Ill-Structured Problems, Scaffolding and Problem-Solving Ability of Novice Nursing Students

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Ill-structured problems (ISPs), such as those encountered in everyday life, often possess either no clear or multiple solutions and also present a degree of uncertainty about concepts, rules and principles that might be necessary for problem organization and solution. Jonassen (2011) recommends scaffolding support for learners as they work to solve ISPs. The present research focuses on the impact of scaffolding on ill-structured problem solving (using case examples) by novice nursing students. The study employed a quasi-experimental, mixed-method design to investigate the effect of two forms of scaffolding—question prompts and alternative perspectives—on ill-structured problem-solving and metacognition. Think-aloud protocols and self-reflections also were used to assess the effect of scaffolding techniques on problem solution. Employing question prompts was found to have an effect on two problem-solving constructs: problem representation and monitoring/evaluation. Using alternative perspectives was found to have an effect on problem representation and constructing arguments to support solutions.

All individuals need to be competent problem solvers both on the job and in everyday life. Those working in health care, in particular, need to be capable in solving problems because of the dynamics of the job environments in which they find themselves. Delivery of good, quality healthcare is a continuing challenge due to increased and changing technologies in the workplace, increased patient complexity, and issues related to healthcare access balanced against the demand to curtail overall system costs, among other concerns (Benner, Sutphen, Leonard, & Day, 2010). These and other transformations of healthcare impact both nursing practice and nursing education (Benner et al., 2010). Because nurses need high degrees of knowledge, skills and problem-solving abilities in order to deliver complex therapies, address patient social issues, and navigate current healthcare settings (Benner et al., 2010), exposure to and practice with the cognitive processes that go into solving ill-structured problems (ISPs) is encouraged at the earliest possible time in nursing education.

Achieving this early introduction can be a daunting task for both educators and learners. Due to the complex nature of ISPs, learners can experience high cognitive loads during the problem solving process. When learners begin the process of solving ISPs, they must bring into working memory all they know about the situation (Jonassen, 2011). Because of the limited capacity of working memory, learners can become overwhelmed with the amount of previous knowledge and new knowledge that has to be “juggle[d]”during the initial stages of problem-solving (Jonassen, 2011). Learners need support as they acquire the skills needed to solve complex ISPs.

Scaffolding can be provided as an important instructional support to help the learner manage increased cognitive load demanded in ill-structured problem-solving situations. The idea of scaffolding support stems from Vygotsky’s (1978) Zone of Proximal Development. Based on his ideas and research, scaffolding would provide the level of support learners need to achieve higher levels of ability in problem-solving than would be possible without this (Vygotsky, 1978).

A survey of research related to the impact of scaffolding on ill-structured problem solving reveals that ‘question prompts’ have been used to this end (Ge & Land, 2003; Ge, Planas, & Er, 2010) because questioning can be fundamental in guiding human reasoning (Graesser, Baggett, & Williams, 1996). Therefore, development of prompts that guide the learner’s thinking while they work to understand the problem and generate solutions is essential (Jonassen, 2011). Questions can aid in problem-solving activities by increasing understanding of causal reasoning associated with the situation as well as in more fundamental skills such as planning, setting goals, and in justifying the problem and problem solutions (Jonassen, 2011). Within the larger study by the Carnegie Foundation on the Preparation of Professionals, Benner et al. (2010) investigated the state of nursing education within the United States. During their study, an exemplary nursing teaching strategy cited by Benner et al. (2010) was the use of questioning that helped students integrate skill and ‘know-how’ to support their development of ill-structured problem solving abilities.

In the absence of prior experience by the problem solver, experiences of others solving the same problem has the potential to facilitate ill-structured problem solving by exposing the learner to alternative perspectives on the situation (Jonassen, 2011). The use of alternative perspectives centers on experts and/or individuals with knowledge in the field or situation telling their version of how they perceive the problem(s) and how they would go about finding a solution. Bruner (1990) showed that people organize their life and experiences around story telling as this means of information transmission because crafting stories it takes less cognitive effort. In solving problems within real world contexts people many times use stories to help explain their actions and thoughts to others (Jonassen &
Hernandez-Serrano, 2002; Schön, 1993). Choi and Lee (2009) found the use of alternative perspectives, told as stories, to supported participants as they worked through difficulties in classroom management and improved their abilities in problem solving. Of note, nursing faculty often use stories of clinical practice situations for teaching. Instructors provide detailed information on the patient condition and situation, nursing thoughts, and actions as they planned and executed patient care (Benner et al., 2010). Jonassen (2011) described alternative perspectives being used in place of prior experience when solving ill-structured problems.

The current study investigated the effects of scaffolding using question prompts or alternative perspectives on the ill-structured problem-solving abilities of novice nursing students with respect to (a) problem representation, (b) developing solutions, (c) making justifications, and (d) monitoring and evaluation. Specifically, the research question posed whether any differences would emerge when comparing three groups in this type of learning situation: those students who received question prompts to help solving ISPs, those students who listened to alternative perspectives while solving ISPs, and those students who served as the control and received no scaffolding support for problem solving.

Methods

The study employed a quasi-experimental, concurrent, mixed-methods design to investigate the research question. The participants in the study were 68 students enrolled in three sections of a beginning nursing course given at a small, Midwestern, private nursing college in the United States. The participants had a wide variety of life experiences coming into the course. What they had in common was the fact that this course was one of their first introductory nursing classes. Participation in the study was voluntary. Approval was obtained from the governing internal review boards.

The course introduced the student to the concepts of health promotion, access to healthcare, health literacy, healthcare costs and the role of the nurse. The course was taught once a week with 120-minute classroom sessions. The study was integrated into the course curriculum to allow assessment of the study participants in a natural classroom setting. The rationale for using this beginning nursing course as a setting for the research study stems from the idea that improving nurse’s ill-structured problem-solving and metacognitive skills should begin at the earliest stages of their nursing education.

Data Collection Techniques and Procedures

All participants read problem cases, one per week, for four weeks and completed a problem solution report for each one. Participants were asked to complete a self-reflection at the end of the study processes after the last case report had been filed. Of the 68 participants, 65 completed all four of the problem cases and 58 completed the self-reflection report. From the last grouping, 6 participants also participated in the “think-aloud protocols” for each of the four cases.

To complete the problem solution reports the participants were asked to read the problem case and then do the following: (a) define the problem, (b) propose solutions, (c) provide evidence for their solutions, and (d) evaluate the solutions. The participants’ responses to these case reports comprised part of the data used to answer the research question.

The problem cases were accessed using the learning management system (LMS) during their regular scheduled class time. The participants typed in their responses to the problem cases during the class time in a text box displayed on the screen below each of the cases. During the baseline and final problem case, scaffolding was not provided for any of the participants. In problem Case 1 and Case 2, the participants from the experimental groups received scaffolding in the form of question prompts or by listening to alternative perspectives via an online link. The control group did not have access to these types of support.

Participants submitted their answers through the LMS once they had completed the assignment. After the problem solution reports were submitted, the course instructor printed a copy of each participant’s problem solution report, removed identifying information and then assigned it a number code. The same number code was used for each participant throughout the study. The course instructor then gave the solution reports to the researcher.

The six participants (two from each section of the course) who participated in the think-aloud protocols were videoed in a separate room during each of the problem cases. The verbalizations of the participants from each group who participated in the think-aloud protocols were transcribed into a word document by the researcher. The word document was then used to analyze the thinking process of the participants as they worked through the problem-solving cases.
All participants were asked to complete a self-reflection after the final problem case. The participants were prompted with self-reflection questions based on their group status (experimental versus control). The participants submitted their self-reflections in the assignment area of the LMS. The same procedure for the solution reports was used to collect the self-reflections.

Measurement and Treatment Material

The problem cases represented the type of ill-structured problems that would be present within the domain of the introductory course and were developed by the researcher. The problem cases were true problems of the domain, challenging, engaging but not mega-cases that tried to include every problem within the domain (Jonassen, 1997). The course faculty then evaluated the problem cases, provided feedback on detail and relevance of the concepts which were then incorporated by the researcher. (See appendix A.)

The question prompts developed for the study were based on the process of question prompt development of Ge (2001), Ge and Land (2003), and Ge et al. (2010). In these studies, the question prompts were elicited from course faculty and tightly categorized based on the four steps of the problem-solving process: problem representation, developing solutions, making justifications, and monitoring and evaluation. The question prompts were domain specific and designed to stimulate deep levels of comprehension by asking what, how, why, and which that can help the participants reflect on their prior knowledge (Jonassen, 1997). The prompts were a combination of problem-solving prompts, metacognitive prompts, and knowledge integration prompts. (See appendix B.)

The experts who were chosen for presenting the alternative perspectives had specific knowledge or experience about the problem cases. This allowed participants insight into different viewpoints that could impact the case. The experts were videoed as they worked through the problem cases and discussed their view of the problems, needed solutions, and evidence for their decisions.

The participants submitted solution reports which were using a scoring rubric. The rubric was based on an analytical rubric system that was developed by Ge (2001) and based on performance criteria. As a framework for her rubric, Ge (2001) also referred to literature by Barnes (1994) and Blum and Arter (1996) and to the rubrics developed by Hong (1998), who validated her rubrics through construct validity.

For the present study, the ISP constructs and the attributes for each ISP construct were used as developed and validated by Ge (2001). Examples or criteria for each construct were developed based on the same ill-structured tasks Ge (2001) used in her study. Based on correspondence with Dr. Ge, the examples or criteria for each construct of the rubric for the present study were developed to be specific to each of the problem cases within the study.

Results

All participants completed a baseline problem case without scaffolding support. Scores from their problem solution reports were analyzed using a one-way Analysis of Variance (ANOVA). The ANOVA showed that the baseline test scores for each of the dependent variables across groups were different on the constructs: making justifications and monitoring and evaluation. Baseline test scores did not differ on representing the problem or developing solutions. Post hoc analysis revealed that there were significant differences between the Question Prompts group and the Alternative Perspectives group in making justifications (p = 0.046) and monitoring and evaluation (p < 0.001). Table 1 is a summary of the means and standard deviations for the four dependent variables across all groups.

Table 1. Scores at Baseline Across Groups

<table>
<thead>
<tr>
<th>Scores</th>
<th>Control Mean (SD)</th>
<th>Question Prompts Mean (SD)</th>
<th>Alternative Perspective Mean (SD)</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>4.07 (1.492)</td>
<td>3.93 (1.386)</td>
<td>3.57 (1.441)</td>
<td>0.662</td>
<td>0.519</td>
</tr>
<tr>
<td>Solution</td>
<td>4.29 (1.069)</td>
<td>4.43 (1.2)</td>
<td>4.13 (1.359)</td>
<td>0.369</td>
<td>0.693</td>
</tr>
<tr>
<td>Justify</td>
<td>3.5 (1.286)</td>
<td>3.36 (1.201)</td>
<td>2.61 (1.196)</td>
<td>3.775</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Monitor</td>
<td>1.14 (1.512)</td>
<td>1.64 (1.129)</td>
<td>0.39 (0.722)</td>
<td>8.127</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Note. SD = standard deviation; F = F statistical value; P = degree of statistical significance.
Due to the significant differences in the baseline of the constructs of making justifications and monitoring and evaluation, the baseline scores were used as a covariate in the repeated measures statistical analysis for the research question.

Results from the statistical analysis results showed that scaffolding using alternative perspectives had a significant effect on problem representation in both Case 1 and Case 2. However, scaffolding using question prompts only had a significant effect in Case 2. There was no significant difference between groups on the construct solution development in relation to either case, while the control group and those in the Question Prompts group performed at an equivalent level while constructing arguments and providing evidence. The Alternative Perspectives group performed at a much lower level than the other two groups. The statistical analysis for the construct of monitoring and evaluation showed the question prompts as supportive but the alternative perspectives as not supportive for both Case 1 and 2.

During participant verbalizations, listening to alternative perspectives or using question prompts supported the participants in representing the problem in more detail when compared to those who did not use scaffolding; and, listening to alternative perspectives supported participants’ ability to develop solutions and provide higher quality solutions compared to those not using scaffolding. Thinking aloud using question prompts supported one participant in her ability to do solution development. There is no evidence that the other participant used the prompts or that they affected her solution development. Also, the Alternative Perspectives participants constructed more arguments compared to those with question prompts and those without scaffolding. Finally, participants in the Question Prompts group provided evidence for their arguments which was not seen when analyzing verbal responses from the Alternative Perspectives group or one participant in the Control group.

Discussion

The findings of the study did not provide a consistent picture of the effect of the question prompts or the alternative perspectives in supporting novice nursing students during ill-structured problem-solving. There are several reasons why this study may have shown inconsistent results. For example, Ge and Land (2004) found if students were unable to interpret the prompts, this led to participants to struggle or dismiss the purpose of the prompts and not use them. In the reflections, an average of 20 percent of the participants stated that the question prompts did not help them and at times made the process more confusing.

In Ge, Chen, and Davis (2005) they found that participants who had little experience with problem solving, being required to use the question prompts was effective, but for students with more experience, the students felt the prompts interrupted their flow of thoughts. When experts solve novel problems, previous schemas can be activated. The presence of additional guidance can cause increased load on working memory and thereby decrease effectiveness and use of guidance technique, a phenomenon called expertise reversal effect (Kalyuga, Ayres, & Chandler, 2003).

Even though all participants in the present study were in their first nursing courses, data on the level of problem-solving experience of the participants was not collected for the study. An explanation for the prompts not being used or causing confusion could be due to the wide range of ages of the participants and different levels of experience in relation to problem-solving. This could have caused some of the students to disregard the question prompts.

The effect of participant bias as well as the lack of integration of domain knowledge can also impact the effectiveness of question prompts. Some of the participants commented in their reflections that the question prompts “were not really helpful” and “I knew my own thinking process for why I came up with the solutions”. This could have caused the participants to simply overlook the question prompts. The lack of domain knowledge would prevent the participants from activating previous schema which is needed to successfully solve problems (Ge et al., 2005). The problem cases were based on previous content taught in the course as well as additional information and resources that were provided to supplement the content. Participants’ self-reflections revealed that many did not access additional resources. It also is possible that participants did not integrate domain knowledge from the earlier in the course.

In two studies where alternative perspective or experts were used to model the problem-solving process, participants either had unlimited access to the videos or had discussions with the experts in an asynchronous environment (ChanLin & Chan, 2007; Choi & Lee, 2009). The ability to view the experts discussing the problems multiple times and the ability to ask the experts questions increased the ability of the participants to internalize the problem-solving process as well as reflect on knowledge and learning (ChanLin & Chan, 2007; Choi & Lee, 2009).
During the present study, due to issues with the link to the alternative perspectives video, the participants could only view the experts one time. This decreased their ability to evaluate and integrate the problem-solving process undertaken by the experts and could have affected the overall effect of the expert modeling. Other study findings also suggest that in order for experts or alternative perspectives to affect problem-solving abilities, there is a need for dialogue and interaction which can increase the chance of integration of domain knowledge which is crucial to the problem-solving process.

Another finding by Ge et al. (2005) was the difference in the verbalizations of the participants and their written solution reports. Ge and her colleagues found that the solution reports did not completely reflect the level of reasoning demonstrated during the think-aloud protocols. Findings from the present study align with these findings: the problem solution reports did not always reflect the level of reasoning found during the participants’ verbalizations. When comparing verbalizations with the participants’ problem solution reports, there were instances in the current study, where identification of the problem, the cause and effect of the problem, seeking additional information, sub-goals, and arguments to support the solutions were not evident in the problem solution report but were evident in the verbalizations. Based on this finding, it is possible that the problem solution reports of those not videoed also may not have captured all of the participants’ reasoning and thoughts. This would have especially impacted results related to question prompting.

Further research on developing learning environments to promote and facilitate problem solving is in great need. Successful problem solving is a skill set needed by most people in both their everyday and working lives. The analysis of the findings from this research study provides evidence that there are many variables that affect how scaffolding support can affect problem-solving abilities and that there is still much to be learned about these processes and impact on reasoning for nursing professionals.

References


APPENDIX A: INTERVENTION PROBLEM CASE 1

The county where you live has been identified in a state report as having higher levels of heart disease and diabetes than the national average. The superintendent of the three high schools within the county is concerned for the future health of the children in her schools and would like to institute programs to increase their health and decrease their risk factors. Many of the county residents as well as the students are overweight or obese. The county has a diverse culture base with families who are African American, Hispanic, Caucasian, and Asian. Many of the families in the county get some type of government assistance. Funding for many of the after school programs have been cut as well as there has been a decrease in the amount physical education included in the school day due to trying to address learning outcomes required by the state. As the nurse for the three high schools in the county you have been asked to develop programs of some type to address this issue and then present your plan to the superintendent.

Task
Your task is to analyze the problem, propose solutions, support your solutions with evidence, and evaluate your solutions. Your final submission will be a solution report that details your identification of the problem and solutions with justifications for your solutions.

APPENDIX B: PROBLEM-SOLVING QUESTION PROMPTS

1. Define the problem
   - What facts from this case suggest a problem?
   - What do you already know about the problem?
   - Do you need additional facts to define the cause(s) of the problem?
   - What is (are) the probable cause(s) of the problem?
2. List and Evaluate alternative solutions
   - List two alternatives to solve the problem
   - Evaluate each alternative by describing it advantages and disadvantages.
3. Choose, justify, and implement a plan
   - Which option will you implement as a plan?
   - Why is this plan the best choice?
   - How will you implement this plan?
4. Evaluate the plan
   - How and when will you monitor the implementation of the plan?
   - How will you know if the problem is solved, alleviated, or is getting worse?
   - What secondary problems should you watch for, and how would you do it?