

Knowledge Sharing among University Students Facilitated with a Creative Commons Licensing Mechanism: A Case Study in a Programming Course

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(Submitted April 11, 2013; Revised September 16, 2013; Accepted December 6, 2013)

ABSTRACT

Creative Commons (CC) mechanism has been suggested as a potential means to foster a reliable environment for online knowledge sharing activity. This study investigates the role of the CC mechanism in supporting knowledge sharing among a group of university students studying programming from the perspectives of social cognitive and social capital theories. By gathering 40 university students' feedbacks and their behaviors, this study found that, in terms of trust, sharing self-efficacy and outcome expectations, the students had a more positive perception of the CC-integrated platform than that of conventional online sharing. In addition, the students were more likely to favor the CC-integrated sharing platform in which they believed that individual identification and profit were more effectively sustained and protected in the process of knowledge sharing. The students' activities on these platforms and their perception of knowledge sharing also revealed relationships that differed from those found in their performance of programming tasks on other online sharing platforms. This study suggests that the employment of the CC mechanism could be helpful in promoting a more positive perception of and willingness to engage in knowledge sharing, thus ensuring the effectiveness of peer communication and collaboration in stimulating programming performance within the Internet-based collaborative context.

Keywords

Knowledge sharing, Creative commons, Programming, University students

Introduction

To encourage knowledge sharing has become the key challenge and one of the important research issues in online learning contexts (Ma & Yuen, 2011). However, previous studies also indicated that most community participants tend to be unwilling to share their knowledge because of a social dilemma associated the sharing behaviors (e.g., Cabrela & Cabrela, 2002; Ridings, Gefen, & Arinze, 2006). Therefore, an increasing number of studies have devoted themselves to research into what interpersonal relationships and environmental support would facilitate online knowledge sharing in virtual communities based on social cognitive and social capital theory (Chou, 2010; Hsu, Ju, Yen, & Chang, 2007; Kimmerle et al., 2007; Zhou, 2008). The rationale behind these studies is that it may well be that a sense of insecurity toward sharing knowledge online may result in limited participatory engagement, as knowledge sharing activities bring about iterative social interaction with peers and involve distributing one's intellectual property. Furthermore, previous studies indicate that the absence of workable norms to establish authorship and to trace the history of shared content creation may hinder the participant's willingness to share knowledge with unknown users in online settings (Hsu et al., 2011; Kanawattanachai & Yoo, 2002). Ambiguous ownership of shared content may reduce student reliance on the engaged environment and in interpersonal relationships among peers, and in turn may impede the development of virtual communities.

Based upon the perspectives of social cognitive and capital theories, knowledge sharing could be regarded as a process of mutual exchange between individual cognition and inter-personal relationships in the social networking context. Taking consideration of both personal needs for and environmental influences on knowledge sharing would be helpful to the advancement of knowledge sharing activity. This issue could be addressed by adopting the Creative Commons (CC) licensing mechanism as it provides flexible protective licensing options for regulating how content creators and users publish, share and reuse online shared materials. Using CC principles, validating the originality of shared content may significantly relieve tension arising from ambiguous contributions to and ownership of intellectual property in knowledge sharing activities (Liu et al., 2013). The objective of this study thus is to design an

online learning environment to support programming learning in a formal education setting with the CC mechanism because cooperative programming activities such as referencing others' works are helpful to students' cognitive development of programming learning (Hwang et al., 2008). To examine the role of the CC mechanism in supporting students' programming learning within the online learning environment, the following questions were posited and investigated:

- How do student knowledge sharing perceptions associated with programming study differ between online learning environments with and without CC?
- Are students more likely to share knowledge in an online learning environment with CC than one without CC?
- How do student knowledge sharing perceptions relate to their sharing/non-sharing intention?
- How do student knowledge sharing perceptions relate to their programming performance?

Literature review

The social dilemma of knowledge sharing

Extensive related studies have been conducted to investigate how individuals have shared knowledge in communities of practice (CoP) (Chiu, Hsu & Wang, 2006). In particular, much literature exists from studies that have looked into the factors that influence the knowledge sharing process in online communities, as the Internet may serve as an online platform that facilitates the sharing process. However, many knowledge management organizations have not successfully facilitated the sharing activity through online platforms due to the reluctance of individuals to share knowledge (Connolly, Thorn & Heminger, 1992; Jian & Jeffres, 2006). The use of online platforms does not necessarily enhance reciprocal knowledge sharing activities.

In a literature review of knowledge sharing cases by Cabrera and Cabrera (2002), they indicated that individuals may tend not to share their knowledge in a virtual community because such sharing may incur many types of costs, including not only that of relinquishing the knowledge that is shared but also those involved in the process of making that knowledge available to others and the social dynamic changes associated with the sharing that knowledge. Therefore, knowledge sharing in a virtual community has been considered a social dilemma, characterized by "paradoxical situations in which individual rationality -- simply trying to maximize individual payoff -- leads to collective irrationality" (Cabrera & Cabrera, 2002, p. 692). In such dilemmatic cases, refusal to share becomes the most advantageous strategy in securing personal benefit within a knowledge sharing context (Dawes, 1980). As more and more learning systems adopt the Internet as the platform to support learning in CoP (Fischer, 2001; Kafai & Pepler, 2011), there arises a need to resolve this dilemma and to enhance and encourage knowledge sharing in online platforms.

A social cognitive approach to facilitating knowledge sharing

Previous studies have investigated the factors that may contribute to the enhancement of willingness on the part of individuals to share knowledge in virtual communities. Kimmerle et al. (2007) identified specific psychological and structural solutions to the social dilemma. The structural solution mainly involves changing the pay-off structure to increase the personal pay-off of knowledge sharing behaviors (Cress & Martin, 2006; Cress et al., 2007). Such a solution is a cooperation-contingent transformation approach (Cabrela & Cabrela, 2002) in which a selective reward is offered to encourage sharing behavior in the individual.

Such an approach relies mainly upon the basic social cognitive theory which asserts that individual cognition and behavior are influenced and shaped in large part by the social networking context (Bandura, 1989). In particular, outcome expectations and self-efficacy are deemed to be the major cognitive forces guiding behavior (Chiu, Hsu & Wang, 2006). Bandura referred to self-efficacy as those capabilities that an individual perceives as producing designated levels of performance (Tsai et al., 2011) and an outcome expectation is a likelihood of the consequence such a performance will produce (Bandura, 1997). As individuals are not confident with their capability and possess low outcome expectation from the community, they may exhibit avoidance behavior to alleviate unexpected consequences of sharing knowledge with community members. Thus, to build up individuals' confidence of and expectation from knowledge sharing could be critical to their increasing willingness to perform knowledge sharing activity. It has been confirmed by many studies that self-efficacy has a positive effect upon students' behavioral

intention to use online learning course websites (Tsai et al., 2011). Furthermore, in the study by Hsu et al. (2007), they confirmed that outcome expectation and knowledge sharing efficacy profoundly influence knowledge sharing behavior. Such a result can also be explained by the value expectancy theory asserting that an individual's behavior is determined by the perceived likelihood, that this behavior will produce a valued outcome (Kalman, Monge & Fulk, 2002).

The literature adduced above suggests that outcome expectation and self-efficacy may play an important role in knowledge sharing activity. Although, the above studies provide a framework for the investigation of knowledge sharing activity from the perspective of social cognitive theory, these studies analyze user perceptions primarily in informal settings. However, research into knowledge sharing in a formal education setting needs to consider also the role that specific pedagogic strategies may play (Bloom, 1984), so that educators may understand how pedagogy may be applied in classrooms. Therefore, the present study aimed to explore how Creative Commons may work as a mechanism in a school class setting to facilitate knowledge sharing and to investigate how students may react to the mechanism in terms of outcome expectation and self-efficacy regarding knowledge sharing.

A social capital approach to facilitating knowledge sharing

The other approach to enhancing knowledge sharing in virtual communities is a psychological solution. The psychological solution does not change the pay-off structure, but instead enhances psychological factors such as trust and the identification of the contributors interacting with others in the virtual community. The solution does not directly manipulate the incentive of contributors but instead increases willingness to share knowledge by enhancing the knowledge sharing mechanism (Kimmerle et al., 2007). For instance, in the study by Kimmerle et al. (2007), they found that identifying and bestowing distinction upon highly cooperative members of the virtual community may encourage participants to trust one another and may marginalize the effect of the fear of being exploited. The results of Fang and Chiu's study (2010) also indicates that procedural and informational justice correlate significantly with a perception of trust in management which in turn contributes to active participation in knowledge sharing in a virtual community.

The above psychological solution to enhancing knowledge sharing relies mainly upon the social capital theory which asserts that an individual's resources comprise not only those possessed by the individual but also those embedded within the social network to which the individual can connect (Nahapiet & Ghoshal, 1998). It has been indicated by Nahapiet & Ghoshal (1998) that, in addition to social network ties, social capital involves inter-personal relationships which manifest themselves as trust and reciprocity norms in social network relationships. Of the inter-personal factors present, trust has come to be considered the prevailing factor exerting influence upon the willingness of individuals to share knowledge in virtual communities. In the literature, trust is "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Rousseau et al., 1998, p. 395). More specifically, Mayer et al. (1995) defined trust as a set of specific beliefs related to benevolence, competence, and integrity (Mayer et al., 1995). Researchers have also generalized the concept of trust into a generalized trust that rests on behaviors that is generalized to a social unit as a whole rather than resting with a specific individual (Putnam, 1993). In the study by Kankanhalli, Tan and Wei (2005), they referred to trust as the belief in the good intent, competence, and reliability of individuals with respect to contributing and reusing knowledge through EKR. Similar to such a generalized notion, Hsu et al. (2007) analyzed the influence of trust with respect to a detailed framework of trust including economy-based, information-based, and identification-based trust (Hsu et al., 2007) in a virtual community. Because such a framework of trust provides clear categories of trust related to online sharing platform, the present study adopted Hsu et al.' definition and questionnaire to evaluate students' perception in different online sharing platforms.

Trust on the part of community members is being considered crucial to the promotion of knowledge sharing in virtual communities (Hsu et al., 2007; Hsu, Chang & Yen, 2011; Chiu et al., 2006). Empirical studies indicate that trust has a positive impact on knowledge sharing intention (Chai & Kim, 2010), self-efficacy and expectation (Li, Hu, & Zhang, 2010) and also on the quality of knowledge sharing that takes place (Chiu et al., 2006). In other words, when a sense of insecurity is experienced in the online learning environment in which participants are engaged, participant intention and willingness to share knowledge, and to participate and interact with others in the virtual community may be reduced. As most Internet-based learning environments require students to learn through iterative

interaction and communication, it is important to foster student trust within these environments, trust which, in turn, shapes their intentions and behavior and engenders a positive attitude toward knowledge sharing.

The role of CC in knowledge sharing in classroom settings

It has been indicated by Cabrela and Cabrela (2002) that one way to increase knowledge sharing is to establish mechanisms by which individuals receive feedback whenever others use their contributions. Therefore, many studies have employed an Internet-based environment based on CC principles in support of knowledge sharing for collaborative learning purposes on the Internet (Monroy-Hernández & Resnick, 2008; Tanaka, Tokui, & Momeni, 2005). CC concepts may function as such a mechanism in a school class setting to facilitate a sharing atmosphere from the perspective of social cognitive and social capital theory. From the social cognitive perspective, the CC approach may increase student outcome expectations associated with knowledge sharing in their coursework. This is due to the fact that CC enforces an identity preservation strategy which requires the users of a work to acknowledge the original creators of the work, thereby increasing the visibility of the knowledge sharer in the community.

From a social capital perspective, the CC mechanism may well increase the sense of trust between students in a formal class setting. Previous research findings reveal that adopting the CC mechanism is helpful in shaping student perception of and interaction with the environment they are engaged in. For example, through integrating the CC mechanism into a collaborative drawing system, the findings of Liu et al.'s (2013) study reveal that the students manifested a higher level of mutual support under a CC-integrated collaborative environment. The empirical findings shed light on the previous suggestion that the principles and features of the CC mechanism are helpful in supporting a reliable sharing environment wherein student perception of knowledge sharing and behavior toward it are heightened. However, in most previous studies, the CC mechanism has mainly been employed to support informal online learning contexts such as the online discussion forum. In other words, the benefit of integrating the CC mechanism together with knowledge sharing activities in a formal learning course (e.g., classroom setting) was left unclear. In such a classroom setting, the social network ties may be different from those in informal context as students know each other in person. Furthermore, students are engaged in the same learning task and sharing of course work may influence their learning performance assessment. Therefore, how CC may play a role to facilitate knowledge sharing in the classroom setting is worthy of investigation. In this study, this concern was of particular importance and learning and course work are supported by the CC mechanism within a formal educational context in a programming course.

Methodology

Participants

The participants in this study were 40 freshmen majoring in Information and Communications in northern Taiwan (21 males and 19 females). They were enrolled in an introductory course in programming languages, and had the basic programming skills needed to perform the programming assignments given them. In addition, these were students who spent an average of 41.8 hours a week using the Internet. In other words, the participants had considerable experience using the Internet and performing tasks involved in research such as information uploading and exchanging. These participants may therefore help us to understand how CC may play a role in facilitating knowledge sharing among Internet users.

Instruments

The purpose of this study was to understand how students share knowledge, i.e., their programming code, in a programming course. Therefore, the online learning environment of this study involved two components: a construction component, which supported students in coding a program, and a sharing component that allowed them to demonstrate their work and to access that developed by others. As shown in Figure 1, the construction component allowed them to build a railway system using building blocks such as track and bridge modules and to apply the programming language (Java) to program the behavior of the railway system. One of the purposes of this study was to understand how the CC mechanism may facilitate the sharing experience. Two different versions of sharing

components were implemented: one of the versions was the conventional online sharing platform, while the other was a CC-integrated online sharing platform. On both platforms, the students could upload their programming works, and were allowed to decide whether or not to share with others. With works shared on the conventional sharing platform, the authors' name, upload time and date were displayed, but the status of how the shared works were retrieved and reused was not visible (Figure 2).

By contrast, the CC-integrated online sharing platform adopted the CC mechanism to enhance the knowledge sharing experience. This study used the Share-alike option of the CC mechanism with which the students could revise and distribute shared programming works with an identical license indicating the original creators' contributions. For a shared work that was declared sharable in this platform, as shown in Figure 3, the platform would display the creator's name and uploading time and date, along with all programming works that were built by modifying this work. In this context, the students would always know who originally created and shared a work, the authorship of the shared work, and who had used this work to create a new one. Consequently, whether or not the CC mechanism was used determined how the two online sharing platforms functioned (i.e., conventional versus the CC-integrated online sharing platforms) in many distinctive aspects.

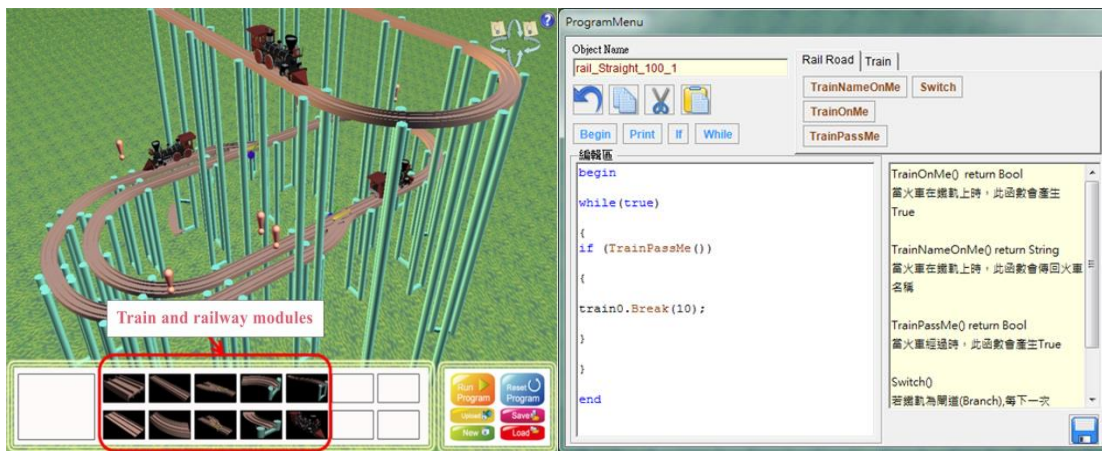


Figure 1. The interface of construction component



Figure 2. The interface of the conventional online sharing community platform

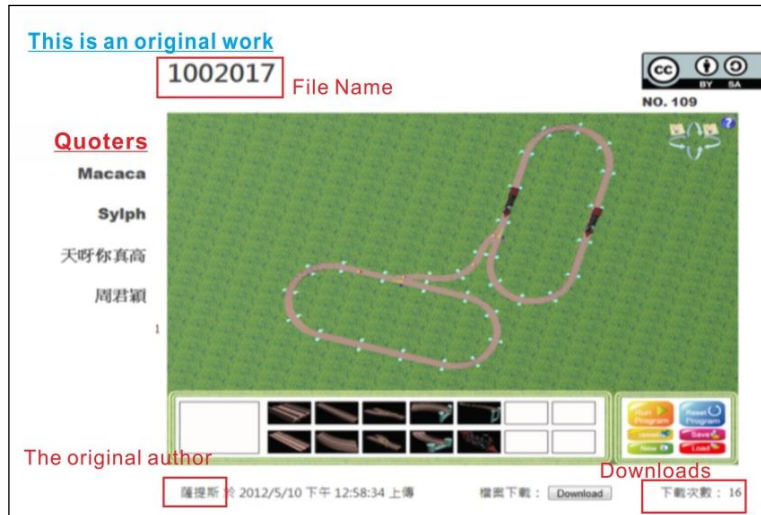


Figure 3. The CC-integrated online sharing platform

To explore student perception of knowledge sharing, a set of questionnaires by Hsu et al. (2007) were employed to examine the students' degree of trust, their outcome expectations and their self-efficacy toward knowledge sharing in this study. The definition of each factor conducted to assess student perceptions of knowledge sharing is listed as follows:

- Economy-based trust: To examine students' trust in the sharing platform due to the costs and benefits in time, knowledge and advantage.
- Information-based trust: To assess students' trust in the sharing platform due to information privacy and openness.
- Identification-based trust: To examine students' trust in the sharing platform regarding inter-dependency and shared identity among community members.
- Knowledge sharing self-efficacy: To assess individuals' perceived self-efficacy of knowledge sharing in the platform.
- Personal outcome expectation: To examine individuals' expectations about their personal gains from sharing in the platform.
- Community-related outcome expectation: To examine individuals' expectations about the impact of their sharing on other members in the platform.

The questionnaires contained a total of 31 items, categorized into six dimensions of knowledge sharing which included "Economy-based trust" (4 items, e.g., By joining this online community, I will save time and effort in learning programming and sharing.), "Information-based trust" (4 items, e.g., This online community protects personal works from unauthorized access.), "Identification-based trust" (6 items, e.g., If I share my works, I know others will respond constructively and caringly.), "Personal outcome expectations" (5 items, e.g., If I share my works with other community members, I will get more cooperation and benefit in return.), "Community-related outcome expectations" (5 items, e.g., My work would help this community accumulate or enrich this website.) and "Knowledge sharing self-efficacy" (7 items, e.g., how confident are you in providing your works?). The original reliability coefficient of each dimension ranged from 0.59 to 0.75. By assessing 40 students' responses to the questionnaire, the reliability coefficient of each dimension was 0.83, 0.81, 0.76, 0.92, 0.93 and 0.94, which serves as a reliable instrument for assessing the student perception in knowledge sharing in this study.

To assess students' perceptions of knowledge sharing toward a particular sharing platform in which they were engaged (i.e., conventional or CC-integrated), the original questionnaire was modified by offering specifically instructional guidance to highlight the sharing platform particularly conducted at each stage. That is, the implement of the questionnaire was conditional on the conducted sharing platforms at different stages. The students' responses to the questionnaires could represent their perceptions of knowledge sharing toward conventional and CC-integrated sharing platforms respectively for later comparisons.

Research procedure

This study was conducted in a formal classroom setting with regular course scheduling. Since the students were enrolled in the same programming course, to divide them into two groups with different treatments would be conflict with the school policy because of unequal conditions for course assessment. In this regard, the within-subjects design was adopted and both experimental treatments were viewed as instructional assistants to support students' programming learning in this study. However, this study did not only compare the CC-integrated platform with the conventional platform, but also compare the perceptions of the students' who shared their works with those who did not in the two platforms. Therefore, the results of the study may be helpful to reveal the factors that influence student knowledge sharing willingness in the two different platforms.

The research procedure consisted of two stages over a period of six weeks. By using the construction component and the online sharing platform, all of the participants were assigned the task of designing and implementing a solution to the given programming problems at two different stages within the schedule of the programming curriculum.

The first stage lasted 3 weeks, during which the participants were first introduced to the construction component, the online sharing platform and the programming task. Then the participants were asked to construct a first railway model using the construction component, and upload their works to the online sharing platform without applying the CC mechanism. Their activities on the platform were logged for further analysis. By the end of this stage, they needed to complete the questionnaire—an instrument assessing their perceptions of knowledge sharing in the online sharing platform without the CC mechanism.

The second stage also lasted 3 weeks. During this stage, the participants were introduced to the concept of the CC mechanism. Then they were asked to construct another railway model, and upload their works to the online sharing platform, this time incorporating the CC mechanism. Finally, the students completed the same questionnaire assessing the participants' perceptions of knowledge sharing within the sharing activity in the platform using CC.

Since this study adopted the within-subjects design, ones may consider that the students may be aware of the instructor's intentions of the following treatment, and then displayed involuntary behaviors in response to the instructor's expectation while introducing the CC mechanism. In this respect, this study introduced the CC mechanism as a kind of technical assistance in providing the students the alternative of information sharing. Such an introduction did not act as an instructional strategy to stimulate the students' behaviors and perceptions of sharing programming works. Therefore, only the characteristics of rather than the benefits of the CC mechanism about information sharing were introduced by the class instructor. The instructor did not offer additional assistance in the completion of programming work except for technical support in resolving unexpected crashes in the system.

Data analysis

The participants' activity logs and their perceptions of knowledge sharing obtained from the questionnaire were used as analytical resources in this study. As reciprocally interactive activities should be initialized by one's sharing voluntariness, this study considered the students' sharing decision making (share versus not-to-share) as an initial step of nurturing consequential interactions between each other. In addition, from the technical aspects, only when a student shared her/his program work, the online sharing platform could display the works to others. Therefore, explicit sharing orientation (share versus not-to-share) is necessary to design the online sharing platform. Given these reasons, this study adopted sharing orientation as a dichotomous variable. To understand the role of the CC mechanism in affecting their perceptions of knowledge sharing, a series of dependent t-tests were employed to examine the differences between perceptions of knowledge sharing in the two online sharing platforms (the conventional versus the CC-integrated). The relationship between the perceptions of knowledge sharing and sharing orientations on the two online sharing platforms, were also examined in order to achieve a better understanding of the factors influencing the students' intention to share their works on the two platforms. In addition, the method of the McNemar test was used to analyze the participants' decisions on sharing/non-sharing knowledge in the two online sharing contexts.

Four indicators were selected to represent the students' participatory interactions with others in the platforms. The frequency of viewing/downloading personal/peer programming works was calculated through analysis of log data,

because the four activities could reveal the participants' efforts in sharing their programming works on the platforms. These sharing behaviors recorded on log data may represent seed (uploading programming works) or follow-up contributions among the students (e.g., viewing or downloading peers' works). While the students reviewed the works shared by their peers, they may appreciate the merits of the shared works and turn to revise one's own works. However, in the CC mechanism, some seed contributions may be original or derived by using other works. It becomes complicated to distinguish clearly seed and follow-up contribution. More fine-grained and specific ways such as sequential analysis or social networking analysis may be more applicable to analyze reciprocally dynamic process. Since this study aimed to reveal the difference of behaviors and perceptions of knowledge sharing between conventional and the CC-integrated sharing platforms, these behavioral records were analyzed at a general level without distinguishing the seed and follow-up contribution to avoid losing the foci of this study.

A set of evaluative criteria was employed to grade the students' performance on the programming tasks from the aspects of the correctness, structure, and complexity involved in the railway model for each programming task. Three qualifying standards in the number of train and railway (40 points), the length and modeling of the railway (40 points), the completeness and correctness of program execution (40 points) would be considered for the grading of the railway model. The students would obtain a total score ranged from 0 to 120 for each programming task.

The evaluation criteria for the programming task were introduced to the students before entering into the research procedure. They were also informed that their sharing activities on both platforms would not be included in the grading of the programming performance. Because this study would focus on understanding the students' perception facilitated by the CC mechanism as a psychological solution to enhance sharing. In other words, this study would not change the pay-off structure associated with the knowledge sharing behavior. Therefore, the students' decision on whether to share or not would not be taken into account in determining their scores and grades in the course. Only the average score of two programming works would represent 10% of each student's total achievement this semester.

Finally, for each of the two different online sharing platforms, the Spearman's correlation analysis was used to examine the relationships between participatory activities on the sharing platforms and the perceptions of knowledge sharing to programming task performances. By contrasting the relative results in different online sharing platforms, the patterns of student interaction with and perceptions of knowledge sharing in the different online sharing platforms were identified and interpreted.

Results and discussion

The perceptions of knowledge sharing in conventional and the CC-integrated online sharing platforms

A series of paired t-tests were employed to explore the role of the different online sharing platforms in the perceptions of knowledge sharing. Table 1 displays the results of the students' perceptions of knowledge sharing toward the two different online sharing platforms. Except for the dimension of information-based trust, the students' responses to the perception of knowledge sharing toward the CC-integrated online sharing platform were significantly higher than those of the conventional online sharing platform. The results revealed that the students had a more positive perception of knowledge sharing in the CC-integrated platform than in the conventional online sharing platform. Such results support that students can establish a higher level of trust and confidence in sharing knowledge on the CC-integrated platform as it affords a protection mechanism. Students may therefore have heightened expectations of personal and interpersonal gain when interacting with that platform.

Table 1. Student perception of knowledge sharing toward different online sharing platforms

	Conventional online sharing platform	CC-integrated online sharing platform	
	Mean / S.D.	Mean / S.D.	<i>t</i> -value
ET	4.16/0.85	4.41/0.74	-2.865**
IT	4.40/0.78	4.58/0.83	-1.365
DT	4.25/0.64	4.51/0.60	-2.767**
SE	4.06/0.86	4.41/0.85	-3.808***
PE	3.44/0.96	3.70/1.06	-2.161*
CE	3.98/0.95	4.39/0.92	-3.101**

Note. Economy-based trust (ET), Information-based trust (IT); Identification-based trust (DT); Knowledge sharing self-efficacy (SE); Personal outcome expectation (PE); Community-related outcome expectation (CE).

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

The relations of the perceptions of knowledge sharing to sharing/non-sharing decision on the conventional and the CC-integrated online sharing platforms

This further examined the differences in knowledge sharing participation level between that of students who shared (Sharing) and those who did not share their works (Non-Sharing) in the two different sharing platforms. As shown in Table 2, the students oriented toward sharing generally evinced more positive perceptions of knowledge sharing than those with non-sharing orientation in both of the two platforms. Furthermore, the t-test results reveal that there were no significant differences found in the conventional online sharing platform. By contrast, the students with different sharing orientations in the CC-integrated online sharing platform exhibited a significant difference in their perceptions of knowledge sharing. More specifically, those students with sharing orientation manifested a significantly higher level of identification-based trust and personal outcome expectation than those disinclined to share. In other words, those students with sharing orientation tended to appreciate the merits of applying the CC mechanism in support of knowledge sharing activities to augment trust among community members and personal gain from the sharing activities.

The findings of this study offer some evidence that the perception of knowledge sharing correlated positively with student decisions regarding sharing with online community members. The students who actually shared their compositions with peers on the CC-integrated online sharing platform exhibited a significantly higher degree of the perceptions of knowledge sharing (i.e., identification-based trust and personal outcome expectation) than did those unwilling to share knowledge.

Table 2. The differences in student perception of knowledge sharing -- between sharing and non-sharing decisions -- for the two different online sharing platforms

	Conventional online sharing platform			CC-integrated online sharing platform		
	Mean / S.D.		<i>t</i> -value	Mean / S.D.		<i>t</i> -value
	Sharing N = 23	Non-Sharing N = 17		Sharing N = 32	Non-Sharing N = 8	
ET	4.33/0.76	3.93/0.94	-1.50	4.50/0.59	4.03/1.15	-1.122
IT	4.50/0.74	4.26/0.85	-0.937	4.65/0.83	4.28/0.82	-1.120
DT	4.40/0.59	4.04/0.65	-1.811	4.62/0.53	4.08/0.70	-2.403*
SE	4.21/0.88	3.87/0.82	-1.264	4.48/0.69	4.13/1.34	-0.726
PE	3.52/0.90	3.32/1.04	-0.663	3.90/0.89	2.88/1.34	-2.613*
CE	4.23/0.90	3.64/0.93	-2.027	4.50/0.66	3.93/1.58	-1.007

Note. Economy-based trust (ET), Information-based trust (IT), Identification-based trust (DT), Knowledge sharing self-efficacy (SE), Personal outcome expectation (PE), Community-related outcome expectation (CE)

* $p < 0.05$

Knowledge sharing/non-sharing decisions when using different online sharing platforms

Table 3. McNemar test on the distribution of students making the decision to share or not to share in the different online sharing platforms

	Sharing	Non-sharing	Total
Conventional online sharing platform	23 (57.5%)	17 (32.5%)	40
CC-integrated online sharing platform	32 (80%)	8 (20%)	40

$\chi^2 = 5.4$; p -value = 0.035.

To examine how conventional and CC-integrated online sharing platforms support knowledge sharing, McNemar’s test was applied to make comparisons of sharing orientations between the two platforms, given two matched subjects. The results of the test showed that the students’ sharing orientations changed significantly from the conventional online sharing platform to the CC-integrated online sharing platform ($p < .05$). As shown in Table 3, the students were more likely to share their work in the CC-integrated online sharing platform (80%) than they did in the conventional online sharing platform (57.5%). The findings support the conclusion that students were more favorable toward knowledge sharing activities in the CC-integrated online sharing platform.

Statistics of activities and programming task performance on the different online sharing platforms

Table 4 reveals the students' participatory interactions and programming performance in the two different online sharing platforms for learning programming. Seven students who were enrolled in the programming construction activity in the first stage were absent from the knowledge sharing activity in the second stage. Therefore, only the 33 students completing both stages were included in the comparative analyses. As shown in Table 4, the students demonstrated a higher frequency of downloading personal programming works and viewing each other's shared programming works while engaging in the CC-integrated online sharing platform than they did in the conventional online sharing platform.

Table 4. Paired samples test among two sharing platforms for participatory interactions and programming performance

	Conventional sharing platform	CC-integrated sharing platform	<i>F</i>	Significance
	Mean / S.D.	Mean / S.D.		
<i>Participatory interactions</i>				
Frequency of viewing personal works	2.24/2.11	1.79/1.65	1.15	0.29
Frequency of downloading personal works	0.15/0.44	0.45/1.77	3.73	0.06
Frequency of viewing peer' shared works	0.88/1.85	1.91/4.38	2.61	0.12
Frequency of downloading peer' shared works	2.09/3.48	2.48/2.11	0.37	0.55
Performance of programming works	107.30/12.12	113.18/13.51	4.08	0.05

A repeated measure ANOVA was conducted on four indicators of participatory interaction and programming performance in the two online sharing platforms. The results of multivariate test by within-subjects design revealed Wilks' $\lambda = 0.97, 0.97, 0.93, 0.99, F(1,32) = 0.29, 0.89, 2.61, 0.37, p < .05$ for the four participatory interactions respectively, and Wilks' $\lambda = 0.89, F(1, 32) = 4.08, p < .05$ for the programming performance between the online sharing platforms. Thus, there were no significant paired differences in the students' participatory interactions and programming performance toward different online sharing platforms.

Because the ANOVA overall test did not yield a significant result, this study further examined the relations of the students' perceptions and activities of knowledge sharing to their programming performance in both of the two online sharing platforms. The contrast of the interrelationships between the two online sharing platforms may shed light on the important factors profoundly related to programming performance in the two different online sharing platforms.

The relationship of activities and of the perception of knowledge sharing to programming task performance on the different online sharing platforms

Correlation analyses were conducted to understand the relationship of activities and of the perception of knowledge sharing to programming task performance in two online sharing platforms. As shown in Table 5, in two participatory interactions (i.e., viewing and downloading personal works), identification-based trust and knowledge sharing self-efficacy were correlated significantly with student performance of programming works in the conventional online sharing platform. By contrast, there were no significant relationships between participatory interactions and the student performance of programming works in the CC-integrated online sharing platform. However, three dimensions of knowledge sharing perception, i.e., economy-based trust, knowledge sharing self-efficacy, and community-related outcome expectations, revealed a significantly positive correlation with programming work performance. This correlation between the two different sharing platforms reveals that knowledge sharing self-efficacy plays a critical role in programming work performances in both of the two platforms. This correlation

between community-related outcome expectation and programming work performance was highest in the perceptions of knowledge sharing in the CC-integrated online sharing platform. Such results may imply that, within the CC mechanism, students may perform better when they expect their contributions to be able to enrich the learning community through sharing their works with other members.

Table 5. The relation of participatory activities and perception of knowledge sharing to programming performances on different online sharing platforms

	Performance with conventional online sharing (n = 33)	Performance with CC-integrated online sharing (n = 33)
<i>Interaction activities in the online platforms</i>		
Frequency of viewing personal works	0.34*	0.17
Frequency of downloading personal works	0.39*	0.01
Frequency of viewing peer' shared works	0.24	0.21
Frequency of downloading peer' shared works	0.16	0.13
<i>Perceptions of knowledge sharing</i>		
Economy-based trust	0.01	0.41*
Information-based trust	0.06	0.03
Identification-based trust	0.36*	0.30
Knowledge sharing self-efficacy	0.36*	0.40*
Personal outcome expectation	0.08	0.23
Community-related outcome expectation	0.29	0.59**

* $p < 0.05$. ** $p < 0.01$.

In contrast, on the conventional online sharing platform, students' participatory interaction (i.e., the frequency of viewing personal works and frequency of downloading personal works), as well as their perceptions of knowledge sharing regarding identification-based trust and knowledge sharing self-efficacy corresponded significantly with programming work performance. Therefore, in the conventional online sharing platform, students usually focused on their own programming works even if they were willing to share their works with others on the platform. They may have intended to gain identity recognition through the knowledge sharing activity rather than through contributing to the community. In contrast, the students' perceptions of knowledge sharing (i.e., economy-based trust, identification-based trust, knowledge sharing efficacy, and community-related outcome expectation) became a significantly prominent factor in their programming work performances on the CC-integrated platform.

Discussion and conclusions

The present study explored the role of the Creative Commons (CC) in student perceptions of knowledge sharing in a university programming course. In this study, the findings revealed some relationships among student learning behaviors, perceptions of knowledge sharing and their programming task performances. For example, the activity involving student self-examination of their programming works was a significant factor in programming performance on the conventional sharing platform, but not in the CC-integrated platform. In other words, student performance was more a function of individual learning activities in the conventional sharing platform. However, student perception of knowledge sharing showed a stronger correlation with programming performance on the CC-integrated than the conventional platform. The above results support the contention that the CC mechanism transformed individual leaning on the conventional sharing platform into a social learning activity.

Furthermore, in addition to assessing the student willingness to share knowledge (e.g., Hsu et al., 2007; Hung & Cheng, 2013), this study examined students' sharing behaviors with reference to their actual sharing or non-sharing decisions. On both of the online sharing platforms, the students who chose the sharing option generally showed positive responses to perception of knowledge sharing than did the others who made the decision not to share. However, the students showed different patterns of interrelationships between the perceptions of knowledge sharing and sharing willingness on the two platforms respectively. In contrast with the previous finding that trust could be predominant in knowledge sharing behaviors (e.g., Hsu et al., 2007), these comparative results provide some evidence that the students' identification-based trust and expectation of personal profit may be a salient factor in their subsequent engagement in knowledge sharing activities mediated by the CC-integrated platform.

In addition, significant transition from the non-sharing to the sharing decision reveals that the students were more willing to share their works with peers on the CC-integrated sharing platform. Hence, this study suggests that the online sharing environment integrated with the CC mechanism not only provides students with a reliable tool for knowledge sharing, but also develops their perceptions of knowledge sharing and willingness to share learning works. In other words, instructors and system developers could consider the CC mechanism to be valuable in creating a secure and comfortable Internet-based environment supportive of knowledge sharing in educational settings.

Consistent with findings in previous studies reporting significant correspondence between self-efficacy and learning performance (Moos & Azevedo, 2009), student knowledge sharing self-efficacy still played a critical role in programming performance in both online sharing platforms. In addition to the knowledge sharing self-efficacy, student trust in identification was significantly related to their programming performance on the conventional platform, whereas their economy-based trust (i.e., trust in receiving benefit from sharing) and community-based outcome expectation (i.e., belief in their contributions to the growth of the community knowledge base) became critical to their programming performance on the CC-integrated platform. These results suggest that the student perception of knowledge sharing, as supported by the CC mechanism, would be crucial to learning performance. Furthermore, in addition to the research into online participation and interaction for collaborative learning (e.g., Chou & Min, 2009; Lang, 2010; Lin & Tsai, 2012), the employment of the CC-integrated platform may serve as a reliable mechanism to facilitate a sense of trust among students and to satisfy individual expectations in such a social learning context.

The present study is only based on a local interest and concern since the sample has been collected from only Taiwanese class. Future study could try to generalize the study's findings with extended sample representing non-Taiwanese subjects. Instead of confirming the effect of the CC-integrated platform, this study turned to differentiate the students' perceptions and activities of knowledge sharing toward the sharing platforms. In this regard, this study performed the within-subjects comparisons to offer some evidence on how the students perceived and interacted with the sharing platforms for knowledge sharing. Since ones may consider the learning effect bias caused by the within-subjects design, this study suggests that experimental design could be conducted to examine the effectiveness of the CC-integrated platform on the students' learning through knowledge sharing. Further research with a larger sample may be needed to validate the causal effects of the CC mechanism on student perception and knowledge sharing behaviors. An intensive investigation into the correlation between the perceptions of knowledge sharing and the process of programming works within a CC-integrated online sharing platform may inform our understanding of how individual differences may alter programming learning trajectories in a knowledge sharing context.

Acknowledgements

This research was partially funded by the Research Center for Science and Technology for Learning at National Central University and the National Science Foundation under 101-2511-S-008 -006 -MY2 and 101-2511-S-008 -005 -MY3.

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