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User-Centered Problem-Based Learning at Learning Commons: In Search of a Unique Learning Pedagogy in Academia

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Abstract

Purpose – The purpose of this study is to make an attempt to explore the problem-based learning (PBL) method supported student learning in out of class space of Learning Commons (LC) for adopting PBL method based user-centered learning pedagogy at LC of academic libraries.

Design/methodology/approach – The study was conducted for the identification of problem-based learning activities in out of class space informal learning at LC. A comprehensive review of the learning commons and problem-based learning method literature enabled the formulation of the constructs and few hypotheses were formulated that constitute a conceptual user-centered PBL activity based learning model. To determine the final form of the user-centered problem-based learning model, survey data collected from university students of Japan was analyzed by the partial least squares technique to confirm the model and validate the hypotheses.

Findings – The results of the study has evidenced that of the twelve hypotheses was supported strongly and confirms that LC completely supports problem-based learning in out of class space. Users are pursuing self-responsible learning and knowledge sharing and acquisition plays a vital role for solving learning problems in the group learning process and it has been determined as a must PBL phase for LC. Users showed a great interest in PBL based informal learning for solving their course work learning problems in out of class spaces of LC.

Originality/value – This problem-based learning method supported user-centered learning in out of class space is one of the first to holistically evident that LC support PBL activities

in informal learning and has been determined as Continuum of Learning in the study and created user-centered problem-based learning pedagogy in academia.

Paper type – Research paper.

Keywords – Learning Commons, Problem-Based Learning, Knowledge Sharing and Acquisition, Group Learning, Informal Learning, User-Centered Learning, Out of Class Space, Continuum of Learning

1. Introduction

Learning commons (LC) has been introduced by academic libraries for the user students to pursue out of class collaborative learning in the academia. LC provides physical, technological, social and intellectual spaces and offers learners, researchers and information professionals to pursue numerous learning and research curricula and activities (Bailey, 2006). Nowadays library users are demanding wider access to print, digital and multimedia sources of information and expecting assistance for learning and research (MacWhinnie, 2003). They are expecting interactive spaces to work in collaboration for their learning (Thomas & McDonald, 2005). Academic libraries have been facing a paradigm shift to user-centric approach to meet the diverse needs of users and introduced LC for meaningful services (Alam, Umemoto & Yoshida, 2016). It is a unique service from the library where librarians and commons staff collaborate with users for learning by teaching to solve their course work problems of assignments, research, writing, technical support, program on information literacy and so on. Learners come and use the LC services and resources for solving their learning problems together with their group mates. Several studies have identified LC as a social and active learning space where learners and library staff are sharing and using information and knowledge for teaching and learning (Beagle, 1999; Jain, 2013; Maury, 2012; Somerville & Collins, 2008). Learning at LC has created the context of knowledge sharing and acquisition among the learners on the way to conclude the learning problems. As LC has created the out of class space for informal learning, they need to confirm its uses in learning problem solving practice of user students.

LC and learning are inseparable and it is a designated space in the library for user students to solve their learning issues. It is a new model of service delivery system in the academic libraries which has introduced a `continuum of services` from a single location. Beagle (2006) has provided the 'Commons Model` for LC and when students are learning they uses the three interrelated and interdependent levels: of the physical commons, the virtual commons and the cultural commons for their self- responsible learning (Beagle, 2006; Beagle, 2008). Learning at LC is completely user-centered as today's student–centered learning implies that students have a choice in what they study and how they study (O'Neill & McMahon, 2005). In user-centered learning at LC students are responsible for their own learning and they determine the course work learning problems to reach in the conclusion.

As an out of class space LC support for informal learning through face-to-face reference encounters, group study rooms, and social areas (Beatty & White, 2005). LC group learning spaces have connected the library with the increased interest among faculty in problem-based learning (PBL) of constructivist learning theory (team-based, group-process, resource-based, inquiry-driven, etc.) (Beagle, 2012). It is PBL that supports LC users by confirming out of class activity for identifying, formulating, searching and sharing learning problems (Khasawneh, 2013). The fundamental approach of PBL is problem solving based learning. It's a learner-centered instructional (and curricular) strategy that encourages students to conduct research, integrate theory and practice, and use knowledge and skills to come up with a viable solution to a problem (Savery, 2006). In this approach learning starts with a posed problem which the students try to reach in an answer. It makes them understand how to deal with the given problems and also enhance their skills to work collaboratively and think logically. Students make use of what they already know about the problems they encounter. In course of learning they create new knowledge and mix it with the old one by sharing and acquiring between them and it continues till checking their hypothesis. In this way they follow the PBL cycle phases of problem identification, formulate inquiry, solution creation and problem conclusion and reach in the solution of the problems (English and Kitsantas, 2013; Hmelo-Silver, 2004; Mergendoller, Maxwell and Bellisimo, 2006).

LC learners are creating knowledge during the group process of learning and they share knowledge among the group mates for generating new ideas and solving problems. They play

a knowledge transformer role among the group mates in the absence of their course teacher. In LC collaborative learning, users actively construct knowledge by acquisitioning knowledge to their early knowledge base as they interpret new information that they have already collected (Loyens & Gijbels, 2008). That is knowledge sharing and acquisition in the PBL process at LC helps the user students to reach the solution and complete the learning. Therefore taking the transformer role of users for knowledge sharing and acquisition into consideration the study has extended the PBL cycle phase for LC.

Prior research has studied the LC as informal learning environments and the relationship between space and learning (Nitecki & Simpson, 2016), determining value co-creation framework for LC to explore the co-created value in learning (Alam, Yoshida & Kohda, 2016), information commons (IC) students' use of informal learning spaces for their studies (Hunter & Cox, 2014), understanding the meanings and the dimensions of library as place of study (Kim, 2016), factors affecting library space assessment, and relationship of space to an academic library's purpose and ambitions (Nitecki, 2011), judging the successful informal learning space design within and outside of library from the learning theory, place making, and architecture perspectives (Harrop & Turpin, 2013).

Since LC has a different setting from the conventional classroom they need to use different techniques and learning methods to lead to success. As an informal learning space LC has introduced an emerging learning pedagogy by offering LC use for user self-responsible learning, knowledge sharing and acquisition and PBL method for problem solving. Using these three synergy together, we frame the challenge for the current study from the theoretical perspective of how problem-based learning theory and knowledge sharing and acquisition is constructing user-centered learning pedagogy at Learning Commons.

2. Research model and hypotheses development

Six key constructs are included in the proposed model. The overall model of the study has to confirm that LC supports PBL method based learning activity of its users. The first construct is needed to check LC use for learning for confirming that its continuum of services of the commons model are being used by PBL learners. Next to confirm user knowledge transformer role in knowledge sharing and acquisition at LC group process of learning. Last

of all it needs to see the aforementioned PBL four cycle phases of problem identification, formulate inquiry, solution creation and problem conclusion are supported by LC. All the mentioned constructs are discussed in further detail along with hypotheses that anticipate particular interaction between them.

2.1 LC use for learning

LC provides various services, spaces and resources for enhancing learning among the students in the library building with a combined effort of students, librarians, faculty, commons staffs, tutoring staffs, writing tutors and instructional designers. LC has integrated traditional library elements with the recent information technologies for creating a vibrant atmosphere to support the joint effort of learning with collaboration. The 'commons model' of Beagle (2006) has combined three interrelated and interdependent levels of LC; physical, virtual and the cultural commons. The first level physical commons includes computer hardware, furnishings, designated spaces and traditional library collections (Beagle, 2006, p. 8). The second level, the virtual commons contains the digital library collections, e-learning tools and online tools (search engines, productivity software, etc.) of the library. The third level, the cultural commons, is made up of social resources like workshops, tutoring programs, research collaborations, coaching etc. (Beagle, 2006, p. 8). Social, cultural and political envelope of cultural commons supports and extends the physical commons and virtual commons and these are the enabler for learning in LCs (Beagle, 2006, p. 5). The users of LC makes use of services and resources from these three levels of commons in their course studies learning problem solving process. LC also gets connected with the four phases of PBL activities and also with the knowledge sharing and acquisition process of learning. Therefore, the study formulates the hypothesis as;

H1: LC use for learning has statistically significant relation with learning problem identification.

H2: LC use for learning has statistically positive relation with formulate inquiry.

H3: LC use for learning has statistically significant relation with knowledge sharing and acquisition.

H4: LC use for learning has statistically positive relation with solution creation of learning.

H5: LC use for learning has statistically significant relation with learning problem conclusion.

2.2 Knowledge sharing and acquisition

Knowledge sharing and acquisition activity helps the users to gather previous knowledge and share knowledge among the groupmates and they integrate those with their own knowledge base and try to generate new ideas on the way to solve problems (Hmelo-Silver, 2004). Learner`s knowledge sharing and acquisition process has a contributing relationship with problem identification, formulate inquiry, solution creation and problem conclusion phases of PBL. Thus, it leads to the following hypothesis:

H6: Knowledge sharing and acquisition has a statistically significant relationship with learning problem identification at LC.

H7: Knowledge sharing and acquisition has statistically positive effects on formulate inquiry.

H8: Knowledge sharing and acquisition has a statistically significant influence on solution creation.

H9: Knowledge sharing and acquisition has statistically positive relation with problem conclusion.

2.3 Problem identification

Problem identification process develops a clear idea about the learning problem and it is the first cycle phase of the PBL method (English & Kitsantas, 2013; Hmelo-Silver, 2004). Students use LC for solving their learning problems such as assignments, presentations, projects and examinations. Through various learning activities like discussion, sharing, feedback, etc. with group mates they try to understand and define the problem. After the completion of the problem identification phase the next phase formulate inquiry begins. Therefore, the study formulate the hypothesis as;

H10: Problem identification practice has statistically significant relation with formulate inquiry.

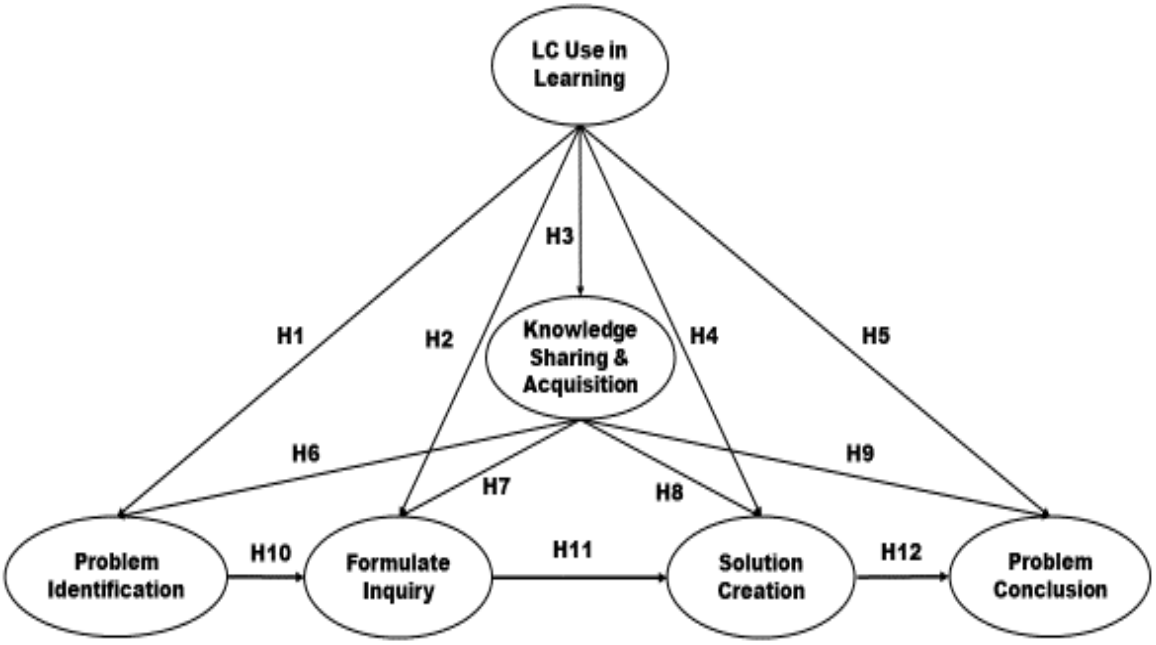

Figure 1. Hypothesized conceptual model of user-centered problem-based learning at learning commons

2.4 Formulate inquiry

Through inquiry students who are working in LC try to create the questions that they need to know for solving the problems (English & Kitsantas, 2013; Hmelo-Silver, 2004). They gather knowledge from different sources and share it among group mates to find the knowledge gap for further query. In this way they develop hypotheses for creating best possible solutions of the problem. Therefore, it formulate the hypothesis;

H11: Formulate inquiry has statistically significant relation with solution creation.

2.5 Solution creation and problem conclusion

In this stage students start thinking about the possible solution of the problem. They try to make sense of the collected knowledge by developing new ideas and searching for the best solution (Allen, Donham, & Bernhardt, 2011; English & Kitsantas, 2013). It leads them to the final phase of problem conclusion where students are prepared for submitting their overall learning outcome and process outcome. Through numerous practices and revisions they

combine the collected knowledge with the old concept and prepare the final presentation for best conclusion. Thus, it leads to the following hypothesis:

H12: Solution creation has statistically significant relation with problem conclusion.

3. Literature review

3.1. Learning commons

With the advancement of rapid technological changes and its high acceptance by the 'Techie Generation' (TechieGen) library users, libraries are now in paradigm shift regarding its collections, spaces and services (Lippincott, 2005). Over the last three decades, academic libraries are embracing a new model of service delivery system which is referred to as learning commons (LC) (Beagle, 1999). Academic libraries are trying to convert them into social, cultural and technological centers by renovating their physical spaces for the diverse user groups as they can work collaboratively with digital and print media (Sinclair, 2009). In defining LC, Beagle (2006, p. xviii) mentioned as it happens when all information commons (IC) resources supporting the IC are "organized in collaboration with learning initiatives sponsored by other academic units, or aligned with learning outcomes defined through a cooperative process." So, LC is a service of libraries that brings in one location of other services, facilities and learning resources to support user learning (Donkai, Toshimori & Mizoue, 2011). LC conceptual model has combined three interrelated and interdependent levels: the physical commons, the virtual commons and the cultural commons (Beagle, 2006; Beagle, 2008). User students use these continuum of services for their course work problem solving in out of class space of LC.

3.2 User-centered learning at LC

The student–centered learning implies that students have a choice in what they study and how they study (O'Neill & McMahon, 2005). Gibbs (1992) has defined student-centered learning as it, "gives students greater autonomy and control over choice of subject matter, learning methods and pace of study" (p. 23). So in student-centered learning students are much more responsible to take charge of their learning and they can choose what to study, how to study and set the learning goals by themselves. LC is a facilitator for user students to

engage them in active learning outside of classroom space and helps them to construct knowledge by solving learning problems. User students use LC spaces for pursuing their self-directed learning and work collaboratively with their group mates. They are very much open to choose their own topics and methods by themselves and are responsible for their own learning. So the student-centered learning at LC is nothing but user-centered learning (UCL) for libraries. It is a unique learning pedagogy in academia based on self-responsible learning of LC users.

3.3 Knowledge sharing and acquisition in group learning

LC support for informal learning through face-to-face reference encounters, group study rooms, and social areas (Beatty & White, 2005). It is an integrative and dynamic model that contextualizes information and offers collaborative work spaces where group processes can modify knowledge in ways that reflect the large-scale growth of knowledge in the culture around us will be more beneficial to them (Beagle, 1999). Here students across the places were increasingly forming their own collaborative study groups to engage more deeply and frequently and sometimes quite adventurously with their coursework and assignments (Bennett, 2003). Learners are creating knowledge during the group process of learning and they share knowledge among the group mates for generating new ideas and solving problems. Lauriden and Cruz (2013) has stated that, ``Learning is the acquisition of knowledge. Sharing is a way of attaining new knowledge among learners``. Thus knowledge sharing and acquisition during group learning at LC is the knowledge transformer role of the user which supports Hmelo-Silver`s (2004) knowledge deficiencies phase of PBL cycle. Therefore, it is confirmed as a new PBL cycle for LC.

3.4 Problem-based learning

PBL is a tutorial process and was introduced in the Medical Faculty at McMaster University in Canada (Barrows & Tamblyn, 1980). The fundamental approach of PBL is problem solving based learning. It's a learner-centered instructional (and curricular) strategy that encourages students to conduct research, integrate theory and practice, and use knowledge and skills to come up with a viable solution to a problem (Savery, 2006). It not only helps the learners to engage in learning but also helps them to create meaning (knowledge) for

solving the learning issues. PBL is an instructional approach in which students learn via the use of an assisted complex problem with no one correct answer. (Hmelo-Silver, 2004). In this approach learning starts with a posed problem which the students try to reach in an answer. It makes them understand how to deal with the given problems and also enhance their skills to work collaboratively and think logically. Learning activities in PBL occur in three phases which have been conceptualized from Mergendoller et al. (2006) and English & Kitsantas (2013) to develop the theoretical model of user-centered problem-based learning at LC. Later the phase 2 (guided inquiry and product/solution creation) was divided into two separate phases and `formulate inquiry` and `solution creation` was determined as phases. Thus, this study takes problem identification, formulate inquiry, solution creation and problem conclusion as PBL phases. Besides that, Hmelo-Silver (2004) has determined knowledge deficiencies as a phase of PBL cycle. Based on that phase this research adopts knowledge sharing and acquisition as a phase of PBL activities in LC.

LC is a collaborative space in academia where users come to use it for their out of class coursework learning. But there is a gap in the literature to measure how this out of class space is creating meaning (knowledge) and solving learning problems of the PBL learners. Thus, LC use for learning has been identified as the main construct of this study. Moreover, there is a gap in the literature about how LC users are learning and solving problems as PBL learners. Therefore all those five phases of PBL have been identified as the construct of the study and a survey was conducted to check the relationship of the six constructs.

4. Methodology

To prove the hypotheses, this research adopts a quantitative approach of online survey design by distributing questionnaires. The study relied upon the quantitative approach to validate the hypotheses and required the survey for getting an overall perception of the population. As the quantitative approach is a more scientific and reliable one to dig into the problem, a structured questionnaire was developed (Eyisi, 2016). Based on the inputs resulting from background studies a conceptual model was developed in Figure 1 and it shows that the number of dependent variables is smaller than the number of independent variables. As a

result, partial least squares (PLS) regression analysis using structural equation modeling (SEM) was used to validate the conceptual model and to test hypotheses (Abdi, 2010).

An online questionnaire was used to collect data for the survey and used Google Forms as an online survey collection tool (Yip, Lo, Ho, & Chiu, 2021; Majid, 2014). It has identified six constructs and the survey instrument used was developed from the relevant literature review. The questionnaire consisted of 26 questions (item) and a seven-point Likert scale was used ranging from 1= strongly disagree to 7= strongly agree.

The survey was conducted in Japan Advanced Institute of Science and Technology (JAIST) and Kanazawa University in Ishikawa Prefecture of Japan. Apart from this, there were few students from Nagoya University with the researchers' personal contact. Accordingly these three academic libraries of those universities comprised the respondents of the study. The sample of the study was the users of Learning Commons in those libraries including bachelor, master, doctoral, certificate, special and visiting students of the institutions. Questionnaires were emailed to JAIST students using student mailing lists requesting them to participate in the survey. Kanazawa University Library authority circulated posters in the entrance of the library asking them to participate in the survey and provided the link of the online questionnaire. Moreover, the researcher personally sent emails to a few students of Nagoya University. For widening the global view of the study certificate, special and visiting students were included who were studying in the mentioned three Japanese universities. Which has brought the opportunity to get varied responses from the university students of the USA, Canada, France, Kosovo and China. A total of 105 students participated in the survey from the three universities. The survey was conducted during June 2019 to July 2019. The analysis of data was done with the SPSS™ 25 software.

Table 1 reports the demographic information of the respondents and among them 62.9% were male and 37.1% were female students. The mean age of the respondents is 23.27 and the median age is 23.00. A majority of 71.4% respondents belong to the 19-24 age group. The second largest 25-30 age group has 23.8% of respondents. Of the respondents, 46.7% were both the Bachelor and Master level student which has coincidently made an equal position of the survey. About 95% of the respondents belong to Japanese universities. 50.2% of the

Table 1. Demographic information of respondents (N=105)

Category	Particulars	No.	Percent (%)
Gender	Male	66	62.9
	Female	39	37.1
Age	19 – 24	75	71.4
	25 – 30	25	23.8
	31 – 35	05	04.8
Academic Status	Bachelor	49	46.7
	Certification Course	1	1.0
	Doctoral	5	4.8
	Master	49	46.7
	Special Auditor Student	1	1.0
Survey University	JAIST	45	42.9
	Kanazawa University	53	50.2
	Nagoya University	2	1.9
	Other Universities	5	5.0

respondents had participated from Kanazawa University and 42.9% were from JAIST (Japan Advanced Institute of Science and Technology). These two universities have formed 93.1% of the total response.

5. Partial least squares (PLS) analysis

The study has employed partial least squares-structural equation modeling (PLS-SEM) which is a widely accepted method for the research that has sensible amount of data and theoretical information (Alolah, Stewart, Panuwatwanich, & Mohamed, 2014; Hair, Risher, Sarstedt & Ringle, 2019). As suggested in this method the study used a two-step model validation process that first examines and validates the measurement model and then tests the proposed theoretical structure (Babin & Attaway, 2000; Gerbing & Anderson, 1992). Several statistical analysis was performed which includes the descriptive statistics of mean, standard deviation, skewness, kurtosis and Cronbach`s alpha related with the profile of sample (Sekaran, 2003). In addition, factor loading, composite reliability (CR) and average variance extracted (AVE) was employed to check the reliability and validity of the dataset. The analysis also includes a test of hypothesis to validate the proposed structural model.

5.1 Internal consistency and descriptive statistics

The descriptive statistical analysis of the six constructs LC use for learning (LCUL), knowledge sharing & acquisition (KSA), problem identification (PI), formulate inquiry (FI), solution creation (SC) and problem conclusion (PC) was conducted in order to gain insight into the variables. Mean, standard deviation, skewness and kurtosis was calculated as part of the process. The LC users of the study have shown a positive attitude towards the problem solving process throughout the problem identification to problem conclusion steps and the mean resembles a high positivity ranging from 5.374 to 5.260 (in a scale of 1 to 7). The standard deviations for all the variables are less than one and they are ranging from 0.893 to 0.972, which indicates the item scores are relatively close to mean scores. The skewness of

Table 2. Internal consistency and descriptive statistics

Construct	Item	Mean	Standard Deviation	Skewness	Kurtosis	Cronbach's Alpha (≥ 0.70)
LC Use for Learning (LCUL)	3	5.349	0.769	-0.751	1.343	0.746
Knowledge Sharing & Acquisition (KSA)	4	5.374	0.932	-0.531	0.651	0.750
Problem Identification (PI)	5	5.337	0.893	-0.818	1.241	0.740
Formulate Inquiry (FI)	5	5.356	0.921	-0.817	1.273	0.779
Solution Creation (SC)	5	5.276	0.972	-0.864	0.452	0.772
Problem Conclusion (PC)	4	5.260	0.944	-0.578	0.565	0.744

the latent variables range from -0.531 to -0.864 and kurtosis ranges from 1.273 to 0.452. Kline (2010) recommends that the indices of skewness should be below 3.0 and the kurtosis is 8.0. Last of all Cronbach's alpha (1951) measures the internal consistency between items in a scale. Results of Cronbach's alpha have exceeded the recommended value of 0.70 (Table 2) and show strong consistency among the items. So the data of this study are found to be normal for the purpose of partial least squares – structural equation modeling (PLS-SEM) and multiple regression analysis for hypothesis testing.

5.2 Indicator reliability and convergent validity

In examining the measurement model the primary step is to assess the indicator loading. The expected loading value is above 0.70 as the construct can explain 50 percent variance of the indicator (Hair, Risher, Sarstedt & Ringle, 2019). Thus the loading ranges from 0.599 to

Table 3. Factor loading, composite reliability (CR) and average variance extracted (AVE) coefficient

Construct	Factor Loading (≥ 0.70)	Composite Reliability (CR) (≥ 0.70)	Average Variance Extracted (AVE) (≥ 0.50)
LC Use for Learning (LCUL)	0.715	0.7664	0.52445
	0.803		
	0.646		
Knowledge Sharing & Acquisition (KSA)	0.837	0.874	0.636
	0.676		
	0.803		
	0.860		
Problem Identification (PI)	0.668	0.839	0.512
	0.683		
	0.758		
	0.796		
Formulate Inquiry (FI)	0.662	0.864	0.564
	0.609		
	0.670		
	0.761		
Solution Creation (SC)	0.889	0.838	0.513
	0.795		
	0.599		
	0.663		
	0.867		
Problem Conclusion (PC)	0.629	0.855	0.600
	0.787		
	0.828		
	0.689		
	0.666		
	0.892		
	0.646		

0.892 (Table 3) and items are not deleted as there are no loadings below 0.50 (Chen & Tsai, 2007; Chin, 1998; Hair, Black, Babin, & Anderson, 2010). As a result they showed a strong reliability of indicator loading and contributed to having increased composite reliability (CR) and average variance extracted (AVE).

Convergent validity is the extent which helps to measure the level of correlation of multiple indicators and other measures of the same construct (Ab Hamid, Sami, & Sidek, 2017). For testing the convergent validity of the scale composite reliability (CR) and average variance extracted (AVE) has been examined (Thomas & Veloutsou, 2013). Reliability proves the internal consistency to which the individual items that constitute a test (scale) correlate with one another or with the test total. The composite reliability (CR) has been regarded as an alternative measure to Cronbach's alpha as it`s items are unweighted (Ando et al., 2005). The composite reliability (CR) and average variance extracted (AVE) coefficient are related with the quality of a measure. The value of 0.70 and higher is required in composite reliability (CR) to be adequate for reliability. In this study the CR of all the six constructs are above the recommended value and they range from 0.838 to 0.874. The next step of examining convergent validity is measuring average variance extracted (AVE). Table 3 shows that the AVE of six constructs have satisfactorily crossed the recommended value 0.50. AVE of this study ranges from 0.512 to 0.636 and it indicates a strong convergent validity of the constructs.

5.3 Discriminant validity - Fornel and Larcker

Discriminant validity is the process of measuring empirically how the constructs are differing from one another (Afari, 2013). For assessing the discriminant validity the square root of each construct was followed as suggested in Fornel and Larcker (1981). The discriminant validity appears when comparing the square root of average variance extracted (AVE) **(in bold)** with the correlation coefficients of each construct. This study finds that formulate inquiry - knowledge sharing & acquisition and formulate inquiry - problem conclusion are having slight variances. The differences between them are 0.114 and 0.005 which can be ignored as it has been reported that Fornel and Larcker do not always work well with the

loadings having strong values (Ab Hamid, et al. 2017; Hair et al., 2019). Moreover, the discriminant validity of this study can be accepted as the factor loadings below 0.70 was not

Table 4. Square root of AVE *(in bold)* and correlations between constructs average variance extracted (AVE)

Construct	Problem Identification	Formulate Inquiry	Knowledge Sharing & Acquisition	Solution Creation	Problem Conclusion	LC Use for Learning
Problem Identification	**0.715**					
Formulate Inquiry	0.660**	**0.751**				
Knowledge Sharing & Acquisition	0.643**	0.865**	**0.797**			
Solution Creation	0.551**	0.738**	0.723**	**0.716**		
Problem Conclusion	0.690**	0.756**	0.790**	0.536**	**0.774**	
LC Use for Learning	0.651**	0.702**	0.740**	0.647**	0.754**	**0.724**

**. Correlation is significant at the 0.01 level (2-tailed)

deleted. Lastly, the other four construct square roots of AVEs are higher than the values of its columns and absolutely they have established the discriminant validity. Thus the measurement model has established the internal consistency, indicator reliability, convergent validity and discriminant validity adequately.

6. Structural equation modeling (SEM) and hypothesis test

As a part of the two-step model validation process of structural equation modeling (SEM), the last step is to validate the structural model. Linear regression was performed to test the proposed structural model and hypothesis to fit the model by checking the relationship of dependent and independent variables (Van Tonder & Petzer, 2018). The structural model comprises six latent constructs that have twenty six observable variables. It shows the path

relationships among the dependent and independent variables as hypothesized in the study. To test the competence of the structural model the factor loading, path coefficient (β) and coefficient of determination ($R^{2)}$ were employed (Chin, 1998).

The overall fit of the model is determined by the coefficient of determination ($R^{2)}$ of each construct (Martinez-Ruiz and Aluja- Banet, 2009). The study has followed the estimates of 0.04 as minimum, 0.25 as moderate and 0.64 as strong for the coefficient of determination ($R^{2)}$ as suggested by Ferguson (2009) for social science research. The structural model has formulated twelve hypotheses *H1, H2, H3, H4, H5, H6, H7, H8, H9, H10, H11* and *H12*. It has appeared from the analysis that all the hypotheses have been supported. The results of coefficient of determination ($R^{2)}$ shows the explanatory power of the research model and moderate to strongly support all the hypotheses. Table 5 has listed the results of the

Table 5. Results of structural equation modeling (SEM) and hypothesis testing

Hypothesis	Path	Coefficient (β)	R^2	t Value	Sig. (p)	Test Status
H1	LCUL ⟶ PI	0.64	0.41	8.43	0.00***	Supported
H2	LCUL ⟶ FI	0.71	0.50	10.18	0.00***	Supported
H3	LCUL ⟶ KSA	0.74	0.55	11.16	0.00***	Supported
H4	LCUL ⟶ SC	0.63	0.40	8.30	0.00***	Supported
H5	LCUL ⟶ PC	0.86	0.74	11.44	0.00***	Supported
H6	KSA ⟶ PI	0.64	0.41	8.53	0.00***	Supported
H7	KSA ⟶ FI	0.87	0.75	17.52	0.00***	Supported
H8	KSA ⟶ SC	0.72	0.52	10.62	0.00***	Supported
H9	KSA ⟶ PC	0.79	0.62	13.10	0.00***	Supported
H10	PI ⟶ FI	0.66	0.44	8.93	0.00***	Supported
H11	FI ⟶ SC	0.74	0.55	11.10	0.04**	Supported
H12	SC ⟶ PC	0.84	0.70	6.44	0.03**	Supported

**** p<.001, ** p<. 05, * p<. 01, based on two-tailed test*

hypothesis testing and all the hypotheses were strongly supported. The first phase of the structure model shows the relationship of independent variable of LC use for learning (LCUL) with the dependent variable of PBL phases of problem identification (PI), formulate inquiry (FI), knowledge sharing and acquisition (KSA), solution creation (SC) and problem conclusion (PC). It specifies that in hypothesis *H1* and *H2* LC use for learning has statistically significant relation with problem identification (PI) and formulate inquiry (FI) has 41% (R^2 = 0.41) and 50% (R^2 = 0.50) of inner relationship with the PBL learners problem dealing phases. The hypothesis *H3* indicates that LC use for learning has statistically significant positive relation with learners knowledge sharing and acquisition (KSA) and helping to create 55% (R^2 = 0.55) new knowledge during learning. Hypothesis *H4* and *H5* shows the relationship between LC use for learning with solution creation (SC) and problem conclusion (PC). It depicts a statistically significant relationship with *H4* of 40% (R^2 = 0.40) and *H5* of 74% (R^2 = 0.74).

The second phase of the model shows the relationship of the independent variable knowledge sharing and acquisition (KSA) with the dependent variables of PBL Phases. The hypothesis *H6* and *H7* explains that knowledge sharing and acquisition (KSA) has 41% (R^2 = 0.41) and

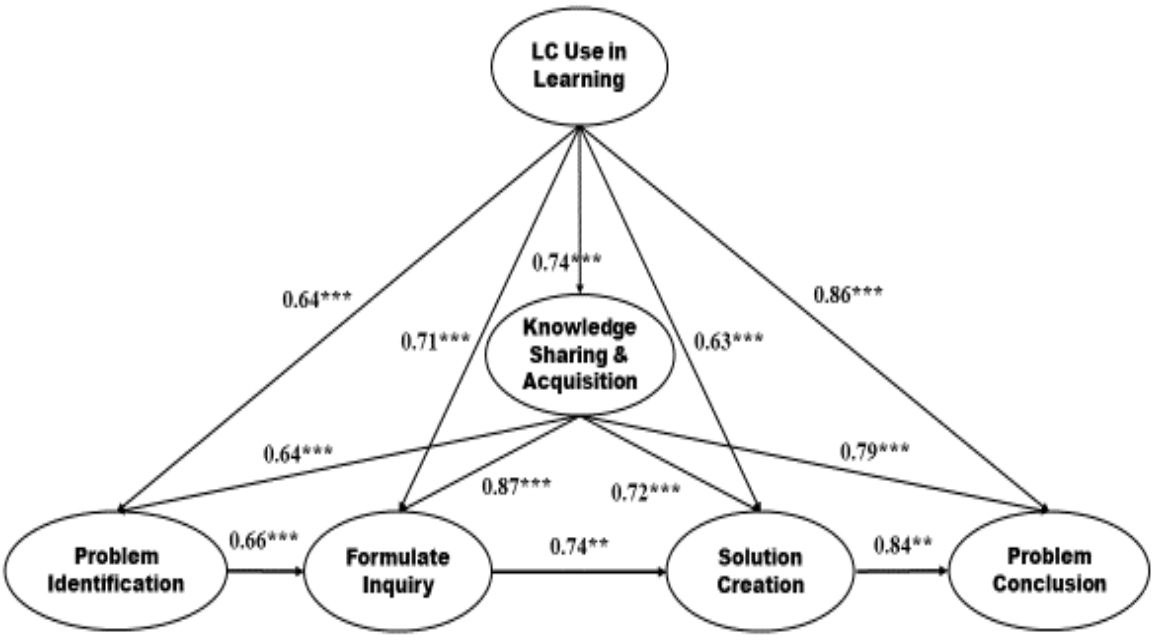

Figure 2. Conceptual model of user-centered problem-based learning at learning commons

75% (R^2 = 0.75) of variance (of inner relationship) with problem identification (PI) and formulate inquiry (FI) and it shows the statistically significant relationship of the two hypotheses. Moreover, in hypothesis *H8* and *H9*, knowledge sharing and acquisition (KSA) can count for solution creation (SC) and problem conclusion (PC) to the extent of 52% (R^2 = 0.52) and 62% (R^2 = 0.62).

The last stage of the structural model shows the relationship of the independent variable problem identification (PI) with the rest of PBL phases and displays statistically significant relationships among them. In hypothesis *H10* problem identification (PI) having 44% (R^2 = 0.44) of variation (to encourage the learners) in connection with the formulate inquiry (FI). On the other side, hypothesis *H11* interprets that 55% (R^2 = 0.55) of formulate inquiry (FI) influences learners for solution creation (SC). According to hypothesis *H12*, solution creation (SC) including all the independent variables can interpret problem conclusion (PC) to the extent of 70% (R^2 = 0.70). Thus the coefficient of determination ($R^{2)}$ resolves that the model fits near strongly.

7. Implications for Learning Commons and academicians

The main point emerging from this study that has implications for library service delivery is that libraries need to boost their common spaces, improve and reorganize up to the mark services and resources, and provide services that support their users' preferred learning. The heart of learning commons is learning. LC has created a unique learning pedagogy in academia by introducing designated learning spaces in an out of class environment. Now the library authority needs to concentrate on PBL process based user-centered learning, knowledge sharing and acquisition in group learning and informal learning for mapping the complete picture of learning at LC. This study determines it as PBL based `Learning Continuum` for LC. Librarians, LC staff, tutoring staff, and IT staff need to understand this continuum to better serve the learner. The success of LC lies in its spaces, environment and the learning method carried by the users in their mind. LC staff may redefine their roles based on this by supporting user learning, collaborative group learning for knowledge sharing and acquisition and informal learning for solving course work problems. The study has confirmed knowledge sharing and acquisition as a PBL cycle phase for LC learning. Therefore,

collaborative group learning opportunities need to flourish as learners can share knowledge and learn by themselves. Further to that, this research will contribute to a broader conversation among academic communities about problem-based learning, user-centered learning, group learning, and informal learning in an out of class space. In the wider world, learning is gaining recognition as a key factor for success of academic institutions. This research has explored PBL based user-centered learning pedagogy out of class space to the academic world. Academics need to contribute their knowledge to make the pedagogy fruitful in academia.

8. Limitations and future research

This study has put forward the problem-based learning method to see the user-centered learning at LC. It did not check the motivation and strategies of the learners as the reasons why they are coming to this space to use for learning. Further study needs to see the self-directed learning (SDL) and self-regulated learning (SRL) methods of user-centered learning at LC. The present study consider that the combined understand of problem-based learning (PBL), self-directed learning (SDL) and self-regulated learning (SRL) methods of constructivist learning theory would make the User-Centered Learning (UCL) as a wide-ranging learning pedagogy in the academia.

9. Conclusion

Analyzing the findings of the study it was found that LC provides the opportunity to the user learners to work in groups for solving their course study problems. After the problems assigned in their course work, learners come to the library and use LC as one of the pioneer vibrant learning spaces in the campus. It is a unique space for them to interact with their learning mates in an out of class environment. Learners appear here for solving the problems absentmindedly bearing the problem-based learning (PBL) method in their mind. During learning they try to identify the problem that has been assigned by the course teachers. For solving the problems they proceed to formulate inquiry, solution creation and problem conclusion phases of PBL. Thus, the study shows that LC supports the PBL method outside of class space. Therefore, academic libraries need to provide sufficient orientation to their LC staff about learning methods. Apart from that the knowledge sharing and acquisition

culture of the users are found as an inseparable part of group learning at LC. It shows that knowledge sharing and acquisition helps the learners to generate new ideas and reach a conclusion with a suitable solution. Thus, LC needs to give more attention in this part and arrange its spaces and services for the proliferation of this behavior of the users. The study also found that LC is a super hub for the learners for its spaces, services and resources. It shows that they use the services and resources for solving the learning problems. They take help from the LC staff and use resources to integrate knowledge in their earlier ideas and rehearse the tentative solution. Thus, it is high time for LC to rethink their continuum of services and resources and adopt PBL method based `Learning Continuum`. They need to arrange the services and resources bearing the PBL learning method and knowledge sharing and acquisition culture in their mind and ensure the best continuum of services for the learners. LC has created a new learning pedagogy by integrating the PBL method, knowledge sharing and acquisition culture and its continuum of services. It is the user-centered learning (UCL) pedagogy at LC in academia.

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