Investigating Singapore Pre-service Teachers' Ill-structured Problem-solving Processes in an Asynchronous Online Environment: Implications for Reflective Thinking

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Background: Solving ill-structured problems is an important aspect in many professions, including the teaching profession. It is therefore appropriate to engage pre-service teachers in solving ill-structured problems.
Aim: This study investigates the ill-structured problem-solving processes in an un-moderated asynchronous discussion for one group of pre-service teachers in Singapore.
Sample: 21 pre-service teachers taking a post-graduate diploma teacher preparation course at the National Institute of Education, Nanyang Technological University, Singapore. The module in this study is a course entitled "Teaching and Classroom Management".
Method: The number of postings by the pre-service teacher on the different processes of ill-structured problem solving and the interactions amongst the participants are analyzed.
Result: The study reveals the weakness of the pre-service teachers in articulating the problem space and their tendency to go straight to generating solutions without going through the other processes of ill-structured problem solving. This paper further points out that these weaknesses are due to insufficient reflective thinking on the part of the pre-service teachers.
Conclusion: Possible strategies to improve the extent of ill-structured problem solving include using films and journal writing to trigger reflective thinking in the pre-service teachers and encourage them to go through the seven steps of the ill-structured problem solving processes. This understanding can inform future use of using asynchronous online discussions to engage learners in ill-structured problem solving.
Keywords: Asynchronous Online Discussion, Ill-structured Problem-solving, Reflective Thinking

探討新加坡職前教師在非同步線上討論解決結構不良的問題 ： 對反思性思考的影響

背景：對許多行業來說，尤其是教書的行業，解決結構不良的問題（就是那些開放式的、答案不唯一的問題）是非常重要的。因此教導職前教師如何解決結構不良的問題是恰當的。
調查目的：這個研究探討一組在新加坡職前教師如何在非同步線上討論解決結構不良的問題。
調查對象：名大學畢業的職前教師，在新加坡南洋理工大學的教育學院，修讀教育學的畢業文憑。在這個研究裏，職前教師所修讀的科目是"關於教書與課堂紀律"。
調查方法：這個研究分析職前教師在非同步線上的討論，以瞭解他們在解決結構不良的問題時所討論的內容和過程。
調查結果：研究發現職前教師的弱點是他們沒有真正瞭解問題，也沒有運用所有解決問題的步驟就即刻爲問題作出答案。研究也指出職前教師的弱點來自他們沒有足夠的反思性思考。
結論：研究建議通過兩個方法，就是安排職前教師看短片和寫個人感想，使他們有足夠的反思性思考，從中可以按部就班的運用七個解決問題的步驟。這兩個方法能幫助未來的職前教師，使他們在進行非同步線上討論時，能更有效的解決解決結構不良的問題。
關鍵字：非同步線上討論, 解決結構不良的問題, 反思性思考

1. Introduction

Many countries are emphasizing thinking skills for their students to prepare them for a knowledge based economy. The importance of reflective thinking in Singapore is seen in the launch of the *Thinking Schools, Learning Nation* (TSLN) vision in 1997. This vision aims to develop creative thinking skills, a lifelong passion for learning and nationalistic commitment in the young. The former Prime Minister Goh

Chok Tong highlighted the need for schools in Singapore to nurture reflective thinkers and problem solvers to keep Singapore vibrant and successful in future. Mr Goh explained that thinking schools are "the crucibles for questioning and searching, within and outside the classroom, to forge this passion for learning among our young" (1997). He added that more autonomy will be given to schools so that teachers and principals can devise their own solutions to problems. To achieve that goal, the Ministry of Education (MOE) in Singapore has fundamentally reviewed its curriculum and assessment system to better develop the thinking and learning skills required for the future. Information Technology (IT) will also be used widely to develop communication skills and habits of independent learning. This means that teachers need to expand their repertoire of teaching and learning strategies to include new and innovative pedagogies, and are able to communicate effectively, collaborate widely and solve problems reflectively.

The creation of thinking schools and learning nation requires teachers who are reflective thinkers and problem-solvers. Reflective thinking requires the teacher to constantly examine his or her aims, beliefs, assumptions and actions (Dewey, 1933; Schon, 1983) and to modify his or her skills in response to the students' needs (Darling-Hammond, 2000). This enables the teachers to thoughtfully examine conditions and attitudes which hinder or promote student achievement. Related to reflective thinking is problem solving ability which is among the most important and meaningful kinds of thinking and learning (Jonassen, 1997). A number of writers have pointed out the connection between reflective thinking and problem-solving (e.g. see Zeichner & Liston, 1987, 1996; Valli, 1993; Spalding & Wilson, 2002).

While most problems that learners encounter in class are well structured problems, the problems they encounter in real life are mostly ill-structured problems. Jonassen (1997) pointed out that solutions to ill-structured problems are not "predictable or convergent" (Jonassen, 1997, pp. 68). This is because ill-structured problems have "many alternative solutions; vaguely defined or unclear goals and constraints; multiple solution paths; and multiple criteria for evaluating solutions; so they are more difficult to solve" (Jonassen, 2002, pp.3)

As most of the complex problems faced by teachers are ill-structured, it makes sense to engage pre-service teachers, not in any other types of problem solving but in ill-structured problem solving. In teacher preparation courses, pre-service teachers are traditionally taught in formal learning context, such as in face-to-face lectures or tutorials. Different modes or strategies, such as class discussions or case studies, would typically be used in these classroom settings to achieve desired learning outcomes. Solving problems, especially ill-structured problems requires the problem solvers to engage in a series of time consuming thinking processes, such as considering alternative perspectives and generating solutions. Asynchronous online discussion, with its permanent storage of message, provides support for reflection (Hammond, 2005; McConnell, 2000; Salmon, 2002) and extends the available time for interaction and learning (Macdonald & Twinning, 2002; Meyer, 2003). Therefore, asynchronous online discussions, with the advantage of increased time for reflection, offer an attractive alternative learning environment to facilitate reflective thinking (e.g., Dede, 2002; Edens, 2000; Kahn, 1997) and to engage learners in solving ill-structured problems (Cheung & Hew, 2004; Groeling, 1999) . The comments posted during the online discussions allow the learners to read, reflect and respond at their own pace (Angeli, Hara and Bonk, 2000).

Jonassen and Kwon (2001) did a study to investigate how the communication

functions and patterns in group problem solving differ in text-based asynchronous online discussion as compared to face-to-face discussion. They found that participants in the asynchronous online discussion groups perceived communicating asynchronously through the online environment to be of higher quality and more satisfying than did the face-to-face participants. The study also found that the participants' patterns of communications in the asynchronous online discussion groups "better reflected the problem-solving nature of the task when compared with the face-to-face environment" (Jonassen & Kwon, 2001, pp. 48).

This study investigates the extent of ill-structured problem solving processes of one class of 21 pre-service teachers at post-graduate level in an asynchronous online environment in Singapore. According to Jonassen (1997), solving ill-structured problems involves seven steps as listed in table 1.

Ill-structured Problem Solving Processes*
1. Articulate problem space and contextual constraints
– Statements that decide if a problem really exist.
– Statements that determine the nature and contextual constrains of the problem.
2. Identify and clarify alternative opinions, positions, and perspectives
– Statements that describe various perspectives, views and opinions on a problem.
– Statements that attempt to seek understanding of the various perspectives, views, and opinions on a problem.
3. Generate possible problem solutions
– Statements that describe solutions to a problem.
4. Assess the viability of alternative solutions by constructing arguments and articulating personal beliefs
– Statements that evaluate the alternative solutions and give reasons for rejecting or accepting any of the solutions.
5. Monitor the problem space and solution options
– Statements that show, explicitly or implicitly, the problem solver's metacognitive process of deciding if a problem is solvable, whether there exist strategies for solving it, and defining the limits of any strategy to solving the problem.
6. Implement and monitor the solution
– Statements that describe how a solution is implemented to solve a problem.
– Statements that describe whether the solution is able to overcome the problem.
– Statements that describe whether the solution is acceptable to all involved parties. Adapt the solution
– Statements that describe how the solution is tried out in actual settings and how it is adjusted based on users' feedback.
7. Adapt the solution
– Statements that describe how the solution is tried out in actual settings and how it is adjusted based on users' feedback
***Adapted from Jonassen, 1997**

Table 1: Ill-structured Problem Solving Processes

In this study, the number of thematic units that reflected each step of Jonassen's

ill-structured problem-solving was counted, and the implications for reflective thinking were discussed. The assumption made in this study was that the thematic units reflected the pre-service teachers' cognitive processing abilities in problem-solving.

2. The Study

2.1 Background of Study

The module in this study was a course entitled "Teaching and Classroom Management". In this course, pre-service teachers attended six face-to-face group tutorials which focused on areas such as learning environment, teaching and learning strategies and classroom discipline models. Shortly after the sixth tutorial, these pre-service teachers were attached to different schools for a 10-week practicum. One of their tasks for this module, during this period, was to participate in an asynchronous online discussion to solve ill-structured teaching and classroom management problems. Instead of solving a problem given to them, these teachers were tasked to share these problems that they faced during teaching and to suggest strategies to help each other solve these problems. While the pre-service teachers were taught classroom management concepts and models, they were not taught how to manage ill-structured problem solving. The asynchronous online discussion provided opportunities to link and engage the pre-service teachers in solving the ill-structured problems they experienced in real practice.

2.2 Participants

The subjects in this study were 21 pre-service teachers taking a post-graduate diploma teacher preparation course. There were 5 male students (24%) and 16 female students (76%). The online discussion platform used is called Knowledge Community.

2.3 Research Questions

The research questions are as follows:

1. How many thematic units did the pre-service teachers contribute to the online discussion?

2. How many thematic units did the pre-service teachers contribute to each of the following ill-structured problem solving processes:

   (i) articulate problem space
   (ii) identify and clarify alternative perspectives
   (ii) generate possible solutions
   (iv) assess viability of alternative solutions
   (v) monitor problem space and solution options
   (vi) implement and monitor solution
   (vii)adapt solution

3. How many pre-service teachers went through each of the above ill-structured problem solving processes?

2.4 Method

To clarify the task and objectives of the online discussions, a face-to-face session, before the start of the online discussion, was conducted to brief the pre-service teachers on what they were required to do. In order to initiate the problem-solving, the pre-service teachers were asked to identify and post at least one teaching and classroom management problem that they encountered in the schools they were attached to. This generated a database of real-life ill-structured problems for the class to engage in. The pre-service teachers were reminded to include enough details about the context of the problem so that their classmates would be able to suggest strategies to help them resolve the issue. An example of an ill-structured classroom management problem that the pre-service teachers posted online is as follows:

“Most of the students in my secondary 3 class are simply uninterested. Some of them engage in mischief such as calling names and paper ball throwing which I have to deal with at times. When assigned work to do, some of them move around the class to copy other's work, while some blatantly hand in blank work. When I gave them a questionnaire to find out more about themselves during my 1st lesson, one response simply said it all " I HATE CHINESE I DUN UNDERSTAND CHINESE I DUN WAN TO LEARN CHINESE I HATE DOING STUPID CHINESE WORK" I can only conduct my lesson to the first few rows of the class and have a disciplinary presence over them. I have to move around to the 2nd half of class at times to prevent them from being rowdy and curb various misbehaviors.”

After the problem generation phase, the pre-service teachers were asked to select any of the ill-structured problems generated by their classmates and help them solve the classroom management problems. The pre-service teachers were given the freedom to contribute to any number of ill-structured problems during the three-week long online discussion. The online discussion provided opportunities for the pre-service teachers to apply the theories that they have learnt in class and/or to suggest strategies that they have tried successfully before with their own students. It also allowed them to receive suggestions on how to solve their own problems.

Lenvin (1999) found that among the different types of asynchronous online communications, participant-to-group dialogue within asynchronous online discussion was most likely to generate reflective thinking.. As the presence of the tutor can oppress certain students and ideas (Fauske & Wade, 2003-2004), the online discussions were not moderated by the tutor. The pre-service teachers had full control of the online discussions. They participated in the online discussions as one big group and they had the freedom to choose any threads to respond to.

Content analysis technique, defined broadly as “any technique for making inferences by objectively and systematically identifying specified characteristics of messages" (Holsti, 1969, pp. 14), is a technique often used to analyze transcripts of asynchronous online discussion (Wever, Schellens, Valcke & Keer, 2006). This study adopted this methodology to analyze the pre-service teachers’ asynchronous online discussion. After the 3-week online discussion, hard copies of the pre-service teachers’ online postings were printed out for analysis. As there was a great difference in the length and comprehensiveness of the messages, thematic units were used as the units of analysis. A “thematic unit” is defined by Budd and Donohue (1967) as “a single thought unit or idea unit that conveys a single item of information extracted from a segment of content” (p. 34). The thematic units were coded using Jonassen’s (1997) breakdown of ill-structured problem solving process. Table 2 lists examples for 5 of the ill-structured problem solving processes.

Ill-structured Problem-solving Processes	Example of thematic unit
1. Articulate problem space & constraints	CPS4: “I refer to Karen Toh's "Sleeping Beauty" problem. Perhaps the pupils find that lessons are boring . . .”
2. Identify alternative opinions, perspectives	CTW4: “Sometimes, it’s not that some students want to be rude to you but they are just simply unaware of the fact that they were being rude. This may be due to the students’ upbringing at home.”
3. Generate possible solutions	SPYA: “I think that if you feel that the classroom is too cramped to carry out Jigsaw group work, you can bring the class to the school hall to conduct lesson so that you do not have to be so worried about the noise level and the students get to have ample space to move around.”
4. Assess viability of alternative solutions by constructing arguments & articulating beliefs	TSM: “ I refer to HF's posting regarding the issue of how to carry out jigsaw group work in a classroom consisting of 42 students. I agree with SPYA that maybe HF could try to locate other places for the group activities. But it could be quite difficult to change classroom frequently. The best is to use the classroom. Here are my suggestions: . .”
5. Monitor problem space & solution options	(After pre-service teacher CTW4 generated the following solution: “For mixed ability classes, we could identify the better ones as “mini-teachers” and get them to sit next to someone who is weaker to teach and guide them on the questions set. This will help to speed up the pace of the lessons without leaving many "lost-sheep" behind.”, she went on to monitor problem space & solution options as shown below.) CTW4: The challenge is, of course, to identify these "mini-teachers". Not all who score well can teach well and it involves lots of trail and error before getting the right combination in terms of seating arrangement. Another challenge would be the self-esteem of the students especially the weaker ones and those who are good may have too big of an ego.”

Table 2: Example of thematic unit for each ill-structured problem solving process

3 Findings

The pre-service teachers posted a total of 106 thematic units. Collation of the number of thematic units for each ill-structured problem solving process is given in table 3.1.

Ill-structured Problem-solving Processes	No. of thematic units (%) showing evidence of this process
1. Articulate problem space & constraints	14 (13%)
2. Identify alternative opinions, perspectives	7 (7%)
3. Generate possible solutions	52[#] (49%)
4. Assess viability of alternative solutions by constructing arguments & articulating beliefs	17 (16%)
5. Monitor problem space & solution options	16 (15%)
6. Implement & Monitor solution	0
7. Adapt Solution	0

Table 3.1: Number of thematic units for each ill-structured problem solving process

[#] 40 out of the 52 (77%) thematic units which contained solutions generated involved sharing of similar experiences by the authors (of the responses) in solving similar problems. Extracts of two such postings are given below:

Example 1: Sharing of similar experiences

"I refer to CB's note about students not turning up after school to meet the teacher. I have also tried to get some students to stay back after school to complete some of their work but they ran off after school without reporting to me. What I did was to retain some of them during recess, making sure they …"

Example 2: Sharing of similar experiences

"I refer to A's posting on "Pupil Behaviour". Some students are very quiet and unresponsive, and it becomes very difficult to get them to answer questions voluntarily. I experience the same situation in my sec 2 express class. Talking to them is like talking to tombstones. Communication is only one-way. They won't even respond when i asked them whether they understand or not. it was a very lifeless class. To improve the situation, I divided them into groups, and told them this will be their permanent groups for future group activities. I asked them to come up with a name for the group. This is to instill in them a sense of belonging to the group. . ."

Collation of the number of pre-service teachers who went through each of the ill-structured problem solving processes is given in table 3.2**.**

Ill-structured Problem-solving Processes	No. of pre-service (%) teachers who went through this process
1. Articulate problem space & constraints	5 (24%)
2. Identify alternative opinions, perspectives	3 (14%)
3. Generate possible solutions	21***** (100%)
4. Assess viability of alternative solutions by constructing arguments & articulating beliefs	6 (29%)
5. Monitor problem space & solution options	5 (24%)
6. Implement & Monitor solution	0
7. Adapt Solution	0

Table 3.2: Number of pre-service teachers who went through each ill-structured problem solving process.

*14 out of the 21 (67%) of the pre-service teachers went straight to generate possible solutions without going through any of the other ill-structured problem solving processes.

4 Discussion

4.1 Observations from the Findings

From the findings, three observations impacting the extent of ill-structured problem solving process amongst the pre-service teachers are made. First, most of the pre-service teachers solved the problems in one single step. While all the teachers were able to generate solutions as many as 67% went straight to generating solutions without going through other processes of ill-structured problem-solving. According to Jonassen (2000), one of the strongest predictors of problem-solving ability is how familiar the problem solver is with the problem type. If the problem solver has solved a particular type of problems before, such as Logical Problems or Algorithmic Problems, then they are likely to find it easier to solve similar types of problem compared to solving other non-familiar types of problems. The traditionally way of engaging learners in problem solving processes is through engagement in well-structured problems, however solving well-structured problem well is independent of performance in solving ill-structured problems (Sunkle, Schraw & Bendixen, 1995). As ill-structured problems are not the typical type of problems that the pre-service teachers have been exposed to, they can be considered novices in solving ill-structured problems since novices tend to try to solve problems in a single step (Bligh, 2000). Novice problem solvers, differ from expert problem solvers, in having poor problem presentations (Jonassen, 2000). The results in table 3.2, which showed that only 5(24%) of the pre-service teachers articulated the problem space, confirmed that the pre-service teachers were indeed not strong in articulating problem space. Jonassen (1997) pointed out that the most important part of ill-structured problem solving is to identify an appropriate problem space from among the multiple and competing representations and understanding of the problems. Bransford (1993) notes that the ability to identify the general problem and generate the sub problems to be solved is crucial for real-world problem solving" (p. 178). Problems in real practice (ill-structured problems) require the problem-solver to be able to sift out the important information from irrelevant and ambiguous representations and construct a problem space that includes relevant information from the context (Jonassen,

2000).

Secondly, the solutions that the pre-service teachers generated are strategies that they personally tried out successfully. For this study, 77% of the solutions contained recounts of similar personal successful experiences. Jonassen (1997) classified this strategy "Recall Analogical Problems" as the first solution generating strategy used by learners to solve well-structured problems. In using this strategy, the problem solver recalls previously solved problem and apply the solution method to the current problem (Polya, 1957). However in generating possible solutions for ill-structured problems, the problem solver cannot only rely on his prior experiences but also need to have epistemic knowledge about the validity of alternative solutions (Kitchner, 1983). The pre-service teachers' weakness in assessing alternative solutions can also be seen from the small number (16%) of the thematic units (refer to table 3.1) that contain evidence of this process. This could also suggest that the pre-service teachers were not reflective enough to come up with alternative solutions that they have not personally tried out. Further discussion on the implications for reflective thinking will be done in the next section of this paper.

Thirdly, none of the pre-service teachers went through the last two ill-structured problem solving processes: implementing and monitoring the solution and adapting the solution. Online postings contributed by the pre-service teachers at the third week of the three-week online discussions were still at the stage of monitoring problem space and solution options. This could mean that three-week duration allocated for the online discussions was too short for the pre-service teachers to go beyond the stage of monitoring problem space and solution options. The pre-service teachers could have, after the deadline given for the online discussions, gone on to implement and adapt their solutions. However, they would not have gone back to the discussion space to report the results as they were told explicitly that for the purpose of grading, any postings after the deadline would not contribute towards their grades. Another reason could be that the recommended solution might be too complicated to be tried out by the pre-service teachers during their training. Jonassen (2000) made an observation that problem solving in formal educational context tends to end at the monitoring problem space process because the solution might be too complex.

4.2 Implications for Reflective Thinking

The study reveals the weakness of the pre-service teachers in articulating problem space and their tendency to go straight to generating solutions without going through the other processes of ill-structured problem solving. As shown in table 3.2, only 24% of the pre-service teachers articulated problem space and only 14% identified alternative perspectives. These weaknesses could be due to insufficient reflective thinking on the part of the pre-service teachers. It is helpful to further analyze the pre-service teachers' level of reflective thinking based on King and Kitchener (1994)'s 3 levels of reflective thinking. The first level is Pre-Reflective Thinking (Levels 1, 2, and 3) where the individuals justify their opinions in a simple fashion because they fail to perceive answers to the problem at hand must contain some elements of uncertainty. Such learners often view the problems they face as having a high degree of certainty and completeness. The next level is Quasi-Reflective Thinking (Levels 4 and 5) where the individuals recognize that knowledge claims about ill-structured problems contain elements of uncertainty. While they can acknowledge differences between well- and ill-structured problems, they are often at a loss when asked to solve ill-structured problems because they do not know how to deal with the inherent ambiguity of such problems. The third level is Reflective Thinking

(Levels 6-7) where the individuals recognize that one's understanding of the world is not "given" but must be actively constructed and that knowledge must be understood in relationship to the context in which it was generated. This view presumes that judgments must not only be grounded in relevant data, but that they must also be evaluated to determine their validity. Accordingly to this Reflective Thinking framework, the pre-service teachers' reflective thinking is at the Quasi-Reflective level. While they might be aware that there were no fixed solutions to the ill-structured problems, their discussions revealed that they have not analyzed the problem well and have not reflected sufficiently on the alternative solutions and their own proposed solutions. This is evident in the low number of thematic units in Table 3.1 showing evidence of the pre-service teachers identifying alternative opinions and perspectives (7%), and in assessing the viability of alternative solutions by constructing arguments and articulating beliefs (15%).

Given the weakness of the pre-service teachers in reflective thinking and the importance of this process in problem solving, the pre-service teachers should be explicitly guided to do so. Scaffolds which are temporary frameworks that support learner performance beyond their capabilities, have been found to support processes such as argumentation, which in turn affects the ill-structured problem solving processes (Cho & Jonassen, 2002). Thus to help the pre-service teachers to come up with coherent argument to assess the viability of alternative solutions, scaffolds are needed. A number of writers have proposed different types of scaffolding to promote reflective thinking in learners. For example, Andrusyszyn and Daive (1997), and Kinchin and Hay (2000) recommend reflective journals, guiding questions, and concept maps. Brickell, Ferry and Harper (2002) discuss how Concept Mapping (Novak, 1990), Venn Diagrams (Gunstone & White, 1986), Critical Thinking (Ennis, 1991) and Six Thinking Hats (De Bono, 1992) could be potential support framework for problem solving and the development of higher-order thinking skills. Film watching and journal writing have also been noted to encourage reflection on the problem-solving process because they reduce the sole emphasis on "getting the right answer" (CTL, 1999).

This paper recommends a combination of the last two strategies- watching films and journal writing, to help pre-service teachers reach a higher level of reflective thinking. After these, the pre-service teacher could then proceed on to the peer-to-group asynchronous online discussion and go through the steps listed by Jonassen. This could help the pre-service teachers to be more reflective and improve the extent of ill-structured problem solving in asynchronous online discussion. In a recent study, Tan (forthcoming) found that the use of films and journal writing were effective in helping a group of pre-service teachers in Singapore reflect critically on issues and solve problems related to teaching and learning. Films, when appropriately chosen, are ideal in triggering the pre-service teachers to reflect on an issue of concern, ponder on the meanings and implications for themselves, and finally change or modify their values, beliefs and actions (Boyd & Fale, 1983).

Among teacher educators, Grant (2002) uses movies like *Dangerous Minds* and *Stand and Deliver* to guide her pre-service teachers to explore topics on teaching in an urban school. A number of teacher educators have suggested using popular film clips to educate pre-service teachers on issues relating to teaching and learning (Gunderson & Haas, 1987; Heilman, 1991; Farhi, 1999; Nugent and Shauness, 2002). After watching the film, journal writing can be used to promote and facilitate reflections

based on the film. A number of researchers such as Holly (1994), Posner (1988), Goldsby and Cozza (1998), Collier (1999), and Thorpe (2004) have studied the usefulness of journal writing for reflective thinking and learning. A journal combines the objective data of a log with the free flowing personal interpretations and expressions of a diary (Holly, 1989). Learners write reflections about what concerns them, excites them, causes them to think, or causes them to learn (Posner, 1988). Redfern (1995) explains that the process of writing ensures that one's thoughts and recollections of events are given a certain degree of structure, and such a permanent record of professional practice can be used to gain further insights at a later date. Critical thinking is also encouraged as the learner is required to discuss and integrate different ideas in the drawing of coherent conclusions (Wilkinson, 1999). Writing journals helps the learners to gain the most from films (Holden, 2000) and thereby facilitates reflective thinking. Though not all pre-service teachers will be more reflective after watching films and writing journals, those who have reached a higher level of reflective thinking will be able to scaffold other pre-service teachers into reaching this higher level in asynchronous online discussion. Lee-Baldwin (2005) described this process as peer scaffolding. Her study on reflective thinking in asynchronous online discussions groups suggested that individuals who demonstrated "higher levels of cognitive processing appeared to scaffold the learning of others, prompting and supporting more complex levels of thinking" (Lee-Baldwin, 2005, pp.108).

Watching films, writing journals and then engaging in asynchronous online discussions are applicable to the pre-service teachers in this study. As mentioned, they attended six face-to-face group tutorials, which focused on areas such as learning environment, teaching and learning strategies and classroom discipline models, before they participated in the online discussions. To scaffold the pre-service teachers' reflective thinking in the ill-structured problem-solving processes in asynchronous online discussion, the teacher trainer could select films which cover these classroom management areas. For example, the film *Dead Poet Society* is an appropriate film on the different teaching and learning strategies used by the teachers featured in the film. The pre-service teachers can explore the creative teaching and classroom management strategies of Mr Keating, and compare them with the conservative teacher-centred teaching and classroom management strategies of other teachers. After watching the film, the pre-service teachers will be asked to write their personal responses on what teaching strategies they have learnt from the film, which teaching strategies are suitable and effective in the Singapore context, the pros and cons of each teaching strategy, and which teaching strategies they intend to adopt when they go for their 10-week practicum. The film and journal thus serve as scaffolds to prepare the pre-service teachers to participate in an asynchronous online discussion. When they discuss online about issues and problems relating to teaching and learning, their background knowledge of and prior reflections from the film and journal will provide the support for them to discuss and solve ill-structured teaching problems reflectively. Having reflected and synthesized their own thoughts through journal writing, they will be more prepared to generate alternative solutions, and construct coherent argument to assess the viability of alternative solutions to the problems online. For example, in discussing the problem of teaching creatively in the classroom, the pre-service teachers could rely on their knowledge and reflections of the unconventional teaching methods of Mr Keating (such as getting the students to stand on tables, teaching literature outdoor etc). In assessing the suitability of creative teaching methods, they could also recall

what they have watched or written on the pitfalls and limitations of Mr Keating's creative teaching methods (for example, Mr Keating told the students to tear out pages from the textbook but this may not be too extreme and ineffective). Those pre-service teachers who are unable to reach this higher level of reflective thinking on their own could be scaffolded by their peers to do so when they subsequently engaged in the asynchronous online discussions. Film watching and journal writing, followed by asynchronous online discussions, thus help to scaffold the students' reflective thinking and guide them as they go through Jonassen's seven steps of ill-structured problem solving process in the asynchronous online discussion.

5 Limitations and Conclusion

Solving ill-structured problems is an important aspect in many professions, including the teaching profession. It is therefore appropriate to engage pre-service teachers in solving ill-structured problems. In this study, the extent of ill-structured problem solving processes amongst a class of pre-service teachers in asynchronous discussions was investigated. The number of postings in the different processes of ill-structured problem solving and the interactions amongst the pre-service teachers were analyzed. The online discussions, as organized in this study saw all the teachers 'achieving' the required outcome of the task, which was to suggest strategies to help each other solve ill-structured problems. However, the pre-service teachers were not fully engaged in ill-structured problem solving. The teachers showed a tendency to generate solutions immediately, without engaging in other processes of ill-structured problem solving, a behavior that is often displayed by novice problem solvers. The pre-service teachers were also weak in articulating problem space. Possible strategies to improve the extent of ill-structured problem solving would be to use films and journal writing, prior to participation in asynchronous online discussion, to trigger reflective thinking in the pre-service teachers and encourage them to go through the seven steps of the ill-structured problem solving processes. When the pre-service teachers watch an appropriate film and journal their thoughts based on guided questions, they are more prepared to engage in online discussion reflectively.

There are a number of limitations to this study. This study was restricted to only one class (21 students) of pre-service teachers. The duration of ill-structured problem-solving via online discussions was limited to a total duration of 3 weeks. The online discussions took place while the pre-service teachers were doing their practicum, during which they had to prepare lessons, teach and do other school based assignments for other modules, hence it took place at a time when they were rather loaded and might not have time to participate actively in the online discussions. The short duration of the module may explain why none of the pre-service teachers went through the last two ill-structured problem solving processes. Given the context of the task that these pre-service teachers were given, which was to help each other solve classroom management problems, the recommended solutions could have been implemented and adapted, if more time was given. The online discussion needs to be organized over a longer duration in order to give the pre-service teachers enough time and opportunities to go through all the ill-structured problem solving processes.

The findings of this study were limited by the reliance on a single method of data collection. Though analyzing online transcripts is a commonly used research methodology in the field of asynchronous online discussion (Wever et. al, 2005), there are criticisms that comments about the

student's intention in writing the message could be just conjectures (Hammond & Wiriyapinit, 2005). Another limitation of this study was the assumption that the thematic units reflected the pre-service teachers' cognitive processing abilities in problem-solving. The level of cognitive processing demonstrated by the pre-service teachers in the asynchronous online discussions might not be truly representative of their true level of thinking. For example, some pre-service teachers might not be fully comfortable with asynchronous online communication or they might prefer face-to-face discussions. These factors might have held them back from posting all their thoughts on the asynchronous online forums.

This study recognizes that there are limitations in asynchronous online discussion, as is the case for all learning tools. However, it is important to note that there are researchers who have pointed out the usefulness of analyzing asynchronous online discussion transcripts. For example, Mason (1991) argued that content analysis enabled judgements to be made about the educational value of asynchronous online discussion. Chi (1997) also pointed out that the rationale for analyzing text-based asynchronous online discussion is that the cognitive processes of learning are being represented at least to a certain degree.

While the observations made in this study might not be generalized to pre-service teachers in general, due to the small sample size and other limitations stated, the suggested strategies offered could nevertheless serve as guidelines that might help to inform educators interested in engaging their learners in ill-structured problem solving in an asynchronous online environment. Further study is needed to determine how construction of problem space can be taught explicitly, and how other types of scaffolds apart from film watching and journal writing can be used to guide learners in solving ill-structured problems in an online environment.

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Received: 3.7.06, accepted 21.8.06.