TEAM LEARNING IN INFORMATION SYSTEMS DEVELOPMENT - A LITERATURE REVIEW

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TEAM LEARNING IN INFORMATION SYSTEMS DEVELOPMENT - A LITERATURE REVIEW

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Abstract

Information Systems Development (ISD) is fast moving, knowledge-intensive and requires a substantive amount of teamwork. In order to develop quality software, teams need to leverage the skills and knowledge of each team member. ISD teams who engage in learning at a group level can perform more effectively and efficiently. However, relative to other disciplines, knowledge and literature about team learning in ISD research is new and dispersed. This fact hampers the cumulative progress in research that seeks to answer questions about how ISD teams learn to work together and improve their performance. We draw on and extend the classification scheme of Edmondson et al. (2007) and conduct a review of ISD team learning research literature. We synthesize the main findings and highlight the limitations of existing approaches. We emphasize potential directions for future research while focusing on the resulting implications for ISD management and methodology. We further demonstrate that there are four distinctive streams in ISD team learning research that differ in the manner that they conceptualize team learning, underlying theories, and research methodologies. Finally, we illustrate how these differing streams can cross-fertilize and thereby present notable aspects of team learning presently addressed by related disciplines for which there is scant or non-existent ISD research.

Keywords: team learning, information systems development, transactive memory system, development methodology.
1 Introduction

Information Systems Development (ISD) keeps changing and evolving rapidly in a huge variety of aspects, including the technologies which are developed, the methods that are applied, and the structures in which it is organized (Avison and Fitzgerald 2006). With agile principles integrated into ISD practices in many companies, the emphasis today is more than ever on the team as a source of creativity and software quality (Dybå and Dingsøyr 2008). Consequently, not only the individual team members must keep pace with frequent changes, but so must the team as a whole. In order to develop innovative solutions, all team members’ skills and expertise must be leveraged and brought to bear at the team level. ISD teams who actively learn about technologies, customer activities, and group processes on a team level can, therefore, develop better software and increase their performance (Janz and Prasarnphanich 2009; Liang et al. 2010). While other disciplines have made attempts to organize their body of knowledge on team learning (e.g. Edmondson et al. 2007; Wilson et al. 2007; Goodman and Dabbish 2011), team learning research in ISD has been dispersed and unorganized thus far. Scholars have accentuated the need for team learning theories that take the specifics of disparate tasks and industry domains into account (Edmondson et al. 2007), but without a consolidated body of research this is hardly possible for ISD. In this paper, we capture, therefore, the current state of research on team learning in ISD in order to foster cumulative scientific progress in our discipline. We concentrate on the following questions: why and how do ISD teams learn; and what are the consequences for future research on ISD management and methodologies. Drawing on and extending Edmondson et al. (2007)’s classification scheme of team learning literature, we critically synthesize substantive findings and reveal limitations that are present in the current streams of ISD team learning literature with regard to conceptualizations, research methodology, logic, and hidden assumptions. Moreover, we contrast research in ISD team learning with current team learning literature from neighboring disciplines. We depict concepts that are frequently investigated in those disciplines but have remained nearly unattended in our field. Finally, we highlight implications for research on ISD management and methodologies and thereby provide fruitful directions for future research in our discipline to understand ISD team learning and its outcomes.

2 Research Methodology

We conducted a systematic review of ISD literature to consolidate the present body of scholarly ISD research on team learning and explore how ISD can benefit from team learning research by related disciplines. We followed a systematic approach as proposed by different scholars (Kitchenham and Charters 2007; Kitchenham et al. 2009; Okoli and Schabram 2010) to create a proper synthesis and scholarly critique of theory (Webster and Watson 2002; Schwarz et al. 2007; Okoli and Schabram 2010). Having defined our research questions, we developed a review protocol. This protocol consisted of: (1) defined research sources; (2) means of access to be used; and (3) basic inclusion and exclusion criteria (Kitchenham and Charters 2007). As a working definition, we conceptualized team learning as any change in the work group’s repertoire of potential behaviors (Wilson et al. 2007), and included papers that addressed antecedents, effects or properties of such change. We excluded educational and technology-focused literature as we wanted to understand the social phenomenon of learning in ISD teams rather than education in classrooms or technological aspects of ISs. In order to restrict the sample of papers to rigorous research, we included only top quality outlets from IS and related disciplines. The list of sources searched included, among others, the AIS senior scholars’ basket of journals, IEEE Transactions on Engineering Management and Software Engineering, Management Science, Decision Sciences, Organization Science and top IS conference proceedings. We searched the selected IS outlets in the database Social Sciences Citation Index via the Web of Science, IEEE Xplore, and the AIS Electronic Library for the search term "learn*". In addition to IS journals, we searched a set of high impact journals from the related disciplines of management and organization science. Since we could build on several rigorous reviews in these disciplines (Edmondson et al. 2007; Wilson et al. 2007; Goodman and Dabbish 2011), we focused on recent papers of these disciplines
published after 2006. We did not impose such a restriction on IS papers. In order to ensure consistency throughout the literature selection process, the first and the second authors of this paper engaged in the selection procedure (Okoli and Schabram 2010) by: (1) jointly conducting an examination of the first 25 papers; (2) discussing any different opinions about whether or not to include any one of these papers; (3) dividing further selection activities between them; and (4) then consulting one another regarding selections only in ambiguous cases. In order to address the critique of systematic literature reviews (Boell and Cezec-Kecmanovic 2011), we also reviewed the selected papers to determine whether any of them referenced research papers that we had inadvertently overlooked in our initial selection process. We realized that some relevant and referenced papers had not been retrieved by our first queries. Consequently, we performed an additional iteration of search and selection for the terms “knowledge management” and “transactive memory” which helped to include these papers. In total, our queries in titles, abstracts, and keywords returned more than 600 hits. Based on the titles and abstracts, we excluded all contributions that clearly did not address learning on a team level or that focused on the examination of knowledge management information systems without also addressing aspects of our defined research questions. 86 papers were selected for closer examination and 60 of these were found to address learning on a team level. We read the latter and extracted data about their findings, key concepts, methodology, and key aspects regarding conceptualizations of team learning, and of ISD if present. At least two authors validated the extracted data for every paper. Finally, we synthesized collectively the 24 studies that addressed ISD team learning, along with the key concepts and emerging patterns they described (Webster and Watson 2002; Schwarz et al. 2007), and contrasted them to the research from related disciplines. These results are presented below.

3 Team Learning in Information Systems Development

Learning on a team level has long been recognized as a decisive factor influencing the performance of all work groups (Wilson et al. 2007). However, there is a variety of definitions of team learning. These conceptualizations of team learning can, therefore, be a useful criterion to understand the logic and hidden assumptions that underlie different streams of research on this topic. Edmondson et al. (2007) differentiate between three conceptualizations prevalent in literature and find that, according to the selected conceptualization, studies differ in their main dependent and independent variables, methods, and findings. In the following, we show that these streams also exist in ISD team learning research. We discuss their assumptions, methods, findings, theories, and potentially fruitful future directions. Moreover, we identify a fourth, recently emerged stream that differs from the others in its underlying concept of team learning and takes a more structural perspective.

3.1 The Team Learning Curve of Outcome Improvement in ISD

Research on performance improvement is traditionally conducted with an emphasis on learning curves (Argote et al. 1990), without any deeper investigation into the underlying mechanisms of team learning at a group level. Accordingly, the concept of team learning is one of mere outcome improvement (Edmondson et al. 2007). Rather than explaining properties of team learning, research in this realm has aimed at finding determinants of team performance improvements. Based on observed improvements in productivity and logical reasoning, research has assumed team learning to occur, without the empirical proof of direct measurements (Edmondson et al. 2007). For example, Teasley et al. (2002) reason that the performance increase they observe in settings of radically collocated ISD teams is largely caused by better opportunities for team learning. Whether and how such learning takes place, however, exceeds the boundaries of this school of research.

Based on analytical models and a case study, Mookerjee and Chiang (2002) show that tighter coordination policies are more appropriate for ISD teams which are early on the learning curve from a total effort perspective than they are for more advanced teams. Following the same school of thought, Boh et al. (2007) define learning as “the increase in productivity of developers as their experience increases” (Boh et al. 2007, p.1322). Accordingly, different types of experience are frequently examined and
related to the development of team performance. For example, the experience of developers and project managers in their respective roles within their ISD teams demonstrates a much stronger effect on team performance than does their mere respective experience within the company (Huckman et al. 2009). In accordance with this finding, experience with the applied software development methodology is emphasized as outstandingly decisive for team performance, while the knowledge gained from such experience is, interestingly, also being forgotten more rapidly than application or domain knowledge (Kang and Hahn 2009). Similarly, team productivity is found to be higher if ISD team members possess diverse experience with related tasks than if they are experienced in more unrelated systems or specialized in a single task (Boh et al. 2007). In general, higher familiarity by team members also appears beneficial for ISD team performance, and improved learning is frequently argued to be due to such familiarity (Boh et al. 2007; Huckman et al. 2009).

Despite its achievements, learning curve research on ISD team performance does not provide a conclusive answer to why such learning occurs or which mechanisms produce this complex interplay of experience and performance. Accordingly, there is an absence of theories in this stream of research that might explain such relationships. Only a minority of studies offer hints at concepts that might be useful for explaining these relationships (e.g. Teasley et al. 2002). Regarding research methodology, learning curve research in ISD builds on mostly quantitative analyses of archival data (Teasley et al. 2002; Boh et al. 2007; Kang and Hahn 2009; Huckman et al. 2009), selectively combined and enriched with other instruments like analytical models (Mookerjee and Chiang 2002) or qualitative follow-up interviews (Teasley et al. 2002).

3.2 Shared Knowledge and Group Memory in ISD

A second stream of literature conceptualizes team learning as a step towards task mastery and typically tries to explain learning effects as the “outcome of communication and coordination that builds shared knowledge by team members about their team, task, resources, and context” (Edmondson et al. 2007, p.277). The underlying assumption of this research is that commonly shared knowledge and meta-knowledge indicate that: (a) learning occurs at the team level; and (b) this common ground is explicitly and implicitly used by teams to improve their performance. It is thereby acknowledged that teams consist of individuals among whom knowledge is unevenly distributed and that the dissemination of individual knowledge into the group is central to realizing performance gains. Nevertheless, shared knowledge and group memory research conceptualizes team learning as the result of activities like the dissemination of knowledge rather than the activities themselves (Edmondson et al. 2007; Wilson et al. 2007; Goodman and Dabbish 2011). Socio-cognitive memory structures indicate teams learn from individual experiences. Different structures of group memory have been proposed in order to grasp this concept. The most pronounced one is Wegner (1987)’s Transactive Memory System (TMS). Such group memory structures connect single team members, who possess specialized knowledge, over the shared meta-knowledge of how certain task characteristics match the single individuals’ resources (Wegner 1987; Alavi and Leidner 2001). In other words, team members use each other as a memory source (Oshri et al. 2008). TMSs constituting an antecedent of team performance have especially been frequently examined on a team level in IS and organizational research (Edmondson et al. 2007; Choi et al. 2010).

One central finding of this stream of research is that knowledge and meta-knowledge shared in group memory account for the performance of ISD teams in several dimensions. Scholars find that knowledge shared in group memory improves ISD teams’ effectiveness and efficiency, and enhances their ability to transfer knowledge to others, as well as their ability to integrate external knowledge creatively into software products (Faraj and Sproull 2000; Kotlarsky and Oshri 2005; He et al. 2007; Espinosa et al. 2007; Oshri et al. 2008; Nemanich et al. 2010; Maruping et al. 2009; Lin et al. 2011; Zhang et al. 2011). In accordance with the demands of Alavi and Leidner (2001) for more research into the facilitating conditions of learning and knowledge management, several research endeavors have been undertaken to find the antecedents for the establishment of group memory structures in ISD.
teams. Unsurprisingly, scholars find close and frequent interactions of team members to be one of these antecedents (Levesque et al. 2001; He et al. 2007). However, such close interactions are much harder to achieve in globally distributed software development teams whose members must potentially work across spatial, temporal, and socio-cultural boundaries. This distribution can heavily impact the teams’ abilities to create a group memory system suiting their needs (He et al. 2007; Espinosa et al. 2007, Oshri et al. 2008). While the negative influence of team distribution can be reduced by employing coordination mechanisms of a wide range, from mutual visits over standardized organizational structures to communication technologies, these must be finely tuned as the situational settings influence the mechanisms’ applicability (He et al. 2007; Oshri et al. 2008).

Group memory systems in ISD evolve over time and can grow or shrink (He et al. 2007). One reason is that ISD team members differ in their needs for interaction depending on their roles and tasks. For example, developers perceive different pressure points in team coordination than do ISD managers (Espinosa et al. 2007). Consequently, ISD teams whose members increasingly specialize in a certain role and work on tasks having low interdependency with others tend to have shrinking group memory over time (Levesque et al. 2001). In line with this argument, Vidgen and Wang (2009) propose that more interconnecting practices, multi-skill development, and autonomy in ISD can enhance team learning. However, recent findings by Nemanich et al. (2010) indicate that there are more complex relationships between team knowledge, autonomy, individual developers’ capabilities, and teams’ ability to learn, than previously assumed. Interestingly, these authors find that possession of existing knowledge does not necessarily improve ISD teams’ ability to learn. Quite the contrary, they find that teams with less prior knowledge are forced to learn more rapidly and receive more benefits from doing so (Nemanich et al. 2010). Moreover, mechanisms to control the importance of large bodies of shared knowledge in ISD teams also appear to exist. Maruping et al. (2009), for example, find that collective code ownership reduces the impact of the group memory system on the quality of software development, while established coding standards increase it. Finally, the establishment of a group memory system can also be fostered by appropriate knowledge management systems (Zhang et al. 2011).

Two theoretical lenses underlie the majority of studies on group memory in ISD research: (1) shared cognition based on the concept of shared mental models (Cannon-Bowers et al. 1993); and (2) TMS (Wegner 1987). Only Vidgen and Wang (2009) and Zhang et al. (2011) ground their work in other theories, namely absorptive capacity and complex adaptive systems. From a methodological perspective, two research designs are applied: (1) survey-based quantitative analyses (Faraj and Sproull 2000; Levesque et al. 2001; He et al. 2007; Lin et al. 2011; Maruping et al. 2009; Nemanich et al. 2010; Zhang et al. 2011); and (2) qualitative, interview-based case studies (Kotlarsky and Oshri 2005; Espinosa et al. 2007; Oshri et al. 2008; Vidgen and Wang 2009). While several of these studies acknowledge that there are processes at the team level that are decisive for the development and use of commonly shared knowledge and meta-knowledge, such processes are not captured in any of these studies. In general, this stream of research measures the teams’ state of common knowledge or meta-knowledge, but it does not address the actual activities which lead to changes in such knowledge.

### 3.3 Team Learning Behavior as a Group Process in ISD

While research on group memory merely acknowledges the existence and importance of team level processes and activities without addressing the same, a behavioral school of team learning research exists which focuses exactly on these aspects. Scholars in this stream of research conceptualize team learning as an ongoing group process of reflection and action (Edmondson 1999), typically including different activities such as information sharing and reflection on expertise (Edmondson et al. 2007). The focus of this stream of research is on teams’ learning behaviors from both a theoretical and methodological perspective.

Team learning scholars have highlighted that, not only is the team knowledge important for team performance, but so is what team members actually do with this knowledge. For example, Walz et al.
(1993) find that software design team members engage in the acquisition, the sharing, and the integration of knowledge into the group. While an overall increase in the level of domain knowledge at a team level might be helpful, the authors also argue that managed conflict within the team stimulates the team's learning behaviors (Walz et al. 1993). Liang et al. (2010) refine this proposition by demonstrating that the quality of developed software actually increases when team conflict that may be attributable to team members' differing backgrounds and expertise exists during a task. Such task conflict does not necessarily harm the productive communication within the team, but it stimulates learning behaviors. Notwithstanding, evidence also exists that simply teaming developers with different backgrounds and expertise alone does not necessarily lead to more engagement in learning behaviors or more creative results (Tiwana and Mclean 2005). Further research might be needed to clarify under what conditions ISD teams can benefit from heterogeneous expertise and task conflict in order to improve team performance. Such conflict about how to complete a task requires spare resources for discussions and conflict resolution. Consequently, the relationship between task conflict and team performance is evidently ambiguous. In contrast, other scholars acknowledge that such learning activities might have a positive influence on the team's performance, but argue that the stronger and more important effect of such learning activities is the resulting increase in individual team members’ satisfaction with work (Janz and Prasarnphanich 2009; Janz and Prasarnphanich 2003). Moreover, focusing on learning behaviors, researchers in this stream provide a possible explanation for the ambiguous findings on ISD team autonomy (Vidgen and Wang 2009, Nemanich et al. 2010) in group memory research – namely that different types of team autonomy might stimulate different learning behaviors and vary in their importance for the overall level of learning (Janz and Prasarnphanich 2009; Li et al. 2009).

Research on team learning behaviors in ISD is not based on a single dominant theoretical lens. It draws from a variety of theories, such as: collaborative learning theory (Janz and Prasarnphanich 2003; Janz and Prasarnphanich 2009); information theory (Liang et al. 2010); and social interdependence theory (Li et al. 2009). Regarding research methodology, this stream heavily builds on quantitative survey-based designs. Yet, as in related disciplines, many scholars exclusively collect research data on an individual level. This can lead to a divergence in the levels of analysis and theory that is, neither always necessary, nor desirable in team learning research (Goodman and Dabbish 2011).

### 3.4 A New Structural Approach to Analyze Team Learning in ISD

Research in team learning behaviors theoretically and empirically examines learning behaviors as a group process, in the sense of uniform activities like reflection and discussion at a team level. More recently, scholars have adopted the perspective that the individual’s role within ISD team learning is more multifaceted than has hitherto been acknowledged (Skerlavaj et al. 2010; Sarker et al. 2011). They conceptualize the team as a network of individuals who interact in different ways and intensities. Team learning consequently consists of interactions between these networked actors in this perspective. To examine these interactions more closely, researchers choose methods and theories that account for both the individual and the team level in their analyses.

For different reasons, some individuals can become more important for overall team learning than others. For example, Sarker et al. (2011) show that there can be “stars” in globally distributed ISD teams who comprise the central institutions for knowledge exchange activities between team members. These stars are highly trusted by the rest of the team and communicate more frequently with more team members. As a result, they can also serve as boundary spanners for different sub-groups within the team. Interestingly, the stars’ own knowledge of technologies or management is not necessarily high (Sarker et al. 2011). Nevertheless, Skerlavaj et al. (2010) show that such central actors in the learning network are often found in senior positions and that the flow of knowledge between single team members is not necessarily reciprocal. Consequently, team members who share more knowledge do not necessarily profit from knowledge returned at an individual level. This might be one possible explanation why research in ISD team learning behaviors as a group process has produced inconsistent
findings about the effects of team level engagement in teaching and assistance to team members (Janz and Prasarnphanich 2003; Janz and Prasarnphanich 2009; Li et al. 2009).

Skerlavaj et al. (2010) and Sarker et al. (2011) follow an innovative approach in researching team learning in ISD by accounting for the structural and relational properties of the ISD teams as groups of interlinked individuals. In accordance with this perspective, they apply Social Network Analysis (SNA) (Wellman et al. 2003) as a central method in their studies of ISD teams. Regarding underlying theories, the scholars draw from a variety of different perspectives to explain the observed phenomena. Despite the low number of studies taking this structural view to date, we argue that these papers represent a new stream of research in ISD team learning. The reason is that they propose a radically new structural conceptualization of the learning team as a network of individuals whose interactions constitute team learning in their entirety. Accordingly, they also show methodological innovation by the application of SNA to the field of ISD team learning. Moreover, by explicitly taking a perspective that models a relationship between team learning and the learning of team members, researchers might possibly be able to overcome one of the most criticized aspects of team learning research, namely the confusion of group learning and individual learning in a group (Goodman and Dabbish 2011). Extending the body of research in this stream appears very promising as it opens up a wide field of explanations for the team level phenomena of learning.

<table>
<thead>
<tr>
<th>Methods / Streams in ISD Team Learning</th>
<th>Total Learning Curve</th>
<th>Group Memory</th>
<th>Group Process</th>
<th>Structural Perspective</th>
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<tr>
<td>survey-based quantitative</td>
<td>7</td>
<td>5</td>
<td></td>
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<tr>
<td>interview-based qualitative</td>
<td>1</td>
<td>4</td>
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<td>archival data for quantitative</td>
<td>4</td>
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<td></td>
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<tr>
<td>others (simulation, SNA)</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
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<tr>
<td>number of studies included</td>
<td>24</td>
<td>5</td>
<td>11</td>
<td>6</td>
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</table>

Table 1. ISD team learning studies: data collection and analysis methods (multiple possible)

Table 1 provides an overview of the studies of ISD team learning we found as well as their methodologies. In summary, we find four streams of research on team learning in ISD based on the three categories proposed by Edmondson et al. (2007): (1) learning curve research which treats learning as a black box between situational factors and outcome improvement; (2) group memory research which takes a knowledge-centered perspective on team learning as the creation of a system of common knowledge and meta-knowledge; (3) team learning behavior research which addresses the distinct team level processes of learning as observable group activities; and finally (4) a structural approach which explicitly accounts for the dynamic learning structures and relations between individuals that constitute team learning in their entirety. These schools all make valuable contributions to a growing body of knowledge and expose distinct features which shed light on equally distinct aspects of team learning in ISD. We consequently agree with Edmondson et al. (2007) that a single, unified concept of team learning is not what scholars should strive to pursue. Instead, we argue for pluralism and cross-fertilization of research streams. Fruitful effects may be created by more theoretical and methodological diversity. Learning behavior research, for example, might profit from analysis of archival data which is common in learning curve research. This could complement existing survey-based approaches to reduce the occasional disparity of the levels of theory and analysis. Similarly, structural approaches might take a larger variety of team learning processes into account to gain a more precise picture of the interactions between individuals and their effects on the team as a collective. Despite all calls for diversity, we also advocate more consistent measures and operationalization across research studies as necessary prerequisites for the cumulative progress of ISD team learning research.
4. **Avenues for Future Research**

The state of research we have presented so far offers a number of insights into ISD team learning. Comparing the state of this research to literature in related disciplines, it is evident that ISD research has partially or totally ignored some aspects research in related disciplines. Below, we will highlight areas of research where organization and management science research has created a diverse body of knowledge while ISD team learning research has only superficially examined them. Thereafter, we will address the resulting implications for what we perceive as outstanding ISD management and methodology research given the present state of team learning research in ISD as well as that of related disciplines.

4.1 **Contrasting ISD Team Learning to Neighboring Disciplines**

**Team Leader Behavior:** Team leaders often play a dominant role in ISD projects (Nambsan and Wilemon 2000). Sarin and McDermott (2003) find that a democratic leadership style, initiation of a goal structure by the team leader, and the leader’s position within the organization positively relate to team learning. Team leadership also plays a critical role for team effectiveness and team performance (Edmondson et al. 2007, Edmondson and Nemhard 2009). For instance, team leaders can stimulate team learning by involving the members in the decision-making process and outlining the team goals and expectations (Sarin and McDermott 2003). In line with this argument, Van der Veg et al. (2010) find that the configuration of power within a team is a key factor important for team learning.

Despite great attention to the role of project managers or team leaders in the success or failure of ISD projects, the link between team leadership and team learning is often missing in ISD team learning research. Among those few researchers who address this link, Vidgen and Wang (2009) note that central task allocation by a project manager without consultation with team members can inhibit learning in ISD. Additionally, Sarker et al. (2011) find formal and emergent leaders to be central for knowledge transfer in globally distributed ISD. Moreover, a change in team leadership style should also influence team learning. A Scrum Master, for instance, is not a traditional team leader. Rather, a Scrum Master’s role is that of a facilitator who solves key issues that impede the team’s success and takes care of interactions and collaborations (Dybå and Dingsøyr 2008). One of the most important roles of a Scrum Master is to conduct retrospectives in order to assess lessons learned. The role of a Scrum Master may consequently influence the team’s learning very differently from traditional leaders. Therefore, ISD researchers should evaluate and assess different leadership behaviors and roles, as well as their influence on group learning in ISD teams.

**Team Learning Goal:** Behavior at work and particularly the learning behavior are each affected by different goals and purposes. Tjosvold et al. (2004) propose that team members may reach different conclusions about how their individual goals are structured, and as a result, adapt their interactions with other team members. Trying to achieve individual goals in a team can conflict with other members’ interests. Tjosvold et al. (2004) conclude that goal setting is likely to affect team learning behavior in terms of interactions, information sharing and supporting other members in group challenges. Using goal orientation theory, Hirst et al. (2009) note that “the relationship between an individual’s goal orientation and creativity is contingent on team learning behavior” (Hirst et al. 2009, p.282).

Prior ISD research emphasizes that an incongruity of goals, for instance, is often found in distributed teams in offshore ISD projects (Levina and Vaast 2008). Team members can have competitive and independent goals that in turn affect team learning. This issue might also be one possible explanation why the influence of knowledge sharing is dependent on the geographical pattern of team member distribution in new product development teams (Staples and Webster 2008). Research on ISD team learning should clarify to what degree learning goals can beneficially influence team learning and performance in different configurations and team structures.
**Task Characteristics:** There is empirical evidence of the effects of task characteristics on team learning. Edmondson (1999) outlines several task characteristics that she argues affect team learning. She asserts that “highly routine repetitive tasks with little need for improvement or modification” may inhibit team efficiency and performance (Edmondson 1999, p.354). On the other hand, uncertain and risky tasks may raise the need for teams to learn continuously in order to understand the environment, as well as customers’ needs. Uncertain tasks may further require team members to coordinate more effectively. Wong (2004) measure task routineness by the frequency of unexpected and novel events that occur during the accomplishment of a task. Research in this direction has created measures and operationalizations of task characteristics in areas related to ISD research, such as new product development (Gino et al. 2010). However, only a few ISD team learning scholars (see Huckman et al.2009) have attempted to develop such instruments for software development tasks in order to set the characteristics of ISD tasks in relation to team learning and performance. We argue that doing so is a worthwhile endeavor, since: not all tasks in ISD are non-routine and not all of them demand creativity which might require different levels of team learning for different types of tasks.

### 4.2 Implications for ISD Management

One of the most prominent fields of research in ISD management is concerned with globally distributed software development projects. An enormous challenge in such a setting is the management of culturally diverse ISD team members. Research is continuously trying to discover and explain effective management practices to address it (Levina and Vaast 2008; Gregory 2010). Team learning scholars have contributed to this endeavor by finding mechanisms which stimulate the creation of a common group memory (Kotlarsky and Oshri 2005; Kanawattanachai and Yoo 2007, Oshri et al. 2008). They have also highlighted the existence of different situational prerequisites to and inhibitors of learning activities across the global team, such as trust, psychological safety, and aspects of collocation (Staples and Webster 2008; Van der Vegt et al. 2010; Choo 2011). Notably, team learning scholars have recently argued that globally distributed team members might actually never be able to develop a real shared mental model because of their different backgrounds. Instead, creating cross-understanding is proposed as a better solution (Huber and Lewis 2010). The implication for global ISD management is that team members should be brought into a position to understand each others’ various values and manner of thinking rather than striving to create one single “negotiated culture” (Gregory 2010, p.6). Future research should investigate which underlying team processes can be stimulated in order to create such cross-understanding.

Team learning research also provides an explanation why personnel turnover is an important cost driver in offshore ISD (Dibbern et al. 2008). When single members leave the team, the existing group memory is negatively impacted, causing a decrease in team performance on occasions when such loss is not successfully accounted for by management (Lewis et al. 2007). Since not all individuals are equally central to team learning activities and knowledge flows (Skerlavaj et al. 2010; Sarker et al. 2011), the loss of a single developer can potentially corrupt the entire memory system within an ISD team. As such, future research should investigate how actors who are pivotal to the team’s learning activities can be identified so that timely precautions are taken to address their central role within the team with special care.

### 4.3 Implications for ISD Methodology

With regard to ISD methodology, team learning research makes several contributions and depicts potential areas for future investigations. First, the findings on team autonomy, which is a central aspect in agile development methods such as extreme programming, are not consistent (Janz and Prasarnphanich 2009; Vidgen and Wang 2009; Nemanich et al. 2010). They indicate that different types of team autonomy can stimulate different team behaviors, but not all of them improve performance.
Research might address the question of what kind of autonomy should be given to ISD teams in different contexts in order to simultaneously stimulate learning and increase performance. Next, increased development of multiple skills by team members and reduced specialization, which are found in lean software development approaches (see Dybå and Dingsøyr 2008; Poppendieck and Poppendieck 2003), influence team learning behavior by reducing the need for awareness of expertise location (Vidgen and Wang 2009; Maruping et al. 2009). However, this does not necessarily lead to higher team creativity or performance as developing similar skills reduces the heterogeneity of expertise and potentially fruitful task conflicts (Tiwana and Mclean 2005; Liang et al. 2010). Under certain conditions, hierarchical team structures with specialist roles can actually foster team learning (Bunderson and Boumgarden 2010). Future research should, therefore, investigate in which cases in ISD an agile team of generalists can perform better and in which cases a hierarchical team structure with several specialists might be superior. Finally, at least some development practices manipulate the relative influence of team learning on software quality in ISD (Maruping et al. 2009). However, which specific developer behaviors are triggered by such practices remains obscure so far. Revealing these behaviors and their underlying mechanisms would constitute a significant step in understanding the relationship between development methodology, team learning, and team performance (Maruping et al. 2009).

5 Conclusion

To the best of our knowledge, we are the first to conduct a literature review of scholarly research on team learning with a focus on ISD. Unlike existing reviews, we thereby account for findings on the specifics of ISD as a complex organizational function. This is in line with recent calls for more domain-specific theories of team learning (Edmondson et al. 2007). Based on the categorization scheme of Edmondson et al. (2007), we examine three perspectives on team learning applied to the field of ISD and highlight their distinct characteristics, assumptions, and limitations: (1) the team learning curve, (2) shared knowledge and group memory, and (3) team learning behavior. In addition to these streams, we identify an innovative approach to research team learning in ISD which takes a structural and relational perspective. We present several aspects which these streams of research can cross-fertilize. We emphasize team leader behavior, learning goals and task characteristics as concepts which ISD team learning research has widely neglected by contrasting team learning in ISD to related disciplines. We also highlight several implications for ISD methodology and management, especially in globally distributed settings and agile development practices. In summary, we hope to contribute to the progress of our field in understanding, explaining, and improving team learning in ISD.

References


