

## Knowledge Management Sharing Tools in Teaching and Learning Programming Subject

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*Received: May 19, 2017*

*Accepted: July 18, 2017*

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### ABSTRACT

Programming subject is a core subject that should be taken by computer science students. However, it is a quite tough subject to score. Failure to understand the fundamental concept of programming may lead them to not completing their studies successfully. Therefore, it is very important for lecturers to help facilitate students' understanding, especially in terms of knowledge sharing. Knowledge sharing can be referred to skills or information acquired by a person via experience or formal education; be it practical or theoretical understanding of a subject. This study intends to look into related researches that incorporate tools in teaching and learning programming and knowledge sharing in their work. We conducted a study to investigate the appropriate sharing tools to be used in teaching and learning (T&L) programming subjects in higher education. First, we identified and analyzed all papers discussed on the tools used in the T&L programming subjects' processes. We also explored the techniques and tools used for sharing programming knowledge. Second, we synthesized and categorized the findings according to tools that are only suitable for knowledge sharing in T&L programming. Our literature reviews reveal that knowledge sharing tools are a favorable medium in aiding students to learn programming subjects more easily and efficiently. Our study managed to come out with the conceptual model of knowledge sharing, expected to provide the appropriate sharing tools in learning programming.

**KEYWORDS:** Knowledge, Knowledge Sharing, Programming Tool, Learning Programming, T&L Programming.

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### INTRODUCTION

Knowledge is a resource key to all aspects and fields in this world. Thus, we need to have a systematic method of acquiring knowledge in order to fully utilise and make it operational and manageable, hence making learning more lively and meaningful. The idea of having a systematic process and strategy for finding, capturing, organising, distilling and presenting data, information and knowledge for a specific purpose and to serve a specific organization or community [1], really suits the definition of knowledge management for educational purposes.

Computer science courses such as algorithms and programming are the "most-difficult" courses with high failing rates [2-3]. Knowledge or information especially in computer science which constantly changes is available from various resources such as books, internet and experienced teachers even though they are often incomplete or contradictory to each other. Moreover, the level of students' competency in programming was found to be varied to certain extent and thus we need to provide a platform of knowledge sharing in order to help them to understand and master the subject. For the slow learner students who are only exposed to the traditional classroom T&L methods, they may face difficulties in capturing the multiple skills of programming.

Alternative methods such as self-paced learning [4] and multi-dimensional discussion [5] can be supportive and aligned to the traditional classroom learning method. Selected tools such as videos, blogs, forums etc. are useful for this purpose. However, the suitable sharing tools should be identified. Based on the identified sharing tools, the knowledge sharing model can be developed as a guide in providing alternative T&L programming.

This paper presents the work-in-progress of our research in modelling the knowledge sharing tools for supporting T&L programming, consists of 7 sections. Section 2 explains the literature of knowledge sharing in educational management. Section 3 discusses research design used in this study. Section 4 shares the results and findings while section 5 emphasises on sharing tools in programming courses. This is followed by section 6 which proposes the conceptual model of knowledge sharing in programming courses and ends with conclusion in section 7.

## KNOWLEDGE SHARING IN EDUCATION MANAGEMENT

Knowledge sharing is the exchange of knowledge between two individuals or more and it includes the interaction between individuals or group. Knowledge sharing has been widely used in the education field, especially in higher education [3]. In this current time, knowledge sharing has become a powerful platform in spreading information; be it in learning or teaching. In the process of teaching and learning, there is no specific or best method or strategy to apply in a particular programming subject, which of course has a diversity of students' acceptance. It is up to the approach and creativity of the lecturers and students' suitability to achieve the objectives of the teaching and learning of a particular topic.

According to [6], there are four main stage of a learning model as illustrated in Figure 1. Firstly, instructions objectives refer to what we want to achieve in each subject, or called as course objectives. Secondly, entry behavior refers to the attitudes and existing skills or knowledge of students. Thirdly, instructions procedures refer to teaching and learning method used in each subject. Lastly, performance assessment refers to process of measuring students' skill such as quizzes, tests or any other related activities.



**Figure 1: Glaser's model [6]**

Based on Glaser's model in Figure 1, this paper will focus on instructional procedures to find the most appropriate method to be implemented. A variety of teaching and learning methods are available for programming subjects such as chalk and talk, group discussion, peer-to-peer study, e-learning, blended learning, etc[3]. Taking into account the importance of sharing knowledge, we put more emphasis on appropriate sharing tool used in programming subjects with consideration on the learning domain, so that teaching objectives can be achieved and students can understand the concepts more easily and clearly[2].

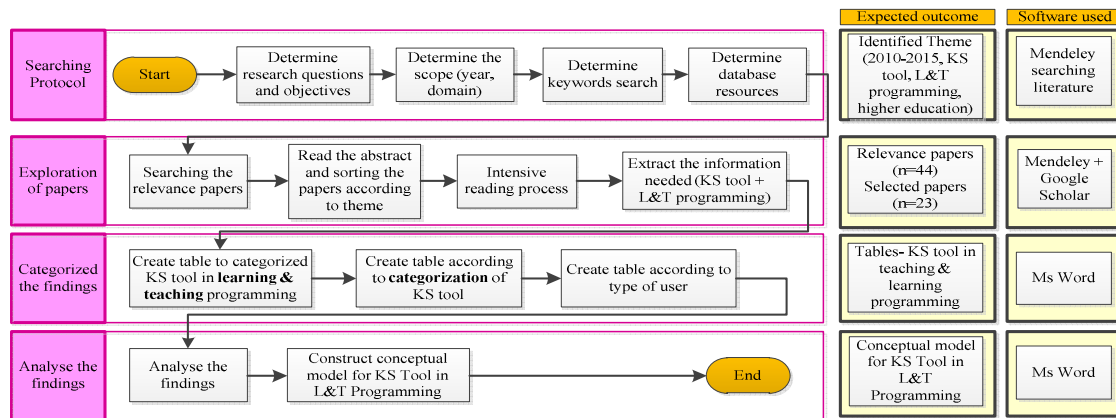
Lecturers and students are the major characters in ensuring the success of teaching and learning processes. It is important for lecturers to create a platform that allows information and instructions delivered to all students in an interesting way and in an optimum time [2,7]. Applying effective methods for information sharing in teaching the programming subjects is crucial to ensure that students easily understand accurate information. This method is also important to ensure that students do not get bored and they can learn in a more relaxed atmosphere. It is clear that when there is knowledge sharing, it will continue to expand as long as improvement occurs among shared people [8]. In the case of knowledge sharing being managed systematically, it will bring positive impacts in terms of knowledge understanding, implementation methods, problem solving, learning ethics and so on. In this era of technological capabilities including the construction of network access and the emergence of portable computer gadgets enables faster and practical knowledge sharing, in diversity fields, particularly in educational management.

Besides that, the rapid development in technology, has led it to be adopted extensively in effective teaching strategies and the sharing of knowledge, through acculturation use of ICT in education to improve the quality of teaching and learning as stated in the Education Development Master Plan (PIPP) 2006-2010. Among them is the use of social media and methods of electronic learning (e-learning), has become the largest contributor in the management of knowledge sharing. Social media for example is the main platform for young people to share information whether personal information, current issues or related subjects. Lecturers can share the problem solving situations via Twitter, Facebook and so on. The students can send a direct answer to the lecturer's status. Methods of teaching and learning through e-learning have been undergoing improvement from year to year.

## RESEARCH DESIGN

This section deals with the research method design, and literature review protocol and procedure of the study. To understand and achieve the objectives of the study, the narrative review method was adopted. The study started with searching protocol, continued with the exploration of papers, categorization of findings and ended with analysing the findings as in Figure 2. In searching the protocol, research questions and objectives were determined. The keywords were selected, limitation of years was determined and database resources were identified.

In this study, the research question highlighted was "what are the appropriate sharing tools in teaching and learning (T&L) programming subjects in higher education?", while the keywords used were "knowledge sharing", "education", "higher education" using the Boolean operator AND. The years between 2012 until 2016 are the limitation of the study. The searching process was executed in three main databases, namely ACM, IEE, and Computers and Education Journal (Elsevier). While, all proceeding of conferences and other related journals were categorized under 'Others'.



**Figure 2: Research design of the study**

Once the papers were selected, the next step was the process of exploration and sorting the papers by reading the abstracts of relevant papers and intensive reading of the selected papers as a whole. Mendeley software has been used to assist the process of searching and reading. After that, the data obtained from the study of literature has been categorized by knowledge sharing tools in teaching and learning, knowledge sharing tools categorization and types of users. Then, the findings were analysed and the conceptual integration model for the knowledge sharing tool is proposed and mapped into the theory chosen.

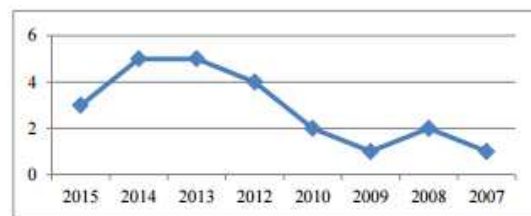
## RESULTS AND DISCUSSION

There were 44 relevant papers found based on the protocol mentioned above. However, only 23 papers were selected and relevant to the objective of this study and 6 papers were out of boundary of determined years, which are 2007, 2008, 2009 and 2010. Still, these papers were included in this research because the papers were very important and provided impacts to the findings. Figure 3 shows the number of papers according to years of publications. There were 5 papers discussed about knowledge sharing tools in programming subject on year 2013 and 2014.

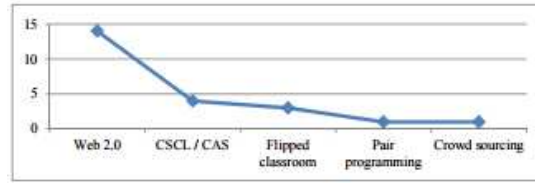
The knowledge sharing tools are organised into five categories which are Web 2.0 technologies, computersupported collaborative learning (CSCL) or collaborative annotation system (CAS), flipped classroom, pair programming and crowdsourcing. The line graph (Figure 4) shows there are a lot of research on the use of Web 2.0 in sharing knowledge in teaching and learning programming, followed by CSCL/CAS. Other considered tools or methods in T&L are flipped classroom using video technology, pair programming approach and crowdsourcing using social media. Since the penetration of social media is high, it gives impact to human lifestyle including learning style.

The Web 2.0 applications such as wikis, (Wikipedia.org), podcasts (youtube.com), blogs (blogspot.com) and social networking sites (facebook.com, Twitter.com) are the most frequently used as learning tool [3]. Other than that, forum also enhances the problem-solving abilities and persuades colleagues in advanced computer software learners to share opinions [9].

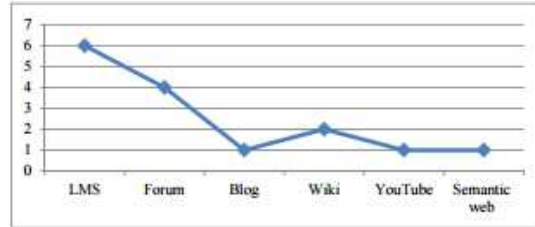
From our findings, the most used Web 2.0 application as sharing tool in T&L programming is learning management system (LMS) as shown in Figure 5. The LMS or also called elearning contains a complete component to manage educational process, especially in sharing notes, discussing the assignments and doing the assessment. The use of forum is also popular not only for learning programming, but also for system development. On the other hand, wiki, blogs, YouTube and the semantic webs are suitable tools for sharing skills and knowledge on how to write a computer programme.



**Figure 3: Number of relevant papers according to year of publication**

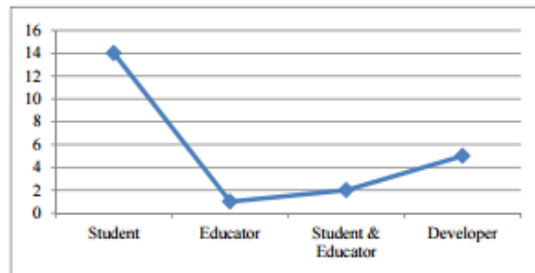


**Figure 4: Number of papers according to KS tools category**



**Figure 5: Number of papers according to Web 2.0 technologies**

Figure 6 depicts four types of users who use tools in programming, namely students, educators, students and educators and developers. Students are the highest number of users who use tool in learning programming because without much assistance from any tools makes the learning process more difficult.



**Figure 6: Type and number of users used knowledge sharing tools in programming**

### SHARING TOOLS IN PROGRAMMING COURSES

Table 1 shows the details of findings. The knowledge sharing tools are associated with authors, years, usage, categorisation and users. From the findings, we can learn the appropriate tools for sharing knowledge are for whom and for what to make the learning process of programming more efficient. Today, video has become one of popular medium for communication and the diffusion of social media makes it easier for people to share the medium. YouTube is a videoonline, one of interesting tools to assist T&L programming. Research findings by [10] reveal that video is a communication medium for programming knowledge between developers.

Developers use video technology to capture screens and software development environment and share the videos through social channels. In some of video tutorial shows step by step how to write a computer program with clear explanation. This approach is suitable for beginner level to learn programming effectively. While question and answer (Q&A) system helps a lot in solving the programming problems among developers or students as discussed by many researchers [11, 13, 29]. Examples of Q&A system are Yahoo Answers, MSDN and CrowCode which are similar to forum concepts where the communication is based on the questions asked by one person and answered by anyone in the group.

**Table 1: Knowledge sharing tools in learning programming**

No.	Authors	Tool	Used for	Categorization	User
1.	[10]	Youtube is a screen- cast, which captures a developer's narration on how a program or software tool works.	System development	Web 2.0-Youtube	Developer
2.	[11]	CrowdCode is a knowledge sharing system through a question and answer system	Microtask programming	Crowd sourcing	Developer
3.	[9]	Screenshot-based interaction system is a system of discussion forums by integrating the social-networking media	Learn system, programming and application	Web 2.0-Forum	Student

4.	[12]	<ul style="list-style-type: none"> <li>Personal communications or emails</li> <li>Project artifacts (comments in source code, shared documents, comments of a bug report, comment in commit message)</li> <li>Personal artifacts (personal notes-logbooks, diaries, post-it's)</li> <li>Knowledge management systems (Internal wiki or groupware systems, internal mailing lists and forums, experience database/groupware system)</li> <li>Internet (public mailing lists, forum)</li> </ul>	software development	Web 2.0-integrated components	Developer
5.	[13]	Microsoft Developer Network (MSDN) C# general forum enables programming knowledge sharing through question and answer (Q&A) process.	C# programming	Web 2.0-Forum	Programmer
6.	[14]	eMUSE is an integrated Web 2.0 tools in a social learning environment	Web Applications' Design	Web 2.0-Learning Management System	Student and Educator
7.	[15]	Video	Computer science course	Flipped classroom	Student
8.	[16]	Video	Learning C++ language	Flipped classroom	Student
9.	[17]	ColourRoom Software is a web-based platform to support virtual communities of educators	About teaching programming matters	Web 2.0-Forum, Wiki	Educator
10.	[18]	Pair programming modules to facilitate knowledge sharing in regular laboratory sessions	Visual Programming Laboratory	Learning approach/method	Student
11.	[19]	Online Forum	Learn Microsoft ASP.NET programming language	Computer-supported collaborative learning (CSCL)	Student
12.	[20]	Piazza is a social question answering (SQA) service that helps a community of learners to interact among themselves and with their facilitators, seeking help from peers.	Learn Java programming	CSCL	Student
13.	[21]	Video	Learn C# programming	Flipped classroom	Student
14.	[22]	<ul style="list-style-type: none"> <li>James prototype tool offering a tight integration of micro-blogging capabilities into an IDE.</li> <li>Pollicono is a tool to enhance bookmarks within the Eclipse IDE</li> <li>Cares is an IDE-based tool that enables engineers to easily discover and communicate with the people who have contributed to the source code.</li> </ul>	System development	Web 2.0	Developer
15.	[23]	Web-based programming assisted system for cooperation (WPASC) recorded logs (written codes, execution, debugging, sharing codes, written feedback and browsing activities) of students' participation level.	Multimedia webpage design using ASP.NET web	Web 2.0-Learning Management System	Student
16.	[24]	Protus 2.0 for learning the essence of Java programming language.	Java tutoring system	Semantic web technologies	Student and Educator
17.	[5]	Web 2.0-Twitter, Google Calendar, Google Docs, VoiceThread	Not specific subject	Web 2.0-Learning Management System	Student
18.	[25]	Wiki clone a wiki-based collaborative learning	Visual Basic Programming Design	Web 2.0 - Wiki	Students
19.	[26]	Personalized Annotation Management System 2.0 (PAMS 2.0) for managing, sharing, and reusing individual and collaborative annotations as well as providing a shared mechanism among multiple users.	Introduction to computer science	Collaborative annotation system (CAS)	Student
20.	[27]	Instant Messaging and Annotation Services include highlight, underline, text annotation	Learn programming design course	CSCL and CAS	Student
21.	[28]	Weblogs as a tool for knowledge sharing	Programming course	Web 2.0-Blog	Student
22.	[29]	Yahoo Answers (YA) is a question-answer based forum	Programming area	Web 2.0-Forum	General
23.	[30]	Studio 1.00 integrates lectures with in-class demonstrations, active learning sessions, and on-task feedback, through the use of wireless laptop computers	Learn introductory programming course	Web 2.0 Learning Management System	Student

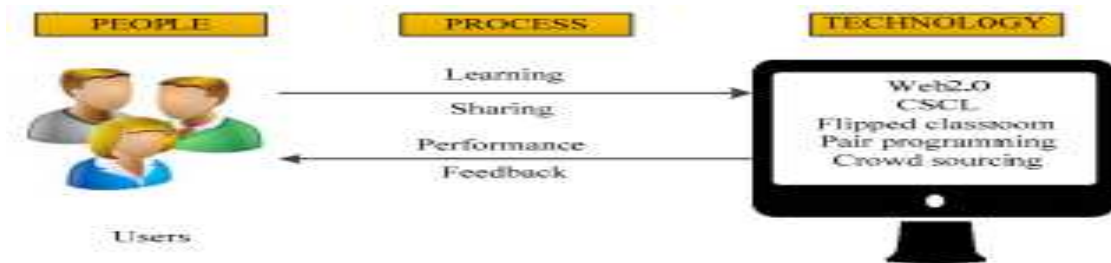
## INTEGRATION OF SHARING TOOLS

Using the findings from the research and literature, a strategy for integrating sharing tools model is proposed in order to systematically organise knowledge resources for a programming subject, so that the

learning process will be more effective. Figure 7 illustrates proposed knowledge sharing model. This model could benefit both lecturers or instructors and students in term of optimising knowledge transfer, by using sharing tools that facilitate easy transfer across platforms.

The proposed sharing tools are Web2.0, CSCL, flipped classroom, pair programming and crowd sourcing as technology component. The integration of these tools would help students to solve programming problems through sharing coding or the solutions. Other than that, students can share notes, feedback on the coding skills and tips on writing a good computer program. The Web2.0 tool can facilitate this process effectively by providing a platform to share knowledge. Meanwhile, the peer-to-peer learning process has been proven to influence in learning programming through the success implementation of pair programming techniques. The use of video as a sharing tool in learning programming could assist students do revision on specific notes or coding as video can be repeated accordingly.

Moreover, the proposed sharing tool has interactivity feature, which could give the end user controls over the content and flow of information in the sharing tools. Learning and sharing process would take place among users and they would get feedback from the tools in terms of performance.



**Figure 7: Proposed knowledge sharing model**

Partial development of knowledge sharing tool are in progress based on the pedagogy content and the use of technology. This tool can be utilized through either web or mobile application. Once the knowledge sharing tool has been fully completed, a study to compare the effectiveness among users with knowledge sharing tool and without knowledge sharing tool will be conducted.

## CONCLUSION

In conclusion, students, taking programming subject should have multiple skills for mastering this subject [21]. This is especially important with the increasing of internetbased and mobile-based tools used to support knowledge sharing in T&L programming subjects. Previous studies show that knowledge sharing tools (web 2.0, collaborative annotation system, flipped classroom, pair programming and crowd sourcing) can be supportive to the alternative T&L programming approach such as self-paced learning and multidimensional discussion in order to help students in understanding and capturing programming subjects more deeply [4, 9-10, 14-16,18,26].

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