The Impact of the Use of Inquiry-Based Learning as a Teaching Methodology on the Development of Critical Thinking

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ABSTRACT

Problem-based learning (PBL) uses patients' problems to develop students' problem-solving and clinical skills. Inquiry-based learning (IBL) was developed as a similar methodology that was more holistic and flexible. This study sought to determine if inquiry-based learning (IBL) enhances critical-thinking ability as measured by the Watson Glaser Critical Thinking Appraisal (WGCTA). The WGCTA was administered to 228 nursing students in the first semester and 257 students in the final semester of their program. When the scores were stratified into groups, the students in the low group showed a significant increase in mean score, no change in the medium group, and a significant drop for the high group.

In 1992, the University of Hawaii at Manoa School of Nursing adopted inquiry-based learning (IBL) as a teaching methodology. The development of IBL resulted from faculty's exposure to the National League of Nursing's curriculum revolution (NLN, 1989), as well as a study of problem-based learning tutorials developed by Barrows and Tamblyn (1980). IBL is designed to increase student involvement in their learning. Since its effect on students' critical thinking had not been tested, the purpose of this study was to determine if IBL as a teaching methodology enhances critical-thinking ability as measured by the Watson Glaser Critical Thinking Appraisal.

PROBLEM-BASED LEARNING

Although many would contend that problem-based learning (PBL) began with Socrates and has continued throughout the history of medical education in the form of bedside clinical teaching, PBL formally originated at McMaster University School of Medicine in Ontario, Canada in the late 1960s. The theoretical underpinnings of PBL include the use of prior knowledge to understand and structure new information, encoding specificity (context) to make the transfer of learning more likely as it reflects real-life situations encountered in practice, and the elaboration of knowledge that occurs through discussion, answering questions, peer teaching, and critiquing (Biley & Smith, 1998).

At its most fundamental level, PBL is an instructional approach characterized by the use of patient problems as a context for developing students' problem-solving skills and for acquiring basic and clinical science knowledge (Albanese & Mitchell, 1993). The PBL literature indicates that students, while demonstrating knowledge gaps or reinforcement of wrong information (Bernstein, Tipping, Bercovitz, & Skinner, 1995), also demonstrate significantly deeper learning and less surface learning than traditional medical school students (Newble & Clark, 1986). They show greater conceptualization and less memorization and judge new information more critically (Moore, Block, & Mitchell, 1990). The PBL learning environment encourages an inquisitive style of learning, rather than rote learning (Biley & Smith, 1998). It is more effective for creating a usable body of knowledge in the student's mind, directly applicable to problem-solving. The skills most important for patient care are problem-solving skills, not memory skills (Barrows & Tamblyn, 1980).

The use of PBL promotes cognitive processes that support clinical reasoning and critical thinking skills. Recent nursing literature (Heliker, 1994; Creedy, Horsefall, & Hand, 1992) has also proposed problem-based learning (PBL) as an approach that promotes conceptual understanding, the development of reasoning skills, and self-directed learning strategies.

INQUIRY-BASED LEARNING

Faculty at the University of Hawaii at Manoa School of Nursing were interested in adopting PBL as a teaching
methodology, but sought a more flexible and holistic approach. They developed IBL as a method that was less dependent on using specific clinical problems, could incorporate principles of systems theory as well as the deductive model, and supported different collaboration models for disciplinary discussion and interdisciplinary teamwork (Feletti, 1993). In addition to tutorials, IBL provided for a variety of different learning methods that supported students' different learning styles. In other words, lectures ("fixed resource sessions") or multimedia type presentations would sometimes be used to amplify a section of the content. Therefore, two major differences between PBL and IBL were: (1) PBL framed learning issues in the context of client problems (IBL focused discussion to include the client's strengths); and (2) in PBL, classroom sessions were always conducted as tutorials. The reliance on multidisciplinary discussion in IBL also provided a broader frame of reference for considering client issues.

Inquiry-based learning was defined by nursing faculty as:

... an orientation toward learning that is flexible and open, and draws on the varied skills and resources of faculty and students, in which faculty are co-learners who guide and facilitate the student-driven learning experience to achieve goals of nursing practice. This includes an interdisciplinary approach to learning, problem solving, critical thinking, as well as an assumption of responsibility by students for their own learning (UHSON, 1992).

At the time this study began, 50% of the clinical courses in the nursing curriculum used IBL as an instructional approach. The tutorials focused on inquiry into client situations. Each tutorial group consisted of a clinical group (8 to 10 students), with the clinical faculty serving as the tutor for content expertise. Interaction was enhanced by having students sit around a table in a room with a blackboard or large writing tablets. The cases discussed in the tutorials generally were predesigned by faculty to cover relevant concepts. In the final two semesters, the clinical courses used the students' real clients as the cases in the tutorials.

Cases were revealed to the students in a sequential manner in the first session, simulating what would occur in a real clinical situation. Students discussed what was "known" about the situation distinguishing relevant from irrelevant data and determining missing information that was needed to formulate and test hypotheses. The tutor's role at this stage was primarily to keep students on track, to encourage them to explore all relevant issues and questions, and to think critically about the cases under discussion. If an important issue was not brought up, the tutor would ask students if there were other areas they needed to explore. Once students determined what they needed to know about the case (learning issues), they divided the learning issues among themselves to research before the next session.

At the next class session, students as "beginning experts" on the assigned topic shared what they learned. Students discussed their topic as evidence to support, refute, or revise earlier hypotheses and interventions (Flannelly & Inouye, 1998). Questions about each other's data and sources of information were encouraged to prevent misinterpretations or errors and to facilitate understanding. When needed, the faculty tutor questioned students to help them think about what was being presented and to problem-solve. Students generally provided written summaries of their learning issues for the group members to facilitate the presentation of their research. After sharing their research, students discussed and identified client needs and approaches to meet these needs that were written on the board.

Within the IBL tutorials, some tutors were more active than others; however, ideally they did not lecture or take over the tutorial, but remained in the background and facilitated the process. The tutor monitored the session to see that all relevant learning issues were discussed sufficiently. Each session had an allotted time for group processing, to discuss how the session could be improved, and to resolve any interpersonal conflicts that arose. The tutor helped the group set ground rules for the tutorials and determine role group tasks for members (for example, recorder, student facilitator, timekeeper, etc).

It was the expectation of the faculty that the inquiry methodology would strengthen students' critical-thinking abilities because the problem-solving imbedded in the context of nursing situations would stimulate the attitude of inquiry and develop the skills required for critical thinking.

CRITICAL THINKING

In recent years, the evaluation of critical thinking has received considerable attention in nursing education because of the requirement to produce outcome assessments of students' growth in this skill for accreditation purposes. Although several definitions of critical thinking have been proposed (Videbeck, 1997; Adams, Whitlow, Stover, & Johnson, 1996) nursing schools most frequently use the definition of critical thinking by Watson and Glaser (Watson & Glaser, 1980, p.1); "Critical thinking is a composite of attitudes, knowledge, and skills which includes: (1) attitudes of inquiry that involve an ability to recognize the existence of problems and an acceptance of the general need for evidence in support of what is asserted to be true; (2) knowledge of the nature of valid inferences, abstractions, and generalizations in which the weight or accuracy of different kinds of evidence are logically determined; and (3) skills in applying and applying the above attitudes and knowledge."

In keeping with the adoption of the Watson Glaser definition, Videbeck (1997) reports that the Watson Glaser Critical Thinking Appraisal (WGCTA) is the most widely used standardized test to measure critical-thinking skills of nursing students. Miller and Malcolm (1990) believed that the WGCTA appeared to be the most useful test for nursing because its emphasis on skills matches the need
for practice ability in nursing. In addition, it has undergone 25 years of use, with resulting revisions and refinement. The WGCTA has been adopted because of its established reliability, it can be easily administered and scored, and it has established norms and comparative data in the literature.

There has been disagreement in the literature about its efficacy, however. McMillan (1987), after analyzing research reporting the use of WGCTA with nursing students, found that the studies had mixed results. One apparent drawback was it was difficult to separate the effects of maturation from the program effects. She suggests that the WGCTA is not sensitive enough to be used in this way and posits that it is not suitable to measure growth of critical thinking in professional settings because the test is based on daily life.

The WGCTA has been frequently used to show the “value added” characteristics of students who have been enrolled in various nursing curricula or subjected to specific instructional strategies. When students were tested at the beginning and end of the programs to document growth in critical-thinking ability, the results have been different in different studies.

In their study of the impact of nursing education on students’ critical-thinking ability, Gross, Takazawa, and Rose (1987) found that both associate degree and baccalaureate degree students showed improvement in critical thinking (as measured by the WGCTA) after completing their nursing education. More recently, however, Vaughan-Wrobel, O’Sullivan, and Smith (1997) found no significant differences in the WGCTA scores between entry and end of the program. They speculated that five factors could explain the negative findings: 1) the test, itself, may not be the best measure; 2) the expectation of gains during the upper division courses might be erroneous (citing studies that report gains in critical thinking occur more significantly in the freshman year than later); 3) the curriculum may not be designed to enhance critical thinking; 4) traditional teaching strategies may not encourage critical thinking; and 5) students may not understand the necessity for careful evaluation of critical thinking and may not be inclined to complete the test carefully when they are almost through with their studies. Other studies (Bauwens & Gerhard, 1987; Kintgen-Andrews, 1988; Adams, Stover, & Whitlow, 1999; Frye, Alfred, & Campbell, 1999) have also found no significant increase in WGCTA scores between entry and end of the program.

Pepa, Brown, and Alverson (1997), in measuring the growth in critical-thinking ability of student nurses who were enrolled in both a traditional and an accelerated curriculum found no significant difference between the groups at the end of the programs, even though there was a significant difference between the two groups at the beginning of the program. There was a significant difference in pre- and post-curriculum test scores for traditional curriculum students but no difference for accelerated students.

In reporting the findings of a study of masters-level students who were exposed to a teaching methodology designed to increase student’s critical-thinking abilities (inquiry-based learning described above), Flannely and Inouye (1998) noted that students with different levels of ability (or who scored high or low in the initial testing) showed different results on the post-testing. This study found that students in the low group increased significantly over time, whereas the scores of medium and high groups remained essentially the same. This finding is intriguing because no previous researchers have analyzed their data in this manner, even when no significant gains were found in levels of critical thinking over the course of a curriculum.

**PURPOSE OF THE STUDY**

This study was undertaken to measure the effect of a newly adopted teaching methodology, inquiry-based learning (IBL), on the critical-thinking abilities of students. The purpose of this study was to identify if students showed an increase in their critical-thinking ability after exposure to this type of teaching methodology.

**METHODS**

The subjects were newly-admitted nursing students over a four-year period beginning the Spring 1991 semester until the Fall 1995 semester.

The Watson Glaser Critical Thinking Appraisal (WGCTA) (1980) was administered to the students in the first week of school and during the final semester of their program. This tool uses items that include problems and arguments similar to those encountered in a work situation. In reliability studies, split-half coefficients ranged from 0.69 to 0.85 with scores stable across time as well as between alternate forms.

Form A was administered during the first semester and Form B during the students’ last semester in the program. Forms A and B consists of 80 items, scores may range from 1 to 80. There are five subtests on the Critical Thinking Appraisal:

*Inference:* Discriminating among degrees of truth or falsity of inferences drawn from given data.

*Recognition of Assumptions:* Recognizing unstated assumptions or suppositions in given statements or assertions.

*Deduction:* Determining whether certain conclusions necessarily follow from information in given statements or premises.

*Interpretation:* Weighing evidence and deciding if generalizations or conclusions based on the given data are warranted.

*Evaluation of arguments:* Distinguishing between arguments that are strong and relevant and those that are weak or irrelevant to a particular question at issue.

As described earlier, the WGCTA is frequently used to
measure gains in critical-thinking abilities resulting from instructional programs in schools, colleges, and business and industrial settings; to predict success in certain types of occupations or instructional programs in which critical thinking is known to play an important role and to determine for research purposes, the relationship between critical thinking abilities and other abilities and traits. In this study, the use of this tool is warranted based on the first two uses.

RESULTS

Data were collected from a total of 228 students at entry and 257 at exit from the program. Of this number, 150 were paired-scores collected from testing the same student on admission and at graduation. The mean scores were 56.38 at entry and 55.35 at graduation. There was no statistical difference between these scores.

As another way of analyzing the data, the scores were stratified into three groups of roughly equal size. The top 48 students became the “high” level (scores of >60), the middle 53 students (scores between 54 and 59), and the low group contained 49 students (<54). The norms reported in the WCGTA Manual (1980) show a similar breakdown. The following data resulted.

<table>
<thead>
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<th>Level</th>
<th>N</th>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
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<td>pre</td>
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<tr>
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<tr>
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Using a paired t-test, there was a statistical difference in the low group with an increase in mean of 2.23 (t = 2.76, p < .01), no change in the medium group, and a significant drop for the high group of 4.79 (t = -4.81, p < .001).

DISCUSSION

The answer to the research question, “To what extent do students who have had IBL in their curricular demonstrate growth in critical-thinking ability (as measured by Watson Glaser Critical Thinking Appraisal)?” appears to be “it depends.” Although it was expected that there would be a significant increase in WCGTA scores in project participants, this was not the case. As noted in the presentation of data, overall there was no significant difference between scores at entry and at graduation. Some students’ scores showed an actual decline in critical-thinking ability in the second test. Although various reasons have been postulated to account for a lack of improvement in critical-thinking scores after a program of study (Vaughn-Wroebel, O’Sullivan, & Smith, 1997) the authors believe that a combination of factors may have contributed to the present findings.

Although it is possible that the test is not a good measure of professional thinking acuity (critical thinking), and hence the effectiveness of IBL, in this regard, the authors agree with Vaughn-Wroebel, O’Sullivan, & Smith (1997) that possibly students in their last semester of a challenging curriculum will not push themselves to high performance on a test that carries no academic credit. This difference in student effort in the pre- and post-testing was also postulated by Thompson & Rebeschi (1999). The possibility that the WCGTA is not a valid measure of nursing student ability was suggested in Adams’ (1999) review of research on critical thinking. She concludes, “Perhaps WCGTA is appropriate to measure general critical thinking ability and appropriate for generalized education such as a liberal arts curriculum. However, nursing is a science and as such may be more accurately tested with a tool developed with that discipline in mind (Adams, 1999 p. 117).”

But, in spite of the above consideration, not all students’ scores declined. Further analysis revealed that the students who performed poorly on the first test showed improved performance on the final test. Flannelly and Inouye (1998) noted similar findings in their study of the effect of IBL on graduate students’ critical thinking, concluding that the students with poor critical-thinking skills to begin with had the most to gain from IBL. This conclusion was further supported by an analysis of the Gross, Takazawa, and Rose (1987) data (which found improvement in WCGTA scores at graduation) whose students scored low (mean score of 45) on the first WCGTA test. This low score compared to the mean score of 46 achieved by the low group in the present study.

This finding may demonstrate that students who score low on the first critical thinking test benefit the most from IBL. Alternatively, regression to the mean is a possible explanation for the increase in scores for the lowest scorers. Further studies are needed to verify this. If a study with a larger sample size found a significant interaction with the entry score, indicating that the treatment effect is more pronounced with those with the lowest scores, this would provide more credible and encouraging evidence of the use of an IBL approach to learning.

Therefore, although more research should be done to validate the findings, it appears that nursing students improve in critical thinking over the course of a curriculum when they were not as skilled in this area to begin with.

CONCLUSION

It can be concluded that students who initially had the lowest critical-thinking scores on the WCGTA showed significant improvement after exposure to a curriculum using IBL. It also appears that students with high WCGTA scores at the beginning of the curriculum did not receive the same benefit from IBL. The fact that students
who received midlevel and high scores on the pretest showed a decline in scores on the measure of critical-thinking ability could also demonstrate that scores beyond a specific numerical point (e.g., 55) require great attention and concentration to achieve. Since the test was administered in the last weeks of their program, graduating students' attention to a test that is not a part of their course grade was likely minimal.

In summary, the results suggest that this methodology appeared to be more effective in developing critical-thinking skills for students whose scores were initially low.

REFERENCES


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