Problem Solving Strategies used by Pre-service Teachers in Learning Technology

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Abstract

Using technology in the classroom to augment the learning of the students is becoming a professional responsibility of teachers in today's technology infused world. Teachers have to constantly learn new software. Learning new software is akin to solving an ill-structured problem and it requires the use of various problem solving skills used either in tandem or individually. The present study is an interpretive qualitative study of eight pre-service teachers, narrowed down from 99 pre-service teachers who participated in this study. The study discusses the problem solving processes used by these pre-service teachers while learning how to use Hot Potatoes™ to create an Online Question Bank in their discipline. Implications of working in such a technology enabled problem solving environment are also discussed.

Introduction

Teachers at all levels are expected to use technology (i.e. computers) as it is considered to enhance the teaching learning process in the classroom (for example: Christmann and Badgett, 2000; Waxman, Connell, and Gray, 2002; Blok, Oostdam, Otter, and Overmaat, 2002). There are many problems to using technology (discussed in Butler and Sellbom, 2002) but one major issue is not being able to keep pace with the changing pace of technology and being able to learn software on their own. This problem of learning new software is a challenge to many and needs to be addressed because if the

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quality of education in India needs to improve, assistance from technology is a necessity. One way to address this issue is to present a learning environment to teachers wherein the process of learning new software that has many uses in education, they are able to develop certain skills that can help them experiment and learn more software for their classroom teaching in the future. One such skill is that of problem solving.

Problem solving is the process of constructing and applying mental representations of problems to finding solutions to those problems that are encountered in nearly every context (Jonassen and Woei, 2012). Jonassen (2012) clarifies that problems that we encounter in our lives – both in the formal educational system and in the informal arena of life - occurs somewhere in the continuum between a well-structured problem and an ill-structured problem.

Research Context

Learning new software is akin to solving an ill-structured problem. Simon (1978) defines ill-structured problems as those that (a) are more complex and have less definite criteria for determining when the problem has been solved, (b) do not provide all the information necessary to solve the problem, and (c) have no 'legal move generator' for finding all the possibilities at each step. Just like, an ill structured problem learning new software provides the learner with opportunities to explore features that she finds useful, interesting and learnable. As the learner learns the new software, she is able to understand the relevance of the new software into her own contexts and gains familiarity with the working environment of the software. In order to learn various features of the software, the learner could use either a well delineated path as given in the tutorials or could follow a self created mechanism that is helpful to complete the task in hand.

In this present study, pre-service teachers were asked to use Masher Program in Hot Potatoes™ to develop your own question bank with all types of questions possible using Hot Potatoes™ Modules. Hot Potatoes™ (freely downloadable from- www.hotpot.uvic.ca) are a set of authoring tools for creating interactive exercises for the World Wide Web; this authoring tool can be used by anyone with basic computer skills. No prior knowledge of HTML is required and the tool creates an exercise in two formats – one the Hot Potatoes format (that can be used for editing the exercises) and the .html format that can be used for viewing the exercises and doing the exercises in a web browser.

The Hot Potatoes™ authoring tool comes in six modules: JBC creates multiple-choice quiz; JQuiz that allows text-entry quiz and lets the learner type in words, phrases or even sentences (open-ended); JMix creates jumbled-word exercise and this makes the learner arrange jumbled words into phrases or sentences; JCross

creates crosswords; JCloze creates fill-in-the-blank exercise where the learners are expected to enter the words that are missing; JMatch creates matching exercise, and the learner is expected to match items in the 1st column with those in the 2nd either using a drop-down menu or by using a drag and drop option. The Windows version of this tool also has a module known as the Masher. The Masher is a tool for automatically compiling batches of Hot Potatoes™ exercises into units. The Masher links the various exercises created using above mentioned modules, together using the navigation buttons, and create an index file for the unit. All the six modules along with the Masher programme have a uniform screen appearance of icons, menus and lay-out, but the steps of creating the exercises in different formats vary in them.

As a scaffold for the pre-service teachers, two video based modules were created and given to the pre-service teachers. These modules used the Cognitive Apprenticeship Model as the theoretical construct in their conceptualisation and design. Cognitive apprenticeship (Collins et al., 1991) is a well-recognised instructional approach with extensive roots in the instructional design literature (Brown, Collins, and Duguid, 1989; Ceci, Rosenblum, and De Bruyn, 1998; Quinn, 1994, 1995; Tripp, 1994) that is prescribed for designing learning environments. The cognitive apprenticeship framework specifies four dimensions for designing powerful environments, namely: content, method, sequence, and sociology. Gopal (2011) discusses how video based material developed using Cognitive Apprenticeship Framework augments pre-service teachers' technology skills in directly using, applying and learning technology.

During this study, the pre-service teachers were engaged in learning Hot Potatoes™ and developing their question bank. This allowed them to use various problem solving approaches. The questions of interest for this research were:

(i) What problem solving processes did the pre-service teachers use while learning how to use Hot Potatoes™ to create an online question bank in their discipline?

(ii) What was the quality of the question banks created by the pre-service teachers using Hot Potatoes™?

Methodology

Sample

The sample in the experiment consisted of 99 (94 Females and 5 Males) pre-service teachers from Army Institute of Education, Delhi Cantt., a teacher education institute for the dependants of Indian Army personnel. The pre-service teachers are admitted into the Institute based on their performance in an entrance examination. This was the first time in

the history of the Institute that such a skewed sex ratio was observed. These 99 pre-service teachers are expected to choose two teaching methodology subjects from the following options of Integrated Sciences, English, Hindi, Mathematics, Sanskrit, Social Sciences, Economics, Business Studies and Accountancy - based on their educational qualification. In this batch, maximum number of students had the subject combination of Integrated Sciences and English, followed by Social Science and English followed by Integrated Science and Mathematics. An important point to note is that Hot Potatoes™ does not have provisions for Hindi font, the Hindi methodology students had to choose perforce their second methodological option – Social Science or English.

Tools for Data Collection

Question Bank Evaluation Rubric: Scoring rubrics are descriptive scoring schemes that are developed by teachers and other evaluators to guide the analysis of the products or processes of students' efforts (Brookhart, 1999). This rubric was used to evaluate the Question Bank that was developed by the pre-service teacher. The rubric evaluated the following seven parameters – Planning of the Question Bank, Research into the Questions, Levels of Questions, Authenticity of Content, Grammar and Language, Utilisation of Features like Timer, Images, Hints and Configuration, Seamless integration of Technology and Pedagogical Principles in the Question Bank. (Table 1 Question Bank Evaluation Rubric)

Table 1

Question Bank Evaluation Rubric

Dimension	3	2	1
Planning of the question bank	The question bank was well planned covering the concepts in the chapters	The question bank covered many concepts of the chapters	The question bank covered few concepts of the chapters
Research into the questions	5 or more type of questions were used to test the students' understanding	3–5 types of questions were used to test the students' understanding	1-3 types of questions were used to test the students' understanding
Levels of the questions	Most of the questions were of knowledge/ comprehension/ application level	Most of the questions were of the knowledge/ comprehension level only	Most of the questions were of the knowledge level only

Authenticity of the content	Questions were framed correctly without any conceptual or grammatical error	Questions were framed correctly with only grammatical errors	Questions were framed with both grammatical and conceptual errors
Pedagogical principles of framing questions	Appropriately used in context	Used but not suited to the context	Loosely framed questions
Utilisation of features	4	2	0
Timer	Appropriately used in context	Used but not in context	Did not use
Images	Appropriately used in context	Used but not in context	Did not use
Hints for answers	Appropriately used in context	Used but not in context	Did not use
Configuration of the outlook in the web browser	Appropriately used in context	Used but not in context	Did not use

Reflective Journals: All pre-service teachers maintained a reflective journal where they recorded their day's progress, the problems they faced, how did they overcome the problems and their experience in the lab. Loughran (2002) argues that reflection emerges as a suggested way of helping educators better understand what they know and do in developing their knowledge of practice through reconsidering what they learn in practice. Reflective Journals offer a place for teachers to explore the planning and outcomes of curricular, instructional, relational and other classroom activities (Cole and Knowles, 2000). To help the pre-service teachers' document their experience in the lab, questions like- What did you plan to do? What sequence did you follow – Did you directly experiment with the software or did you view the tutorials – Are there any specific reason for choosing this option? What discussion did you have with your peers today about the lab work? – were given as guided questions to help in their documentation process.

Procedure of Data Collection

Before the commencement of the study, the pre-service teachers had already completed 6 months of training in the Institute. They had also completed their *teaching internship programme for 20 weeks @ 3 days per*

week. This programme ran parallel to the college curriculum and the pre-service teachers were expected to deliver a minimum of 20 lesson plans in their respective methodologies and also conceptualise, conduct and analyse a test based on the lessons taught by them in their respective methodologies and allotted classes.

They were then instructed to develop a question bank on the class and topic of their choice. This topic should have been something they would have taught during their teaching-internship programme. This question bank was prepared on the paper and was to be used as a starting point during the study.

The study took place over six days, where all the students came in groups of 20 into the laboratory. Each group was given 90 minutes per day to work on their project. The lab was equipped with internet connection (so that the pre-service teachers don't access the tutorials, etc. from the publisher's website without the knowledge of the pre-service teachers the sites were blocked and help files deleted from the programme). At the end of the six-day period, it was expected that the students learn how to use Hot Potatoes™ and create the question bank in their topic of choice. It was not binding on them to use the same questions that they had initially planned for the question bank, they had the freedom to change the questions – both in content and level- to maximise assessment process using computers. No instruction on this accord was given to the pre-service teachers. The duration of six days @ 90 minutes was chosen based on the ease learning the software and the experience of the researcher- where pre-service teachers were seen creating question banks within five days @ 60 minutes in the lab. In order to give an advantage to the pre-service teachers who were using the computer for the first time, the time duration was increased and the Masher programme was included in the task. Figure 1 represents the parameters involved in the study.

All the 99 pre-service teachers created question banks and these question banks were analysed using the rubrics mentioned above. These scores were then arranged in an ascending order – according to their subject disciplines of Integrated Science, Social Science, English and Mathematics. Based on these scores two groups were created, Group A consisted of the Adept Hot Potatoes™ Users based on the high score on the rubric, and Group B constituted those students who had lower score on the rubric due to either poor quality questions, questions not integrating computers in assessment purposes, incorrect questions, incorrect question type, and non-functioning of the question bank in the web-browser. The middle scores were left as such. *The reflective journals of top four and bottom four scorers were chosen for analysis in this study*.

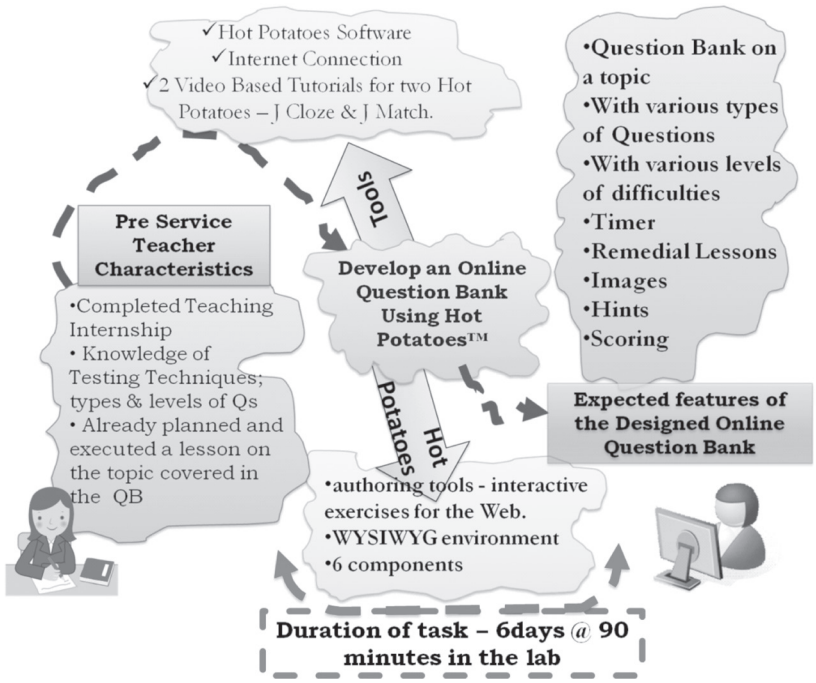

Fig. 1: Schematic Representation of the Study

Discussion

The research was an *interpretive qualitative study*. An interpretive approach provides a deep insight into 'the complex world of lived experience from the point of view of those who live it' (Schwandt, 1994) and assumes that reality is socially constructed and the researcher becomes the vehicle by which this reality is revealed (Cavana, Delahaye, and Sekaran, 2001). The researcher *used a process approach* towards the research to study the problem solving processes used by the pre-service teachers while learning how to use Hot Potatoes™ to create an Online Question Bank in their discipline.

A problem solving strategy or process is a technique that may not guarantee solution, but serves as a guide in the problem solving process (Mayer, 1983). The reflective journals analysed show evidence of the following types of problem solving processes commonly used by pre-service teachers:

- ***Trial and Error:*** Where the pre-service teacher worked on numerous alternative solutions before zeroing down on the best possible solution. This approach was used for deciding the look, feel and appearance of the question bank; whether images were required for a particular question; whether timer was required for a

particular set of questions. Some instances are:

- ***Problem Description:*** "Why is the computer not saving my file in JCloze?" – (S1–Subject: English - Group A).
  Solution Process: *I wanted to save my file as 'fill in the blanks.jcl' so that it would be easy for me to use the file later. But every time I typed the file name, the computer gave an error of 'gap in file name, do you want to proceed? May create problems later?' I didn't understand what was being said, so I renamed my file as 1fill.jcl and it saved it easily. As I wasn't sure about my mistake, I tried 1 fill.jcl when the computer again gave me the error, I understood that file names need to be saved without spaces* (Dated: 27 February).
  Researcher's Comments: As one advanced in the use of Hot Potatoes™, one realises that Hot Potatoes follows the basic HTML rules and there are known issues in HTML where if the image file has a space in between, the servers are not able to display the image correctly. This rule was built into the HotPotatoes™ system, due to which if an image is inserted with a space in its name, it presents it as an error. The way a user can know about this issue, is either by having a bit of knowledge of HTML or by trial and error of file names.
- ***Problem Description:*** 'My quiz was not able to distinguish between true and false answers.' (S2 – Subject: Social Sciences- Group A).
  Solution Process: *I was puzzled when I saw the output of my True and False quiz, where all answers were being marked correct by the computer. Not knowing what to do, I redid the whole exercises, only to realise that I was getting the same output. Then I went back to the J Quiz module, and unchecked the true options - It worked fine the first time. But then again I realised in some questions the true answers were also marked false. When I went back to the J Quiz module, I realised, I was supposed to only select the correct answer and not the other options—because of which I was going wrong.* (Dated: 29 February- 2012).
  Researcher's Comments: As JQuiz also allows multi-select questions, if all answers are left checked, JQuiz will not present an error. Hence, the user needs to take appropriate precaution while choosing the correct response (Mark as correct option).
- ***Problem Description:*** 'I didn't know which module to use for

True and False' – (S3 – Subject: Social Sciences; Group B).

Solution Process: *I just could not find where to do true and false. At one point I was wondering if it was a mistake in the instructions given by the professor....So, I saw again. I didn't find any Hot Potato with True and False. Although when I opened J Quiz I saw the right(✓) and wrong symbols (×) but no way to do it. I gave up.* (Dated : 28 February).

Journal Entry Dated 29 Feb: I was very excited about coming to the lab. Because I asked my friend where to do True and False and she told me I had to do it in JQuiz... yepieee.

Researcher's Comments: JQuiz can create four different types of question: multiple-choice/ true or false, short-answer, hybrid (a short-answer question that turns into a multiple-choice question after several attempts), and multi-select (in which the student has to choose several of a set of options, then check the choices). The default action of the software is set at Multi-select questions, and the user needs to change this setting to the MCQ or T/F option to work on those exercises. With a bit of tweaking in the programme, one can very easily reach this option.

- ***Looked for patterns*** (where the pre-service teachers tried to look for patterns within their own learning and tasks in hand).
  - ***Problem Description:*** 'Today I spent the whole time, trying to insert image into my file.' (S6- Subject- Social Science; Group B).

    Solution Process: *Then, I remembered from my experience of Open Office Impress and Writer that to insert an image, we first download the image, place it in a folder and then go to the insert option and insert the image. I used the same steps today in JCloze, I first downloaded the picture from the internet, saved it in a separate folder called Images, then went to insert and inserted the image. My image came...But I wanted my image in the centre and that is not happening.* (Dated : 1 March).

    Researcher's Comments: Inserting image in the Hot Potatoes™ exercise is just like other software and the process used by the pre-service teacher is correct.
- ***Means-End Analysis*** (where the pre-service teacher first analysed the problem by viewing the end—the goal being sought —and then tried to decrease the distance between the current position in the problem space and the end goal in that space).

- ***Problem Description:*** 'Problem of pictures not coming in the HTML file.' (Student 8; Subject Mathematics, Group A).

  Solution Process: *When the file was exported to the HTML file, the inserted picture was not visible and without my image, the question had no meaning. So, first I tried changing the compatibility in the explorer being used. I also tried inserting smaller size of the image. I also enabled Java because I kept getting the msg of Java needs to be enabled. So, I thought that it was the reasons. Anyways, I don't know what was the reason, but in the end, my image was visible in my browser. That's all I want for now.* (Dated: 2 March).

  Researcher's Comments: As discussed earlier, the inserting images require a bit of caution in two parameters: location of the image saved and the file name of the image. If these two are taken care of then, the images are always visible.

- ***Other Strategies*** (here the pre-service teacher was not able to distinguish a software related problem and an educational issue).
  - ***Problem Description:*** 'My J Cross kept crashing today. I kept getting a violation error. Drrats....' (S4- Subject – English; Group A).

    Solution Process: *I was pretty sure today, that I kept getting a violation access that because I had not made the crossword myself and I had plagiarised it from a site. I was baffled at the intelligence of this software, that it was able to detect plagiarised questions too. So, I decided to make another crossword all by myself and it worked. I am not pretty sure that this is a very intelligent potato – unlike our real life ones...* (Dated: 29 February).

    Researcher's Comments: What the pre-service teacher experienced was a case of software issue, where the software needed to be restarted. But the pre-service teacher mistook this for a case of plagiarism and in fact warned many pre-service teachers about the intelligence of this software. Later on, a few students tried to debunk this myth that the software was able to detect plagiarised crossword, but somehow the access violation error surprised many. The result was that many pre-service teachers made their own crosswords. After the completion of the study, the researcher explained the cause of the error and clarified it was not about plagiarism.
  - ***Problem Description:*** 'My crossword is not looking

like others crossword'. (S5; Subject – Science; Group B).

Solution Process: *When I see my crossword, it looks not like others. I don't know what to do. I tried to add clues nothing happened. I asked my friends and no one knows my mistake. I cannot show my file to anyone. I am leaving it for you Madam to tell me what is not good with crossword of mine.* (English as per Journal entry dated: Not mentioned in the Journal).

Researcher's Comments: The pre-service teacher was not able to differentiate between a Crossword and Word Maze. The teacher made a maze and was not able to get the look of a crossword as all the blanks were filled with redundant alphabets. The researcher did not correct this error when spotted, because it is expected that pre-service teachers know various methods by which they can impart instruction or conduct test.

Implications

The present study focussed overtly on the various problem solving strategies used by pre-service teachers to develop an Online Question Bank using Hot Potatoes™; while covertly it also aimed at also seeing whether the pre-service teachers were able to translate their pedagogical content knowledge into a technology based environment, harnessing the potential that technology has to offer to education and educationist. This study has two major implications:

(i) ***Strengthening Teacher's TPCK:*** Koehler and Mishra (2009) state that TPCK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones. Working with Hot Potatoes™ allows the teachers in the classroom to present students with interesting learning environments for testing. This environment can be used for additional practice tests and can be taken by the students whenever they wish to practice. As Hot Potatoes™ can also be used for remedial and enrichment lessons; knowledge of this tool is an asset to the teachers. Working in a self-learning, technology rich problem-solving environment gives the teachers' confidence to work and explore new tools in

education and make their classes interesting.

(ii) ***Strengthening Teacher Education Curriculum*** *by including activities for teachers following the paradigms of constructivism, problem solving modules, individualised learning experience, and confidence to experiment with technology:* Present-day teacher education curriculum presents the above mentioned activities as theoretical constructs and does not provide the teachers with experience to work in such paradigms. In this study, using problem solving strategies, pre-service teachers themselves learnt (constructivism) the various ways and uses of adapting Hot Potatoes™ in their subject areas. Pre-service teachers gained confidence to explore technology and find out ways in which they are able to rectify their own mistakes – a very essential step when we learn any new software.

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