

Shared context for engineering students learning business

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ABSTRACT

The shared context is a learning environment in which knowledge sharing is promoted by communication and collaboration among students. This engages students in any learning activity using cooperation, evaluation and interaction to build knowledge socially when coming across disagreement and difference. The communication technologies make it possible for everyone to contribute to the online community for sharing knowledge. The paper discusses the theoretical framework and then provides an example illustrating how to design teaching and learning activities to cultivate the sharing culture in classes with both engineering and business students. Business people tend to be extroverted while engineers are usually introverted. There are usually communication barriers among students from these two disciplines studying in the same subject. A survey was conducted to investigate students' attitudes to the shared context and results suggest that this can integrate the higher learning motivation into the physical interactions and communications among peers. It encourages knowledge sharing through socialization – an important step towards knowledge creation – in both the online and real worlds. The shared context is effective when it integrates with different skills and interests of students who provide diversity into the traditional classroom learning. This makes knowledge possible to be accumulated, examined, revised and distributed.

Contribution/ Originality

This paper revealed the importance of knowledge sharing in education. The shared context helps students of various disciplines (especially engineering) to collaborate with each other and enhance their learning performance. It is found that online communication is able to facilitate such collaboration and support teaching and learning activities in a traditional classroom

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1. INTRODUCTION

Some famous business leaders are engineers like Henry Ford, Thomas Edison, John Frank Stevens, Herbert Hoover, Jimmy Carter and Steve Jobs. Nowadays 44% of Fortune 500 CEOs have business and engineering degrees (Straighterline, 2017) while 33% of the S&P CEOs have engineering degrees and 11% have business degrees (Business Insider, 2011). There are Fortune 100 CEOs (Visually, 2013) with various degrees including engineering (14%), business administration (11%), accounting (9%), economics (8%), chemistry (2%), chemical engineering (2%), mathematics (2%), and history (2%).

Engineers have several qualities defining good business leaders. Engineers like solving problems with information collection. Relevant facts are gathered before diving into problems and this practice also works remarkably well in business areas. Like good businessmen, engineers are good at probing for data and separating them for conclusions and this leads to a better decision making (Sternberg, 2007). In addition, engineers are proficient in data analysis and mathematical modeling. They convert a problem into logical terms and work with databases and programming languages. Engineers are analytical and detail-oriented and take risks after careful calculation. They are good at risk assessment that is a process leading to probabilistic ranking of possible outcomes. Moreover, engineers are not emotional in their decision making and they understand that it is necessary to isolate the factual from the emotional issues (Gurke, 2011). Finally, engineers are intuitive and creative and they are able to solve problems by thinking outside of the box. They identify the reasons of a problem and suggest economical solutions. Creativity and objective analysis equips engineers with the necessary skills for business success (The New York Times, 2009).

Although an engineering degree is a good foundation for business management, there are still some difficulties faced by engineers working in the business areas. Engineering work is vastly different from several business areas like sales and marketing. Some personalities and traits may be good from the perspective of engineers but they are considered undesirable in the field of business. Business people tend to be extroverted and they enjoy meetings and are energized by working with people around. Engineers are usually introverted and they prefer working alone. Engineers are not shy but just need some time to themselves.

Since 1988, M.I.T. has offered a programme called the Leaders of Global Operations that is a specialized crossover master programme between its management and engineering schools (The New York Times, 2009). Graduates of this programme earn both an MBA and a master degree in engineering. This provides a better training for the real business environment in which engineers and businessmen interact and provide a great value to the market. To provide engineers with business skills can help them to address a business problem from a technical perspective. In Britain, to be registered as a chartered engineer requires the demonstration of management and leadership skills. Engineers need to show that they can apply engineering skills in a real business situation.

Good communication skill is important for ones to express their ideas in writing and conversation. Furthermore, people skills are required to interact with others respectfully and effectively. Good personal relationship is important because the collaboration and support of others are required to accomplish in the business world (Herbst, 2017; Young, 2010). Leadership does not come naturally. The vigorous engineering curriculum does not include business subjects triggering a business mentality. This leads to a conflict when introverted engineering students study business subjects in which they need to learn the practices of extroverted business people. These two types of students may not understand the buzzwords and jargons of each other. They may only put emphasis on issues related to their own concerns. Engineering students may focus on their product designs and do not understand the difficulties of salespeople selling a million product units each year. Similarly, business students are eager to use their best commercial ideas and not interested in the technology-related issues. In addition, business students are trained to spend time on networking with people while engineering students like taking off and working on projects on their own pace.

Knowledge is generated, acquired and exchanged in learning and teaching activities. It is necessary to understand how students access right knowledge and how information is exchanged efficiently among students themselves. To handle new knowledge is dependent on sharing of knowledge that, in turn, on communication and cooperation among peers (Mariano and Awazu, 2017; Silva *et al.*, 2012). Knowledge is created when there are interactions among individuals instead of an individual operating alone (Nonaka *et al.*, 2001; Pee and Min, 2017). Therefore, teaching is not only concerned about spreading knowledge but also the capability of adapting and applying acquired knowledge to a new context that needs a shared context to share, create and utilize knowledge.

The purpose of this paper is to discuss the way of developing the curriculum for engineering students studying in business subjects in a tertiary institution. The emphasis will be put on how to establish a sharing culture in which students communicate with others to share knowledge in the learning process. In particular, the relationship of the knowledge management, cognitive process and relevant learning theories will be discussed in order to build a learning context facilitating the knowledge management in this sharing culture. The paper will first introduce the pedagogical background relevant to the curriculum development and then an example of the syllabus design will be provided. Students' attitudes to the shared context were collected in the survey and the result showed that this could enhance engineering students' learning capability and, thus, academic performance in business subjects.

2. KNOWLEDGE MANAGEMENT IN SHARED CONTEXT

Managing knowledge can be tricky as knowledge is intangible and dynamic. An important function of knowledge management is to transfer knowledge to people who need it. Knowledge sharing in an organization is to recreate and maintain ambiguous and complicated procedures in a new situation (Intezari *et al.*, 2017; Shih and Tsai, 2016; Szulanski, 1996). The exchange and sharing of knowledge in an organization occurs at different levels: (1) from individuals to individuals and groups, and (2) from groups to groups and the organization (Alavi and Leidner, 2001; Renzl, 2008; Sedighi *et al.*, 2016).

Figure 1 shows the distribution of explicit and tacit knowledge in the knowledge conversion cycle. An individual may learn from the externalization of others (e.g. speech given in a seminar) and further develop his own explicit knowledge from different knowledge sources like reading journals, and finally converts his explicit knowledge into new tacit knowledge in his mind (i.e. from steps "formalizing" to "selecting"). However, if there is no sharing with others (i.e. from steps "adapting" to "organizing"), tacit knowledge is not possible to be acquired normally.

In the educational context, sharing knowledge with peers is mainly performed through collaborative and cooperative learning, which are important features of the student-centered approach. In an ideal educational environment, learning should be social and collaborative instead of being isolated and competitive. Sharing with peers and responding to each other can deepen understanding of a given concept and improve thinking skills (Ashok *et al.*, 2016; Gerdy, 1998; López-Nicolás and Meró-no-Cerdán, 2011). Learning is intrinsically a social function in which students benefit from knowledge-creating communities inside and outside the school (Henttonen *et al.*, 2016; Jonassen, 1995). In their communication with peers, learners may steadily create, share and interpret others' knowledge and transform it into their own meaning (Hsu and Sabherwal, 2012; Pea, 1993). Sharing of knowledge not only increases the interest of students in learning, but also enhances analytical thinking. A student who participates in discussion should be responsible for one's learning and becomes a critical thinker (Palacios-Marqués *et al.*, 2016; Totten *et al.*, 1991). Learners can perform at a higher intellectual level when they work in a collaborative manner than when asked to work unconnectedly (Rosendaal and Bijlsma-Frankema, 2015; Vygotsky, 1978). Sharing is particularly important when students manipulate metacognitive knowledge to create new structures and concepts.

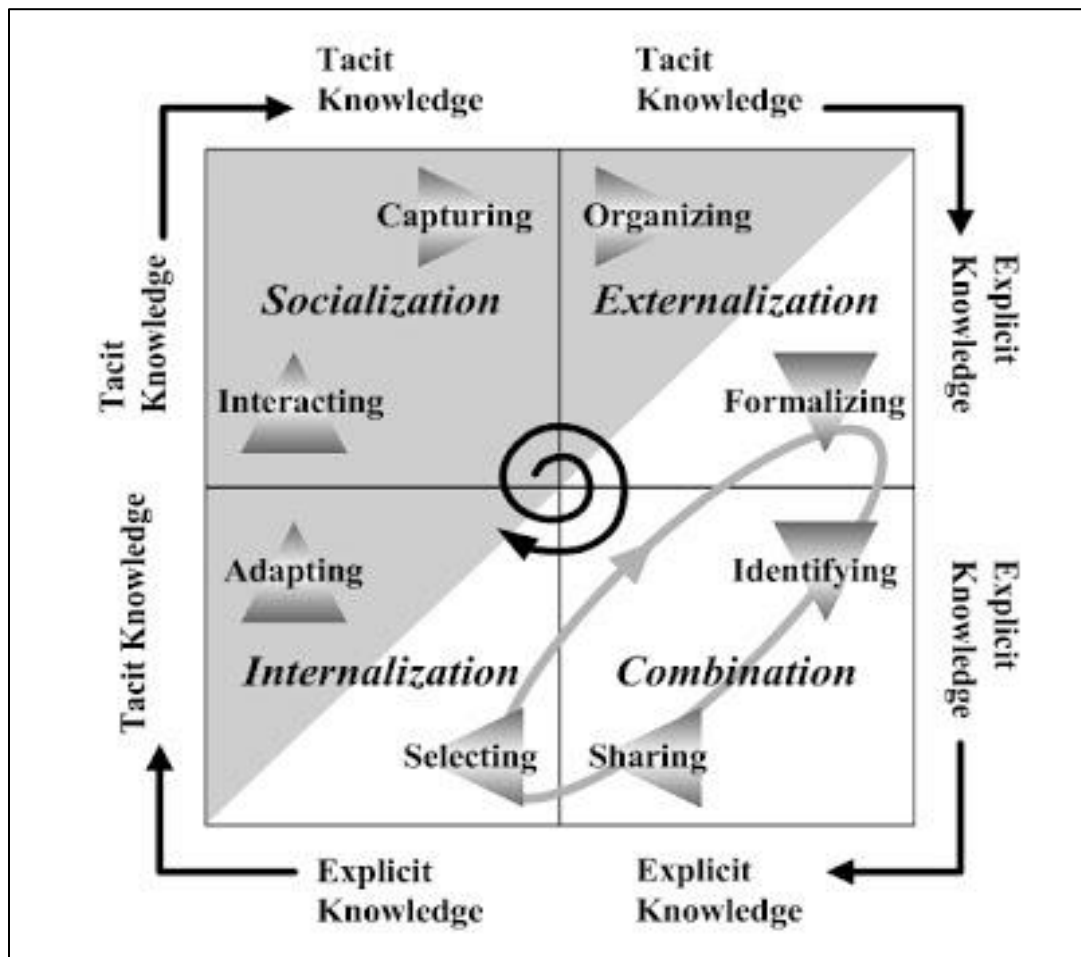


Figure 1: Distribution of explicit and tacit knowledge in the knowledge conversion cycle

(Source: www.jaist.ac.jp/ks/labs/umemoto/km_e.html)

Table 1 presents the relationships among the types of knowledge, steps in the knowledge conversion cycle and cognitive process. Cognitive processes are involved in the capturing and reusing of knowledge and in selecting and replicating the best practices in an organization. Bloom’s original taxonomy described six levels of cognitive domains, namely knowledge, comprehension, application, analysis, synthesis, and evaluation. This was later revised and expanded. Table 2 further elaborates cognitive processes and summarizes the learning actions associated with each level of the revised Bloom’s taxonomy.

At the two lowest levels of the revised Bloom’s taxonomy (i.e. remembering and understanding), students deal with the factual knowledge as well as to recall and understand specific details, information and ideas. In the middle two levels (i.e. applying and analyzing), students handle conceptual and procedural knowledge and demonstrate their abilities in some meaningful ways such as comparing and contrasting relevant concepts and examining others’ work critically. At the two highest levels (i.e. creating and evaluating), students are expected to create new knowledge, which involves the awareness of their own cognition and more metacognitive knowledge.

Table 1: Relationships among types of knowledge, conversion cycle and cognitive process

Types of knowledge (Salisbury, 2009)	Knowledge conversion step involved	Cognitive process involved (Anderson and Krathwohl, 2001)
Metacognitive knowledge	Mainly collected in socialization	Require metacognitive knowledge to create and evaluate
Procedural knowledge	Mainly constructed in internalization	Use procedural and conceptual knowledge to apply and analyze
Conceptual knowledge	Mainly constructed in externalization	
Factual knowledge	Mainly collected in combination	Remember and understand factual knowledge

Table 2: Learning actions at the six levels of the revised Bloom’s taxonomy

Learning level	Cognitive process	Approach	Key actions
6	Creating	Organizing information in a new or different way	Verify, set up, propose, produce, prepare, plan, organize, modify, manage, invent, formulate, devise, develop, design, create, construct, compose, assemble, and arrange
5	Evaluating	Examining informational sources to assess their quality and make decision based on predetermined criteria	Support, recommend, rate, qualify, predict, judge, estimate, defend, critique, assess, argue, and appraise
4	Analyzing	Using lower-level thinking skills to recognize important components and examine each part	Test, survey, solve, sketch, predict, modify, find, figure, examine, diagram, compare, combine, and change
3	Applying	Following procedures or steps to answer new problems	Interpret, illustrate, identify, estimate, diagnose, demonstrate, criticize, contrast, construct, classify, calculate and appraise
2	Understanding	Building new connections in their minds	Translate, transform, summarize, rewrite, review, restate, report, reorganize, paraphrase, organize, interpret, indicate, illustrate, identify, explain, discuss, describe, defend, compare, and classify
1	Remembering	Retrieving information from memory	State, select, repeat, recite, recall, quote, name, locate, list, label, identify, describe, define, copy, and arrange

Figure 2 illustrates the study paths of students in terms of what types of knowledge they should acquire and what cognitive skills they should master. The cognitive processes in the revised Bloom’s taxonomy suggest a way for students to move forward to attain a higher level of skills and knowledge after each knowledge conversion cycle. This guides educators in designing the syllabus for individual courses and ensures that the various courses in a programme contribute towards helping students achieving the programme outcome. For example, in a university foundation course, the focus may be on factual knowledge whereas in a more advanced course students need to handle more conceptual and procedural knowledge and develop their own metacognitive knowledge as well.

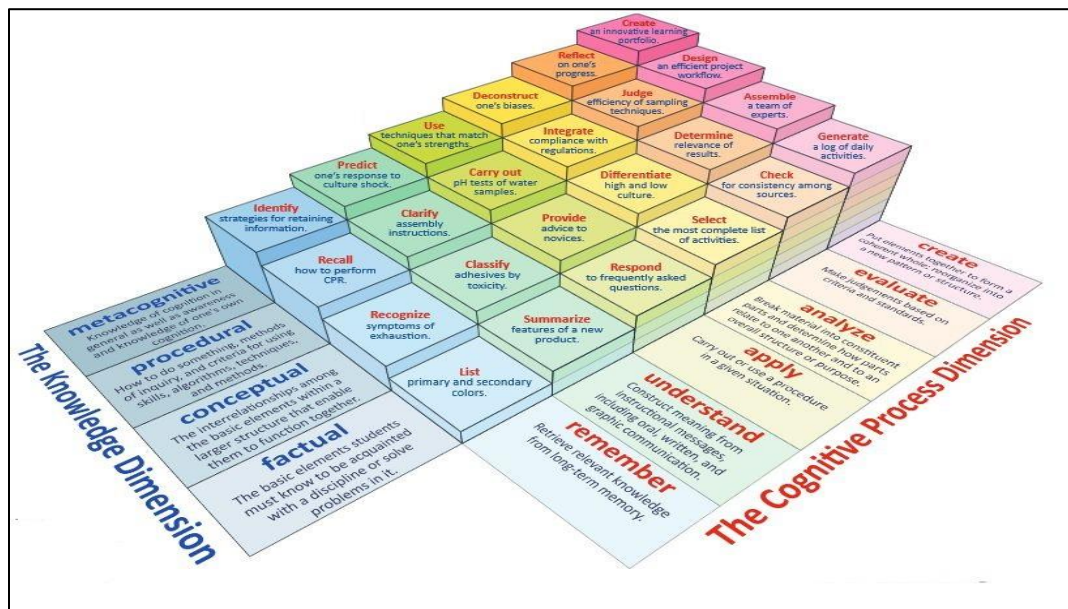


Figure 2: Relationship between types of knowledge and cognitive processes

(Source: www.celt.iastate.edu/wp-content/uploads/2015/09/RevisedBloomsHandout-1.pdf)

3. AN EXEMPLAR OF SYLLABUS DESIGN

This example describes the use of the shared context to design a group project and related teaching and learning activities for an undergraduate course on management information system. The project involves improving the security of a company’s online store. Students work in groups to act as consultants. There are three main stages in this project. As they work on this project, the students will acquire cognitive skills starting from the bottom of the framework and move up to the top (see Table 3).

In Stage 1, the students need to understand and remember factual knowledge (such as authentication, confidentiality and integrity of networks) in the subject. This is equivalent to lower order thinking in the revised Bloom’s Taxonomy. Sharing among peers is not emphasized here and students mainly obtain explicit knowledge from various sources to construct their own knowledge. In the blended learning, classroom lectures may be used in conjunction with a learning management system (LMS) like Blackboard to facilitate such knowledge transfer (e.g. uploading course materials). After each lecture, questions are posted on Blackboard to help students to check if they understand the concepts. Students are encouraged to use online tools such as search engines to search relevant information for completing these questions.

In Stage 2, students are provided with the background information about the company, tasks to be completed, resources containing pointers (e.g. hyperlinks) to information sources for completing the tasks, procedures to complete the tasks, and the evaluation rubric. As this is a project on network security, students should be able to identify security risks, demonstrate investigation and problem solving skills and make recommendations. These are mainly cognitive skills of applying and analyzing relevant knowledge and students are required to manipulate conceptual and procedural knowledge.

After the project has started, the instructor gets students to explore the problem in class by asking them to come up with possible reasons for the occurrence of the incidents mentioned in the project to identify the potential security risks. The instructor may also post some guiding questions in the discussion forum and monitor the students’ discussions. In this stage, the instructor’s role has changed

from that of a knowledge transmitter to that of a facilitator. The instructor may meet with the groups at regular intervals to check progress and resolve issues. As they work on this project, the students will convert their explicit knowledge into tacit knowledge (internalization in the knowledge conversion cycle in which procedural knowledge is created). They also need to communicate their ideas and thoughts to group members (externalization in the knowledge conversion cycle in which conceptual knowledge is created). Thus, sharing among peers is more important in the second stage of the project. In blended learning, students may also communicate with each other after class or use e-mails or chat rooms.

In Stage 3, the students present their report and plan of action. Their work is also uploaded on Blackboard. The instructor assesses whether they have learnt and applied sound conceptual and procedural knowledge in identifying the security risks, recommending solutions to strengthen online security and suggesting defending measures against security threats in computer networks. Students are also required to evaluate the work of other groups and make comments. In doing so, they learn from the others, convert tacit knowledge of others into their own one. Sharing in this stage is the most important. Informal communication in an online community and observation of others' work help students to share metacognitive knowledge.

Table 3: Summary of teaching and learning activities in a group project

Learning Stage	Knowledge acquired & cognitive skills learnt	Teaching and learning activities
3	Work with cognitive knowledge to evaluate and create issues	<ul style="list-style-type: none"> • Students comment on other groups' presentation; • Informal communication in an online community and observation of others' work
2	Manipulate conceptual and procedural knowledge to apply and analyze issues	<ul style="list-style-type: none"> • Put hyperlinks to information sources and other details on LMS; • Guide students to explore and investigate the problem in the classroom; • Post guiding questions to the online discussion forum & track and monitor the discussions; • Instructor meets groups periodically; • Collaborative and cooperative learning and sharing of knowledge among group members is needed to complete the task; • Students discuss face-to-face after class or use emails and chat rooms to communicate
1	Remember and understand factual knowledge	<ul style="list-style-type: none"> • Classroom lectures; • Use of LMS to facilitate knowledge transfer; • Questions posted on the LMS; • Use online tools such as search engines to search relevant information

4. SURVEY RESULTS

In the academic year 2016 – 2017, the authors taught subjects “Social Media Marketing” and “Internet Marketing” in a university. The syllabi were designed and developed based on the shared context proposed in this paper. In these two subjects, 125 students taking the classes were engineering students and they responded to the survey for collection of their attitudes to the teaching and learning activities in the subjects. Table 4 lists the survey questions and their responses expressed in the Likert scale from 1 (strongly disagree) to 5 (strongly agree). In order to find out if this shared context can enhance students to share knowledge among themselves, the survey scores in past one academic year are compared. In last academic year, there were 137 engineering students taking these two subjects but

the shared context was not implemented and only the traditional teaching and learning methods like lectures and projects were used.

Table 4: ANOVA test results comparing students' attitudes to the shared context

Questions	Average Score		Significance
	when the shared context was used (n=125)	when the shared context was not used (n=137)	
Q1. I was encouraged to share my knowledge with other students.	4.1	3.5	0.032
Q2. I was encouraged to learn from other students.	4.2	3.6	0.000
Q3. I was encouraged to ask questions and discuss ideas.	3.9	3.4	0.015
Q4. I enjoyed sharing with other students.	3.5	3.4	0.125
Q5. I strengthen connection with other students.	3.8	3.3	0.041
Q6. It was easy for me to share knowledge.	4.2	3.5	0.000
Q7. I fulfilled my responsibilities in the group work.	4.0	3.8	0.220
Q8. I got useful feedback from other students.	4.4	3.5	0.000
Q9. The course provided me with a valuable learning experience.	4.1	3.9	0.000

The survey results show that with the exception of Q4 and Q7, there are significant differences between the average scores in two situations – the shared context is used or not. These results reflect that the shared context can enhance sharing of knowledge and facilitate communication among students.

It is also interesting to find out if engineering students and business students have different attitudes to the shared context. In the two subjects mentioned above, there were 233 business students. The average scores of these two types of students are compared and presented in Table 5. The results show that there is no significant difference between average scores of engineering students and business students. Although the purpose of the shared context was originally designed and implemented for business students, this was found to be valuable to other students.

Based on the survey results, the shared context proposed in this paper can integrate the higher learning motivation into the physical interactions and communications among peers. It encourages knowledge sharing through socialization – an important step towards knowledge creation – in both the online and real worlds (Adhikari, 2010; Lee and McLoughlin, 2011; Taranath *et al.*, 2017; Yeo and Marquardt, 2015). Students are presented up-to-date information that stimulates their interest in the subject. They are also encouraged to ask and discuss ideas and questions. In the educational context, sharing knowledge with peers is mainly performed through collaborative and cooperative learning. This is an important feature of the learner-centered approach (Wang *et al.*, 2014; Yen *et al.*, 2015; Younker and Bracken, 2015).

Learning is intrinsically a social process and students benefit from being members of knowledge-building communities in and outside of school. In communication among peers, learners may steadily create, share and interpret others' knowledge and transform it to be their own meaning (Pea, 1993;

García-Peñalvo and Conde, 2014; Young, 2014; Chu, 2016; Cheng, 2017). Through sharing knowledge students engage in discussion and they are responsible for their own learning and they become critical thinkers (Totten *et al.*, 1991; García-Peñalvo and Conde, 2014; Jonsson, 2015; Younker and Bracken, 2015). Sharing is particularly important when students manipulate metacognitive knowledge to create new structures and concepts.

Table 5: ANOVA test results comparing business and engineering students' attitudes to the shared context

Questions	Average Score		Significance
	Engineering students (n=125)	Business students (n=233)	
Q1. I was encouraged to share my knowledge with other students.	4.1	3.9	0.332
Q2. I was encouraged to learn from other students.	4.2	4.0	0.210
Q3. I was encouraged to ask questions and discuss ideas.	3.9	3.8	0.215
Q4. I enjoyed sharing with other students.	3.5	3.6	0.101
Q5. I strengthen connection with other students.	3.8	3.5	0.312
Q6. It was easy for me to share knowledge.	4.2	4.1	0.121
Q7. I fulfilled my responsibilities in the group work.	4.0	3.9	0.453
Q8. I got useful feedback from other students.	4.4	4.2	0.231
Q9. The course provided me with a valuable learning experience.	4.1	3.8	0.234

In addition, students acquire useful feedback on their work and enjoy a valuable learning experience because students can communicate with peers and teachers using online communication and social media tools after normal face-to-face learning sessions. This can facilitate the communication among teachers and learners, and enhance the learning experience in both online and offline environments (Escrivao *et al.*, 2011; Yeh *et al.*, 2011; Jambaya and Izadikhah, 2012).

5. CONCLUSION

The aim of this paper is to integrate various relevant learning practices and theories into a framework to achieve educational objectives of knowledge creation and sharing. The example given in this paper has illustrated the use of the shared context in educational institutes and the survey results suggested that this can effectively enhance elaboration and cooperation among students in classes. The objective of knowledge management in an educational institution is to facilitate teaching and learning. When students study, they learn to acquire knowledge and develop cognitive skills starting from lower order thinking and move on to higher order thinking. At each level, a certain type of knowledge is emphasized. For example, students are required to remember and understand factual knowledge at the lowest level while metacognitive knowledge is more important when students learn to create and analyze issues at the highest level (Khorasgani and Moazzeni, 2011; Smiderle and Green, 2011; Laal, 2011; Maio, 2013; Dalkir, 2015).

The knowledge conversion cycle in knowledge management indicates that learning includes acquiring factual knowledge (Combination stage) especially in the early stages of the learning. Thus, the teacher-

centered approach will play a more important role here. As students make the progress, acquiring metacognitive knowledge through sharing, collaboration and cooperation among peers (Socialization stage) become more important. This means that the student-centered approach will play a greater role in the later stages of learning in which educational objectives and learning activities should be designed to facilitate cooperation among students (Cheng, 2012; Oye and Salleh, 2013; Segarra-Ciprés *et al.*, 2014). In-class and online discussions and the use of social media tools can enable such a knowledge sharing. Blended learning which brings together the advantages of face-to-face and online learning appears to be the optimal choice for the knowledge shared context (Jayasingam *et al.*, 2013; Rodriguez-Ponce *et al.*, 2013).

Now the communication technologies make it possible for everyone to contribute to the online community and the learning activities are supported by collaboration among students. Learners can access different ideas, resources and perspectives from each other, and collaborate in the online environment beyond the physical environment. The online community is able to break the boundaries of classroom and enables students to learn with others when all provide their perspectives to others. Collaborative learning is successful when all learners contribute knowledge and present ideas and viewpoints to solve problems. The shared context puts emphasis on knowledge dissemination and allows students to learn in a more complex manner. Information technology supports knowledge construction collaboratively and provides media for organizing and restructuring ideas contributed by all in the classroom. The Internet enhances the partnership and interaction among students (Gorry and Westbrook, 2013).

The social negotiation process is involved in learning in which the viability of students' understanding is evaluated. Presenting contradictory ideas can stimulate learning and understanding process. The shared context engages students in any learning activity using cooperation, evaluation and interaction. They build knowledge socially when coming across disagreement and difference. With clarification, explanation, and justification of one's idea, students can construct meaning actively and form their own viewpoints. The shared context is effective when it integrates with different skills and interests of students who provide diversity into the traditional classroom learning. This makes knowledge possible to be accumulated, examined, revised and distributed (Castillo and Cazarini, 2014).

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