Antecedents to Team Performance on Student IT Projects

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ABSTRACT

A study was performed to test the impact of factors suggested by social capital and social cognitive theories as important antecedents to team performance on information technology (IT) course projects. Specifically, the impact of personal outcome expectations and social interaction ties on the quality and quantity of knowledge sharing is examined; then, the impact of the quality and quantity of knowledge sharing on team performance is analyzed. The analysis is performed using the partial least squares approach to structural equation modeling. The results indicate that personal outcome expectations significantly impact knowledge sharing while no evidence was found for a relationship between social interaction ties and knowledge sharing. Additionally, both the quantity and quality of knowledge sharing were found to have significant positive effects on team performance.

Keywords: Knowledge sharing, Team performance, Team projects, Social capital, Social cognitive theory

1. INTRODUCTION

Using teams to design, develop, and implement information systems is a necessity and the norm in most business organizations and within the software development industry. Teaching information technology (IT) students tools, techniques, methods, and technologies to develop state-of-the-art systems addresses only one aspect of becoming a successful professional in today's work environment. Developing communication and interpersonal skills and learning how to effectively interact with other professionals is also critical for attaining professional expertise and success.

One way universities build these soft skills is through a project or practicum course where students work in teams to develop a system for "real-life" clients. The overarching objective of these courses is for students to address challenges that are not simply "textbook" problems or cases, but include the nuances associated with dealing with a client and others on the team. These courses allow students to gain experience working on a team and to develop skills that lead to improved team performance, and in turn result in more successful projects. The importance of these courses to the education of IT students is evidenced by the number and diversity of papers published focusing on various aspects of these courses and the number of suggestions made for improving these courses (Broman, Sandahl, and Baker, 2012; Oakley et al., 2007; Pimmely, 2003; Schlimmer, Fletcher, and Hermens, 1994). Some of the more relevant work includes a study that investigated determinants of student team performance and found that peer evaluations and objective measures from a learning management system were correlated with team grades and performance (Braender and Naples, 2013) and the work on the impact of team emotional intelligence on team effectiveness (Dunaway, 2013). Lastly, the importance of collaboration on student team performance in a recent teaching tip also suggests the importance of this topic (Buche, 2013).

Many factors are thought to influence team performance and many of these have been studied including how teams are formed (Bergey, 2012); time separation and coordination (Espinosa, Cummings, and Pickering, 2012); culture (Hodgson, Hubbard, and Siemieniuch, 2013); team familiarity and role experience (Huckman, Staats, and Upton, 2012); leader behavior (Kolb, 1993) and emotional display (Van Kleef et al., 2012); media (Wellens, 1989) and information sharing (Mesmer-Magnus and Dechurch, 2012); and communication frequency (Patrashkova-Volzdoska et al., 2003). Additionally, there have been articles summarizing the extant research and calling for further research on team performance (Salas, Cooke, and Gorman, 2012).

One of the factors identified as important for team performance is knowledge sharing. Knowledge sharing is defined as the process of identifying relevant knowledge distributed throughout an organization and transferring it to another context where the knowledge is needed (or useful) (Choi, Lee, and Yoo, 2010). Within teams, knowledge sharing allows members of a team to identify other team members that have the knowledge to solve problems or perform tasks; resulting in the reduction of time or costs associated with performing a task. Knowledge sharing has been studied almost exclusively as an objective of the project management process and as necessary for project success (Choi, Lee, and Yoo, 2010; Jewels and Ford, 2006; Malhotra and Majchrzak, 2005; Nambisan and Wilemon, 2000; Petter, Mathiassen, and Vaishnavi, 2007). There has been a good deal of research on improving knowledge sharing on project teams and identifying the factors that influence knowledge sharing during the software development process (Chenghong, Yunjie, and Cheng, 2008; Hsu, Lee Jang, and Der-Chen, 2011; Kettunen, 2003; Liang et al., 2009; Liyun, Keyi, and Zhenzhong, 2010; Lu, Wang, and He, 2010; Mitchell and Seaman, 2012; Newell et al., 2005; Sena, Shani, and Stebbins, 1999; Uchihira et al., 2012; Zhixin, 2012). In addition to these findings, Choi, Lee, and Yoo (2010) found a link between knowledge application and team performance; but did not find a significant link between knowledge sharing and team performance.

Despite this plethora of research on knowledge sharing and team performance, no research was found that investigates the antecedents to knowledge sharing and team performance for student projects in software development courses. To address this gap in the current knowledge base, a study was performed to test whether constructs from social cognitive and social capital theories can help explain the quantity and quality of knowledge sharing occurring during these projects (Bandura, 1986). These theories suggest antecedents to the behaviors observed during IT project activities and therefore may prove useful for instructors as they attempt to improve the development process. The quality and quantity of knowledge sharing were then analyzed to determine their impact on team performance.

The contribution of this research is to test the link between important aspects of IT students' perceptions (personal outcome expectations and social interaction ties) on knowledge sharing and team performance during software development course projects. The results provide guidance for instructors to improve student learning by taking these constructs into account prior to project initiation.

2. RESEARCH QUESTIONS & HYPOTHESES

2.1 Research Questions

This project was conducted to address two overarching research questions, they are:

1. Do student perceptions of project outcomes and their social ties have an influence on knowledge sharing on software development projects?

2. Does knowledge sharing influence team performance on student software development projects?

2.2 Theoretical Background

2.2.1 Outcome expectations and knowledge sharing: Bandura's Social Cognitive Theory (Bandura, 1986) proposes that human behavior is defined by a social environment and the set of personal factors and behaviors that occur in this environment. One of the personal factors that is thought to impact behaviors is outcome expectations. Outcome expectations are defined as "a judgment of the likely consequences such performances will produce." Bandura's theory has been used to examine behaviors related to computer and Internet use, computer training, as well as knowledge sharing in virtual communities (Chiu, Hsu, and Wang, 2006; Compeau and Higgins, 1995a; Compeau and Higgins, 1995b; Compeau, Higgins, and Huff, 1999; Hsu and Chiu, 2004a, 2004b). According to the theory, individuals will behave in ways that improve the chance of attaining positive outcomes. A simple example of outcome expectations is that if I study an hour longer, I will perform better on a test. In the case of our class projects, if students believe that sharing knowledge will lead to more a more productive environment and working relationship with their team mates, then we would expect students to share knowledge with one another with the expectation that by doing so they will improve the project's likelihood for success (and improve the likelihood of a better grade, both individually and for the team). Based on the theory, the following hypotheses are proposed and tested:

> **H1a**: Students' personal outcome expectations are positively associated with their ***quality*** of knowledge sharing.

> **H1b**: Students' personal outcome expectations are positively associated with their ***quantity*** of knowledge sharing.

2.2.2. Social interaction and knowledge sharing: Social Capital Theory postulates that social capital is the set of resources embedded with a network of relationships possessed by an individual, i.e. a social network (Chiu, Hsu, and Wang, 2006; Nahapiet and Ghoshal, 1998). The theory suggests that social capital strongly influences the extent to which interpersonal knowledge sharing occurs (Chiu, Hsu, and Wang, 2006). It is proposed that close social interactions between individuals increase the quantity and quality of knowledge exchanged. It would be expected that if the students' social ties outside of class are high then they would be more inclined to share knowledge during the class project. Students that are friends or share some social bond are more likely to trust one another and feel a sense of obligation to pull their weight on a project. Based on this theory and prior research findings the following hypotheses are proposed:

> **H2a**: A higher level of students' social interaction ties are positively associated with their quality of knowledge sharing.

> **H2b:** A higher level of students' social interaction ties are positively associated with their quantity of knowledge sharing.

2.2.3 Knowledge sharing and team performance: The knowledge management literature suggests that knowledge sharing should have a direct positive impact on team performance. This occurs due to reduced mistakes, increased efficiency in tasks, better decision-making, and avoiding non-productive work. Most of the prior research in this area supports this view (Argote and Ingram, 2000; Cummings, 2004; Hansen, 2002); however, other studies have tested the relationship between knowledge sharing and team performance with mixed results (Choi, Lee and Yoo, 2010). In these cases, it was posited that while knowledge had been shared it had not been applied. Based on this research, it would be expected that the quantity and quality of knowledge sharing would improve team performance on student software development projects. Therefore, the following hypotheses are proposed and tested:

H3a: The quality of knowledge sharing will lead to higher team performance.

H3b: The quantity of knowledge sharing will lead to higher team performance.

2.3 The Research Model
The use of social capital and social cognitive theory to help in explaining team performance has been examined for product development teams (Brookes et al., 2007). It seems logical that the creation and communication of knowledge during the development process would be important for team performance. The importance of information sharing and team performance is specifically discussed and analyzed in detail in prior research (Mesmer-Magnus and Dechurch, 2012). Based on these hypotheses a research model is proposed and is presented in Figure 1.

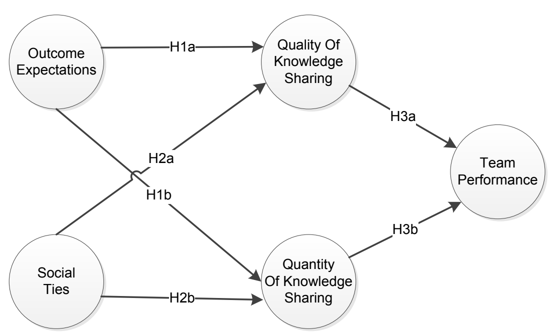

Figure 1: Research Model

3. RESEARCH METHODOLOGY

To test the proposed hypotheses data was gathered in software development courses using a survey instrument (see Appendix 1). The first course was a "project" course where students worked on a development project for the entire semester. Data was collected from different sections of the course. Each section worked on a different project. The second course from which data was collected was a database management course. The projects in this course were "shorter" projects consisting of requirements gathering, database design, implementation, testing, and demonstration of operational functionality. These projects were performed over a three week period at the end of a 15 week semester.

The survey instrument included scales for each of the constructs being studied: outcome expectations, social interaction ties, knowledge sharing quantity, knowledge sharing quality, and team performance. All of these scales were developed and validated in prior research (Chiu, Hsu, and Wang, 2006; Choi, Lee, and Yoo, 2010; Compeau and Higgins, 1995a; Compeau, Higgins, and Huff, 1999). To analyze the data and test the hypothesized research model, a PLS (partial least squares) method for structural equation model (SEM) estimation was used. PLS estimates the structural model using an iterative OLS regression-like algorithm that aims to explain the variance of the dependent variables by minimizing the residual variance of all dependent variables, both latent and observed. Due to the iterative approach of PLS, less restrictive assumptions regarding data distribution and sample size are possible. SmartPLS software version 2.0 was used (Ringle, Wende, and Will, 2005).

4. RESULTS

4.1 Measurement Validation
All the variables included in the model were measured as reflective. The results of tests for reliability and construct validity indicated satisfactory results. The descriptive statistics for the survey items and the model constructs are presented in Appendices 2 and 3. The reliability indexes of the latent constructs were evaluated using composite reliability. Composite reliability of 0.70 or higher is considered acceptable (Lee et al., 2011). To assess convergent and discriminant validity, the square root of the average variance extracted (AVE) should be at least 0.707 (Chin, 1998) and exceed the correlation between the subject construct and all the other constructs (Gefen and Straub, 2005). In addition, the standardized item loadings should load more highly on the intended construct than others and also should be greater than 0.707 (Chin, 1998; Lee et al., 2011) .

The results of the measurement validation for the reflective constructs are given in Table 1 and the item loadings are presented in Appendix 4. The composite reliability for each of the variables is much higher than 0.707. The square root of the variance extracted (AVE) for all the constructs is also higher than the benchmark 0.707. As the quantity of knowledge was measured by only a single item, its AVE is 1 and therefore the reliability cannot be calculated. All of the standardized item loadings load on the intended construct more highly than the others. All of them are greater than 0.70 except for EXP3 and KL1. Using a bootstrapping procedure to further test the significance of these items on the intended latent variable reveals that they are both highly significant (p-value $< .01$). Based on these results and the fact that both of these scales have been validated and used in prior research, it was deemed more appropriate to include these items in the analysis rather than dropping them out.

4.2 Testing the Structural Model
The final sample size included in the analysis was 121 student subjects. The PLS results are given in Figure 2. Outcome expectations have a significant positive effect on both quality (0.585, $p<.01$) and quantity of knowledge sharing (0.563. $p<.01$), supporting hypotheses H1a and H1b. Both quality (0.474, $p<.01$) and quantity of knowledge sharing (0.239, $p<.01$) have significant positive effects on team performance, supporting H3a and H3b.

CONSTRUCT	AVE	SQRT AVE	COMPOSITE RELIABILITY	OE	KL	KT	ST	TP
OE	0.5157	0.7181	0.8623	**0.7181**				
KL	0.5915	0.7691	0.8957	0.5599	**0.7691**			
KT	1.0000	1.0000	1.0000	0.5792	0.6029	1.0000		
ST	0.9117	0.9548	0.9117	0.3868	0.1615	0.2595	**0.7955**	
TP	0.9023	0.9499	0.9023	0.4670	0.6178	0.5244	0.0822	**0.8358**
OE: Outcome Expectations, KL: Knowledge Quality, KT: Knowledge Quantity, ST: Social Interaction Ties, TP: Team Performance								

Table 1. Reliability, Convergent, and Discriminant Validity Measures

However, social ties did not have significant effects on the quality or quantity of knowledge sharing; therefore no support for H2a or H2b was found in this study.

In addition to the analysis of the path coefficients in the model, the R-square values indicate the amount of variance explained by the model for the construct. In this case, the quality and quantity of knowledge sharing explain 41.8% of the variance of team performance. And social ties and outcome expectations together explain 31.7% of the variance for the quality of knowledge sharing and 33.7% of the quantity of knowledge sharing. In social science research R-square values above 0.25 but below 0.5 are considered significant, but weak. In this case all of the values fall in this range.

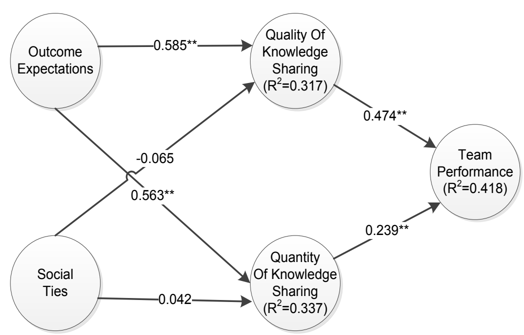

Figure 2: PLS Results

5. DISCUSSION, LIMITATIONS, AND IMPLICATIONS

The results of this study suggest that:

1. Students are more motivated to share knowledge when they perceive that it could improve the success of the project they are working on (and, in turn, the grade they receive in the class). That is, outcome expectations increase both the quality and quantity of knowledge sharing.

2. Both the quality and quantity of knowledge sharing are positively related to team performance.

These results suggest that if instructors can increase the level of outcome expectations they may be able to improve team performance via knowledge sharing. By emphasizing the importance of the project's success on the students' grades, and on their success after college as a professional, an instructor may increase both the quality and quantity of knowledge sharing that takes place during the project. Some specific actions an instructor could take to raise outcome expectations include the following: increase or emphasize the proportion of the students' grades that will be allocated to the final project outcomes, or by providing feedback and critical evaluation early in the project schedule (this should raise expectations), providing high quality examples or "archetypes" of work products and final deliverables.

Additionally, there are actions that instructors could take to improve both the quantity and quality of knowledge sharing during student IT projects. First, instructors could explicitly measure knowledge sharing (using the scales included in this study or other direct or indirect means) and making it part of the students' grade calculation. This may improve the course and learning objectives related to team performance by focusing attention on knowledge sharing. Also, there may be specific techniques that could be used or taught to improve knowledge sharing among the students during the project. Several techniques suggested by agile software development proponents may be useful for this. One technique used within the agile software development approach is "paired programming," this is where two programmers work together at the same workstation. While one writes code, the other is responsible for reviewing the code. By using this approach with "pairs" of students (with or without different levels of coding skills) to perform assigned tasks; more communication and creativity in design and development could occur. Certainly, frequent "stand-ups" or other regular communication structures used in agile (and traditional) approaches would seem a good procedure to surface challenges and potential solutions more quickly resulting in more knowledge sharing. These and other techniques for improving knowledge sharing on student software development projects may be fruitful topics for further research.

The impact that these activities have on the *quantity* versus the *quality* of knowledge sharing may vary. Given the strength of the relationships found in this study, it would appear that both quantity and quality are important. It seems logical that the quality of the knowledge sharing would be more critical to project success, i.e. relevant, useful knowledge would be more valuable than just more (or potentially irrelevant or distracting knowledge). In fact, there may be a point at which the amount of knowledge sharing is too much and would begin to have a negative effect on the project. For example, if new techniques are introduced too quickly, students may never master any and may therefore not perform certain basic activities (process modeling).

However, no evidence was found that social ties significantly affect the sharing of knowledge among students in software development courses. This could be good news for software development project course instructors. The instructor of a course can influence students' perceptions and expectations regarding outcomes much more easily than they can influence the social ties that students have with one another. One possible downside of the lack of significance between social ties and knowledge sharing is that students may not recognize the value or importance of developing a professional network outside of the classroom (or more importantly, the workplace). If students are actively engaged in professional student organizations, they should be more likely to share knowledge with colleagues or team members in class. Another aspect or plausible explanation for this finding is that students may "compartmentalize" their lives; i.e. they may explicitly segregate or separate their "work" life from their "home" life. Given the academic environment, this may be more likely versus the "real-world" work environment. While still in school students spend a much lower proportion of their time with professional colleagues (their fellow students) as compared to most working IT professionals. One way for instructors to attempt to influence this is by giving credit for participation in student organizations or sponsored events. This also could be an area for further research.

There are several limitations to this study. First, the data was gathered from only one university and from courses taught by only one instructor in a relatively short time frame (two years). To improve the generalizability of the study additional work could be performed to include student projects from diverse educational environments including multiple schools, courses, sections, terms, and projects. Additionally, while there did not appear to be any significant differences between the scores of participants in different courses, sections, and projects; it would be expected that some of these "environmental" constraints would have an impact on social ties, outcome expectations, and knowledge sharing. For example, it would be expected that a primarily commuter based student population may be less inclined to have "social ties" on student projects than a small, residential student body.

6. CONCLUSION

Based on data collected from project-oriented IT courses, an empirical study was performed to test whether constructs suggested by Social Cognitive Theory and Social Capital Theory were applicable to a student software development project environment. The results indicate that students' outcome expectations regarding knowledge sharing have a significant positive relationships with the *quantity* and *quality* of knowledge shared on student projects. There was also a positive significant relationship between the quantity of knowledge shared and team performance as well as a positive significant result between the quality of knowledge shared and team performance. The implications and limitations of these results were discussed and suggestions for instructors were proposed based on the results.

7. REFERENCES

Argote, L. & Ingram, P. (2000). Knowledge Transfer: A Basis for Competitive Advantage in Firms. *Organizational Behavior and Human Decision Processes,* 82(1), 150-169.

Bandura, A. (1986). *Social Foundations of Thought and Action*. Englewood Cliffs, NJ: Prentice Hall.

Bergey, P. K. (2012). Editorial: Team Formation and Performance. *Engineering Management Review, IEEE,* 40(1), 2-2.

Braender, L. M. & Naples, M. I. (2013). Evaluating the Impact and Determinants of Student Team Performance: Using LMS and CATME Data. *Journal of Information Systems Education,* 24(4), 281.

Broman, D., Sandahl, K., & Baker, M. A. (2012). The Company Approach to Software Engineering Project Courses. *IEEE Transactions on Education,* 55(4), 445-452.

Brookes, N. J., Morton, S. C., Grossman, S., Joesbury, P., & Varnes, D. (2007). Analyzing Social Capital to Improve Product Development Team Performance: Action-Research Investigations in the Aerospace Industry with TRW and GKN. *IEEE Transactions on Engineering Management,* 54(4), 814-830.

Buche, M. (2013). A Memory Game to Demonstrate the Power of Collaborative Efforts to Improve Team Performance. *Journal of Information Systems Education,* 24(3), 167.

Chenghong, Z., Yunjie, X., & Cheng, Z. (2008). How do People Seek Knowledge in Information System Projects: A New Perspective from Social Network Theory. Paper presented at *The Third International Multi-Conference on Computing in the Global Information Technology*.

Chin, W. (1998). Issues and Opinion on Structural Equation Modeling. *MIS Quarterly,* 22(1), vii-xvi.

Chiu, C.-M., Hsu, M.-H., & Wang, E. T. G. (2006). Understanding Knowledge Sharing in Virtual Communities: An Integration of Social Capital and Social Cognitive Theories. *Decision Support Systems,* 42(3), 1872-1888.

Choi, S. Y., Lee, H., & Yoo, Y. (2010). The Impact of Information Technology and Transactive Memory Systems on Knowledge Sharing, Application, and Team Performance: A Field Study. *MIS Quarterly,* 34(4), 855-870.

Compeau, D. & Higgins, C. (1995a). Application of Social Cognitive Theory to Training for Computer Skill. *Information Systems Research,* 6(2), 118-143.

Compeau, D. & Higgins, C. (1995b). Computer Self-Efficacy: Development of a Measure and Initial Test. *MIS Quarterly,* 19(2), 189-212.

Compeau, D., Higgins, C., & Huff, S. (1999). Social Cognitive Theory and Individual Reactions to Computing Technology: A Longitudinal Study. *MIS Quarterly,* 23(2), 145-158.

Cummings, N. J. (2004). Work Groups, Structural Diversity, and Knowledge Sharing in a Global Organization. *Management Science,* 50(3), 352-364.

Dunaway, M. M. (2013). IS Learning: The Impact of Gender and Team Emotional Intelligence. *Journal of Information Systems Education,* 24(3), 189.

Espinosa, J. A., Cummings, J. N., & Pickering, C. (2012). Time Separation, Coordination, and Performance in Technical Teams. *IEEE Transactions on Engineering Management,* 59(1), 91-103.

Gefen, D. & Straub, D. (2005). A Practical Guide to Factorial Validity Using PLS-Graph: Tutorial and Annotated Example. *Communications of the AIS,* 16, 91-109.

Hansen, M. T. (2002). Knowledge Networks: Explaining Effective Knowledge Sharing in Multiunit Companies. *Organization Science,* 13(3), 232-248.

Hodgson, A., Hubbard, E. M., & Siemieniuch, C. E. (2013). Toward an Understanding of Culture and the Performance of Teams in Complex Systems. *IEEE Systems Journal,* 7(4), 606-615.

Hsu, I. C., Lee Jang, Y., & Der-Chen, H. (2011). Knowledge Sharing Platform for Project Team Based on Web Feeds. Paper presented at the *International Conference on Uncertainty Reasoning and Knowledge Engineering (URKE)*.

Hsu, M.-H. & Chiu, C.-M. (2004a). Internet Self-Efficacy and Electronic Service Acceptance. *Decision Support Systems,* 38(3), 369-381.

Hsu, M.-H., & Chiu, C.-M. (2004b). Predicting Electronic Service Continuance with a Decomposed Theory of Planned Behavior. *Behavior & Information Technology,* 23(5), 359-373.

Huckman, R. S., Staats, B. R., & Upton, D. M. (2012). Team Familiarity, Role Experience, and Performance: Evidence from Indian Software Services. *IEEE Engineering Management Review,* 40(1), 99-118.

Jewels, T. & Ford, M. (2006). Factors Influencing Knowledge Sharing in Information Technology Projects. *e-Service Journal,* 5(1), 19.

Kettunen, P. (2003). Managing Embedded Software Project Team Knowledge. *IEEE Proceedings on Software, 150*(6), 359-366.

Kolb, J. A. (1993). Leading Engineering Teams: Leader Behaviors Related to Team Performance. *IEEE Transactions on Professional Communication,* 36(4), 206-211.

Lee, L., Petter, S., Fayard, D., & Robinson, S. (2011). On the Use of Partial Least Squares Path Modeling in Accounting Research. *International Journal of Accounting Information Systems,* 12, 305-328.

Liang, C., Gable, G. G., Wiewiora, A., & Trigunarsyah, B. (2009). The Interrelations among the Project Team's Conduit Networks, Knowledge Network and Its Performance. Paper presented at the *International Conference on Management and Service Science, MASS '09*.

Liyun, Q., Keyi, W., & Zhenzhong, M. (2010). Antecedent Factors of Knowledge Sharing in Project Teams: Evidence from Chinese Construction Sector. Paper presented at the *International Conference on E-Business and E-Government (ICEE)*.

Lu, W., Wang, Z., & He, L. (2010). Research on Incentive Mechanism of Knowledge Sharing among Teams in Enterprise. Paper presented at the *International Conference on E-Business and E-Government (ICEE)*.

Malhotra, A. & Majchrzak, A. (2005). Enabling Knowledge Creation in Far-Flung Teams: Best Practices for IT Support and Knowledge Sharing. *IEEE Engineering Management Review,* 33(4), 86.

Mesmer-Magnus, J. R. & Dechurch, L. A. (2012). Information Sharing and Team Performance: A Meta-Analysis. *IEEE Engineering Management Review,* 40(1), 119-136.

Mitchell, S. M. & Seaman, C. B. (2012). Software Process Improvement Through the Identification and Removal of Project-Level Knowledge Flow Obstacles. Paper presented at the *34th International Conference on Software Engineering (ICSE)*.

Nahapiet, J. & Ghoshal, S. (1998). Social Capital, Intellectual Capital, and the Organizational Advantage. *The Academy of Management Review,* 23(2), 242-266.

Nambisan, S. & Wilemon, D. (2000). Software Development and New Product Development: Potentials for Cross-Domain Knowledge Sharing. *IEEE Transactions on Engineering Management,* 47(2), 211-220.

Newell, S., Adams, S., Crary, M., Glidden, P., LaFarge, V., & Nurick, A. (2005). Exploring the Variation in Student Project Team Knowledge Integration Competency. *Proceedings of the 38th Annual Hawaii International Conference on System Sciences*.

Oakley, B. A., Hanna, D. M., Kuzmyn, Z., & Felder, R. M. (2007). Best Practices Involving Teamwork in the Classroom: Results From a Survey of 6435 Engineering Student Respondents. *IEEE Transactions on Education,* 50(3), 266-272.

Patrashkova-Volzdoska, R. R., McComb, S. A., Green, S. G., & Compton, W. D. (2003). Examining a Curvilinear Relationship Between Communication Frequency and Team Performance in Cross-Functional Project Teams. *IEEE Transactions on Engineering Management,* 50(3), 262-269.

Petter, S., Mathiassen, L., & Vaishnavi, V. (2007). Five Keys to Project Knowledge Sharing. *IT Professional,* 9(3), 42-46.

Pimmely, R. L. (2003). A Practical Approach for Converting Group Assignments into Team Projects. *IEEE Transactions on Education,* 46(2), 273-282.

Ringle, C. M., Wende, S., & Will, A. (2005). *SmartPLS (Vol. 2014)*. Hamburg, Germany: SmartPLS.

Salas, E., Cooke, N. J., & Gorman, J. C. (2012). The Science of Team Performance: Progress and the Need for More. *IEEE Engineering Management Review,* 40(1), 95-98.

Schlimmer, J. C., Fletcher, J. B., & Hermens, L. A. (1994). Team-Oriented Software Practicum. *IEEE Transactions on Education,* 37(2), 212-220.

Sena, J. A., Shani, A. B., & Stebbins, M. W. (1999). Collaborative Knowledge Teams: The Case of a Software Project Team at Seagate. Paper presented at the *Portland International Conference on Management of Engineering and Technology*.
Uchihira, N., Hirabayashi, Y., Sugihara, T., Hiraishi, K., & Ikawa, Y. (2012). Knowledge Transfer in R&D Project Management: Application to Business-Academia Collaboration Project. Paper presented at the *Portland International Conference on Management of Engineering and Technology*.
Van Kleef, G. A., Homan, A. C., Beersma, B., Van Knippenberg, D., Van Knippenberg, B., & Damen, F. (2012). Searing Sentiment or Cold Calculation? The Effects of Leader Emotional Displays on Team Performance Depend on Follower Epistemic Motivation. *IEEE Engineering Management Review,* 40(1), 73-94.
Wellens, A. R. (1989). Effects of Telecommunication Media Upon Information Sharing and Team Performance: Some Theoretical and Empirical Observations. *IEEE Aerospace and Electronic Systems Magazine,* 4(9), 13-19.
Zhixin, Z. (2012). The Design of Technical System for Software Project Tteam Sharing Knowledge. Paper presented at the *24th Chinese Control and Decision Conference (CCDC)*.

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APPENDICES

APPENDIX 1: SURVEY INSTRUMENT

Student Teams Knowledge Sharing Survey

This survey is being used to collect data about students' knowledge sharing experiences during class-related projects. Your participation is entirely voluntary. You may quit at any time without any negative consequences.

There are 27 questions relating to your experience on a group or team project in a class. Please use your most recent experience to answer the questions. Your responses will be used to calculate average aggregate scores. No names or other identifying information will be used in the analysis. Identifying information will be gathered, but it will be available only to the researcher and stored separately from the data. For questions about this research, please contact me:

For questions or concerns about the rights of research subjects or the voluntariness of this consent procedure, please contact the Research Compliance Office

By completing this survey you are agreeing to the use of your responses for this research project.

THANK YOU!

All the questions except for Q21 used the following scale 5 point Likert scale:
Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), Strongly Agree (5).

Q1 Sharing knowledge on our project helped me to make friends with other members of the team.
Q2 Sharing my knowledge gave me a feeling of happiness.
Q3 Sharing my knowledge improved my reputation with other members of the team.
Q4 Sharing my knowledge gave me a sense of accomplishment.
Q5 Sharing my knowledge strengthened the ties between me and the other team members.
Q6 Sharing my knowledge enabled me to gain better cooperation from other members of the team.

Q7 I maintain close social relationships with some members of my team.
Q8 I spend a lot of time interacting with some members of my team.
Q9 I know some members of my team on a personal level.
Q10 I have frequent communication with some members of my team.

Q11 The knowledge shared by the members of my team was relevant to the project.
Q12 The knowledge shared by members of my team was easy to understand.
Q13 The knowledge shared by members of my team was accurate.
Q14 The knowledge shared by members of my team was complete.
Q15 The knowledge shared by members of my team was reliable.
Q16 The knowledge shared by my team was timely.
Q17 The amount of knowledge shared among my team was:
None (1), Little (2), Some (3), A Lot (4), A great deal (5)

Q18 The team was able to achieve the project goal.
Q19 The team was able to complete the tasks assigned.
Q20 The team was able to complete the tasks by the deadline given.
Q21 The team effectively performed the tasks assigned.
Q22 The quality of the project deliverables was high.
Q23 The project was successful.

APPENDIX 2: DESCRIPTIVE STATISTICS FOR SURVEY ITEMS

Item	Item stem	Average	Std Dev
OE1	Sharing knowledge on our project helped me to make friends with other members of the team.	4.0330579	0.9030862
OE2	Sharing my knowledge gave me a feeling of happiness.	3.9180328	0.7776864
OE3	Sharing my knowledge improved my reputation with other members of the team.	4.1735537	0.7711213
OE4	Sharing my knowledge gave me a sense of accomplishment.	4.1967213	0.6509922
OE5	Sharing my knowledge strengthened the ties between me and the other team members.	3.9098361	0.8528426
OE6	Sharing my knowledge enabled me to gain better cooperation from other members of the team.	3.9752066	0.8704674
ST1	I maintain close social relationships with some members of my team.	2.8688525	1.0980886
ST2	I spend a lot of time interacting with some members of my team.	2.9752066	1.143553
ST3	I know some members of my team on a personal level.	3.0661157	1.1813519
ST4	I have frequent communication with some members of my team.	2.9672131	1.1848522
KL1	The knowledge shared by the members of my team was relevant to the project.	4.147541	0.6763066
KL2	The knowledge shared by members of my team was easy to understand.	3.8934426	0.7799913
KL3	The knowledge shared by members of my team was accurate.	3.892562	0.7724598
KL4	The knowledge shared by members of my team was complete.	3.8032787	0.8493006
KL5	The knowledge shared by members of my team was reliable.	3.9090909	0.7852813
KL6	The knowledge shared by my team was timely.	3.8196721	0.9448984
KT	The amount of knowledge shared among my team was:	3.7295082	0.7929116
TP1	The team was able to achieve the project goal.	4.4098361	0.6773075
TP2	The team was able to complete the tasks assigned.	4.4016393	0.611999
TP3	The team was able to complete the tasks by the deadline given.	4.3770492	0.7195943
TP4	The team effectively performed the tasks assigned.	4.0819672	1.041218
TP5	The quality of the project deliverables was high.	4.214876	0.7874708
TP6	The project was successful.	4.3471074	0.7822057

APPENDIX 3: DESCRIPTIVE STATISTICS FOR MODEL CONSTRUCTS

Construct	Average	Std Dev
Outcome Expectations	4.034294	0.813808
Social Interaction Ties	2.969136	1.151008
Knowledge Quality	3.910959	0.810775
Knowledge Quantity	3.729508	0.792911
Team Performance	4.305479	0.788183

APPENDIX 4: PLS COMPONENT BASED ANALYSIS: INDICATOR CROSS-LOADINGS

ITEMS	OE	KL	KT	ST	TP
OE1	**0.727**	0.422	0.462	0.333	0.412
OE2	**0.732**	0.350	0.366	0.301	0.318
OE3	**0.512**	0.123	0.224	0.204	0.222
OE4	**0.742**	0.400	0.312	0.144	0.299
OE5	**0.849**	0.467	0.526	0.465	0.419
OE6	**0.705**	0.501	0.489	0.176	0.299
KL1	0.422	**0.627**	0.399	0.104	0.368
KL2	0.507	**0.726**	0.381	0.114	0.404
KL3	0.471	**0.851**	0.577	0.148	0.592
KL4	0.400	**0.865**	0.497	0.154	0.517
KL5	0.347	**0.714**	0.355	0.167	0.383
KL6	0.423	**0.805**	0.530	0.067	0.541
KT	0.579	0.603	1.000	0.260	0.524
TP1	0.285	0.506	0.393	0.046	**0.787**
TP2	0.355	0.540	0.413	0.007	**0.816**
TP3	0.430	0.512	0.369	0.048	**0.750**
TP4	0.483	0.540	0.488	0.123	**0.849**
TP5	0.269	0.372	0.429	0.094	**0.765**
TP6	0.384	0.452	0.409	0.078	**0.803**
ST1	0.444	0.221	0.263	**0.904**	0.136
ST2	0.301	0.128	0.245	**0.855**	0.067
ST3	0.198	0.018	0.178	**0.764**	-0.002
ST4	0.217	0.063	0.061	**0.814**	-0.047

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