Comparing Changes in Content Knowledge Between Online ProBLem Based Learning and Traditional Instruction in Undergraduate Health Professional Students

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Abstract

Problem Based Learning (PBL), a student centered instructional strategy, has been used as an effective pedagogical technique in the education of health care professionals to bridge the gap between theoretical knowledge and practical application. PBL has also been proposed as an instructional method that provides for active and collaborative learning in the online environment. Current research is inconclusive regarding the effect of PBL on content knowledge change. Furthermore self-directed learning readiness (SDLR) and motivation have been identified as attributes that may affect student success in PBL and online learning environments. This study investigated changes in content knowledge after participation in an online PBL module or traditional instruction in an undergraduate nutrition course. The study also examined the relationships between student SDLR and motivation and content knowledge change. The findings of this study indicated that online PBL was as effective as traditional instruction in promoting content knowledge change. Student attributes of SDLR and motivation did not affect the observed change in content knowledge.

Keywords: Learning outcomes, self-directed learning, motivation, student centered learning, nursing education

Introduction

The goal of educating health care professionals is to prepare them for effective participation in a challenging work environment. Attitudes about appropriate methods to achieve this goal have evolved much like they have in other disciplines over the last century; movement from the apprenticeship model, to a traditional teacher directed behaviorist approach, to a student centered constructivist approach has slowly taken place (Tompkins, 2001). Over the past decade, the student centered approach has been shown to increase student motivation for learning, increase applicability to real world situations and

promote life-long learning (Hung, Bailey, & Jonassen, 2003; Jonassen, 2000; Land, Hannafin & Oliver, 2012). Problem Based Learning (PBL) has been suggested as one method that utilizes this student centered approach and has been shown to improve critical thinking and clinical reasoning skills (Rounds & Rappaport, 2008; Chia-Wen & Yi-Chun, 2013).

The increasing interest in student centered learning environments, such as PBL, has coincided with an expansion in online learning. Online learning environments should emphasize a student centered constructivist approach and provide students with learning outcomes equivalent to traditional instruction. Phillips (2005) has suggested that problem solving assignments with real world problems can replace the traditional classroom experiences and provide an active learning strategy in the online environment. PBL provides real world problems for students to solve and has been incorporated into online instruction in the health professions and other disciplines (e.g. Anderson & Treadway, 2009; Choi, 2003; Nathoo, Goldhoff, & Quattrochi, 2005; Rounds & Rappaport, 2008; Ryan, Dolling, & Barnet, 2004; Schell & Kaufman, 2009; Spinello & Fischbach, 2004; Valaitis, Sword, Jones, & Hodges, 2005). Despite the growing use of PBL as an online instructional strategy, research to determine changes in content knowledge through online PBL has shown varying results. Sendag and Odabasi (2009) found that online PBL learning did not have a significant effect on content knowledge acquisition. Bilgin, Senocak and Sozbilir (2009) demonstrated improvement in performance on conceptual but not quantitative problem solving when online PBL was utilized. In addition, it has been suggested that both PBL and online learning require students to be motivated and possess self-directed learning readiness (SDLR) in order to achieve desired learning outcomes (Boyd, 2004; Levett-Jones, 2005; Schrum & Hong, 2002; Song, Singleton, Hill, & Koh, 2004).

This research study compares content knowledge change between two learning strategies: the first being an online PBL instructional module and the second being traditional instruction in a face to face class. Student attributes of SDLR and motivation and the association of these attributes with content knowledge change are also examined. An increased understanding of the impact of online PBL, as well as SDLR and motivation have on knowledge acquisition is essential to the design of effective instruction.

Literature Review

PBL involves the presentation of a clinical problem as a teaching strategy (Ridley, 2007) and has been used since the 1970's in the training of health care professionals in face to face (F2F), and more recently, in online instruction. PBL allows information to be mastered in the same context in which it will be used (Donner & Bickley, 1993) and therefore is a method of instruction that strives to bridge the gap between theoretical knowledge and practical application. Zubaidah (2005) described four phases of traditional PBL. Phase one presented learners with an authentic problem that they might encounter in the work setting. In this phase learners identified learning needs and constructed learning goals to move toward problem solution. Phase two required that learners consult resources to gather information to fulfill learning needs and goals. In phase three, learners brought back the results of their research to the group and discussed their findings to work toward problem solution. Finally, phase four required that learners use the results of their learning process to solve the problem (Zubaidah, 2005). Online PBL has been implemented replacing F2F problem presentation and group interaction with similar web-based activities (Nathoo et al., 2005; Ng, Bridges, Law, & Whitehall, 2014; Schell & Kaufman, 2009).

Research has shown that in F2F instruction, participation in PBL-based instruction resulted in an increased application of knowledge to practice, increased critical thinking, development of lifelong learning abilities, and increased collaboration and communication among students and faculty (e.g. Donner & Bickley, 1993; Pastirik, 2006; Siu, Lasschinger, & Vingilis, 2005; Tiwari, Lai, So, & Yuen, 2006). Online PBL implementation has resulted in similar outcomes (Anderson & Treadway, 2009; Choi, 2003; Nathoo et al., 2005; Pastirik, 2006; Rounds & Rappaport, 2008; Ryan et al., 2004; Schell & Kaufman, 2009; Siu et al., 2005; Spinello & Fischbach, 2004; Tiwari et al., 2006; Valaitis et al., 2005). Online PBL has been shown to have additional benefits in the online environment; students noted flexibility, convenience and the ability to pace their own learning as important to their learning experience (Mazurak, Whybrow, Varnhagen, & Field , 2005; Nathoo et al., 2005). Gould and Sadera (in press) found that undergraduate participants in an online PBL module enjoyed learning and felt that their knowledge increased while using information in realistic settings as compared to traditional instruction. Ng et al. (2014) noted no difference in assignment grades between students who participated in online versus F2F PBL learning.

Despite these advantages of PBL, there has been conflicting evidence regarding learning outcomes when PBL is compared to traditional instruction. For example, Colliver (2000) reviewed the medical education literature and found that overall traditional PBL neither improved knowledge acquisition or clinical practice. In addition, Kirschner, Sweller, and Clark (2006) cautioned that employing a minimally guided learning approach such as PBL was less effective and efficient than more directed approaches to learning unless students have sufficient prior knowledge to provide 'internal guidance'. Yun-Jo and Reigeluth (2008) found that some students had problems communicating in online PBL and needed more structure from the instructor while other students were comfortable minimal guidance. Fisher, King and Tague (2001) suggested that prior knowledge was also important for a learner to be self-directed in specific content areas. As a result learning effectiveness in PBL may be influenced by the learners Self Directed Learning Readiness (SDLR).

Self-Directed Learning

Self-direct learning (SDL) is the ability of the learner to take initiative to diagnose their learning needs, formulate learning goals, select learning resources and strategies and evaluate learning outcomes (Knowles, 1975). SDLR is the degree to which the learner possesses the characteristics and attitudes for SDL. Song and Hill (2007) described SDL in the online environment as a composite of personal attributes, the learning process and the learning context. The learners' personal attributes included their motivation, their ability to take responsibility for their learning, their resource use, and cognitive strategies. They suggested that learners brought characteristics such as intrinsic or extrinsic motivation, prior knowledge and experience and resourcefulness to the learning context.

SDLR is important to consider because students who score low in this attribute prefer teacher directed activities while those who score high prefer more independent projects such as case studies and PBL (Fisher et al., 2001). Levett-Jones (2005) argued that nursing students, particularly in the early stages of training, lacked self-directed learning skills, became frustrated in the PBL process and were unable to achieve learning with the minimal guidance provided by this instructional strategy. Litzinger, Wise, and Lee (2005) found that some undergraduate engineering students decreased in their SDL after participating in PBL while others increased in this ability. Litzinger et al. (2005) suggested that perhaps decreases in SDL skills after PBL occurred because of frustration with this instructional strategy.

Motivation

PBL has been associated with increasing motivation for learning but student motivation may also influence the success of this instructional method. PBL requires student motivation (MacKinnon, 1999). Moreover, student motivation is associated with satisfaction and success in online learning (Song et al., 2004; Boyd, 2004; Schrum & Hong, 2002). Richardson (2007) and Chen and Jang (2010) argued that motivation impacted students' attitudes, behavior and study habits. They indicated that these factors influenced learning outcomes in distance and online learning. These findings suggest that further research on the influence of motivation in online PBL should be pursued.

Purpose of the Study

The purpose of this research was to examine the change in content knowledge after participation in an online PBL module versus traditional instruction. Student SDLR and motivation were also measured as variables used to examine the relationship of these student characteristics with content knowledge change after participation in online PBL.

The following research questions guided this study:

1. Is there a statistically significant difference in student content knowledge change after participation in an online PBL module as compared to content knowledge change in traditional instruction?
2. Is there a relationship between student SDLR and content knowledge change as a result of participation in an online PBL module?
3. Is there a relationship between student motivation and content knowledge change as a result of participation in an online PBL module?
4. Does SDLR or learning motivation moderate the effect of PBL?

Research Design

This research used a quasi-experimental design with non-equivalent groups. Quantitative methodologies were utilized with a sample of convenience composed of students from four sections of an introductory nutrition course taught by the same instructor. This required pre-nursing course in the College of Health Professions at a Mid-Atlantic university provides an in-depth study of nutrition in health and disease tailored to future health care professionals. Students self-selected into each section without knowledge of the difference in instructional strategy for the Diet and Disease Unit. Two sections were selected to receive the online PBL module and two received a traditional PowerPoint lecture for the Diet and Disease Unit. The remaining course units were taught with the same instructional strategies in all four sections. Students were assigned a participant number to facilitate linking data collected at pre and post administration of study instruments.

Participants

Ninety-eight percent (98%) of the health professional students enrolled in the four sections of the course consented to participate (124/126); data from the two students who chose not to participate were discarded. The sample consisted of 104 (83.9%) females and 20 (16.1%) males. The average age was 20.4 years (*SD* =3.79). The majority of students were pre-nursing majors (74%, *n* = 124). A summary of demographic characteristics for participants on the whole and by group is presented in Table 1. There were no statistically significant group differences among the demographic characteristics collected.

Table 1.

Demographics and Background Characteristics by Group

	All Participants (*N* = 124)	PBL (*n* = 63)	Traditional Instruction (*n* = 61)
Gender			
Male	20 (16.1%)	10 (15.8%)	10 (16.4%)
Female	104 (83.9%)	53 (84.1%)	51 (83.6%)
Mean age	20.4 (SD=3.79)	19.9 (SD=1.8)	20.9 (SD=5.05)
Age range			
18-20	96 (77.4%)	51 (80.9%)	45 (73.8%)
21-22	19 (15.3%)	8 (12.7%)	11(18.0%)
23-30	6 (4.8%)	4 (6.3%)	2 (3.3%)
>30	3 (2.4%)	0	3 (4.9%)
Major			
Pre-nursing	94 (74%)	50 (79.4%)	44 (72.1%)
Health education	4 (3.2%)	3 (4.8%)	1 (1.6%)
Exercise science	8 (6.4%)	3 (4.8%)	5 (8.2%)
Gerontology	4 (3.2%)	0	4 (6.6%)
Pre-dental hygiene	2 (1.6%)	1 (1.6%)	1 (1.6%)
Other	12 (9.7%)	6 (9.5%)	6 (9.8%)
Computer Expertise			
Novice	11(8.8%)	4 (6.3%)	7 (11.5%)
Intermediate	96 (77.4%)	49 (77.8%)	47 (77.0%)

Expert	16 (12.9%)	9 (14.3%)	7 (11.5%)
Reason for course			
Major requirement	100 (80.6%)	52 (82.5%)	48 (78.7%)
Upper level elective	10 (8%)	3 (4.8%)	7 (11.5%)
Other	14 (11%)	8 (12.7%)	6 (9.8%)

Instrumentation

Two instruments were utilized to gather data from the study participants. The Diet and Disease Assessment (DDA) was used as a pre/posttest of content knowledge. The Self-directed Learning Readiness Motivation Assessment (SDLRMA) was used to collect information on student attributes of self-directed learning readiness and motivation. This SDLRMA also included items designed to gather demographic data at pretest and study habits data at posttest.

Diet and Disease Assessment (DDA)

The DDA was used to assess content knowledge at both time points. Differential change in content knowledge between instructional groups would be inferred to result from exposure to different instructional methods. The 21 multiple choice questions on the DDA were designed to test knowledge of diet therapy for diabetes and lipid disorders. This instrument was reviewed by content area experts to determine question clarity, validity and consistency with the learning objectives. The order of the questions was varied between pre and post administration to prevent student recollection of responses and reduce potential threats to validity in assessment of changes in content knowledge. The DDA was administered with both groups one week prior to instruction and again following participation in their assigned instructional strategy (i.e., online PBL or traditional). The test-retest reliability on this instrument was moderate $r = .42$, $p = .01$ and Cronbach's Alpha was 0.50 at pretest and 0.67 at posttest.

Self-Directed Learning Readiness and Motivation Assessment (SDLRMA)

The SDLRMA consisted of 57 items in three sections: a brief five question demographic questionnaire; a 40 item Likert scale survey to assess SDLR; and 12 additional items assessing motivation. SDLR was measured using the Self Directed Learning Readiness Survey for Nursing Education (SDLRSNE) developed by Fisher et al. (2001). Three subscales of the Motivated Strategies for Learning (MSLQ) developed by Pintrich, Smith, Garcia, and McKeachie (1991, 1993) were utilized to assess intrinsic and extrinsic motivation and control of learning beliefs. The MSLQ was designed with the intent that researchers could use individual subscales to suit their research purposes.

This instrument was administered to the participants at week five of the fall semester to gather demographic information and to determine student attributes in both groups prior to participation in instruction. The SDLRMA was administered again in the ninth week with additional questions aimed at determining student resource use and other sources of information related to diet and disease which students may have encountered outside of the class environment.

Cronbach's alpha for the SDLR total score was 0.88 at pretest and 0.92 at posttest; test/retest reliability between week five and week nine administrations was high ($r = 0.82$). Cronbach's alphas for motivation scales were: intrinsic goal orientation, 0.73 at pretest and 0.52 at posttest; extrinsic goal orientation, 0.67 at pretest and 0.52 at posttest; and control of learning beliefs, 0.72 at pretest and 0.67 at posttest. Test/retest reliability for motivation attributes in this study ranged from 0.41 – 0.52.

Procedures

Online PBL Module

The text based module was designed by the researcher and reviewed by experts in PBL, online learning and medical nutrition therapy. Recommendations obtained from these experts were utilized to change wording and structure and to increase student understanding. After completing the pretest and the SDLRMA, the 63 participants in the treatment group were presented with an online description of a typical clinic patient. Lab values, symptoms, medical, family and diet history were presented. The course

management system, Blackboard, was utilized to present information and resources related to the module. Participants in each of the two PBL sections worked in groups of three or four students to complete the online activities. For the activity, students chose roles on a task force responsible for developing an educational tool for the clinic patient. The goal of the group activity was to diagnose the patient and to create an educational tool based on appropriate medical nutrition therapy.

The online PBL module was conducted in four phases modeled after the traditional PBL phases described by Zubaidah (2005). In the first phase students were directed to review the case problem and identify their learning needs and goals to fulfill their role on the education task force assigned to create an educational tool for the clinic patient. The second phase required each student to use online and print resources to research the information they would need to complete their role in diagnosing the patient and constructing the educational tool.

In the third phase of PBL, students were given the option to use asynchronous group discussion boards, blogs, and/or email to communicate with group members. Students were required to use the group blog or discussion board to share the information that they gathered in phase two with other group members and the instructor. The instructor utilized the blog and discussion board areas to comment on the information gathered by each student and to provide suggestions for additional research if needed. The instructor commented once in discussion boards or blogs during the phase three discussions so as to facilitate rather than direct problem solving. These comments were designed to encourage students in their work and/or to suggest additional areas they might need to consider as they organized information to create the educational tool. In phase four, students utilized the information that each group member gathered to create an appropriate educational tool for the clinic patient based on the patient diagnosis and medical nutrition therapy needs. The 63 participants in the PBL group completed the DDA posttest and second SDLRMA after instruction.

Traditional Instruction

A traditional lecture with learning objectives, assigned readings, and a PowerPoint presentation were used as the instruction for the control group. Lecture notes and a PowerPoint presentation were adapted from materials provided by the textbook publisher. These materials were also reviewed by the same experts that reviewed the PBL module. The reviewers shared feedback with regard to consistency with the learning objectives. Recommendations from the experts were utilized to modify the PowerPoint slides and lecture notes accordingly. After students completed the DDA pretest and SDLRMA, a traditional lecture was conducted by the same instructor using the PowerPoint slides and lecture notes in both traditional sections during the same time period as the online module was being utilized in the PBL sections. Afterwards the PowerPoint was made available through the course management system to control group students only. This group had no other Blackboard interaction related to this module and could not access the online PBL module used with the treatment (PBL) group. The 61 participants in the traditional group also completed the DDA posttest and second SDLRMA after instruction.

Results

The purpose of this research was to determine content knowledge change and the influence of student SDLR and motivation on this change after participation in an online PBL module or traditional instruction. Differences in content knowledge, SDLR and motivation are reported for each learning strategy. SDLR and motivation as moderating influences on PBL content knowledge change is also presented.

Content Knowledge differences

Pre-test comparisons revealed that there were content knowledge differences at baseline, prior to instruction, between the PBL group (M=9.21, SD=2.49, n=63) and the Traditional group (M=10.15, SD=2.73, n=61; t (122) = -2.01, p <0.05). This difference represented a moderate effect size (Hedges g = – 0.36). Initial differences suggested that groups were not completely equivalent with respect to background knowledge. However, both PBL and traditional groups demonstrated significant gains in content knowledge from pre-test to post-test (PBL t (62) = -15.61, p < 0.05; Glass' Δ = 2.24; Traditional t(60) = -13.47, p >.05; Glass'Δ = 1.96), and the average gains made in each group were not significantly different, t (122) = 0.43, p > 0.05, Hedges' g = 0.08. There were no significant differences between post-test means (PBL m = 14.78, SD = 2.66, n=63; Traditional m = 15.50 SD = 3.12, n = 61; t (122) = -1.37;

p>.05, Hedges' *g* = -0.24), suggesting that pre-test differences had diminished over the course of the study.

SDLR differences

Unlike for content knowledge, pre-test differences between the PBL and traditional groups were not statistically significant. No significant gains for either the PBL group or for the traditional group was noted, nor were the post-test means significantly different (Table 2). A SDLR score of 150 or greater indicated a readiness for self-directed learning activities (Fisher et al., 2001). Of the 124 participants who completed the study, 103 (83%) had SDLR scores of 150 or greater and 21 (17%) had lower scores. Fifty-two students (82.5%) in the PBL group obtained scores above 150 compared to 51 students (83.6%) in the traditional group.

Motivation differences

Of the three motivation outcomes, intrinsic, extrinsic, and control of learning beliefs, none were found to be different at pre-test or at post-test. With the exception of intrinsic motivation for the traditional instruction group, no within-group changes in motivation were found. Intrinsic motivation decreased significantly for the traditional group, that is from a pre-test mean of 5.13 (SD = 0.85) to a post-test mean of 4.88 (SD = 1.05), $t(60) = 2.49$, $p < 0.05$ (Table 2).

Table 2.

Means, Standard Deviations, and Mean Differences in Content Knowledge, SDLR and Motivation at Pre-test and Post-test by Group

	All Participants (*N* = 124)	PBL (*n* = 63)	Traditional Instruction (*n* = 61)	t PBL vs. Traditional	p
	Mean (SD)	Mean (SD)	Mean (SD)		
PreKScore	9.67 (2.64)	9.21 (2.49)	10.15 (2.73)	-2.01	0.05
PostKScore	15.13 (2.91)	14.78 (2.66)	15.49 (3.12)	-1.37	0.17
Pre SDLR	160.90 (12.76)	159.76 (13.31)	162.08 (12.17)	-1.01	0.31
Post SDLR	160.01 (16.27)	159.17 (16.06	160.87 (16.57)	-0.58	0.44
PreIntrinsic Goal Orientation	5.04 (0.82)	4.95 (0.78)	5.13 (0.85)	-1.22	0.22
Post Intrinsic Goal Orientation	4.88 (0.94)	4.88 (0.83)	4.88 (1.05)	-0.02	0.09
PreExtrinsic Goal Orientation	5.88 (0.96)	5.85 (1.06)	5.91 (0.87)	-0.32	0.75
Post Extrinsic Goal Orientation	5.85 (0.90)	5.89 (0.93)	5.80 (0.86)	0.73	0.90
Pre Control of Learning Beliefs	5.92 (0.91)	5.97 (1.04)	5.86 (0.76)	0.69	0.49
Post Control of Learning Beliefs	5.98 (*SD* = 0.78)	6.04 (*SD*=0.76)	5.90 (*SD*=0.79)	1.20	0.90

*p<.05

Interaction Model

A multiple regression model in which post-test content knowledge was regressed on pre-test content knowledge, SDLR, and motivation measures, group status, and the interaction of group with SDLR, and

motivation measures was conducted to test whether SDLR and/or motivation moderated the effect of PBL. Significant interaction terms would suggest individual differences in learning readiness and motivation are differentially enabled by PBL and traditional instruction.

None of the pre-test covariates were significantly associated with post-test content knowledge. Moreover, no differences in PBL vs. traditional instruction were observed, even after controlling for the pre-test motivation measures. Finally, interaction terms assessing motivational moderation of PBL effects were not significant, suggesting that motivation did not moderate the effect of PBL.

Study Hours and Resource Use

Further analysis of variables showed the traditional instruction group reported fewer study hours (*M* = 3.97, *SD* = 2.78, *n*=63) than the PBL group (*M* = 5.74. *SD* = 6.33, *n*=61) resulting in a statistically significant difference between the two groups. More students in the traditional group relied on the textbook and print resources than the PBL group, whereas more students in the PBL group used online resources. This pattern of resource use indicated that the majority of participants in both groups performed as intended in the respective instructional strategies. There were no differences between the two groups in the number of students exposed to previous nutrition courses or other outside influences that affected their knowledge of diet and disease during the instructional period.

Table 3.

Study Hours, Resource Use and Outside Influences

	PBL (n =61)	Traditional (n=63)	χ^2	*p*
Study Hours *Mean (SD)*SD Study Hours	5.74 (6.33)	(2.78) [a]		.049*
Text Use	36(59%)	50(79%)	8.99	.003*
Suggested Online	54(89%)	0(0%)	124	.001*
Print Resources	13(21%)	27(43%)	7.92	.005*
Additional Online	56(92%)	38(60%)	11.96	.001*
Prior Nutrition Course	14(23%)	12(19%)	0.12	.727
Television	20(33%)	27(43%)	2.06	.151
Radio	3(5%)	8(13%)	2.68	.102
Magazine	10(16%)	13(21%)	0.67	.436
Physician	7(11%)	12(19%)	1.75	.186
Family	24(39%)	23(37%)	0.002	.964
Health Professionals	14(23%)	18(29%)	0.86	.354
Other Classes	42(69%)	38(60%)	0.26	.661
No Influences	13(21%)	9(14%)	0.73	.391

Note: [a]$t(122) = 1.99$; $p < 0.05$.

Discussion

The study purpose was to determine whether content knowledge changed as a result of an online PBL module compared to traditional instruction. The influence of student SDLR and motivation on this change was also examined. The results suggest that both PBL and traditional learning environments were equally successful in improving content knowledge from pre to post-test. Therefore using online PBL was as effective as traditional instruction in changing content knowledge for these study participants.

These findings are consistent with the reviews of Albanese and Mitchell (1993), Colliver (2000), and Norman and Schmidt (1992) who concluded that PBL performed neither better nor worse than traditional

instruction in regards to changes in content knowledge in the face to face environment. Dennis (2003), using a post-test only comparison, found that online PBL was as effective as face to face PBL with regards to learning outcomes. Ng et al. (2013) found equivalent performance on assignments in online and face to face PBL. Albanese (2000) further suggested that expecting students who were previously taught with traditional strategies to do better in their initial exposure to a PBL environment is unreasonable. Therefore the results of the current study can be interpreted as positive, in agreement with existing PBL research, and in support of using online PBL as an effective instructional strategy.

In their model of SDL for online environments, Song and Hill (2007) suggested that SDL is made up of the following three components: personal attributes; learning process and learning context. Based on an SDLR score of 150, the majority of participants in this study were ready for self-directed learning activities such as PBL. However, since SDLR did not moderate the instruction effect, whether students were very ready or not ready for self-directed learning had little to do with their course performances. Further investigation is needed to determine whether these students are representative of all pre-nursing and health professional students and if online PBL is effective in changing content knowledge in student groups with much lower SDLR scores.

Pre-instruction intrinsic motivation, extrinsic motivation, and control of learning beliefs scores were not significantly associated with the posttest scores that were adjusted for pretest content knowledge. Participants in this study scored greater than 3 on a 7 point scale for intrinsic and extrinsic motivation and control of learning beliefs scores suggesting that they were capable of achieving academic success (Pintrich et al.,1991). Richardson (2007) and Chen and Jang (2010) found that intrinsic and extrinsic motivation scores did not predict learning outcomes with students who were engaged in distance and online learning suggesting that although students may have different kinds of motivation, their course performances are independent of their motivation for learning. Richardson (2007) found that student motivation and attitudes affect study behaviors which positively influence learning outcomes. Since the majority of students in both groups had high levels of both intrinsic and extrinsic motivation and control of learning beliefs it is likely that they were willing to practice study behaviors leading to improvement in content knowledge from pre to posttest. In fact data collected on study hours demonstrated that students in both groups were willing to spend time engaged with the resources provided for the Diet and Disease Unit to increase their content knowledge.

Both the control (traditional) and PBL group exhibited similar levels of content knowledge on the post-test. However, a significant difference was found between groups in resource use and study behavior. Specifically, the online PBL students made more use of online resources than the traditional instruction group. This finding confirms that students participated in PBL as intended. Future research could be conducted to determine what benefits students accrue from developing familiarity with these online resources. For example King et al. (2012) found that conducting PBL online was advantageous to increasing discipline specific skills, team skills, and fluency with information technology. Future research could be directed at determining whether these students developed similar skills.

Students in the PBL group also spent more hours studying than students in the traditional group. Mounsey and Reid (2012) found that medical students engaged in case based learning (CBL) spent more time on the learning modules than their peers who were not provided with cases. As in the current study learning outcomes were the same when this group was compared with a traditional group. These findings suggest that perhaps PBL, like CBL, was less efficient than traditional instruction in achieving similar content knowledge gains. Additional research on student study habits in each phase of the online PBL module could determine whether more study hours are required to obtain content knowledge or whether this instructional method motivates students to spend more time with the material. Perhaps the additional study time experienced by PBL students garnered benefits beyond content knowledge changes such as increased critical thinking, problem solving and application of knowledge to practice. Additionally a follow-up study of long term student recall of information would help determine whether online PBL has increased effectiveness in retention of knowledge over that achieved with traditional instruction. Gaining an understanding of these behaviors and additional outcomes would be beneficial in determining effective practices and additional resources that could be provided to enhance the learning experience.

Several limitations to the study are important to emphasize. First, students self-selected into classes and may have brought differences in background and ability that contributed to differential performance, such

as the pre-test differences in content knowledge favoring the traditional group. Second, no attempts were made to control access to materials outside the course. Students were free to use any kind or amount of supplementary materials to help them learn. It is unknown to what degree students' use of such materials may have facilitated their learning independent of type of instruction. Differences in reported use (i.e., more print for traditional students vs. more online for PBL students) suggest students used supplementary materials in expected ways, but quality of those materials was not assessed. Finally, although the length of the module (two-weeks) was imposed for research purposes, in practice students may require much more time to realize benefits associated with PBL, given the complexity of the tasks and learning outcomes expected of the student (Kuhn, 2011).

Conclusions

This research showed that online PBL and traditional instruction were equally effective in increasing content knowledge in health professional students. The change in content knowledge obtained with both learning strategies was not associated with student SDLR or motivation. This finding suggested that factors other than SDLR or motivation as assessed may have contributed to successful learning outcomes in the online PBL module.

Intrinsic and extrinsic motivation scores and control of learning beliefs scores obtained in this study were also high. Research in this area suggested that both intrinsic and extrinsic motivation and learner control can lead to successful learning outcomes in the online environment. The high motivation and control of learning beliefs scores obtained by this group of health care professional students indicate that they were prepared to be successful in an academic environment.

The results of this study suggest that online PBL can be an effective instructional strategy with health care professional students. SDLR, motivation and control of learning beliefs did not impact changes in content knowledge gained in PBL. The majority of students in this study possessed the attributes to be successful in this self-directed learning environment. However success was attained even in the absence of these attributes suggesting that the learning environment can be designed to effectively support all students.

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