Team and Media Competencies in Information Systems

von
Kathrin Figl

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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) 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, conceptual modelling, human-computer-interaction and information systems education. Kathrin Figl has authored over 35 papers, including 3 best paper awards, in peer-reviewed conference proceedings and journals.

Rosenheimer Straße 145, D-81671 München
Telefon: (089) 45051-0
oldenbourg.de

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Abstract

Numerous studies indicate that team competence, based on effective virtual and face-to-face communication, is a key factor for successful project work. The ability to effectively work in teams by using different media has been a key competence for computer scientists for a long time. Hence, the development of team- and media-competence is a worldwide, major issue for academic education. Gradually, more attention is paid to developing this generic competence as part of academic curricula.

The major scientific goal of this work is to investigate the influence of person-centered interventions in technology-enhanced environments on the development of team knowledge, skills and attitudes. A further aim is to improve the understanding of teamwork and associated media use in the Computer Science and Information Systems studies. At the University of Vienna, five different courses which aimed at developing students' team- and media-competencies along with subject specific and/or other generic competencies were conducted and researched. In these courses, emphasis was placed on team projects with authentic tasks selected by students and on providing a cooperative atmosphere. Relevant didactical elements were visualized and made explicit with the help of activity diagrams.

Students' perceptions were collected in online questionnaires (n=900), interviews and video observations and analyzed with quantitative and qualitative methods.

Empirical results show how communication frequency and use of different communication media influence climate in student teams. The overall communication frequency seems to be a relevant factor for team climate and collaboration, independent of the kind of media actually used. In addition, results demonstrate the suitability of online media for different teamwork processes. Further results detail the communicative purposes and tasks which students use online media for, in the context of the studies and of teamwork, like e-mail, chat, voice over IP and bulletin boards and go in line with Media Synchronicity theory.

Another main result refers to the fact that the investigated person-centered interventions have significant effects on the development of team competencies of students. Results indicate that courses had significant effects on the development of team competencies, whereby effects on knowledge and skills were stronger than on attitudes. As expected, sub-skills promoted by specific interventions in a course were also perceived as being most significantly improved as a result of that course. These positive evaluation results show innovative and continuing ways of developing team competences in Computer Science studies.

Finally, the book draws up general concepts referring to ways of supporting teamwork and promoting team competencies of students in the context of Computer Science and Information Systems curricula.

Contents

1 Introduction

Teamwork is very important in everyday working life (European Association for the Education of Adults, 2004), particularly in information systems development. Well working teams are "ideal structures for generating and sharing knowledge, enhancing performance and improving satisfaction" (Tannenbaum, Salas, & Cannon-Bowers, 1996, p. 504). Therefore, academic education in Computer and Information Science should prepare students for working effectively in teams and foster collaborative skills that are needed in the workplace. Working in teams is an essential part of working in modern companies, especially in the IT industry. Teamwork in information systems development was important from the early start on; already in 1971 Gerald Weinberg (1998) wrote in the classic "The Psychology of Computer Programming" about programming teams and referred to programming as a team effort.

It's been broadly acknowledged and confirmed in studies (e.g. Motschnig-Pitrik, 2002) that it does not suffice for graduates to be technically competent, social competence, in particular teamwork and communication are essential too. Unfortunately, engineering and Computer Science education provides little formal team training (Adams, 2003). Working collaboratively in a blended learning environment can provide students with an authentic experience of teamwork. Such courses offer perfect circumstances for observing teams from team building to performing complex tasks like collaborative web engineering. In the context of research on promoting team competencies in engineering education (Fellers, 1996; Nance, 2000; Ruiz & Adams, 2005), this book specifically focuses on the possible contribution of a number of different technology-enhanced courses based on person-centered principles.

A second main focus of the book is media use in teamwork. Not only in international teams, but also for almost all teams in IT-related environments working without virtual communicative means like e-mail, chat or online platforms would be unthinkable in modern information society. Communication via several media is a crucial factor for team climate and team effectiveness. Therefore, the study investigates the use and appropriateness of communicative means in teamwork and how communication frequency and use of different communication media influence team climate in student teams.

In addition, there are presented several didactical elements for strengthening team and media competencies of students. Based on the theoretical and empirical part, there are proposed strategies for promoting team competencies in Computer Science and Information Systems curricula.

1.1 Overview of Book

Figure 1 shows an overview of the main parts of this book.

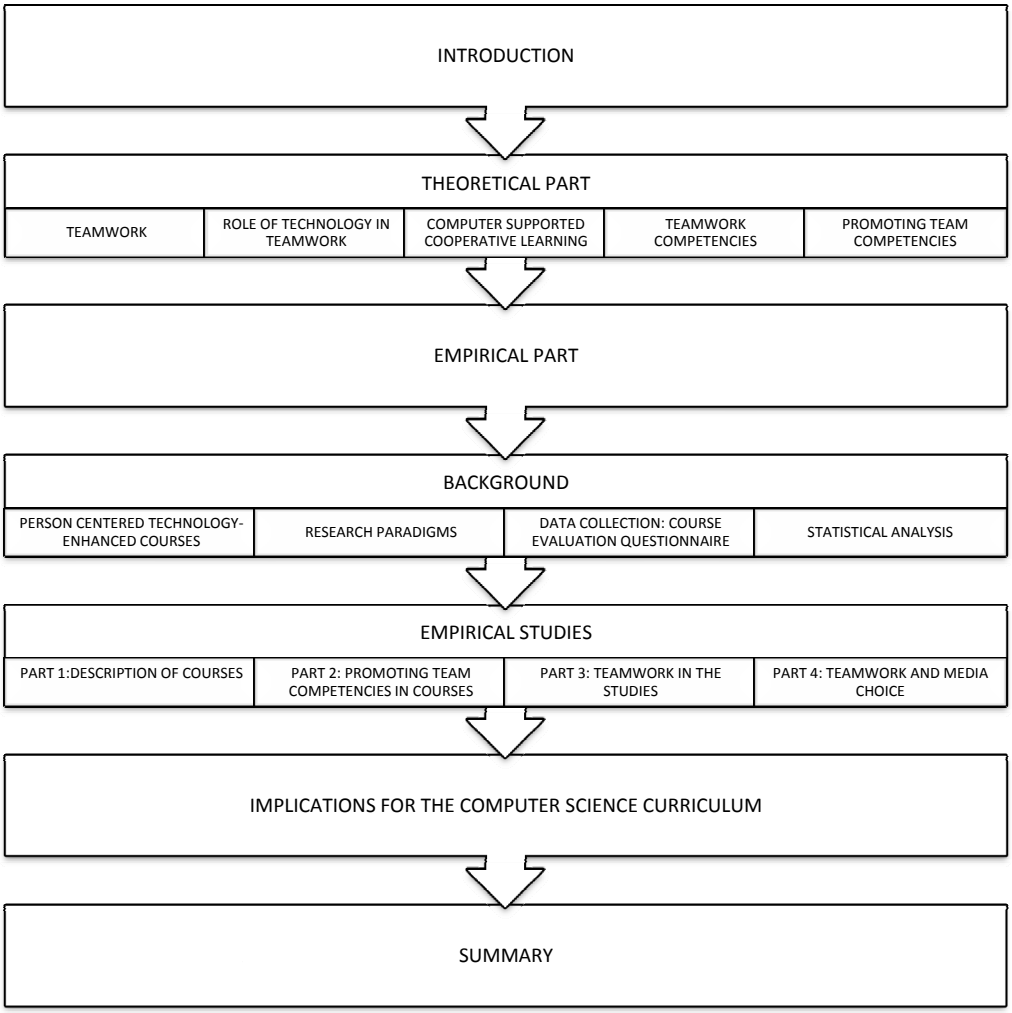

Figure 1: Overview of Book

The book will start with a theoretical part on teamwork, team effectivity and processes, as well as the role of technology for team communication and collaboration. Furthermore, the pedagogically appropriate use of teamwork and cooperative learning in Computer Science and Information Systems courses will be outlined. Teamwork competencies will be described and an overview of possibilities for promoting teamwork competencies with specific focus on Computer Science studies will be given.

In the empirical part there are presented research questions, hypotheses, questionnaires, study designs and results of several empirical studies. These empirical studies are structured in four parts and answer the following research questions: How do students evaluate the courses Soft Skills, Person Centered Communication, Organizational Development, Web Engineering, Project Management and their effect on team competencies? How do students generally perceive teamwork in the Business Informatics studies? How do students use several media for communicating in their teams? As course evaluations are a main part of the empirical evidence, a description of the investigated courses and their didactical elements potentially influencing team competence is included at the beginning of the empirical part. In addition, underlying research paradigms and methods appropriate for evaluating blended learning courses are discussed. Presentation and discussion of course evaluation results will enable the reader to get some insight into the potentials and limitations of didactic elements on developing team competence in courses. Furthermore, there are presented studies on teamwork and media choice.

Based on the results of the empirical studies, the book ends with a strategic discussion on how to include the promoting of team competence in Computer Science and Information Systems curricula. Finally, there will be presented a summary of main research results.

1.2 Team Competence as Employability Factor and Educational Objective

In discussions on key qualities for job qualification terms like “social competence” and “team competence” are prevalent. Team competence can be seen as a major sub competence for employability. A comprehensive working definition of employability was proposed by Yorke: “a set of achievements – skills, understandings and personal attributes – that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy” (Yorke, 2006, p. 8).

Beside technical skills and personal attributes, workplaces require interactive attributes such as teamworking, interpersonal and communication skills (Harvey, Moon, & Geall, 1997). Employers want employees to work efficiently in teams, to develop ideas and engage effectively with others in teamwork situations and to be able to work in different teams for different projects (Harvey et al., 1997). Studies show that this demand for team competencies of graduates does also apply to information technology firms (Bailey & Stefaniak, 1999, 2001; Motschnig-Pitrik, 2002b). A main reason for this demand is probably represented by the fact that teams are widely used in information system development (Slyke, Trimmer, & Kittner, 1999).

As far as job advertises in the IT sector are concerned, there is a focus on technical skills, and little phrases are used for non-technical skills (1995: 6.6%, 2001: 4.8% phrases of all skills), thereby communication and interpersonal skills are most often mentioned (Gallivan, Truex, & Kvasny, 2004). There is a recruitment gap, meaning that although firms strongly

demand soft skills beside technical skills, job advertisements rather focus on hard skills (Trauth, Farwell, & Lee, 1993).

In the Study "Higher Education and Graduate Employment in Europe", funded by the European Commission, "working in a team" was one of the 36 investigated competencies. According to this study, graduates perceive "working in a team" as one of the Top 6 competencies required in their current employment (Place 4 in UK, Place 6 in Europe and Japan) (Brennan, Johnston, Little, Shah, & Woodley, 2001, p. 23). In a study performed by the American Society of Mechanical Engineers (ASME) "team/teamwork" was rated as the most important and "communication" as the second important competence for graduated engineers by the industry as well as the academia sample (Bahner, 1996). In the UK, the Higher Education Academy worked out student employability profiles in cooperation with the Council for Industry and Higher Education (Rees, Forbes, & Kubler, 2006). Subject specific student employability profiles state that a graduate in Computing should have the ability to "work as a development team member, recognizing the different roles within a team and different ways of organizing teams" (Rees et al., 2006, p. 58).

Universities react to the demand of team competencies in the work life and include team competencies as educational objectives in their curricula. In curricular design guidelines team competence is often characterized as core/key skill or as transferable/generic skill, whereby transferable skills are: "the generic capabilities which allow people to succeed in a wide range of different tasks and jobs" (Training Agency, 1990, p. 5). A huge amount of studies on educational objectives recommends promoting team competence as one of the main generic skills in higher education. The British Dearing-Report, for example, recommends higher education to focus on the key skills communication, numeracy, use of information technology and learning how to learn, which are said to be the keys to success of graduates (Dearing, 1997). According to Yorke (2006, p. 5) undergraduate programs should foster abstraction, system thinking, experimentation and "collaboration (involving communication and team-working skills)". In addition, EU documents consider teamwork and collaboration as core competencies for employable graduates and strongly support their promotion in curricula (European Commission, 2003).

Correspondingly, the promotion of team competencies is more and more demanded in Computer Science and Information Systems curricula. According to the American ABET (Accreditation Board for Engineering and Technology) criteria for accrediting Computing curricula in 2008/09, a Computer Science program should "enable students to achieve, by the time of graduation:

- An ability to function effectively on teams to accomplish a common goal
- An ability to communicate effectively with a range of audiences" (ABET, 2008, p. 14).

The curriculum for Computer Science (Bachelor) of the University of Vienna states with respect to graduates: "They (graduates) can develop complex software systems in a team; know the demands of working in teams, as well as the competence to acting responsibly in the job". (Studienprogrammleitung Informatik, 2007, p. 3).

1.2.1 Current Study on Graduates Requirements

In November 2007, a study was conducted by the Research Lab for Educational Technologies (University of Vienna, Faculty of Computer Science) on competencies of (business) informatics graduates. Employers were asked to tell how important 25 competencies were for them and how high they rated the level of graduates' achievement. On a job fair in Vienna four interviewers asked representatives of IT-related companies to fill out the questionnaire. The questionnaire was a short version of the competencies questionnaire used in the EU Project Tuning Educational Structures in Europe (Tuning management committee, 2006), with some more questions added. The questionnaire included instrumental, interpersonal and systemic competencies. A total number of 35 questionnaires were filled out.

Results show that team competence is considered important by companies (mean=3.50, SD=0.99). The most import competence was "the capacity to learn" and team competence was rated second important. Compared to the level of achievement of other competencies, team competence lies approximately in the middle (mean=2.79, SD=0.8). Figure 2 shows the importance and the level of achievement of competencies.

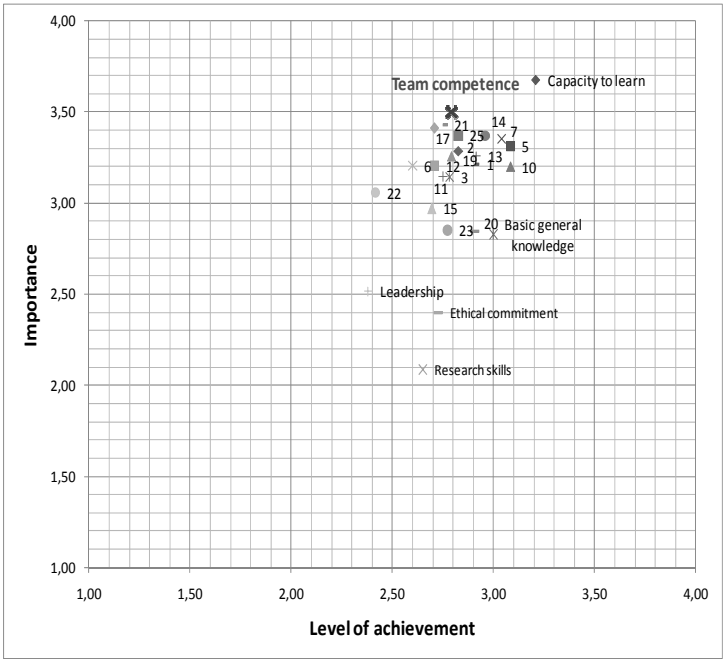

Figure 2: Importance and Level of Achievement of Competencies Rated by IT-Related Companies (n=35). 1.Capacity for analysis and synthesis, 2.Capacity for applying knowledge in practice, 3.Capacity for organisation and planning, 4.Basic general knowledge, 5.Oral and written communication in German, 6.Oral and written communication in English, 7.Ability to deal with new technologies, 8.Research skills, 9.Capacity to learn, 10.Information management skills, 11.Critical and self-critical abilities, 12.Capacity to adapt to new situations/flexibility, 13.Capacity for generating new ideas (creativity), 14.Problem solving, 15.Decision-making, 16.Team competence, 17.Interpersonal skills, 18.Leadership, 19.Ability to work in an interdisciplinary team, 20.Intercultural competence, 21.Ability to work autonomously, 22.Project design and management, 23.Initiative and entrepreneurial spirit, 24.Ethical commitment, 25.Concern for quality

Universities should especially concentrate on competencies with high importance and low level of achievement (Tuning management committee, 2006, p. 27). Therefore, current efforts in promoting team competence should be maintained or strengthened since this competence is rated as very important.

In addition, 17 course instructors from the faculty of Computer Science (University of Vienna) rated the importance of the above named competencies. Course instructors rated the importance lower than the employers did (mean=3.18, SD=0.73). Team competence reached place 10 in comparison with the other competencies. This result goes in line with the results of the Ilmenau University of Technology (2002) which also made a survey with a very similar questionnaire. The employers there rated the importance of team competence for graduate engineers (mean=3.43, n=39) higher than graduates (mean=3.26, n=249) and course instructors (mean=2.29, n=16) (Technische Universität Ilmenau, 2002; Wächter, 2002).

In a further question, companies were asked how much time of university education for (business) informatics should be dedicated to soft skills training compared to subject specific training. On average, companies recommended 1/3 of time to be dedicated to soft skills as depicted in Figure 3.

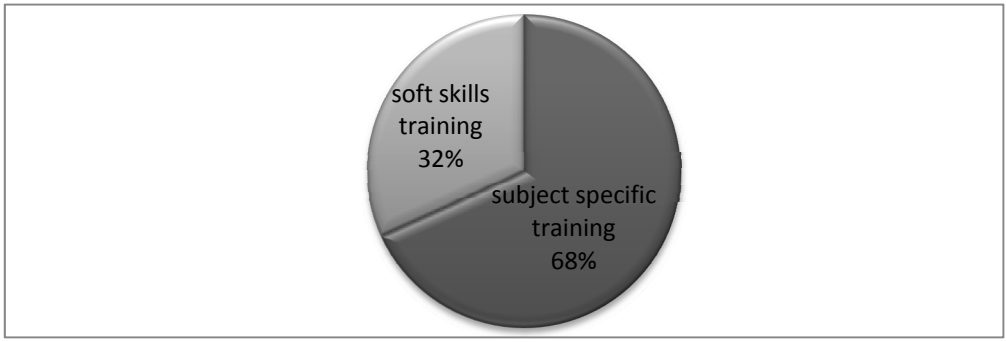

Figure 3: Recommended Focus of Training (n=35)

Theoretical Part

The theoretical part includes six different chapters which provide an overview of main theories and current state of research on teamwork, media use in teams and team competencies. The following topics are discussed in detail: teamwork in general, the role of technology and communicative media in teamwork, the use of computer supported cooperative learning and teamwork at university, teamwork competencies and its measurement. Finally, there are outlined possibilities for promoting teamwork competencies in general and in Computer Science and Information Systems courses as well as related literature on the effectiveness of team training.

2 Teamwork

This part will start with basic definitions of groups and teams and their differences. Furthermore, this part will deal with important factors for effective teamwork and the question in which contexts teamwork is more effective than individual work and in which it is not.

2.1 Definitions of Group

The term "groups" in this chapter is used synonymously to "smalls groups", which is the more common term in scientific research. A widely used definition of groups provided by Paulus (1989) is: "A group consists of two or more interacting persons who share common goals, have a stable relationship, are somehow interdependent, and perceive that they are in fact part of a group." This definition includes the following characteristics of groups:

- at least three group members in contrast to dyads,
- direct or indirect interaction among group members,
- interdependence,
- stability of relationships – the group lasts for a specific time,
- sharing of goals,
- structured interactions,
- recognition of members as being part of the group.

There is a variety of definitions of groups and authors use different criteria, for instance the existence of collective norms, goals, motives or group-consciousness. A common criterion is that interaction should last at least a certain amount of time. The number of group members should be so small as to make face-to-face interaction between all members possible. A maximum number of 20 people is typically set (Fischer & Wiswede, 2002). There are various degrees of groupness. At the high end of groupness there are for example working groups who have known each other for a long time. On the low end, it is more difficult to decide whether it is a group. For instance, travellers flying with the same airplane: They have the same goal to travel safely and they are somehow interdependent (Baron & Byrne, 1997). On the other hand, they will not interact much in the future and they probably do not perceive themselves as a group. Another example would be students taking an exam together; they would not be called a group, either. Therefore many researches in that field state that the feeling of belonging to a group is crucial for characterizing a group (Moreland, 1987). Another possibility is to simply distinguish between social and non-social groups. Non-social groups are defined as a collection of two or more people who are in the same place at the same time, but are not interacting with each other, whereas social groups interact and are

interdependent (Aronson, Wilson, & Akert, 1998). In groups there are usually four key aspects (Baron & Byrne, 1997, p. 437): roles (differentiated functions within groups) with corresponding status and prestige, norms on how to behave in different situations and cohesiveness.

2.2 Definition of Team

The terms “teams” and “groups” are often used interchangeably, although some authors make differences between these two terms. Cohen states that the term “teams” is more often used in management literature (e.g. “empowered teams”, “team effectiveness”), whereas in the academic literature the term “group” is typically used (e.g. “group cohesion”, “group effectiveness” (S. G. Cohen & Bailey, 1997). In group dynamics literature the words small-group and team are used interchangeably (D. Johnson & Johnson, 2006, p. 532). Nevertheless, there is a distinction between teams and small groups. In literature, the term small groups may also be used for non-social groups without interdependence, whereas the term team is usually only used for strongly interdependent groups. Therefore, teams are small groups, but small group may or may not be teams.

For this work there was used the following definition of a team derived from several often-cited definitions:

“A team has four characteristics:

- two or more individuals
- shared or common goals
- task interdependency
- desired productive outcome” (D. P. Baker, Horvarth, Campion, Offermann, & Salas, 2005).

This definition also implies that team members take decisions together (e.g. for team goals) and that there is some kind of cooperative work and coordination. Johnson and Johnson (2006, p. 532) further include specific team member roles and limited life-span of teams in their definition:

“A team is a set of interpersonal interactions structured to achieve established goals. More specifically, a team consists of two or more individuals who

- are aware of their positive interdependence as they strive to achieve mutual goals,
- interact while they do so,
- are aware of who is and is not member of a team,
- have specific roles or functions to perform,
- and have a limited life span of membership.”

Another often cited definition is “A team is a temporary or an ongoing task group whose members are charged with working together to identify problems, form a consensus about

what should be done, and implement necessary actions in relation to a particular task area." (Katzenbach & Smith, 1993).

With respect to the use of teams in the workplace, Katzenbach and Smith (1993) investigated the difference between teams and other forms of working groups in organizations. Compared to teams which should achieve a collective goal, in a work group, individual outcomes are achieved. Interdependence in workgroups is low and members are responsible for their own results. Members do not have to collaborate as much as in a team and tasks do not require the combined work of more than one member. Compared to them, teams create work products with the joint effort of more than one member and each team member is held accountable for the end product.

According to David and Frank Johnson (2006, pp. 18-21), in organizations there are four different types of groups: pseudogroups, traditional work groups, effective groups and high-performance groups. Pseudogroups are assigned to work together, but actually, they are competing or not interested in cooperating. In traditional work groups, individuals are evaluated and rewarded separately, but not as a team, as already described. According to previous explanations, pseudogroups and traditional work groups, unlike effective and high performance groups, cannot be characterized as teams. In an effective group, there are shared goals and members feel responsible for the common success. High performance groups have an even higher degree of commitment and outperform their expectations. They also exhibit synergy and achieve higher team performance, which is "more than the sum of its parts".

One way to classify teams is by taking into account the setting they are used in: work teams, sports teams and learning teams (D. Johnson & Johnson, 2006, p. 534). In the context of this book, of great interest are work teams and learning teams. Thereby teams of interest can also be characterized as computer-assisted teams, since they use computer functions like "information access and processing, performance structuring, and communication" (Hollingshead & McGrath, 1995, p. 48) in the context of teamwork. Electronically linked teams or virtual teams are a specific form of teams, meaning that face-to-face meetings take place seldom or not at all.

2.3 Social Inhibition and Loafing

This chapter summarizes important basics on working in teams compared to working alone. Even the mere presence of others may influence the work on a task. The mere presence of others can imply performing a task in the vicinity of others who are doing the same but without interacting or performing a task in front of an audience. The others are merely present, but there is no interaction (Aronson et al., 1998, p. 330).

Social facilitation means that people perform better in the presence of others than alone. Evaluation apprehension leads to alertness and arousal and to a better performance on well-learned simple tasks (Aronson et al., 1998, p. 331). The performance of complex, difficult tasks is likely to be lower when being watched.

If individual efforts cannot not be evaluated or distinguished from others' efforts (e.g. clapping hands in a group, cheering loudly, pulling on a rope), social inhibition or loafing can occur, implying that motivation and effort are reduced. People feel less noticed and relaxed and perform simple tasks worse compared to when being watched. On the other hand, social inhibition can lead to better performance on complex tasks. Studies on social loafing show the tendency that social loafing is stronger with men than with women, because men focus more on their own performance than on the group (Aronson et al., 1998, p. 336). Social loafing does occur under various work conditions for a wide variety of tasks (Baron & Byrne, 1997, p. 445). According to the collective effort model (Karau & Williams, 1993), social loafing occurs because the links between effort, higher performance and desired awards are not as direct as when working alone.

There are several strategies which can reduce social loafing, e.g. making individual effort of group members identifiable, increasing the perceived value of the task, regarding individual contributions as unique and important, strengthening group cohesiveness and individual commitment (Baron & Byrne, 1997, pp. 447-448).

2.4 Individual versus Group Performance

Although it is widely recognized that certain tasks can be accomplished better by teams than by individuals, if for example several abilities from different team members are needed for complex tasks, there are limitations for teamwork. Malik (1999) for instance provocatively states that all big achievements of mankind have been achievements of single persons and that there are hardly any examples of team-productions in art. This general statement is criticized by other researchers of the scientific community, e.g. Burow (2000). It does not apply to the field of Computer Science. As already described in chapter 1.2, working in teams is usually the most suitable approach for accomplishing goals in Computer Science. Reading or solving difficult mathematical problems however are examples of activities best suitable for being carried out alone (Baron & Byrne, 1997, p. 439).

Generally, process gain is referred to if teamwork leads to better results than individualistic work. Process loss indicates that groups produce fewer ideas and worse solutions or put less effort in performing/learning than if working individualistically (D. Johnson & Johnson, 2006, p. 98). There are some tasks for which process loss is likely to occur. One example is brainstorming; there is a number of studies showing that nominal groups (subjects work individually and afterwards put results together) produce more ideas than real brainstorming groups (Diehl & Stroebe, 1991). Reasons for this productivity loss in groups are the freerider effect/social loafing (because contributions are not identifiable, as already described in chapter 2.3), the feeling that single contributions are less important and production blocking (because group members take turn to present ideas) (Diehl & Stroebe, 1991). For an efficient brainstorming it would be better to let individuals produce ideas alone and then combine ideas (e.g. Delphi-Method, (Fischer & Wiswede, 2002, p. 611)).

Whether a group outperforms individuals depends on the type of task (Aronson et al., 1998, p. 348). Table 1 gives an overview of task types and group performance. Process loss can

occur due to communication problems, because groups do not manage to identify their most competent member, or because they fail to share information (Aronson et al., 1998, p. 349).

Table 1: Performance of Groups in Several Tasks According to Steiner (1972) Cited After Fischer and Wiswede (2002, pp. 610-611)

Task Type	Group Performance
Additive (e.g. psychomotoric tasks, clapping, cheering)	Group performs better than the best member.
Compensatory (e.g. estimation tasks)	Group performs better than most of members.
Disjunctive (e.g. problem solving)	Performance of group can equal performance of the best member, if best member is identified, he/she convinces others that he/she is right or it is obvious that solution is right.
Conjunctive (not divisible, e.g. mountaineering group)	Group performance equals least proficient member.
Conjunctive (divisible, e.g. Software Engineering, Soccer)	Performance is better than the worst member is and can reach a high level, if tasks as subdivided according to competences.

According to common beliefs, decisions made by groups are likely to be better than those made by individuals, because expertise and knowledge are higher. Nevertheless, there are some contradictory study results. Interestingly, the group polarization effect shows that groups are more likely to adopt extreme positions than individuals (Baron & Byrne, 1997, p. 457). Another problem related to discussion making of groups is that groups discuss rather information that is already shared by all members than unshared information which is obtained only by single members (Aronson et al., 1998, p. 351). Making wrong decisions can also be an effect of "groupthink", groups with a high level of cohesiveness and the belief that the group is infallible may ignore relevant facts and stick to a poor decision (Baron & Byrne, 1997, pp. 458-461).

Many tasks in the field of Information and Computer Science can be characterized as conjunctive and are best suitable for being performed by teams. For example systems development is a team activity since information systems offer high complexity and time schedules do not allow single work (Humphrey, 2000b, p. 3).

2.5 Team Effectiveness

The primary goal of this work is to find ways of improving team competence in order to enhance later team performance. Therefore, all factors relevant to the effectiveness of groups and teams have to be co-considered. Furthermore, it has to be clarified, that team competence plays only a part in determining the actual performance of teams. In addition, knowledge about factors for performance and effectiveness of groups and teams are an important part of team knowledge competencies.

Team effectiveness is the degree to which the output of a team meets requirements like quality, quantity and time (time especially refers to the performance of a team) (Hackman, 1990). Factors like team size, composition, interdependence, task type, motivation, team processes,

communication structure and rewards influence team effectiveness (Campion, Medsker, & Higgs, 1993; S. G. Cohen & Bailey, 1997).

According to Adams, Ruiz and Simon (2002) the following characteristics are important for teams to become effective: common purpose and clearly defined goals, role clarity (individual task assignments), psychological safety (team climate based on trust and respect; no embarrassment or rejection of team members), productive conflict resolution, mature communication (e.g. listening, providing feedback) and accountable interdependence (mutual dependence of individuals' work). As far as the use of teams in higher education is concerned, "literature shows that learning styles, context, task, individual differences, team longevity, student preference for teaching methods, attitude toward teamwork and misunderstanding of the meaning of teams are the main factors having an impact on team effectiveness" (Ulloa & Adams, 2004a).

Generally, most team effectiveness models follow an input-process-output approach (Paris, Salas, & Cannon-Bowers, 2000, p. 1053). For detailed reviews on team effectiveness models see for example Essens (2005). A comprehensive meta-study on factors for team effectiveness can be found in Cohen and Bailey (1997). In the context of this work the Team Effectiveness Model (Tannenbaum, Beard, & Salas, 1992) as depicted in Figure 4, seems to be the most interesting model, because it includes variables relevant to the training of individual team competencies. The model is very comprehensive, because it includes the dimensions teamwork and task work on individual and team level and also incorporates feedback loops (Essens et al., 2005).

Teamwork happens in the context of organizational and situational characteristics (e.g. available resources, reward structures, which incite competition or cooperation). There are four main input variables (task, individual and team characteristics and work structure) influencing the output of the team via team processes. Teams have to solve tasks varying in complexity and type. In addition, team members differ according to their technical task competencies as well as to their team competencies, motivation, personality characteristics (e.g. sociability) and mental models. Furthermore, teams act under diverse work characteristics including manifold work and communication structures. Teams can be characterized by team climate as described in chapter 2.6, norms, homogeneity and cohesiveness. In the second phase of the model, team processes and team interventions have their place. Team interventions like individual and team training positively influence team processes and will be described in chapter 6 in detail. Input factors in combination with throughput factors lead to output in the form of team performance, team and individual changes (e.g., change in knowledge, skills, attitudes and motivation). Finally, the team's performance can serve as feedback for changing input variables.

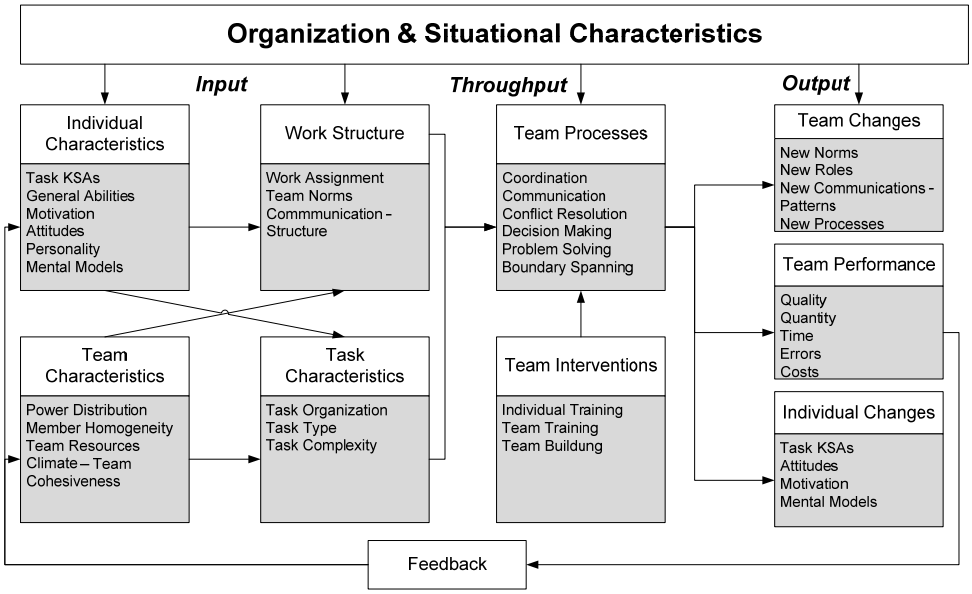

Figure 4: Team Effectiveness Model (Tannenbaum et al., 1992)

2.6 Team Composition

There is a wide variety of general literature about appropriate team composition, e.g. how to assign appropriate roles according to personality characteristics (Belbin, 1981), and also specific literature related to software engineering. Team heterogeneity with respect to skills and knowledge has as effect team effectiveness, complex problem solving and finding creative solutions positively (Bradley & Hebert, 1997). Certain personality characteristics such as extraversion, thinking and judging (according to the Myers-Briggs Type Indicator, (Myers, 1995)) can also have a positive effect on team project success in information technology team projects (Peslak, 2006). Extraversion of team members also leads to better group decision making (Yellen, Winniford, & Sanford, 1995). Studies show that diversity of personality, e.g. measured by the Keirsey-Bates Temperament Sorter (Keirsey & Bates, 1984) correlates positively with the success of student software engineering teams (Pieterse, Kourie, & Sonnekus, 2006). On the other side, personality diversity can also lead to team conflict as shown for information system development teams (Trimmer, Domino, & Blanton, 2002). Diversity, measured by the Belbin Team Role model, was found in studies performed in an organizational context to be positively related to performance in complex tasks, but negatively related as far as straightforward tasks are regarded (Higgs et al., 2005). In a detailed analysis Gorla and Lam (2004) give recommendations for the most effective personality characteristics of the Myers-Briggs Type Indicator for specific team roles in a software team. They suggest that team leaders and team members should be different with respect to their personality characteristics, while heterogeneity among team members is not as important. Team

leaders should be “intuitive” (not detail-oriented, but whole-picture oriented) and “feeling” types as far as decision-making is concerned (making decisions not on logic considerations, but on personal considerations and effects on others) (Gorla & Lam, 2004, p. 82). Team leaders and team members, preferably both, are “judging” types (are organized, stick to already made decisions), since this characteristic helps to meeting project deadlines. It can be assumed that it is advantageous if systems analysts are “thinking” types with respect to decision meeting (analytic, logical approach). Interestingly, an important personality characteristic for programmers is extraversion, since it is positively related with team performance, probably because of the high need of interaction with others (Gorla & Lam, 2004, p. 81).

2.7 Team Climate

Assessing team climate can help to understand strengths and weaknesses of teams. Despite the fact that team climate surveys are often used for team development and improving their performance, they are also useful for describing the climate of student teams.

A well-established model of how teams function is the Team-Reflexivity-Model (West, 1994). It includes two fundamental dimensions concerning the way teams function: task reflexivity and social reflexivity. Those two dimensions of social and task orientation are generally popular in team description (Kauffeld, 2001). 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). Thus, task reflexivity is displayed in the team’s ability to achieve its goals and objectives and in the team’s concentration on their tasks. The dimension social reflexivity concerns the team’s ability to promote the well-being of its members; it includes social support and conflict resolution. As depicted in Figure 5 fully functioning teams show high task and social reflexivity. If reflexivity is low, teamwork does not function. Teams are cold and efficient if they solely focus on tasks and too cosy if they concentrate on social aspects and ignore their tasks.