

Student Team Creativity in Information System Development: Social Capital Perspective

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***Abstract*—Creative teams can help software companies to grow and to obtain advantage. It is important for contemporary educational units to increase student team creativity in information system development and provide training for student teams to product creative results. A survey design was selected to collect data and test the proposed model. Thirty-six teams (204 students) enrolling in an information system department project training course that required three semesters of project-based lessons were investigated. To test our specific hypotheses, Partial least squares method was used. This study analyzes the creativity of student teams participating in an information system development project and examines antecedents of their creativity. The results find structural and relational capital positively influence knowledge sharing. Cognitive capital negatively influences knowledge sharing. And knowledge sharing positively affects team creativity. This study also demonstrates that knowledge sharing significantly mediates the effect of social capital on team creativity. Whilst this study explores issues in team creativity for information systems development student teams, some suggestions are made for educational designers using similar activities in other disciplines. Educational designers should define clear work processes for information system development student teams establish explicit functional role and division of labor for team members, and design information system development activities/tasks that require interactions among team members.**

***Index Terms*—information system development project (ISDP), social capital, knowledge sharing, team creativity.**

I. Introduction

Innovative information technology (IT) application can assist organization establishing competitive advantage. Creativity is key component for developing innovation. Organizations are interested in enhancing the creativity of the information systems design process in order to develop and implement innovation information technology (IT) application [1]. Previous study also pays attention on the challenges of working creatively [2]. For developing innovative information systems (IS), IS managers have to train IS professionals/teams to develop creativity. A study of information technology managers identified the need to "emphasize creativity and innovation" as one of their top human resource issues [3]. Thus, for developing innovative IT, educational training should focus on creativity [4]. Educational environment and method are vital for training students or employees to develop creativity [5].

Most creative pursuits in industry involve interdisciplinary teams working together to develop a product such as a software that can't be created by a single individual alone. Today, teams are very common in organizations [6]. Working in collaborative teams is a popular approach in organizations. Teams are often promoted as an important vehicle for the development of creative ideas [7]. In software companies, information system development project (ISDP) team is a basic unit for developing IS. ISDP team members have to cooperate with others to complete team tasks. During information system development (ISD) processes, the collaboration and discussion will stir team creativity. Thus, the main focus of this study is the ISDP team creativity.

For human resource managers of software companies, creative teams can engage and develop innovative information technologies which are establishing competitive advantage [8]. However, how ISDP teams develop creativity? It is an important issue for contemporary educational units and companies to increase team creativity in information system development and provide training for teams to product creative results.

Recently, group collaboration has become rather a popular approach in organizations [9]. Restated, ISDP team members have to cooperate with each other to complete team tasks. Educational researchers and practitioners have long advocated the need to equip students with collaborative learning skills [10], which are essential for 21st century workforce. Collaborative learning theory also indicates the interactions among students can facilitate students to exchange knowledge and ideas [11] such as knowledge sharing. Besides, collaborative learning is essential for effective brainstorming, which is an effective method of stimulating team creativity [12]. Thus, for ISDP teams, they may develop team creativity during collaborative learning processes. *For understanding training of ISDP team creativity, this study focuses on the ISDP student teams.*

Numerous interactions occur among team members during the collaborative learning process [11]. King and Anderson [13] indicated team creativity incorporates the interpersonal discussion among team members. Through effective interactions, teams facilitate the exchange of information and create new knowledge and ideas. Interaction among its members should make teams become more productive in terms of their creative output.

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ISDP teams may lead to increased creativity since team members share ideas from different perspectives. Nemiro [14] indicated creativity in collaborative new product teams is a product of complex interpersonal interactions. Restated, interactions among ISDP team members can facilitate creativity development during collaborative learning processes.

Interactions constitute social relationships which are considered social capital of such teams [15]. Previous researches indicate there is a positive relationship between social capital and knowledge sharing [16]. These ideas and knowledge exchange may promote brainstorming which can increase team creativity [12]. Previous literature shows that knowledge sharing is an antecedent of knowledge creativity [17]. Despite the extensive studies of how social capital influences knowledge sharing [16] and how knowledge sharing influences knowledge creation such as creativity [17], this study explores similar issue (the relationships among social capital, knowledge sharing and creativity) because of two reasons. First, previous studies surveyed in different organizations such as cable provider, mail service provider and insurance company, and virtual community to explore the relationships among social capital, knowledge sharing and creativity [17, 18]. In these studies, characteristics of information systems development are ignored. Second, previous studies explored the relationship between social capital and knowledge sharing at individual level. Today, many organizations use teams in daily operations [19]. Team performs many organizational tasks such as information system development. Despite potential importance, scholars know little about the relationships among social capital, knowledge sharing, and creativity at team level. For understanding the key factors of training and developing ISDP team creativity, the purpose of this study is to fill the void by establishing an analytical model for empirically testing the relationships among social capital, knowledge sharing, and creativity in ISDP student teams.

II. LITERATURE

A. *Creativity of Information System Development Teams*

Teams are groups that members cooperate with others to achieve a common goal [20]. The results of creativity include new, original, suitable or useful outcomes, ideas or procedures [21]. One popular perspective equates creativity with divergent thinking or the extent to which individuals can generate novel solutions or responses to specific problems [22]. Another perspective of creativity is that it involves associational skills such as the generation of multiple or remote association [23]. However, since divergent thinking involves associational processes, these two perspectives are compatible. Team creativity can thus be defined as divergent thinking in teams as reflected in ideational fluency. Divergent thinking in teams is affected by both associational and social processes [24].

Curtis et al. [25] indicated software development is a set of activities using information technologies and methods to build software to solve problems. These activities of information system development include system analysis, system design, programming, testing, maintain, and so on. Project teams are a popular management tool during information system development (ISD) processes. Most ISDs employ "project teams" to perform development tasks [26]. In ISDP teams, team members have to cooperate together in different project-related activities, develop solutions from various views and integrate each outcomes or ideas into systems. Thus, team creativity of this study refers to new and useful ideas proposed by an ISDP student team during information system development processes.

B. *Collaborative Learning*

Collaborative learning involves interpersonal processes by which a small team of learners work together and share knowledge and skills in order to complete a problem-solving task designed to reach a specific learning goal [27]. Peer interaction in small teams is an important part of collaborative or cooperative learning [28]. The core concept of cooperative learning is team member work with others cooperatively to enhance learning performance and that of other team members [11]. In team-oriented work environments, employees can learn from colleagues with knowledge and provide assists to colleagues by sharing information and working together [29]. Cooperation, coordination, and collective approaches are essential conditions for knowledge creation, knowledge sharing, and the overall learning processes [30].

In an ISDP, tasks are interdependent. For instance, system analysts interact with users and then produce the requirements documents. Programmers write code/software based on documents produced by system analysts. Programmers and system analysts have to work together cooperatively. If some ISDP members fail to complete their tasks, the ISDP cannot succeed. Thus, learning of ISDP student team is similar collaborative learning.

C. *Knowledge Sharing*

Grant [31] defined knowledge sharing as a process of strengthening organizational effectiveness by maximizing the use of knowledge that is shared by organizational members. Lee [32] defined knowledge sharing as the transfer or dissemination of knowledge from one person, group or organization to another. This broad definition includes both tacit and explicit knowledge [33]. The current study considered both tacit and explicit knowledge to be equally important components of ISD knowledge. This study also defined *knowledge sharing as activities involving the transfer or dissemination of knowledge among ISDP student team members*.

D. *Social Capital*

Lin [34] described social capital as "resources embedded in a social structure that are accessed and/or mobilized in purposive action". Nahapiet and Ghoshal

[16] described social capital as a set of resources embedded in social relationship among social actors. Social capital is formed by social relationships [15]. Nahapiet and Ghoshal [16] proposed that structural, relational, and cognitive aspects are the three dimensions of social capital. The structural dimension deals with the overall pattern of relationships found in organizations. The structural dimension can be examined as the overall pattern of connections among social actors [16]. The relational dimension is assets created and leverage through ongoing relationship that influence actors' behavior [16]. The cognitive dimension refers to the common understanding among actors through shared language [16].

Israel et al. [35] investigated how social capital influences the educational achievements of students and their school engagement. Tomai et al. [36] noted the importance of social capital in students. Studies indicated that social capital is a value issue that can elucidate student learning issues [37].

Besides, ISD research also indicated the ISD teams' external social capitals are positively associated with a team's flexibility that is essential to team performance such as team creativity [38]. In other words, social capitals are key antecedents for improving ISDP team performance (team creativity).

III. Model and Hypotheses

A. Model

Social capital has been conceptualized as the sum of the assets or resources embedded in the networks of relations between individuals, groups, and organizations. It exists through interpersonal relationships among individuals, groups, and organizations. ISDP teams need to cooperate and interact with team members to achievement team goals. For example, an ISDP team includes project manager, system analysts, and programmers. The system analyst is responsible for dividing complex problems into several small and simple tasks, and for evaluating and designing system specifications. Meanwhile, the programmer is responsible for developing a system platform or components, and for coding and testing programs according to system analyst defined specifications. The primary tasks of system analysts are to analyze business flows and produce requirement specifications. Systems analysts frequently discuss with other analysts during the system analysis stage, owing to the system functions for which they are responsible being related. For example, system analysts consult with other system analysts to exchange ideas regarding the best methods of passing and receiving system data, and integrate flows to plan consistent system flows and system data. Programmers who face development problems frequently ask others who have previously experienced problems for help in developing a solution. Besides, system analysts should interact cooperatively with programmers in order complete team tasks. Previous studies indicated interaction is a key issue for developing creativity [13]. These cooperative and interpersonal relationships form social capital.

Previous researches indicated there is a positive relationship between social capital and knowledge sharing [16]. Creativity literature showed that knowledge sharing is an antecedent of knowledge creativity [16, 17] such as creativity. Thus, this study explores the factors influencing ISDP student team creativity based on the perspectives of social capital and knowledge sharing in a collaborative learning environment.

B. Hypotheses

Coleman [37] claimed that social capital helped to promote actions between persons or corporations. Tsai and Ghoshal [39] further refined this relationship by showing how social capital facilitates resource exchange and innovation development in organizations. Nahapiet and Ghoshal [16] proposed social capital as a framework for understanding the creation and sharing of knowledge. They indicated organizations can create knowledge and share knowledge because of social capital. They shown knowledge sharing is enabled by structural links among individuals (structure capital), the relationships among individuals are strong (relational capital), and individuals have common cognition to understand and apply knowledge (cognitive capital). These social capitals enhance sharing knowledge among individuals.

Social capital assumedly affects knowledge sharing by (1) providing access to people with relevant knowledge or needs and questions, (2) providing an atmosphere of mutual trust, (3) the sharing of a common ability which assists in understanding other people's knowledge and correctly explains knowledge [18].

Scholars agreed that structural, relational, and cognitional capitals are important antecedents of knowledge sharing [16, 18]. In this study, three variables associated with the social capital of an ISDP student team were selected to measure their impact on the level of knowledge sharing: structural, relational and cognitional capital.

Structural capital refers to members can connect to each other and know what knowledge other members have [16, 18]. In other words, there are channels to transfer knowledge which you need. It is a cost-effective way to share knowledge [40]. The connections among team members can reduce the time and effort required to obtain knowledge. Thus, knowledge sharing can be easy to achieve and sustain. In an ISDP student team, database managers are responsible for designing, building and managing database; programmers are responsible for coding programs to complete project tasks. For completing project tasks, database managers should corporate with programmers. If there are links among database managers and programmers, they can know who has knowledge that they need, and exchange and dissemination knowledge easily. If programmers lack structural capital, the cost of connecting database managers is high. The effective knowledge/information sharing would reduce.

Members with high relational capital mean there are strong relationships among them [16, 18]. While people

have strong relationships with each other, they are close, trust each other and support others. In an ISDP team, for maintaining these close relationships, programmers and database managers with high relational capital would be more agreeable to share knowledge to support each other.

High cognitive social capital gives members a common understanding and interpretations [16, 18]. In an ISDP team, programmers and database managers with high cognitive capital can communicate with others, realize knowledge held by others and exchange information easily because of common understanding. In other words, the common language can facilitate knowledge sharing. Thus, the following hypotheses are proposed:

H1: Social capital that an ISDP team has positively influences knowledge sharing.

H1a: Structural capital that an ISDP team has positively influences knowledge sharing.

H1b: Relational capital that an ISDP team has positively influences knowledge sharing.

H1c: Cognitive capital that an ISDP team has positively influences knowledge sharing.

Researches claim that knowledge sharing positively relates to creativity [17]. Developing team creativity often confronts three inferiorities. First, social loafing [41] may occur if team members assume others will contribute more. Second, evaluation apprehension [42] may result from the fear of a negative response to proposals. Third, production blocking [42] i.e., the danger of losing thoughts while others generate and present ideas, may undermine team creativity.

Knowledge sharing can overcome all of the above three inferiorities of developing team creativity. First, in a team with high knowledge sharing, team members actively transfer their knowledge to each other and easily acquire the knowledge of other members. Restated, social loafing is minimized in high knowledge sharing teams. Second, members of high knowledge sharing teams are likely to communicate alternative views and ideas. That is, teams with high knowledge sharing are usually tolerant of different ideas. Third, members of a team with high knowledge sharing actively exchange knowledge and ideas. Compared to low knowledge sharing teams, they consider more views and alternatives when developing information systems, which could overcome the limitation of production blocking [43]. Thus, sharing knowledge among team members enhances team creativity.

In ISDP teams, knowledge sharing may affect team creativity positively. In the corporate learning context, students often share known knowledge to assist other students. Sharing diverse knowledge may enhance divergent thinking. For example, students may share syntax when developing programs. During the process, teams may develop new and useful solutions for problems.

The above discussion of the relationship between knowledge sharing and team creativity suggests the following hypothesis:

H2: Knowledge sharing positively influences ISDP team creativity.

The research model is shown in Fig. 1.

IV. METHOD

A. Subjects

Student teams which had been asked to develop information systems in a project training course for three semesters were the research subjects. The systems which these teams developed comprised project management system, on-line community system, e-learning system, and so on. The average team size was six members (range = 3-8). These team members are students of information management department of a Taiwan university.

B. Investigation Procedures

The instructor of each team and all team members answered the questionnaires before the end of the project training course of the third semester. The items which included social capital and knowledge sharing were answered by students. The team creativity items were answered by the instructor of each team. All questionnaires were required to return to the author. A total of 224 members of thirty-eight teams were surveyed. However, eight students dropped out of the class. The final survey data were received from a total of 216 members of thirty-eight teams, providing a total response rate of 100 percent. Besides, all instructors answered completely and returned the 38 questionnaires, yielding a total response rate of 100 percent.

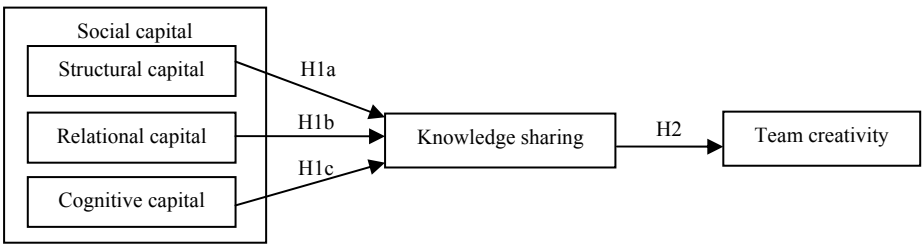

Figure 1. Research model.

C. Measures

This study used 5-point Likert scales to measure structural capital, relational capital, cognitive capital and knowledge sharing. The scale developed by [18] was modified to include items for structural capital, relational capital, cognitive capital and knowledge sharing. The reliabilities for the scales of [18] were 0.76, 0.76, 0.63 and 0.78. The questionnaire comprised items regarding structural capital, relation capital, cognitive capital and

knowledge sharing. All students answered the questionnaire completely.

The items measuring the team creativity were adapted from [44], with some modification. The reliability for the team creativity scale of [44] was 0.96. The instructors who guided the student team in completing the ISDP were asked to answer the team creativity questionnaires. The items of all constructs as listed in Table I.

V. Analysis and Results

A. Aggregation Tests

Structural capital, relational capital, cognitive capital and knowledge sharing were aggregated by taking the average of team members' scores in order to test team level effects. Between-group differences and within-group agreement on constructs measures had to be adopted for testing the suitability of aggregation [45]. Amason [46] demonstrated that one-way ANOVA is can be used to test between-group differences. This study computed the variation between groups and the variation within groups for each measure. The analytical results showed that all between-group variances for the four constructs (structural capital, relational capital, cognitive capital and knowledge sharing) were significantly greater the within-group variances. And then this study estimated within-group agreement (r_{wg}) using the method developed by [47], which assesses consistency within a group with respect to ratings on a common scale. According to [48], an r_{wg} exceeding 0.7 indicated within-group agreement. In this study, the r_{wg} coefficients of knowledge sharing of two teams were lower than 0.7. Thus, this study excluded the data for the two teams. The r_{wg} coefficients of four constructs of data for the other team (*thirty-six teams, 204 members*) were above 0.7, demonstrating within-group agreement. Thus, the results indicated it is appropriate to infer team level constructs for average team member score on each variable.

B. PLS Analysis

The analysis of survey data were done by using the Partial least squares (PLS) with the bootstrap re-sampling procedure. PLS uses a component-based approach to estimation and allows the measurement and structural models to be analyzed simultaneously. PLS can estimate reliability, convergent validity and discriminant validity and analyze the relationships among constructs [49]. Direct, indirect and moderating effects can be evaluated by using the PLS method [50]. In this study, the research model included independent variables, mediator, and dependent variable and explored direct and indirect effects among these variables. Thus, PLS was a suitable data analysis technique.

Following the recommended two-stage analytical procedures, this study assessed the measurement model and then tested the structural model.

Measurement model

The measurement model for constructs was assessed by examining reliability, internal consistency and validity. The criteria for acceptable constructs adhered to the studies of Nunnally [51] and Bagozzi and Yi [52] that indicated internal reliability and composite reliability should exceed 0.7. In this study, the composite reliability scores and Alpha coefficients of all constructs exceeded the threshold of 0.7, indicating the measurements were reliable.

Chin [53] revealed that, indicator factor loading must be measured for reflective scale while evaluating the measurement model. Hair et al. [54] indicated that the indicator loadings should be greater than the threshold of 0.3. All path loadings of reflective indicators by this study measures were above the acceptability value of 0.3 ($p < 0.05$). Thus, the validities of all indicators were verified.

Average variances extracted (AVE) were calculated to assess the convergent validity. The scores of AVE by this study measures were above the acceptability value of 0.5 [55]. The measurements exhibited convergent validity. The square roots of AVE were calculated to verify the discriminant validity [55]. In this study, the square root of the AVE for each construct was greater than the inter-construct correlations [53]. The measurements exhibited discriminant validity.

Structural model

The results of PLS were presented in Table I. The mediating effect in research model could be divided into two different parts as shown in Fig. 2. The first part was the independent variable-to-mediator relationships and the second part was the mediator-to-dependent variable relationship. The first three rows of Table I showed the independent variable-to-mediator relationships. H1a was supported by the data analysis results (path coefficient: 0.52, $p < 0.05$). H1b was supported by the results. A path coefficient of 0.57, which was significant at $p < 0.05$, indicated relational capital has a positive impact on knowledge sharing. However, H1c was not support. The results indicated cognitive capital significantly and negatively related to knowledge sharing, ($\beta = -0.22$, $p < 0.05$). The fourth column of Table I showed the mediator for dependent variable relationship. H2 (Knowledge sharing positively influences ISDP) was supported by the data analysis results (path coefficient: 0.51, $p < 0.05$).The results indicated that social capital influences team creativity via mediator (knowledge sharing). The indirect effects of structural capital, relational capital, and cognitive capital on team creativity via knowledge sharing were 0.27 ((0.52)*(0.51)), 0.29 ((0.57)*(0.51)) and -0.11 ((-0.22)*(0.51)), respectively. Summarized research results were shown in Fig. 2.

VI. Discussion and Implications

A. Implications for Expected Findings

As predicted, structural and relational capital positively influence knowledge sharing which are consistent with the literature [16, 56]. Structural capital, relational capital and cognitive capital jointly explained 71% of the

knowledge sharing variance. 26% of the variance in team creativity can be accounted by knowledge sharing.

TABLE I.
THE RESULTS of PLS

	Mediator		Dependent variable		Hypothesis
	Knowledge sharing		Team creativity		
	Coefficient	T-value	Coefficient	T-value	
Structural social capital	0.52	4.09* [1]	-	-	H1a is supported.
Relational social capital	0.57	5.03*	-	-	H1b is supported.
Cognitive social capital	-0.22	2.09*	-	-	H1c is not supported.
Knowledge sharing	-	-	0.51	6.39*	H2 is supported.

[1] * indicates $p < 0.05$.

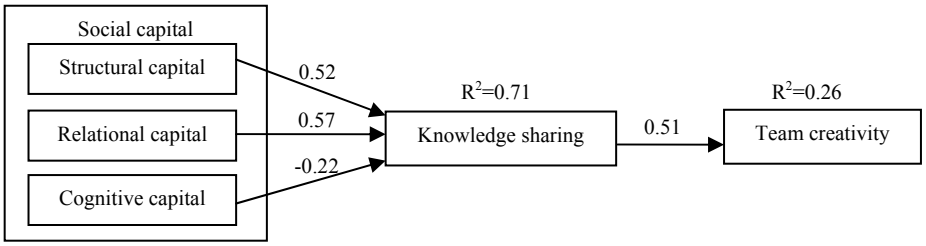

Figure 2. PLS results for the proposed research model.

In this research context, students were required to complete an ISDP by cooperative learning. The ISDP of a student team is asked to develop a website system. The team members are asked to learn knowledge and skills about development techniques (e.g., PHP or JSP), about database knowledge (e.g., SQL language and database management), and multimedia skills (e.g., FLASH or PHOTOSHOP). Team members complete ISDP by division of labor. Thus, all team members need to learn knowledge and skills required to complete their tasks. For example, a team member is responsible for producing a FLASH anime needed to acquire FLASH skills. A team with high structural and relational capital means there are channels and strong relationships among members. Thus, the team member can connect with another who has FLASH skills to acquire detail and whole FLASH knowledge (structural and relational capital). In a cooperative learning context, structural and relational capital assists team members in executing knowledge sharing activities.

The results also indicate knowledge sharing impacts on team creativity positively. According to creativity studies, different and rich knowledge enable divergent thinking [26] and overcome the limitation of production blocking [43]; thus, enable team creativity. Yang and Cheng [26] explains rich ideas, knowledge and information stimulate project teams to adopt different approaches to identifying problems of project tasks. These information and knowledge can stimulate project teams to think divergently and assist project teams have different perspectives. In other words, knowledge sharing can make team members to obtain different knowledge and facilitate team members to solve problems from different views to enhance opportunity of developing creativity. Knowledge sharing positively influences knowledge sharing which is consistent with the literature. Besides, this finding of this study demonstrates social capital obtains a certain mediating outcome (knowledge sharing), which increases team creativity.

Whilst this study explores issues in team creativity for ISDP student teams, some suggestions are made for educational designers using similar activities in other disciplines.

1. For building structural capital of team members, educational designers should *define clear work processes for ISDP student teams, and establish explicit functional role and division of labor for team members*. These can assist team members to know knowledge position in their teams.
2. For building relational capital of team members, educational designers may *design ISDP activities/tasks that require interactions among team members*. Chiu et al. [57] also indicates that a higher level of team members interaction implies a larger number of knowledge that the team shares.
3. Cooperation, coordination, and collective approaches to work are all desirable characteristics of knowledge creation, sharing, and the overall learning process [30]. For enhancing team learning performance (team creativity or knowledge creation), educational designers may *design collaborative context/tasks* for encouraging knowledge sharing and creativity.

B. Implications for Unexpected Finding

The results of this study indicate cognitive capital negatively influenced knowledge sharing. The finding is not as expectation [16, 18].

Goodman and Leyden [58] presents that team members need some time to get to know each other, before they can become a well-functioning team. In other words, familiarity (such as cognitive capital) is related to team productivity. Team members with high familiarity (such as cognitive capital) can quickly understand knowledge which is provided by another one. The results of [58] are consistent with social capital literature. However, Katz [59] indicates teams with long longevity tend to communicate less with information providers because team members assume tasks/knowledge/information they do not need to be shared anymore. Team members are too familiar to decrease knowledge sharing. In this study, each student attends to a project team of project training course for three semesters. Three semesters are a long cooperative time for each ISDP student team. Team members with high cognitive capital have similar cognitive framework to understand knowledge and analyze problems. Thus, when a team member confronts a challenging problem, he/she may assume other members have the same viewpoint to analyze this problem and may think that knowledge sharing is not needed.

Based on the above discussion, team longevity may be an important issue for knowledge sharing. Educational designers should avoid designing long-term project activities for student teams and ask students to cooperate with differ peers in different projects.

C. Strengths and Limitations

This study analyzed ISDP training from an educational perspective to identify the antecedents of team creativity in ISDP student teams. Whilst this study explores issues in team creativity for ISDP teams, some suggestions are made for educational designers using similar activities in other disciplines.

Several limitations of the study are noted. First, it does not measure how the structural capital, relational capital and cognitive capital and knowledge sharing of ISDP teams change over time. All measures of these constructs are taken at a single point in time. Second, this study focuses on the context of ISDP student teams. Other ISDP contexts are not explored in this study. Further studies need to test the results across other types of software development teams. Besides, future studies may explore how the sources and contents of knowledge sharing influence team creativity.

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