences* and *skill competences*. Knowledge competences include, for instance, knowing about proper behaviour in teamwork, roles in a team or the team's goals. With respect to attitude competences, positive attitudes towards teamwork are important for effective teamwork. Skill competences represent the learned capacity to interact with other team members and include group decision-making skills, adaptability/flexibility skills, interpersonal relations skills and communication skills (Cannon-Bowers et al., 1995).

2.2 Possibilities for Promoting Team Competences

There are several possibilities to promote team competences in courses, varying in the available amount of time and resources, and the training of the instructor (Figl, 2009):

- Thoughtfully including team projects in class, e.g. instructional decisions on team composition, size, dealing with social loafing, fair assessment of teamwork, etc.
- In-depth support and coaching of team projects by instructor, e.g. team building activities, monitoring and supporting team processes, including reflection and feedback on teamwork.
- Direct promotion via lectures and training exercises.

Team projects are a specific form of cooperative learning which is defined as “the instructional use of small groups so that students work together to maximise their own and each other’s learning” (Johnson, Johnson, & Smith, 1991, p. 3), or as “an educational approach in which the learning environment is structured so that students work together towards a common learning goal” (Prichard, Bizo, & Stratford, 2006, p. 119). Computer supported cooperative learning (CSCL) (Beatty & Nunan, 2004; Strijbos, Martens, & Jochems, 2004) is a combination of group-based learning and its supporting technology. Cooperative learning goes beyond putting students in groups and giving them assignments (Fellers, 1996, p. 45); it should be regarded as an overall goal in education, since this kind of learning meets the demands of the modern knowledge society better than teacher-centred lectures (Reinmann-Rothmeier & Mandl, 2001, p. 631). Cooperative learning is proven to be capable of producing various positive effects, for instance less dropouts—especially at the beginning of the studies—because it can contribute to students’ sense of belonging to colleagues and feeling of security (Seymour & Hewitt, 1997). A meta-study on the effects of cooperative small-group learning on science, mathematics, engineering, and technology students found significant positive effects on achievement, persistence and attitudes (towards subject matter, self esteem and motivation) (Springer, Stanne, & Donovan, 1999). Another meta-analysis on cooperative learning methods showed that students showed higher academic achievements—with respect to grades, quality of products such as reports—than competitive and individualistic efforts (Johnson, Johnson, & Stanne, 2000).

In the context of this paper we are particularly interested in the fact that cooperative learning can promote social competences like communicating effectively and managing conflicts more effectively than individual learning (Johnson & Johnson, 1998). It is evident that cooperative learning calls for developing and demonstrating a certain set of skills and attitudes that we subsume under the term “team competence.” Team projects in courses share many elements with teamwork in a workplace setting (e.g. shared goals and task interdependency); therefore, generalization and transfer from the learning experience to later team situations is possible (Ettington & Camp, 2002).

Working in teams usually allows students to realise the benefits of teamwork (Ruiz & Adams, 2005), even though some studies showed that students prefer individual work, because their individual effort is recognised higher than in teamwork. This is more likely if students did not receive proper training before teamwork (Ulloa & Adams, 2004). Negative experiences with teamwork, especially with “social loafing,” can undermine students’ attitudes towards working in teams (Ruiz & Adams, 2005). If teamwork is not well managed, negative team experiences might discourage students and create negative attitudes towards teamwork in class (Ulloa & Adams, 2004). In addition, these negative experiences with teamwork not only have negative effect on students’ attitudes toward team participation, but may also contribute to poor team performance on the job and should therefore be avoided (Buckenmyer, 2000).

Therefore it is important to place a specific focus on the integration of team projects in class to avoid negative team experiences. There is a variety of pre-instructional decisions an instructor has to make when employing team projects in class. These include the decision on the team size, the team composition (options are for instance self-selection by students or selection by faculty e.g. via personality tests to create balanced teams), and assigning roles to team members in a team. At the beginning of a course, students should be guided to recognise their current level of team competences to enable focused training and development of missing or required competences. Besides including team building activities in the class to promote cooperative learning during a project (Ruiz & Adams, 2005), instructors should continuously support and monitor the team process. An important aspect is the prevention of social loafing. Social loafing occurs when it is difficult to identify individual contributions, team cohesion may deteriorate and redundant efforts are likely (Johnson & Johnson, 1998). Strategies for dealing with social loafing try to make individual effort of team members identifiable and try to strengthen individual commitment (Baron & Byrne, 1997, pp. 447-448). Especially fair assessment of team projects including individual effort analysis—for instance via students’ logs on their contribution, self and peer evaluation, individual tests or presentations of each team member and cross-validation with individual work (Hayes, Lethbridge, & Port, 2003; Hazzan, 2003; Wilkins & Lawhead, 2000)—is important.

Team projects in class are comparable to a behaviour modelling training (BMT) approach for team competences, which has proven to be effective for improving team skills (Taylor, Russ-Eft, & Chan, 2005). In this approach, it is important to practice skills in the training setting and to learn through feedback. Therefore, feedback by instructors or team mates (e.g. in a peer-review exercise) is a further crucial factor for learning from the team experience.

Additionally, reflection can support the transfer of the cooperative learning experience to other team situations (Bolton, 1999). Reflection may help students to understand reasons for unsuccessful team dynamics and provide them with stronger self-awareness about how they behave as a team member (Wills & Clerkin, 2009).

Although collaborative learning is one "natural" method of preparing students to work in teams and promote team competences, there are further possibilities, such as lecturing theoretical inputs and integrating team related exercises in the course. This kind of direct training can take place prior to a team project in a course to enhance effective teamwork, or during the work on the team (Ruiz & Adams, 2005). Theoretical input on relevant factors of team processes and effectiveness allows to "prepare team members for managing their own team process" (Ulloa & Adams, 2004). Concerning practical exercises for training team competences (e.g. communication, coordination, conflict handling) there exists a variety of training manuals and course materials for courses in higher education (Gershwin, Cyr, Smith, Travis, & Wiseman, 1997; Hamilton, 1994; Prichard, Stratford, & Hardy, 2003; U.S. Department of Education, 1997).

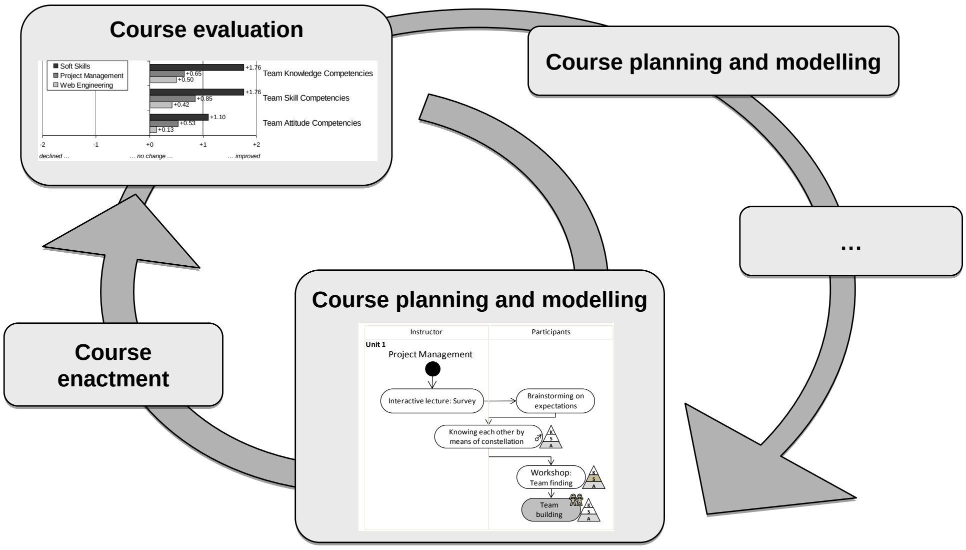
3 Designing Courses for the Promotion of Team Competences

For continuous improvement of a course design we need to address the question on how to confirm or even prove that some pedagogical elements tend to be superior in certain aspects than others. The educational action research approach (Dewey, 1938; 1946) can provide a theoretical basis for introducing a cyclic, iterative refinement process during course design. In extended action research (Motschnig-Pitrik, 2004; Susman & Evered, 1978) the action research cycle consists of the phases diagnosing, action planning, action taking, and specifying learning. First, goals are formulated and hypotheses are set up. Actions for improved learning and teaching are planned. Modelling and/or visualising activity flows of the learning and training process can support the design process (Derntl, 2006). In the action-taking phase the course is held and data is collected for evaluation. Problems are identified through data collection and subsequently analysed. In order to overcome problems and obstacles, alternatives for actions are developed and tested. The knowledge attained is used immediately. This cyclic procedure is repeated until a satisfying status is reached. Results on achievement of objectives iteratively flow into the next cycle. Successful course designs are extracted, collected and documented for later reuse. Visual models as representations of course designs help to document and communicate course designs to other researchers, course designers and instructors. This may facilitate instructional reusability of designs (Hummel, Manderveld, Tattersall, & Koper, 2004).

Figure 1 proposes a process based on iterative action research cycles, employing visual models and course evaluation to design for cooperative learning and improve the promotion of competences in courses. By linking evaluation results to design elements (e.g. teamwork setting) in a course, a feedback loop is created (Lewis, Aldridge, & Swamidass, 1998). Instructors are able to identify what was working and whether their efforts enhanced students' team competences. Based on evaluation results they can improve their course designs and enactment over several successive iterations.

The next sections detail how the steps "planning and modelling of cooperative learning" and "evaluation of a course" are best implemented.

Figure 1 Designing and evaluating courses for the promotion of team competences



3.1 *Planning and Modelling of Cooperative Learning Scenarios*

The discussion in Section 2 leads us to the conclusion that incorporating teams in courses or other educational offerings is definitely a complex task. To support instructors and learning designers in this task, we propose a method to improve the planning of teamwork and associated facilitation and promotion of team competences by using visual design models.

There are a plethora of visual instructional design languages and tools (Botturi, Derntl, Boot, & Figl, 2006; Botturi & Stubbs, 2007; Gibbons, Botturi, Boot, & Nelson, 2007) already on the market. The use of visual models can help instructors and learning designers in visual thinking—i.e., planning and reflecting the design of cooperative learning and the promotion of teamwork competences through drawing visual representations of learning activities and environments. It is long known that design of collaborative learning often involves lots of subjective decisions and the relationship between designed collaboration and intended outcome is rarely specified at design time (Dillenbourg, 1999; Strijbos et al., 2004). There is also agreement that designing for collaborative learning is inherently more complex than designing for classic linear instruction and training. In recent years, various projects and initiatives (e.g., Dillenbourg, 2002; Harrer & Hoppe, 2008; Hernandez-Leo, Asensio-Perez, & Dimitriadis, 2005 ; Tattersall, 2006) have tried to support the process of designing for collaborative learning with visual design languages and scripts. Unfortunately, these approaches do not offer fully suitable guidelines and toolkits for making explicit, evidence-based links between the design of collaborative learning and the competences eventually attained by students.

To model cooperative learning settings and the hypothesised promotion of team competences in particular actions and activities, we propose a visual notation in the style of extended UML 2.0 activity diagrams. The basic set of UML 2.0 symbols required for understanding activity diagrams and our extensions is displayed and described in Table 1. Additionally we use the symbol set of the coUML visual design language (Derntl & Motschnig-Pitrik, 2007), which basically extends UML activity diagrams with symbols to visualise the mode of presence (web/distant, face-to-face, blended) of learning activities. In its basic notation, coUML does not include means for modelling (a) hypothesised promotion of competences and (b) social setting—individual vs. cooperative—of learning activities. To enable visualization of these important complementary information assets, we introduce additional visual elements (symbols), which are defined as extensions to UML actions in Table 2. Similar to other domain-specific conceptual modelling grammars, graphic symbols (constructs) and rules for combining constructs are defined (Gemino & Wand, 2004). Attaching the proposes symbols to learning activities in the course design models allows planning and hypothesising about the intended use of teamwork and promotion of team competences. For an example of a course design model employing this extended notation see Figure 2 in the following case study section.

Table 1 UML 2.0 activity modelling elements (Object Management Group, 2004, p. 416) used in this paper.

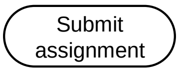
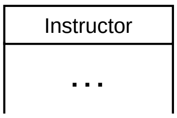
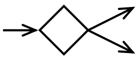
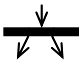
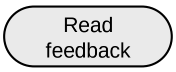
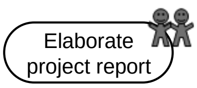
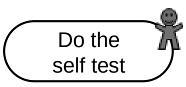
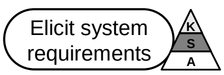
Symbol	Description
	**Initial node**: Activities (or activity diagrams) start with an initial node.
	**Final node**: Activities end with a final node.
	**Action**: An action represents some atomic behaviour executed in the modelled system; in our course design diagrams presented in this paper, actions are used to model any actions performed by participating roles.
	**Call action**: An action with a rake-style symbol represents the call of an activity; the called activity is usually modelled in more detail in a separate diagram. This way, activities can be modelled at different hierarchical levels.
	**Swimlane**: Swimlanes represent partitions within activities; we use swimlanes to show which roles (instructors, students, tutors, etc.) execute actions.
	**Decision** or **Merge**: A hollow diamond represents either (a) a decision, where the flow is split up into at least two mutually exclusive flows; or (b) a merge, where multiple split flows are reunited into one single flow.
	**Fork** or **Join**: Forks and joins are represented by vertical or horizontal bars. At a fork node, the flow is split up into multiple concurrent flows, while a join node, reunites concurrent flows into one single flow.
	**Object**: Object nodes (rectangles) are used to define object flow in an activity, e.g. to show that an object is output of one action and input to another action.
	Flow: To model the control flow and object flow within an activity, simple arrows are used to connect the nodes. If the arrow connects control nodes (actions, forks, joins, decisions, merges, initial and final nodes) with each other it is referred to as control flow. If the arrow connects objects with control nodes it is referred to as object flow.

Table 2 Extensions proposed for actions.

Symbol	Description
	**Web-based action**: Light fill colour is used to model web-based actions that primarily proceed online.
	**Cooperative action**: An action symbol with two stick-figure symbols attached models course participants cooperating in teams.
	**Individual action**: A single stick-figure symbol is used to model actions executed by individual participants.
	**Competence-developing action**: Can be used to explicitly model that an action addresses one or more specific levels of competence development. The team competence "pyramid" attached to the action symbol shows three levels: knowledge (K), skills (S), and attitudes (A). Light fill colour on a level indicates moderate promotion of this competence level; dark fill colour is used to indicate strong promotion of that level of competence. The competence pyramid was inspired by the team competences model proposed by Cannon-Bower et al. (1995), who introduced this competence distinction.
	**Combinations of the above**: The extensions defined above can also be combined for single actions, e.g. the example to the left shows a web-based collaborative action that strongly addresses team skills and attitudes.

3.2 Evaluating the Effectiveness of Team Competence Development

Evaluating whether the design for cooperative learning and team sequences in a course have enhanced students' team competences, requires measuring the outcomes. Assessing student's competences and prior experiences in the beginning of a course can provide a baseline for training and for comparison with some post-assessment (Adams, Ruiz-Ulloa, & Pereira, 2002). In comparison to other team related variables team competences are more difficult to measure, because "they are not readily quantifiable, as are team inputs and outputs" (Baker & Salas, 1992, p. 369). In addition to costly and time-consuming assessment-centre techniques it is also feasible to apply structured interviews, situational judgment tests (Stevens & Campion, 1994) or questionnaires for measurement. In questionnaires it is particularly hard to construct knowledge-oriented items, because it may be too easy to "figure out" the correct solution (Baker et al., 2005). Additionally, knowing how to behave in certain team situations does not necessarily lead to actual appropriate behaviour in a team situation (Baker et al., 2005). In courses, peer ratings obtained from team mates can be a further option (Halfhill & Nielsen, 2007). Several authors (Schlimmer, Fletcher, & Hermens, 1994; Smith & Smarkusky, 2005) constructed questionnaires or competence matrices on teamwork competences, in which students can rate their team colleagues (on dimensions like team process, interaction, contribution and responsibility).

4 Case Study: Project Management Course

4.1 Course Description

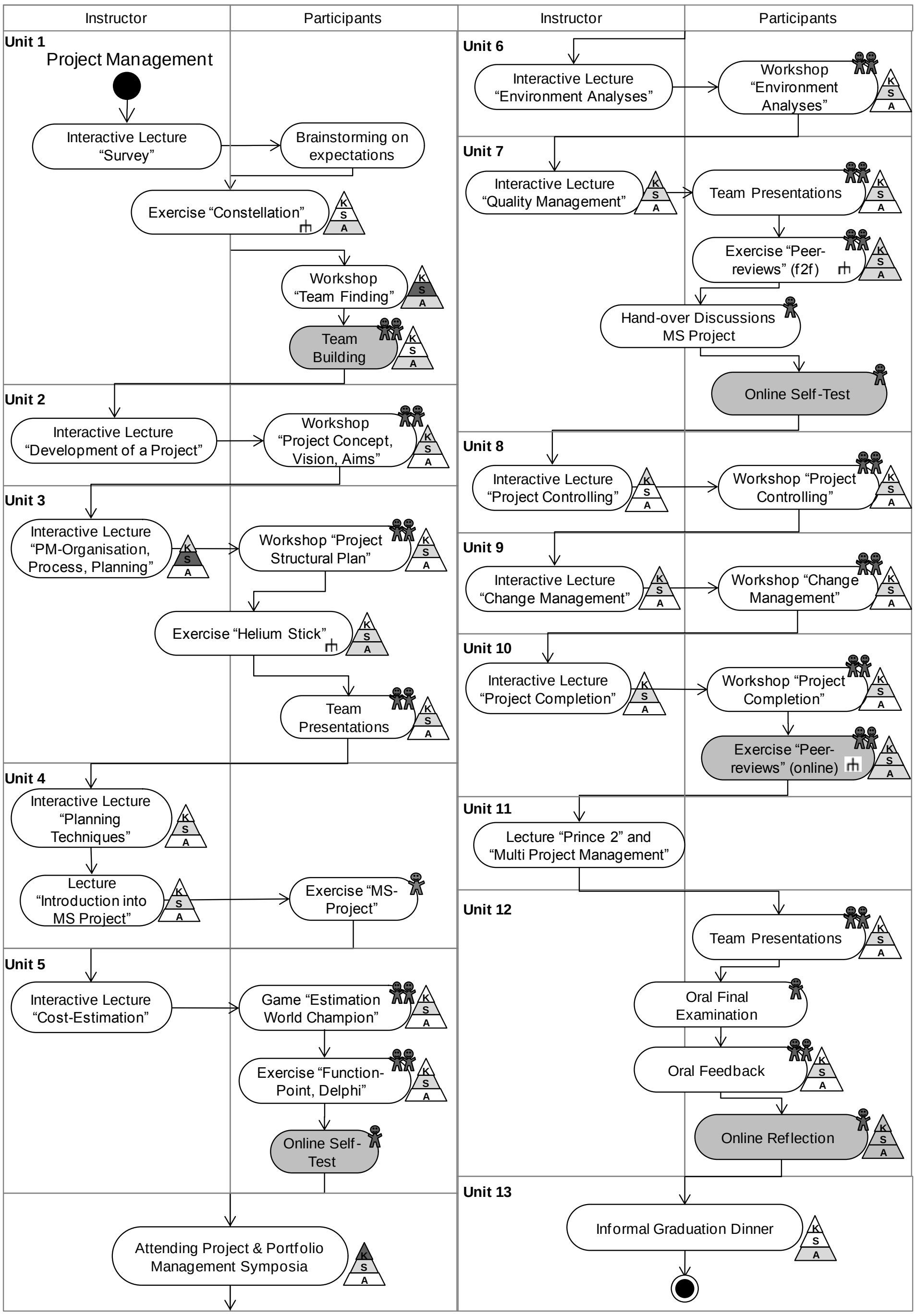
The Project Management course is a combined lecture and lab course and is part of the Computer Science curriculum at the Faculty of Computer Science, University of Vienna. The overarching learning goal of course is that students know project management methods and techniques, and that they are able to apply particular methods and techniques of planning and controlling IT projects after finishing the course. During the course, students were familiarised with specific criteria of IT projects, learned to use project management tools (in particular MS Project®) and to work efficiently in teams. Subject-specific topics covered in the course were network plans, cost and time estimation of projects, project metrics, quality assurance and program management. Students created and planned projects in small teams, developed project deliverables and used MS Project as a tool for planning and controlling. In the face-to-face units of the course, solutions were presented and discussed, practical exercises were done, and teamwork issues were reflected.

In order to experience both a scientific viewpoint on project management as well as its practical application, the course was designed as an interactive cooperative learning scenario. In the course units, students received compact subject-matter inputs and experimented with project management tools during workshops and practical exercises. One of the main concerns was to design the course as interactive as possible and to offer opportunities for project-based teamwork. Particularly the practical (e.g. MS Project, time and effort estimation, peer reviews), game-based (e.g. online self test), and communication facilitation activities (e.g. brainstorming on students' expectations) in the course enabled students to actively deal with project management. During workshops, teams performed tasks that referred to theoretical inputs or their team project. Student teams elaborated various project management topics which they presented in the face-to-face units.

4.2 Visual Course Design

Figure 2 gives an overall design model of the Project Management course. It includes instructor activities and student activities amended with visual icons (introduced in Table 1) to emphasise the promotion of team competences in particular activities. The model includes various activities that are designed to promote, among other competences, students' teamwork competences.

Figure 2 Visual design model of the Project Management course (activity graph starts in left column and continues in right column)



Team projects. Students formed teams and chose a software project or an organizational project as their work context. The project involved the elaboration of a topic/milestone and its brief presentation in class via a PowerPoint presentation. The team had to work through a number of project phases such as project definition und vision, work breakdown structure, activity list, milestone plan, Gantt chart, risk analysis, etc. Projects were partly performed outside of class, partly in workshops in class, and uploaded onto the virtual learning environment. For fair grading not only the team project was taken into account but also an individual project planning task. Additionally, active participation in the course units, in online self tests, in the online assessment, as well as in the final face-to-face examination were used as evaluation criteria. The following elements (see Figure 2) were included to best support the team projects:

- *Workshop "Team Finding"* and *Team Building*: This workshop allowed students to exchange and discuss their preferences for team constellation and find their team members. Students could select their team members themselves rather than being assigned to a team by the instructor. We chose to allow for self-selection of teams, because students tend to prefer this setting and report better team experiences when being able to selecting their team members (Bacon, Stewart, & Silver, 1999). Complete teams could sign up on the e-learning platform and receive a virtual team workspace.
- *Team Presentations*: The teams present the momentary status of their projects and discuss it with the lecturer and the group.
- *Exercise "Peer Reviews":* Peer reviews were employed both face-to-face and online (Figl, Bauer, Mangler, & Motschnig-Pitrik, 2006). Each team was paired with one other team to build "partner teams". Students reviewed their partner team's project documents and completed a review checklist. This was followed up by a face-to-face or online discussion with the partner team as depicted in Figure 3 and Figure 4.
- *Exercise "MS Project":* To avoid social loafing in teams and to ensure that students acquired basic skills in working with the project management software before they began working in their team**,** each student had to create a project plan for a small IT project using Microsoft Project. Each of those small projects included about 25 activities, a small number of milestones, and resource planning.
- *Oral Final Examination*: The oral examination served as a means to determine individual contributions in the team project; teams were asked to share their team experience. Additionally students were tested individually on their acquired knowledge.
- *Oral Feedback*: The instructor gave the teams feedback on how he/she had experienced the team's process and outcomes.
- *Online Reflection*: Students were encouraged to reflect on their team project via online questionnaires for self evaluation.

Figure 3 Sub-model of the exercise "*Peer Reviews*" (face-to-face)

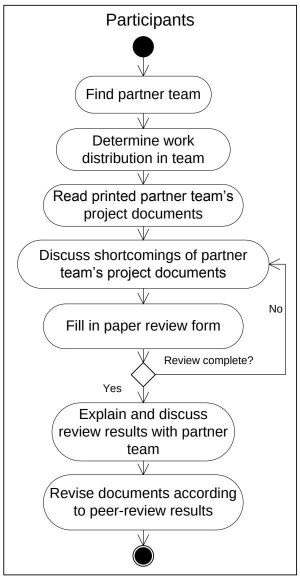
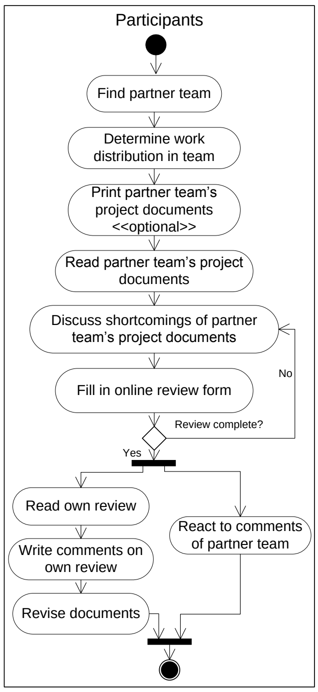


Figure 4 Sub-model of the exercise "Peer Reviews" (online)



Lectures and training. As a complement to the team project, the course included direct promotion of team competences via lectures and training exercises:

- *Interactive Lecture "PM-Organization, Process, Planning", "Planning Techniques", "Introduction into MS Project", "Quality Management", "Change Management", Interactive Lecture "Project Completion":*

Topics of lecture-based input regarding team-related knowledge included roles in a project team as for example project manager, time and effort estimation of work packages, reallocating tasks in case of resource conflicts or due to unexpected events as staff shortfalls and handling of the tool MS Project.

- *Exercise "Constellation"* (see Figure 5): Constellation was used in the context of courses as an "icebreaker" and socialising game. In the back of the lecture room the participants were asked to choose their physical location according to their answers to questions asked by the instructor (e.g. length of study, distance to university, and experience with project management). This vivid exercise breaks the ice and favors peer exchange.
- *Exercise "Helium Stick"* (see Figure 6)*:* The "helium stick" exercise is a typical team building exercise where participants stand in two lines in front of each other. A two-meter long stick is placed on their fingers by the instructor and they need to lower the stick in a way that each student's hands support the stick in each instant of its movement. Interestingly, the stick will initially move up rather than down until the people manage to coordinate their movements. This playful exercise helps to developing team-based strategies and is accompanied by collective discussions and reflections.

Figure 5 Sub model of the "Constellation" exercise

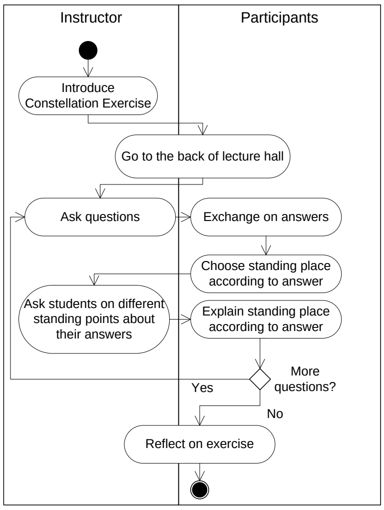
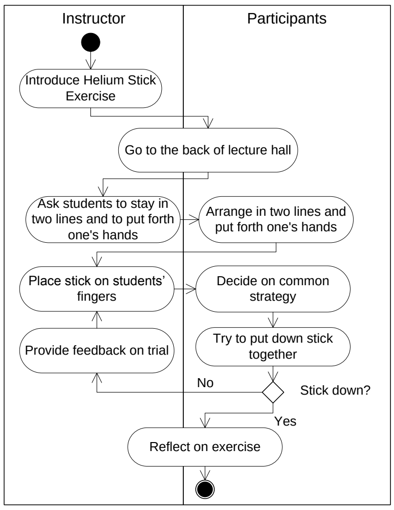


Figure 6 Sub-model of the "Helium Stick" exercise



The model of the Project Management course includes 28 actions/activities that are hypothesised to have a positive influence on team competences (i.e. those activities with a team competence pyramid icon attached). The model evidently displays that the highest emphasis is put on skill competences (2 × strong + 22 × moderate), followed by emphasis on knowledge competences (1 × strong + 8 × moderate) and attitude competences (8 × moderate). In comparison to design models of other courses within the same curriculum (which are not included in this paper for lack of space), the Web Engineering course for instance had lower emphasis on promotion of team competences, while the Soft Skills course had higher emphasis. In Web Engineering, the focus is more on technical skills using web technologies, while in Soft Skills the focus is almost completely on teamwork and related interpersonal competences. The actual effect on competences in these courses as rated by students is presented in the next sub-section.

4.3 Course Evaluation

The Project Management course (and other courses of the study) was evaluated by means of a post-hoc questionnaire including rating-scale as well as open-ended items. As depicted in Figure 7, students indicated that in the Project Management course it was easier to work in teams and to establish positive interactions with each other than in other courses of the study. In an additional open-ended item they gave explanations for their judgments: "Very open atmosphere with a lot of talking and closer contact with the lecturers" — "It was very easy for me to establish relationships with the others because I was very interested in the subject and because the course matter was very well presented (one simply *had* to be active)" — "After completion of the theoretical part of the course we iteratively put it into practice, which promoted learning" — "By means of the relative free organization of teaching, by means of teamwork, by means of the pleasant atmosphere during the courses."

To find out whether students would judge Project Management to have more or less influence on team competences than other courses, additional items were included in the questionnaire. According to a Chi-Square test, students rated the perceived changes of their team knowledge, skill and attitude competences to be different for the courses considered (i.e., Soft Skills, Project Management and Web Engineering). As shown in Figure 8, students rated the perceived effect of the Soft Skills course on these competences as higher than the effect of Project Management and Web Engineering, respectively. This is congruent with the distribution of emphasis on team competences in the visual design models. In accordance with the visual model of the learning activities included in Project Management and their influence on team competences, the course's effect on attitude competences was rated lower than the effect on knowledge and the top-rated skill competences.

Figure 7 Teamwork in Project Management in comparison to other courses of the Computer Science study (scale: 1 = more difficult … 5 = easier; n = 15)

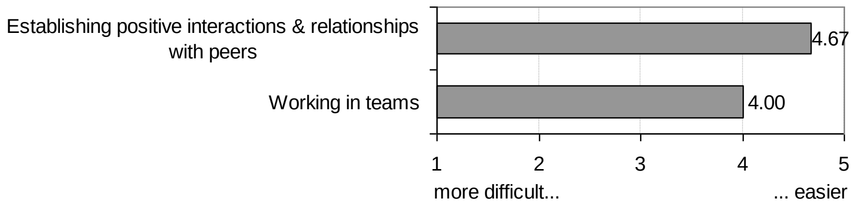
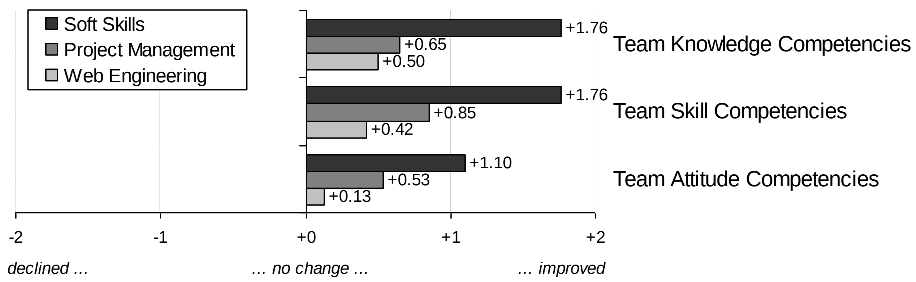


Figure 8 Promotion of team competences in Project Management (n=20)



Additionally we asked students to assess if the Project Management course enhanced specific team-related skills (31 items) on a 5-point scale. Results showed that group decision making was fostered most strongly, followed by communication and flexibility competences and interpersonal relation competences were fostered least. Data reveals that students rated the overall influence on team competences highest in the Soft Skills course; however, when asked about specific team skill competences like gathering and sharing information or reallocating tasks, students rated the Project Management course to have more effect. In particular, the Project Management course had positive effects on competences like identifying possible alternatives or considering different ways of doing things. These positive evaluation results could be traced back to modelled learning activities concerning planning techniques, project environment analysis and project controlling, which requested students to deal with several eventualities that could happen in and to a project team.

5 Summary and Outlook

In discussions on key qualities for job qualifications, team competences are frequently mentioned as important generic competences; correspondingly, the promotion of team competences is more and more demanded in study programs. Since the inclusion of team competences and cooperative learning is a tough challenge for teachers and designers, this paper proposed a novel approach to modelling cooperative learning and team competence promotion, which is intended to support the courses design process.

UML activity models were extended with simple visual icons to enable the modelling of hypotheses about how courses would promote team competences. Additionally the paper presented a case study, in which a complete course on Project Management was modelled and evaluated with respect to promotion of team competences. Visual modelling of the course made explicit which course elements were designed for promoting team knowledge, skill and attitude competences. Empirical quantitative and qualitative evaluation results reflected the hypothesised and modelled positive influence of the course on team skill competences. The perceived changes in competences as rated by students demonstrated that the promotion of team competences at different levels (knowledge, skills, and attitudes) as planned in the visual design model was achieved during runtime. Survey data showed that the course was successful in fostering students' team skill competences like identifying possible alternatives or considering different ways of doing things in a project team. Additionally, the case study illustrated the usefulness of employing visual models for identifying, planning and evaluating important learning activities.

Therefore, several possible contributions to the knowledge society, especially in the area of learning and education emerge from the research presented. Firstly, the process of modelling and testing hypotheses on competence and knowledge build-up supported by visual models can be transferred to a variety of teaching and training settings. There are several face-to-face as well as technology-enhanced learning scenarios besides the presented one, in which the concept can be used—for instance, in higher education as well as staff development. Secondly, the concept is not limited to the promotion of team competences, but could be generalised to address additional competences, since most learning activities include the levels of knowledge, skills and attitudes. While we acknowledge that planning for competence promotion can never immediately lead to actual effects, we point to the importance of thoughtful integration and planning of learning activities in today's knowledge society to support the creation, sharing and use of knowledge.

Acknowledgements

This research was supported by the University of Vienna through the projects "Technology-Enhanced Learning" (SP395001) and "E-Learning Umsetzung" (SP395002).

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