A Systematic Review of Developing Team Competencies in Information Systems Education

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ABSTRACT

The ability to work effectively in teams has been a key competence for information systems engineers for a long time. Gradually, more attention is being paid to developing this generic competence as part of academic curricula, resulting in two questions: how to best promote team competencies and how to implement team projects successfully. These questions are closely interwoven and need to be looked at together. To address these questions, this paper identifies relevant studies and approaches, best practices, and key findings in the field of information systems education and related fields such as computer science and business, and examines them together to develop a systematic framework. The framework is intended to categorize existing research on teams and team competencies in information systems education and to guide information systems educators in supporting teamwork and promoting team competencies in students at the course and curricular level in the context of teaching in tertiary education.

Keywords: Team Competencies, Team Projects, Curriculum Development, Information Systems Education

1. INTRODUCTION

From the start, working in a team was an essential part of information systems (IS) development; as early as 1971, Gerald Weinberg (1998) addressed programming as a team effort. Many tasks in the field of information and computer science can be characterized as conjunctive and divisible and therefore are best suited to being conducted in teams. For example, systems development is a team activity since information systems offer high complexity and time schedules do not allow individual work (Humphrey, 2000b, p. 3). Team competencies are a main factor for team performance in a work environment (Cannon-Bowers et al., 1995). As recent studies have confirmed, team task skills—including the ability to work effectively in a team—moderate the effect of application and development skills on the performance of IS projects (Chien-Lung, Jiang and Klein, 2008).

Therefore, it is not sufficient for IS graduates to be technically competent. Social competence, in particular teamwork and communication, are also essential. Academic education in IS should prepare students to work effectively in teams and foster collaborative skills necessary in the workplace. The demand to include the promotion of team competencies in IS curricula is expressed by stakeholders with an interest in the design of IS curriculum—IS faculty and university departments, accrediting agents (e.g., ABET [Accreditation Board for Engineering and Technology]), Business and IT professionals, and recruiters, as well as students (Downey, McMurtrey and Zeltmann, 2008). The critical skills of IS professionals such as team competencies should drive the development of an IS curriculum (Downey, McMurtrey and Zeltmann, 2008). Since teams are used widely in information system development (Slyke, Trimmer and Kittner, 1999), information technology firms want employees to be able to work efficiently in teams (Kabicher, Motschnig-Pitrik and Figl, 2009).

Universities have reacted to the demand for team competencies in professional life and include team competencies, often characterized as transferable/generic skills, as educational objectives in their IS curricula. The IS Model Curriculum 2010 views team competencies as abilities that have been important for the IS profession for a long time and should be integrated into a curriculum. It states that, "IS professionals must exhibit strong ethical principles and have good interpersonal communication and team skills" (Topi et al., 2010, p. 370).

Although curricula have integrated team competencies as an important learning outcome, existing programs still lack a substantial effort to include the promotion of team competencies. According to a literature review on gaps in IS curricula and the importance of skills according to the viewpoints of different stakeholders, Surendra and Denton (2009) conclude that practitioners value interpersonal skills more than academics and suggest the increased inclusion of communication and team skills in IS curricula. Also, related studies such as engineering and computer science still provide too little formal team training (Adams, 2003).

Despite increasing consciousness about the need to consider team competencies in IS education, there are very

few research papers that directly address strategies for including these competencies in the IS curricula. Existing literature often either focuses on the description of specific interventions in single courses that have been proven to be effective in promoting students' team competencies or on how to promote generic skills in curricula in general. To fill this gap and to provide an overview of isolated approaches to promoting team competencies, this paper seeks to combine and review existing literature.

The remainder of this paper proceeds as follows: the paper commences with a definition of team competencies. Then it presents a systematic framework of possibilities for promoting and training teamwork competencies in IS studies. The utility of the framework is demonstrated by using it to summarize existing work on promoting teams and team competencies in IS education. Since team projects are the main way to foster these competencies, but only if thoughtfully implemented, the paper will summarize and integrate important findings on how to best include them in IS courses. An overview of approaches for the promotion of team competencies in IS courses, derived from close disciplines such as computer science and business education will be given.

2. TEAMWORK COMPETENCIES

Since the understanding of necessary competencies underlying teamwork is important for the creation and assessment of training (Cannon-Bowers et al., 1995), a clear definition of the competencies required will be given before discussing possibilities for promoting team competencies.

Team competencies at the individual level are the characteristics that a team member has to have to successfully engage in teamwork (D. P. Baker et al., 2005). They are team-generic, held by individuals, and can be transported to other teams.

As depicted in Table 1, team competencies cannot only be characterized in relation to teams, but also in relation to tasks. Task-generic team competencies are transportable to other tasks, e.g., interpersonal or communication skills. For IS curricula, team-generic, task-contingent and transportable team competencies are especially relevant, since graduates may apply for jobs in different companies and have to work within different teams in their job. Examples for important task-contingent team competencies, which can be developed in IS studies, are project management skills or knowing specific role responsibilities in a development or IT integration team.

		Relation to task	
		Specific	**Generic**
Relation to team	**Specific**	Context-driven	Team-contingent
	Generic	Task-contingent	Transportable

Table 1: Types of Team Competencies (Cannon-Bowers et al., 1995, p. 339)

Similar to competencies in general, which include "knowing and understanding (theoretical knowledge…), knowing how to act (… application of knowledge to certain situations), knowing how to be (values as an integral element of the way of perceiving and living with others in a social context)" (Tuning management committee, 2006, p. 20), team competencies can also broken down to knowledge, attitude, and skill competencies (Cannon-Bowers et al., 1995).

Team skill competencies refer to the "capacity to interact with other team members" (D. P. Baker et al., 2005, p. 236) and studies show that they are positively related to team effectiveness (Cannon-Bowers et al., 1995, p. 348). Attempts to extract major sub-skills (Cannon-Bowers et al., 1995, p. 343) lead to the following skills: group decision making/planning, adaptability/flexibility, and interpersonal relations. Communication competencies form the basis of the other three core skills because listening effectively or asking questions, for example, are preconditions for making decisions in a team. Team knowledge competencies include mental models about how and when to use the teamwork skill competencies described above (D. P. Baker et al., 2005, p. 239). In team situations, team members have to choose from several behavioural alternatives and to judge which alternatives are the most appropriate. Research results reveal that knowledge competencies are related to individual performance in team settings (Morgeson, Reider and Campion, 2005). Additionally, there are two main team attitude competencies, "the belief that teamwork is critical for successful performance of team tasks," and as collective orientation, "an attraction to, or desire to be part of, a team" (D. P. Baker et al., 2005, p. 239). Team attitude competencies are especially important since they influence whether teamwork skills are put into practice (D. P. Baker et al., 2005, p. 246). Team members' preference for working in teams and positive attitudes toward teamwork are positively related to better team processes and higher team performance (Campion, Medsker and Higgs, 1993).

3. OVERVIEW OF POSSIBILITIES FOR PROMOTING TEAM COMPETENCIES IN IS CURRICULA

The previous section defined team competencies. This section proposes a systematic framework for better understanding how to train and promote team competencies in IS education. Team competencies training in general can be defined as, "an instructional system in which individuals enhance knowledge, skills, and attitudes that, applied in a team context, result in improved team effectiveness" (Ruiz and Adams, 2005).

A search on the relevant literature was conducted to review previous research in supporting teams and promoting team competencies in IS courses and to cover related subjects such as business and computer science. This was done via keyword search using ERIC, by retrieving secondary citations and searching relevant journals (e.g., *Journal of Information Systems Education*, *Journal of Information Technology Education*, *Journal of Management Education*). The search was restricted to papers in English. The key terms used were: "team competence," "team competencies," "teams," and "teaming," in combination with "development" and "promotion." More than 100 papers from journals and conference proceedings were selected and included. This may not be exhaustive, but it covered the research field comprehensively. Further literature on teams, team training, measuring team competencies, and collaborative learning in general was included to provide a

cumulative body of related knowledge. This integration of ideas from multiple disciplines as well as different research streams and fields helps identify efficient approaches and strategies for team competencies promotion in IS education.

Based on the literature review, the core concepts were synthesized into the "Team Competencies Promotion" framework depicted in Figure 1. It gives an overview of the main strategies used to prepare students to work in teams within IS curricula. In the framework, activities for supporting teamwork and team competencies are modelled according to the intensity of team competence promotion. Subsequent sections will detail how promotion can take place on each of these levels:

- Course level
  - Thoughtfully including team projects in courses
  - Direct promotion of team competencies (in compulsory or optional subjects)
- Instructor level: training for course instructors
- Curriculum level
  - Alignment of courses employing teamwork
  - Decision on the appropriateness of teamwork for courses

There is a variety of concrete activities reported in the literature that instructors can use to promote team projects and to include team competencies training in class. As illustrated in Figure 1, the promotion of team competencies in courses varies according to the intensity of the training. The intensity can be characterized as a continuum from courses solely employing team projects without any further support (regular team project) to courses in which team projects are well introduced and coached with team building activities, reflection and feedback (in-depth support of team projects), to courses that promote interpersonal and team competencies via specific training activities and theoretical input ([additional] team competencies training). For a stronger promotion of competencies, more course time, experience, and training is needed when coaching teams.

The framework also categorizes activities along the course timeline, starting with activities such as building teams in the beginning of the course to activities such as assessment of teamwork during and in the end of the course. Courses including in-depth support of team projects as an add-on also should include all activities of the lowest level (regular team project), that are always relevant for supporting team projects such as dealing with social loafing. Team competencies training may either be an add-on for a course with a team project or could be of another format (e.g., lecture-based input and exercises only). Additionally, an evaluation of the effect of the team competencies training can be included in courses to ensure positive effects on students' team competencies.

The following section will provide a cumulative body of knowledge and research results for each of those activities. The first two levels, regular team projects and in-depth support of team projects, will be described together, since they follow the timeline of a team project in a course.

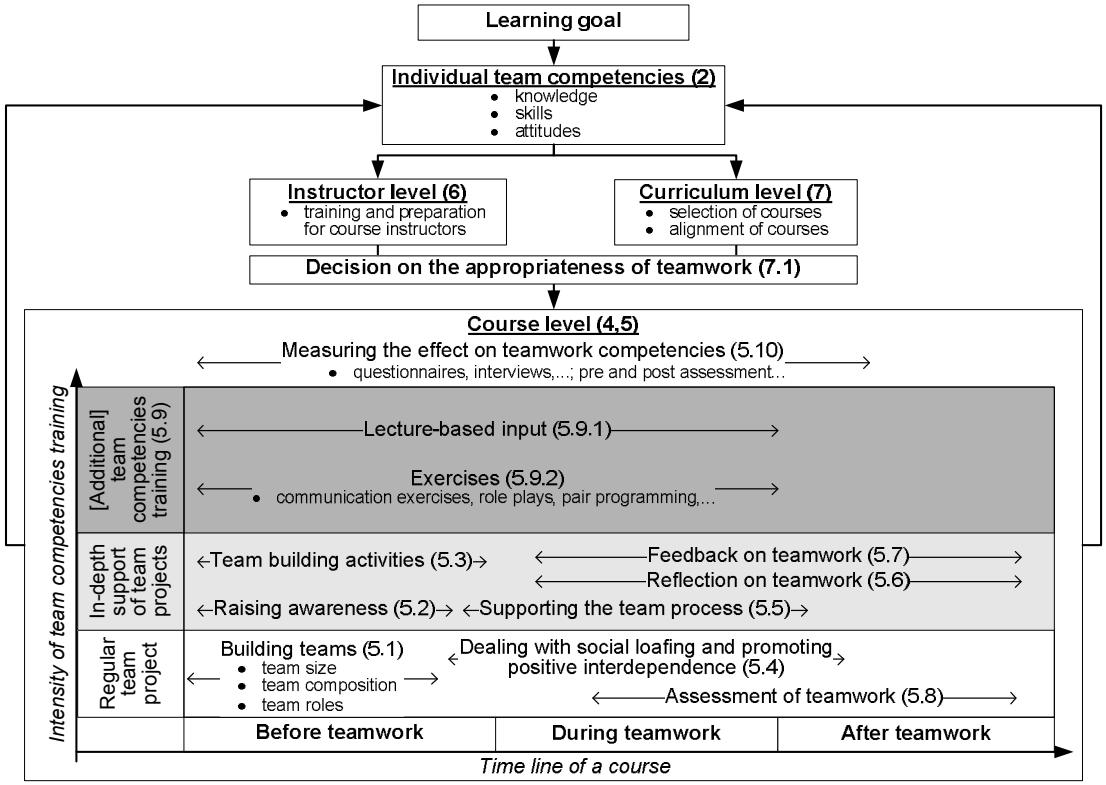

Figure 1: "Team Competencies Promotion" Framework (Numbers in brackets refer to relevant sections in the paper)

4. COURSE LEVEL: BACKGROUND

4.1 The importance of team projects in IS education

Researching the use of teamwork in IS education is especially relevant, because this teaching and learning method is very common in comparison to other studies because, "most courses in systems analysis and design and many programming courses require students to work on group projects" (Wells, 2002). Team projects are especially appropriate for IS courses, since knowledge is applied to complex and unstructured tasks (LeJeune, 2003). In software engineering, team projects are a common practice and have been implemented for a long time.

The prevalence of team projects in IS education is also demonstrated by the large amount of case studies and best practices showing how to use teamwork in a variety of IS courses such as IS and decision support courses (Fellers, 1996), database management systems, and IS analysis and design (Nance, 2000; Poindexter, Basu and Kurncz, 2001; Slyke, Trimmer and Kittner, 1999), e-commerce (Ngai, 2007), introductory programming (McKinney and Denton, 2006), introduction to computer science (Daigle, Doran and Pardue, 1996; LeJeune, 2003) and software engineering (Bielikova and Navr, 2005; Hilburn, 2000; Hogan and Thomas, 2005; Tadayon, 2004; Turhan and Bener, 2007).

4.2 Basics of team projects and their positive effects

Team projects can be looked at in the broader context of cooperative learning, defined as "the instructional use of small groups so that students work together to maximize their own and each other's learning" (D. Johnson, Johnson and Smith, 1991b, p. 3). Team projects are characterized as a formal cooperative learning method in which the course instructor has to formulate instructional learning objectives, decide on the group size, and choose a method for assigning students to teams and roles (D. Johnson and Johnson, 2006, p. 480). According to literature on teams-in-work contexts, teams are usually defined by four criteria: "two or more individuals, shared or common goals, task interdependency, desired productive outcome" (D. P. Baker et al., 2005). The underpinnings of cooperative learning used in education and teamwork in professional settings are similar, because both concepts have several elements in common such as member interdependency, a common goal, dynamic exchange of information, and coordination of tasks and team member roles (Prichard, Bizo and Stratford, 2006, p. 120). Although a comparative review of teamwork and cooperative learning literature reveals many similarities, there is little scientific attempt to bring these concepts together (Prichard, Bizo and Stratford, 2006, p. 121).

Felder and Brent (2003) suggest using cooperative learning and problem-based learning to satisfy the ABET criteria for curricula. Studies indicate a variety of positive effects of team projects; they were found to enhance the promotion of social competencies such as communicating effectively and managing conflicts more than with individual learning (DuFrene and Lehman, 1996). Further positive effects are fewer dropouts—especially at the beginning of the studies—because they contribute to the students' sense of belonging and feeling of security (Seymour and Hewitt, 1997), as well as positive effects on student achievements in comparison to competitive and individualistic efforts (D. Johnson, Johnson and Stanne, 2000) and attitudes toward subject matter, self-esteem, and motivation (Springer, Stanne and Donovan, 1999). Students also appreciate the relevance of team projects in IS courses to situations in work life.

Wilson, Hoskin and Nosek's (1993) experiment in collaborative programming showed that the collaboration among students enhanced problem-solving and enjoyment of the task. Research in the area of data flow diagramming suggests that novice learners learn better in cooperative teams than alone (Powell, Bordoloi and Ryan, 2007). However, cooperative learning does not necessarily have a positive impact on individual learning, as shown by Wehrs (2002) in an introductory IS course. It is important to develop core competencies on an individual basis.

4.3 Team projects as training for team competencies

Working in teams allows students to realize the benefits of teamwork but negative experiences with teamwork, especially with social loafing, can undermine students' attitudes toward working in teams (Ruiz and Adams, 2005; Venter and Blignaut, 1998). For example, students often complain about coordination problems, social loafing, and team conflicts in teamwork (Slyke, Trimmer and Kittner, 1999). If teamwork is not well managed, negative experiences can discourage students from teamwork, create negative attitudes toward teamwork (Ulloa and Adams, 2004), and may contribute to poor team performance in later employment. Therefore, negative experiences should be avoided (Buckenmyer, 2000).

In comparison to teamwork in work settings, at university there is a lack of continuity concerning the teaming process (Adams, 2003). Teams in a specific course usually last only one term; therefore, there is little time for team forming and building of personal relationships which is possible for teams in work organizations.

Incorporating teams in courses and supporting students in overcoming team-related problems are complex tasks. Students' negative experiences could be avoided to some degree by using appropriate instructional strategies for incorporating teamwork in class as outlined in the next sections.

The general goal of supporting teams is "effective teaming" characterized by mature communication, clear roles, and productive conflict resolution (Ulloa and Adams, 2004). Or as put by R. Johnson and Johnson (1994), for efficient teamwork it is important that students "1) get to know and trust each other, 2) communicate accurately and unambiguously, 3) accept and support each other, and 4) resolve conflict constructively." From the IS students' point of view, the quality of communication (attending team meetings, responding to mails) and balance of member contribution are major factors for teamwork quality (Napier and Johnson, 2007).

A conceptual model for facilitating teamwork in engineering classes was proposed by Adams (2003; 2002) as in Figure 2. It includes training before working in teams and monitoring by instructors as well as pre- and post-assessment to measure the effect of the team training.

Transfer of learning from team projects to later work teams is more likely to take place if students perceive team competencies as relevant, opportunities for practice and feedback are given, and generalization is possible due to

identical elements of team projects and later work teams (Ettington and Camp, 2002).

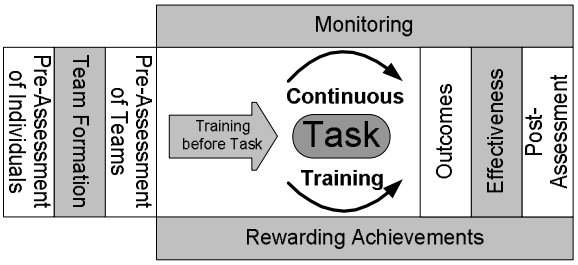

Figure 2: Model for the Development and Facilitation of Effective Teaming (Adams and Okudan, 2003, p. 11)

5. COURSE LEVEL: ACTIVITIES FOR PROMOTING TEAMS AND TEAM COMPETENCIES

5.1 Building teams for team projects

5.1.1 Team size: Deciding on the size of groups is one of the main pre-instructional decisions for team projects. A typical range is two to four students, although there is no ideal size (D. Johnson and Johnson, 2006, p. 481). Adams (2003) recommends three to five students per team. According to Wells (2002), it is important to keep team sizes under five, so all team members can be involved with all parts of the team project. The task type is a main factor for choosing an appropriate team size. A bigger group has more resources (knowledge, skills, time…) and can work on projects with a higher workload, but coordination and reaching agreements is more difficult. Lower-achieving students that participate less than others can benefit more from smaller teams by means of increased participation and collaboration. Additionally, the visibility of each student's effort is higher in smaller groups.

5.1.2 Team composition: Another pre-instructional decision of the instructor is the assignment of students to groups. Generally, team members can be assigned by faculty or by self-selection of students. Research on this decision is contradictory; some suggest team assignment by faculty because it resembles the realistic scenario of work life or because students are likely to choose friends in self-selection, which may be less efficient because it is more difficult to be tough with friends (Adams, 2003). On the other hand, students mostly prefer self-selection and report better team experiences when self-selecting their team members (Bacon, Stewart and Silver, 1999). If choosing team colleagues, friendliness, dependability, and desired grade are important attributes for students (Connerley and Mael, 2001).

Methods for team assignment by faculty include random methods and the use of personality tests such as Myers-Briggs or Kolb learning styles, or variables such as team experience, work schedules, or academic performance, so that stronger and weaker students are in teams together (Adams, 2003). One of the most studied variables in the field of team composition is heterogeneity in learning styles, interests, skills, expertise, task orientations, gender, team attitudes and styles.

From a socio-constructivist point of view, symmetrical groups may generate socio-cognitive conflict and learning if their members have similar knowledge but different points of view. From a socio-cultural point of view, it would be better for group members to have different levels of knowledge so internalization and learning can arise (Dillenbourg et al., 1996, p. 9). In general, it is more difficult for low achievers to benefit from team projects than for high achievers, because they are more likely to be passive, especially if they are in a team with high achievers (Mulryan, 1992). Wells (2002) proposes building student teams in IS courses similar to the "chief programmer teams" of Baker and Mills (1979). In these teams, there should be one experienced student with high programming skills and work experience guiding his/her less skilled team members.

Studies show that diversity of personality measured by the Keirsey-Bates Temperament Sorter (Keirsey and Bates, 1984) correlates positively with the success of student software engineering teams (Pieterse, Kourie and Sonnekus, 2006). On the other hand, personality diversity also can lead to team conflict as shown with information system development teams (Trimmer, Domino and Blanton, 2002). Nonetheless, those inventories can help to create balanced teams with respect to strengths and weaknesses; knowledge of team members' personalities may lead to better understanding and may be used to manage the team process (Clinebell and Stecher, 2003).

Computer programs can help the instructor to assign students to teams and may include variables such as time preferences, work experience, and project preferences (e.g. Redmond, 2001).

5.1.3 Team roles: Assigning roles to students can help to ensure interdependence among team members (D. Johnson and Johnson, 2006, p. 484). Moreover, providing roles and responsibilities for student teams corresponds to the job environment. Mennecke and Bradley (1997) showed, with respect to teams in IS classes, that structuring student team roles leads to higher team cohesion and higher quality of student output. Felder and Brent (2003) use rotating roles (e.g. coordinator, group process monitor) so each member can experience and learn from different roles. Similarly, Adams (2003) describes roles for supporting the process of team projects (Time Keeper, Encourager, and Devil's Advocate). For design courses, Felder and Brent (2003) recommend these roles: process or product designer, process analyst, process engineer, and economic analyst. Online tools that enable students to assess their generic skills with a questionnaire and receive a recommendation of which team role to take can be helpful (as presented by McMahon, Luca and John (2007) in a multimedia course).

5.2 Raising awareness

Even at the beginning of a course, students have a long learning and experience history and their level of team competencies vary greatly. Students should be made aware of the level of team competencies they hold and about areas in which there is room for improvement (Nüesch, Wilbers and Zellweger, 2006), building a base for further promotive actions. Since students are not always open-minded toward interventions, the importance of teamwork in the IS field should be illustrated.

5.3 Team building activities

Team building activities before teamwork can support cooperative behaviour (Ruiz and Adams, 2005). For example, team charters can be used to specify ground rules for interaction (Bolton, 1999). Team members may work out and write down a code of cooperation including norms of interaction with each other to accomplish the given tasks.

5.4 Dealing with social loafing and promoting positive interdependence

Free-riding and coordination problems are often mentioned by students as arguments against teamwork during studies. There are studies showing that students prefer individual work because their individual effort is recognized more strongly than in teamwork—this is even more likely if students did not receive training before teamwork (Ulloa and Adams, 2004).

If individual efforts cannot be evaluated or distinguished from others' efforts, social inhibition or loafing and free-riding can occur, implying that motivation and effort are reduced. According to the collective effort model (Karau and Williams, 1993), social loafing occurs because the links between effort, higher performance, and desired awards are not as direct as when working alone. Additionally, social loafing/free-riding may be supported when it is difficult to identify single contributions, team cohesion is low, and redundant efforts are likely.

There are several strategies to reduce social loafing such as using appropriate evaluation methods, identifying individual effort of team members, increasing the perceived value of the task, regarding individual contributions as unique and important, and strengthening group cohesiveness and individual commitment (Baron and Byrne, 1997, pp. 447-448). Bailey et al. (2005) propose a governance device, the "signatory code," to determine whether a team member may get credit for an assignment, including voting procedures or peer evaluations.

Additionally, ensuring individual accountability and positive interdependence between team members may diminish social loafing and enhance teamwork. Personal responsibility—feeling responsible for contributing an equal share to achieve common goals—can be fostered by smaller group sizes and assigning roles. There are several ways to structure positive interdependence: positive goal, reward, resource (each member has only a part of the resources and information needed) and role interdependence (R. Johnson and Johnson, 1994). Positive interdependence leads to a joint effort, a low amount of free-riding, sharing, and mutual support, since students "perceive that they are linked with group mates in such a way that they cannot succeed unless their group mates do" (R. Johnson and Johnson, 1994).

5.5 Supporting the team process

To effectively include teamwork in class, the process level of teamwork has to be taken into account (Nüesch, Wilbers and Zellweger, p. 8). Team processes can be defined as "intragroup and intergroup actions that transform resources into a product" (Gladstein, 1984). The Introductory Team Software Process (TSPi) (Humphrey, 2000a) describes the process for semester-long team projects in software engineering courses and provides instructions for instructors, forms, and scripts (Carnegie Mellon University, 2008). TSPi includes two main components: team building in the beginning of the course (roles, definition of goals) and teamwork during the course (planning, coordination, communication, and handling conflicts). Several case studies give examples of how to use TSPi in class (Hilburn, 2000; Tadayon, 2004).

Teams change as the semester progresses. This change can be explained with recurring-phase theories and sequential-stage theories (D. Johnson and Johnson, 2006, pp. 27-28). For example, Tuckman's sequential-stage theory includes five stages of team development: forming, storming, norming, performing, and adjourning (Tuckman and Jensen, 1977). Sullivan, Knight, and Carlson (2002) describe how teams can be mentored in each of these team building stages in courses such as invention and innovation. Bacon et al. (1999) found that improved team experiences are linked with team longevity, or in other words working together for a whole term in combination with adequate descriptions of outcomes of the team project.

As work on the tasks starts, instructors should monitor teamwork, observe team dynamics, and the development and attitudes of team members (Adams, 2003). Although monitoring and assisting teams and their learning process is important, the goal is to place the responsibility for developing and using team competencies on students.

Finally, instructors can reward demonstrations of team achievement, such as meeting major deadlines, in the form of certificates or verbal acknowledgements (Adams and Okudan, 2003, p. 5).

5.6 Reflection of teamwork

Instructors may plan some time for reflection during and at the end of a course to ensure effective teamwork and positive relationships between team members, provide feedback to individual members, and promote the learning of team competencies and social skills (R. Johnson and Johnson, 1994). Reflecting on an individual's behaviour on the team and about goal attainment can help students to reach conclusions for future teamwork and enhance their own repertoire of team-related strategies.

Reflection can be defined as "the process of internally examining and exploring an issue of concern, triggered by an experience…which results in a changed conceptual perspective" (Boyd and Fales, 1983, p. 99). Reflection-in-action would take place while teamwork is in process and reflection-on-action afterward (Schön, 1983). It is crucial for effective teamwork for teams to reflect on their actions, identify helpful actions of members, and clarify whether coordination and working together is going well or should be changed. According to the Team-Reflexivity-Model (West, 1994), fully functioning teams show high task and social reflexivity. The dimension of social reflexivity concerns the team's ability to promote the well-being of its members; it includes social support and conflict resolution. Task reflexivity can be described as "the extent to which team members overtly reflect upon the group's objectives, strategies, and processes and adapt them to current or anticipated endogenous or environmental circumstances" (West, 1996, p. 559). Team reflexivity, especially task reflexivity, is positively related to team effectiveness and efficiency (Hoegl and Parboteeah, 2006; Schippers, Den Hartog and Koopman, 2007). Onyett (2008) uses "events

that occur as learning opportunities" for developing team reflexivity. A team's reflection on events such as team successes, mistakes, conflicts, member and organizational changes, or new tasks can improve task and social reflexivity. Reflection on the team process also can promote the transfer of one team situation to the next (Bolton, 1999).

Guided reflective writing within team projects helped students to understand the reasons for unsuccessful team dynamics and decision processes and improved self-awareness as a team member (Wills and Clerkin, 2009). Brown and Dobbie (1999) asked students in a software engineering course to write an essay about what they learned from teamwork and students could read essays from students of former semesters and profit from these experiences. Similarly Wills and Clerkin (2009) used reflective writing in a business strategy course and Lewis (1998) proposes keeping a journal throughout the teaming experience.

For reflecting on team processes, communication and collaboration during and after teamwork e-portfolios can be useful (Jafari and Kaufman, 2006). Paretti (2004) presents a case study of the use of e-portfolio for assessing and reflecting communication skills in engineering education.

5.7 Feedback on teamwork

Team projects in class can be compared to practice-based team training in the form of behaviour modelling training. The behaviour modelling training approach first presents behaviours and skills and then facilitates practice and feedback. Trainees can practice skills in the training setting and learn from the trainers' feedback. In a meta-study, Taylor, Russ-Eft, and Chan (2005) found positive effects of behaviour modelling training on team skills. Instructors can give feedback on a team-level and teammates can provide feedback for individual team members in a peer-review. Since students may be reticent to give direct feedback, worksheets can be used for this purpose (Bolton, 1999). Cortez et al. (2009) describes how students can give each other immediate feedback on teamwork skills in team situations using wireless handheld devices.

5.8 Assessment of teamwork

Similar grading of team members may not always be fair, especially if team members made varying contributions. Motivated students may be discouraged if they get a low grade because of a badly performing team or the same grade as "free-riders" within their team. There are several strategies and proposals for fair grading of teamwork (Hazzan, 2003; Wilkins and Lawhead, 2000), including individual effort analysis with students' weblogs, self evaluation, tests to ensure that students know about their team projects, presentations by each team member, or cross-validation with individual work (Hayes, Lethbridge and Port, 2003). Confidential or open peer-review regarding team contribution is another possibility (Smarkusky et al., 2005, p. 463). Willcoxson (2006) describes using a combination of team and self-evaluation to determine individual input into team processes, management, and resourcing of the project. A good solution for keep students from protecting one another is to let them assign individual contribution points to their colleagues so they do not have to identify bad team members, but can provide an assessment of the quality and quantity of the contribution and an ordering/ranking of individual efforts (Hayes, Lethbridge and Port, 2003, p. 625).

5.9 Additional team competencies training

Team projects can help prepare students for working in teams. Nevertheless, requiring students to work in teams should not be the only way to promote team competencies. There are several more ways to improve teamwork competencies, as this section will demonstrate.

Educational researchers recommend including explicit transfer of knowledge about teamwork, reflection on team processes, promotion of a constructive attitude toward teamwork, and training of team skills in curricula (Nüesch, Wilbers and Zellweger, p. 6). Empirical research shows that training in team skills before collaborative learning may enhance teamwork and have a positive effect on team interaction and on learning outcomes (Prichard, Bizo and Stratford, 2006; Prichard, Stratford and Bizo, 2006). Trained teams may manage their time better and member participation may be more balanced.

Explicit training can be implemented before a team project in a course or complement it during the team's work (Ruiz and Adams, 2005). Going back to curricular design for promoting team competencies, another possibility would be to include courses that focus explicitly on team training.

5.9.1 Lecture-based input: Lecturing on team-relevant knowledge can have a greater impact on students' team knowledge than teamwork experience without lectures (Smarkusky et al., 2005). Learning about relevant factors of teamwork, processes, and effectiveness may "prepare team members for managing their own team process and be able to define and apply strategies that allow them to deal with those factors affecting team effectiveness" (Ulloa and Adams, 2004). Before working in a team, the transfer of knowledge concerning elements for effective teamwork (e.g., knowing about the free-rider effect and how to deal with it) and using appropriate strategies for supporting the team process (team building, role allocation, setting goals, time planning, task assignment) is reasonable (Nüesch, Wilbers and Zellweger, p. 9).

Adams (2003) recommends the following topics to train engineering students to work in teams: "1. Roles and responsibilities, 2. Norms, 3. Goal specification and setting, 4. Effective meetings, 5. Communication and listening techniques, 6. Conflict resolution, 7. Techniques for team processing, 8. Performance expectations." Other examples of relevant topics for lecture-based input in IS courses (Brown and Dobbie, 1999; Smarkusky et al., 2005; Ulloa and Adams, 2004) are outlined in Section 5.11.

5.9.2 Exercises: For team communication and coordination exercises there exists a variety of training publications and course materials for higher education in general and for IS and computer science education in particular (e.g. Smarkusky et al., 2005; Ulloa and Adams, 2004). Therefore, this paper describes only a few exemplary exercises that were implemented and evaluated in IS courses.

Icebreaker games: Socializing games such as constellation (students are asked to choose a place to stand in the classroom according to their answers to questions asked by the instructor such as length of study, experience with a

topic) can be used to break the ice and create exchange in the beginning of a class (Figl, Derntl and Kabicher, 2009).

Communicating requirements: Wells (2002, p. 10) describes the use of the "tinkertoy game" in IS courses as an ice-breaking exercise at the beginning of the team's work and for training communication skills. In this exercise, communication between typical users, analysts, and programmers is simulated. Student groups have to construct a target model, but only the "users" actually see the target model; they explain it to the "system analysts" who explain it to the "programmers." This exercise helps students see how important it is to understand the user's point of view before constructing, recognize that communicating requirements is difficult, and realize that analysis and drawing system models can support communication between users, system analysts, and programmers.

Active listening: Bauer and Figl (2010) describe an exercise in active listening to improve IS students' communication skills via several media. In this exercise, the students were organised into groups of three. One student told a story, one student listened "actively," and the third student had the role of the observer. The "felt-experience" is another exercise for deepening mutual understanding (Dugal and Eriksen, 2004) because students engage in a dialogue on the meaning of a quote.

Role plays: Employing in-class role-plays can be a good way to train team communication skills and factual knowledge (e.g., project management or software engineering) simultaneously. Tyson and LaFrance's role-plays (2006, p. 36) demonstrate problems with team member turnover or teach risk assessment, reviews, and status project review meetings. In a requirements elicitation role-play, students are assigned the roles of developers and focus group members/costumers (S. L. Sullivan, 1993). Further role-plays can be found for teaching object-oriented concepts (Steven and David, 2002).

Pair-programming: In pair programming, one student programs while the other student tries to maintain a global view of the program and gives advice. Pair-programming is another possibility for fostering communication skills for programming situations in IS classes and may help to reduce student's frustration while programming (Howard, 2005).

5.10 Measuring the effect of interventions on teamwork competencies

The assessment of students' team competencies is necessary to evaluate the influence of team training in courses. A pre-assessment of individual and team attitudes, skills, and experiences in teamwork will provide a baseline for training and comparison with a post-assessment (Adams, Ruiz-Ulloa and Pereira, 2002). In a needs assessment phase prior to training, individual team competency deficiencies are evaluated to select specific objectives and methods for the training program (Ulloa and Adams, 2004). Additionally, measures of team competencies can be used to assist with grading or monitoring team competencies and to provide feedback to students.

Team competencies are difficult to measure compared to other team-related variables because "they are not readily quantifiable, as are team inputs and outputs" (D. P. Baker and Salas, 1992, p. 369). Assessment centre techniques offer direct insights into the behaviour of individuals in team situations, but are costly and time-consuming. Other possibilities for measuring team competencies are structured interviews, situational judgment tests, or questionnaires. Halfhill and Nielsen (2007) suggest using self-reports and peer ratings from teammates to quantify teamwork competencies and their improvement. They also suggest providing questionnaires on teamwork competencies and meeting management skills for this purpose. An evaluation form was constructed by Schlimmer, Fletcher and Hermens (1994) for a similar purpose. Smith and Smarkusky (2005) describe competency matrices for peer assessment of the team process, knowledge, and skills in project-based courses. Students can rate their colleagues according to the competency matrix (including dimensions of process, interaction, contribution, and responsibility), giving examples to students.

Questionnaires are the most frequently used method for assessing teamwork competencies. A general problem with questionnaires about teamwork competencies is that they are forgeable to a certain degree and may lead to socially desirable answers. Individuals may fill out a personality-based questionnaire describing themselves as good team players even if they are not. Knowledge-oriented questionnaires are hard to construct because it may be too easy to recognize the correct solution, and knowing how to behave in a certain situation does not necessarily lead to carrying out the appropriate behaviour (D. P. Baker et al., 2005).

Examples for existing questionnaires are the Knowledge, Skills and Abilities Test for effective teamwork (Stevens and Campion, 1994), a situational judgment test, and the ALL Teamwork Framework (D. P. Baker et al., 2005), which includes a test for measuring knowledge and attitudes toward teamwork.

5.11 Evaluative studies on the effectiveness of team competencies training

In the work context a variety of studies prove that team training can be effective and leads to improved team performance (Salas, 2001; Stout, Salas and Fowlkes, 1997). The effects on affective outcomes (such as improved attitudes of participants, satisfaction, and team cohesion) are especially consistent and studies show that link more convincingly than the link to team members' behaviours (Woodman and Sherwood, 1980, p. 182).

Even though there are many case studies on how to prepare IS students to work cooperatively and how to promote team competencies in courses, only a few include measurement and evaluation of the interventions. Examples show that in most case studies a variety of training methods and activities are mixed and their overall effect is measured mostly with self-constructed questionnaires and student reflections.

Since different evaluation methods were used and the constructs measured were not explicitly defined, the results of the studies are hard to compare. From the nine studies examined, four authors reported an enhancement of team skill competencies and one an improvement in team attitude competencies.

McKinney and Denton (2006) researched the promotion of team competencies in a programming course. The course included instructor-chosen teams according to grades,

instruction, reflection on team skills, peer evaluations, and feedback on team performance provided by the instructor. The study confirmed that this kind of team promotion led to a development of students' team skills (McKinney and Denton, 2006, p. 141).

Pimmel (2003) described how group assignments in a computer architecture and design course can be converted into team projects. He included team training, monitoring of the team process by the instructor, and reflection on the process. Evaluation results showed improvement in the students' team skills and their attitude toward teaming.

Smarkusky et al. (2005) integrated team knowledge modules on time management, team building, team roles and responsibilities, team communication, team contracts, team dynamics, meeting processes, team problem solving and peer evaluation in two consecutive software engineering courses. Results indicated that students with formal team training had higher scores in a team knowledge test than students who only experienced teamwork without training (Smarkusky et al., 2005, p. 464).

A framework proposed by Hogan and Thomas (2005) describes how to improve teamwork competencies in software engineering. It uses, among other things, templates for time management and meetings, assigning the most experienced students to different teams and peer assessment. Qualitative students' reflections showed improvements in student communication, time management, and cooperation skills.

Brown and Dobbie (1999) supported their teams in a software engineering course using tutorials on team processes (setting goals, time management, communicating, managing documents, roles). They measured the effect of their intervention only on a team-level. The results indicated that teams were good at coordinating tasks and maintaining team spirit.

Mennecke, Bradley and McLeod (1998) included role assignment and group process training in six training sessions in IS business courses. They reported higher team cohesion, better team performance, and less negative social behaviour for the group with this treatment.

Slyke, Trimmer and Kittner (1999) taught team knowledge, skill, and abilities in an course on IS. On one side, they included a lecture and discussion session on the importance of teamwork and gave students handouts related to teamwork. On the other side, they used in-class collaborative exercises and "real-life" team projects monitored by instructors in which students had to build systems (analysis, design and prototype implementation). Students perceived team performance as higher due to intervention, but there was no change in the students' team attitudes.

The Effective Team Player (ETP)—Team Training program (TP) covers themes such as why teams are important in engineering, the differences between groups and teams, effective teams, team development and its barriers (e.g., task structure, missing communication skills, social loafing, conflicts), effective teaming and team processes, and when to use individuals versus teamwork (Ulloa and Adams, 2004). The ETP Team Training program (Ulloa and Adams, 2004) was included and evaluated in an engineering management course. Evaluation results showed that students gained a better understanding of real teams and being a team member (Ulloa and Adams, 2004). Students reported that the training would help them in future team situations because it improved their team skills.

In the context of the framework presented, the author investigated the influence of four courses (Web engineering, project management, soft skills, and person centered communication) on students' team competencies via online questionnaires and qualitative interviews over a period of three years. The courses were selected from an IS and computer science curriculum in order to resemble different intensities of team competencies training as proposed by the framework. Preliminary results indicated that employing regular team projects without other training activities and support by instructors (course Web engineering) had the least effect on team competencies (Figl, 2009).

The results provided support for the hypothesis that addressing team competencies in intensive team projects with in-depth support (course project management) and additional team competencies training (course soft skills) is highly effective. In general, students perceived the effects on knowledge and skills more strongly than effects on attitudes.

Additionally, the effects of a course focusing on communication exercises and encounter groups, but not including an intensive team project (course person centered communication) were evaluated. In this course, although students reported personal growth and improved understanding of others in the interviews, the influence on students' team competencies could not be captured as well in quantitative questionnaire data. Future research is needed to determine whether IS curricula can benefit from courses that focus solely on team competencies and how these courses should be designed.

In summary, the preliminary findings underscored the impact and value of enhancing regular team projects with additional teamwork-related exercises and support.

6. INSTRUCTOR LEVEL: TRAINING AND SUPERVISION FOR COURSE INSTRUCTORS

At most higher education institutions, expertise in the field is an essential requirement for teaching, whereas training on teaching is not necessarily demanded. This is based on the belief that the content to be taught is the key and that the teaching process is not as important (Fellers, 1996, p. 48). However, teaching "requires considerable instructor training and continuous refinement of skills and procedures" (D. Johnson, Johnson and Smith, 1991a).

According to Adams and Pereira (2002), training faculty members on how to lead teams could be "one of the most important activities required to make engineering student teams function effectively," because up to now, many engineering and computer science faculty have "little or no training in developing, implementing and evaluating teams" (Adams, 2003). Additionally, supervision and coaching for course instructors on effectively facilitating teamwork in engineering classes is needed (Adams and Pereira, 2002; Mead et al., 1999).

It is a big challenge for course instructors to teach students how to work in teams and to create an appropriate environment for teamwork because the course instructor plays a role similar to a sports team coach when using teamwork in class by being responsible for forming teams,

defining tasks, and monitoring and evaluating teams' performance (Adams and Pereira, 2002). This is especially true for the use of team projects in IS classes. For example, supporting teams working collaboratively on software or Web engineering projects needs a thoughtful integration of knowledge from the domains of software engineering, teams, and social learning. This demand is less likely for tasks such as supporting teams writing seminar papers.

Empirical studies (Figl, 2009) reveal that students would like to have stronger teamwork support provided by lecturers (with respect to team building, team roles definitions, feedback, reviews, reflection, and fair grading). For example, instructional support is needed to minimize the problem of free-riding, which may lead to negative attitudes of students toward teamwork.

Studies demonstrate that students' team competencies do not simply improve as a result of requiring them to work together, but the development has to be facilitated by the instructor (Porter, 1993). He/she should facilitate the team processes and provide additional team competencies training.

In conclusion, it is recommended that training be offered with specific focus on teaching IS courses including cooperative learning and teamwork. For instance the "Building Engineering Student Team Effectiveness and Management Systems" (BESTEAMS) faculty at the University of Maryland designs and provides resources for instructors to effectively support engineering student project teams (University of Maryland, 2010).

Teaching assistants also could be trained to coach student teams, (e.g., with the team coaching approach by Hackman and Wageman (2005)) if a number of teams are used (Sargent et al., 2009). In the first study year in particular, guidance and team support by tutors is useful since students usually lack teamwork experience at the beginning of their studies (Drury, Kay and Losberg, 2003).

7. CURRICULUM LEVEL

Generally, there are three basic ways in which students can interact with each other; they "can compete to see who is 'best,' they can work individualistically toward a goal without paying attention to other students, or they can work cooperatively with a vested interest in each other's learning as well as their own" (R. Johnson and Johnson, 1994). A curriculum should aim at promoting students so they can be effective in each of these patterns of interaction.

There have been isolated attempts to provide ideas and strategies for fitting the promotion of team and communication competencies in computer and information science curricula (Gruba and Al-Mahmood, 2004; Smarkusky and Smith, 2004). At the curricular level, major decisions have to be made as to how to integrate team competencies in compulsory or optional subjects. In particular, the amount of time dedicated to team competencies, balanced with other learning goals, should be defined at a curricular level.

Of course, there is the possibility of combining factual learning goals with promoting team competencies via courses focusing on factual matter and including cooperative teamwork. To judge whether courses are suited in principle, several factors have to be taken into account, as outlined in the next section. In the chosen compulsory courses, team competencies training and theoretical input on teamwork also can be included as an add-on. However, time capacity for team related input in these courses will be low, since there are other teaching and learning goals to be attained as defined in the curriculum.

Therefore, a fundamental decision will be whether to include a specific course dedicated to the promotion of interpersonal and team competencies or to offer optional or additional courses. These courses can focus solely on team and other generic competencies, specifically addressing IS students.

For example, in the IS Model Curriculum 2010 there is no course specifically addressing the promotion of interpersonal and team skills, but team communication is mentioned as a learning objective of the core course IS project management, and it is required that "students should be provided opportunities to work together on team-oriented projects" in an IS degree program (Topi et al., 2010, p. 389). Beyond that, no further recommendations for the promotion of team competencies, listed as part of foundational knowledge and skills, are given.

Concerning the alignment of courses, a good mixture of individual work and teamwork in courses should be planned. It is important to monitor the number of team projects students are involved in at the same time (Ettington and Camp, 2002). Additionally at the curricular level, students should receive instruction on team projects and team dynamics early in their studies (Ettington and Camp, 2002). To provide the basis for strategic course alignment including cooperative teamwork or direct promotion of teamwork, modelling dependencies among courses with dependency graphs and facilitating the sharing and coordination of teaching staff is helpful, as realized in the project "active curriculum for Computer Science," (Kabicher, Derntl and Motschnig-Pitrik, 2009) for example.

Besides focusing on single courses, it also could be possible to improve students' team competencies by offering team projects that last longer than a semester or take place in subsequent courses. Smith et al. (2008) describe an approach of evolving projects over a longer time span (from freshman to senior level) to develop students' team and project management competencies.

Another possibility could be offering an additional minor that complements the existing curriculum; for example, the University of Tennessee offers a minor in engineering communication and performance (Seat, Parsons and Poppen, 2001).

There is a growing need to assess the level of knowledge and skills of graduates for evaluating and improving curricula, and efforts to include team competencies in curricula should be accompanied by participatory evaluation. For example, in the IS 2002 Model Curriculum there is a standardized outcome assessment, including assessment of team skills (Reynolds et al., 2004). In the context of measuring soft skills, Beard et al. (2008) propose using student performance on team projects as a measure for teamwork skills in curricula.

7.1 Decision on the appropriateness of teamwork

When deciding whether to employ teamwork in a course, course content is a relevant factor. Team projects can involve different kinds of tasks and the task types determine the

appropriateness of working individually or in a team. One important task feature refers to whether tasks are "shareable" among team members (Dillenbourg et al., 1996, p. 11). Teamwork is especially effective if tasks have several steps, a variety of information input, and can be performed by combining individual contributions (Strijbos, Martens and Jochems, 2004, p. 32). For design tasks and ill-structured tasks with several possible solutions and uncertainty relative to the rules or procedures used (e.g., software or Web engineering), collaborative learning and teamwork is especially suitable, since much interaction is necessary (Strijbos, Martens and Jochems, 2004, p. 32). Although courses including the implementation of software projects are destined for team projects, it is recommended that students should get familiar with software development, an important part of IS curricula, individually before working in teams (Humphrey, 2000a).

For concept-learning tasks or learning of factual knowledge, the tasks employed most frequently are well-structured tasks with one correct solution and few rules or principles to be applied. These conditions generate low interaction (Strijbos, Martens and Jochems, 2004, p. 32). Therefore for the learning objective of acquiring factual knowledge or basic concepts, individual learning is recommended. Nevertheless, there are also possibilities for learning factual knowledge in a collaborative setting, e.g., via peer-teaching. Courses such as basic mathematics and analysis may not present the best opportunity for students to work solely in teams because reading or solving difficult mathematical problems are examples of activities best suited to individual work (Baron and Byrne, 1997, p. 439).

8. CONCLUSION

This paper proposed a systematic framework to categorize ways of supporting and promoting team competencies in students in the context of IS curricula. A major aim was to provide a holistic view of how to best promote team competencies and how to successfully implement team projects in IS education. Generally, strategies have to be defined for planning the integration of team competencies at a curricular level, for training course instructors to be able to teach those courses, as well as for the course level. At the course level, efforts reported by IS educators to promote team competencies ranged from simply including team projects to including extensive team training in courses. The review makes a contribution to both the academic literature investigating team competencies promotion and the practitioner literature by outlining main aspects of pedagogically appropriate use of teamwork in IS and presenting a variety of related approaches and studies from the IS education fields. The bottom line is that, when employing team projects, instructors should reflect on factors such as how teams are built, how social loafing can be avoided and how teams are assessed. If team projects also should fulfil the purpose of training students in team competencies, team building activities, monitoring and supporting the team process and reflection and feedback can be included.

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