

## Review Article

# Problem Based Learning in a Pathophysiology On-line Review System

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### Abstract

This study examines the effect of an on-line problem based learning system on high school students in a health science program. The learning system focuses on critical thinking skills as they relate to determining the diagnosis of a disease based on physical assessment and the understanding of pathophysiology. The study findings suggest that the on-line review system significantly improved the student's ability to determine the correct diagnosis from information presented in a scenario based problem format. The study was implemented after a full and comprehensive review and approval by the Human Subjects Committee at Florida State University.

**Keywords:** Computer Supported Learning; Critical Thinking; Health Science; Pathophysiology and Diagnosis.

### Introduction

Health science education is commonly becoming a part of the various programs offered to high school students throughout the United States. These programs are developed for students interested in entering the medical profession and obtaining state certification in entry level occupations before graduation. The difficulty in these programs is the necessity to train adolescents to function in an atypical environment and operate at an adult level. Unlike the typical high school setting, these students must learn to operate within a system that requires mature levels of critical thinking to function safely.

Yet students frequently become passive in the process of receiving knowledge, especially in light of the advances in technological access. It is apparent that students need to learn to "Develop and effectively apply critical thinking skills to their academic studies, to the complex problems that they will face, and to the critical choices they will be forced to make" [1]. Therefore, in this study we examined the effect of an on-line problem based learning system on high school students in a health science program. The major research questions are:

- What is the learning effectiveness of an on-line problem focused pathophysiology review system?
- Does the on-line problem based pathophysiology review system

improve student's critical thinking in the area of medical diagnosis?

### Literature Review

Researchers that focus on the area of critical thinking have identified that frequently this skill is not very well developed in both children and adults. In the field of psychology, researchers have concluded that a significant amount of adults have difficulty with critical thinking [2-4]. The ability to effectively utilize critical thinking is essential in medicine to meet patient needs, identify potential problems, develop proper interventions and in many cases, develop alternative therapies. Health care providers must be able to provide care based on an understanding of pathophysiology behind the problem being addressed [5].

To facilitate this process, teachers need to utilize diverse methods for instruction and expose students to various methodologies [6]. When evaluating the best approach to teaching critical thinking research suggests that educators should utilize a mixed approach that integrates various strategies into standard instructional content [7]. One such area involves the use of the integration of explicit instruction, a process whereby the learner receives clear and precise explanations regarding the necessary skills and information they are required to learn [7,8]. In addition, explicit to instruction is another key component to successfully teaching critical thinking skills is the role that background knowledge represents in the process. Researchers have concluded that this is an

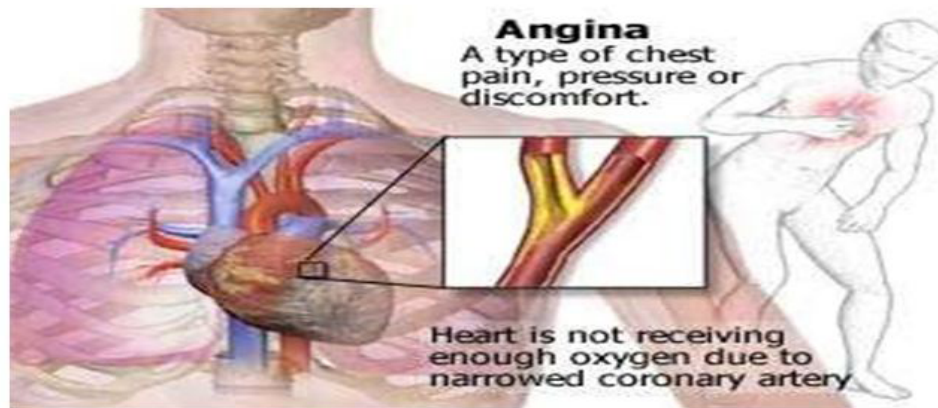
essential component to the process [9]. Students must have a foundation in this area so that they have the necessary tools to solve complex problems [4]. Therefore, any instructional system must provide for the integration of background knowledge to be successful.

As part of the critical thinking learning process, a method of assessment tasks must be included. These tasks should involve the application of authentic real-world problems [2,10]. The basis for these assessments should be structured and include simulations that can approximate conditions that could be encountered in the real-world [11]. Researchers have demonstrated that technology and web based instruction can support and enhance traditional classroom instruction. That computer based instruction can be effective in improving learning when supported with traditional instructional methods [12,13].

## Method

This study used a quantitative approach to evaluate the effect of problem based learning in on-line review system. This system was implemented to augment the normal instruction given to high school health science students in the area of the pathophysiology of disease. Specifically, the ability to diagnosis these illnesses when presented with a problem based scenario in which specific signs and symptoms are provided. The online study system was accessed by the research students using chrome books on a dedicated web site that only they had access to. The study system was made up of two parts, an explicit instructional unit and a scenario based review unit.

The explicit instructional review unit was made up of three separate lessons covering cardio-pulmonary, abdominal and neurological diseases. Each disease was summarized in a one page format (Appendix 1) which included a graphic representation, a one paragraph explanation of the physiology of the diseases process and a list of the common symptoms.



### Pathophysiology

Angina often occurs when the heart muscle needs more oxygen carrying blood than it is getting, such as during times of physical activity or strong emotions. Severely narrowed coronary arteries, due to atherosclerosis or fatty plaque deposits, may only allow enough blood to reach the heart when the demand for oxygen is low. With physical exertion, like walking up a hill or climbing stairs, the heart works harder and needs more oxygen. The narrowed coronary arteries are unable to provide the additional blood flow required. The resulting decreased myocardial oxygen perfusion, known as ischemia, produces the symptoms of angina.

### Signs and Symptoms

1. Onset of pain occurs when the heart must work harder, usually during physical exertion or stress
2. Mid-sternal dull chest pain or pressure that spreads to the arms, back, or neck
3. Pain may feel like gas or indigestion
4. Pain is relieved by rest, oxygen administration, nitro glycerine tablets or a combination of the three.

Appendix 1: Explicit Instructional Review.

The scenario based review unit (Appendix 2) was developed using a PowerPoint based learning tool. Students would review various scenarios after each explicit instructional unit, which included different situations, complaints and assessment results. After they reviewed the given information they were provided a list of possible options and were instructed to attempt to determine the possible diagnosis. Once an option was selected the student was then shown the correct answer, the rationale and identifiers in the scenario that supported the correct diagnosis.

which was divided into three separate units. During each unit, the students assigned to the research group were instructed to use the on-line system to review the diseases covered in lecture. To ensure the students reviewed the material they were required to copy the written pathophysiology for each disease and list of symptoms from the explicit instructional unit into a dedicated composition book separate from their classroom notes.

### Data Collection

Data was collected using quantitative knowledge tests. Specifically, at the completion of the first two unit's two different assessment tests were administered. The first test, designated as the short answer test, provided the student with ten diagnosis that were randomly selected from the list of diseases that they had studied in class and were covered by the review program. These tests were specific to the unit that the instructor had just completed teaching and was administered within 1-2 days. The student was required during the test to write from memory the basic pathophysiology of the disease and at least three common signs or symptoms (factual knowledge test).

The second assessment test used a scenario based format similar to what was used in the pre-test; this was designated as the scenario test. In this test, the students were given five scenarios that encompassed the common signs or symptoms of specific diseases they had learned in class and that was also covered by the review system. The student was then required to read the scenario, evaluate the signs and symptoms and then using critical thinking skills identify the diagnosis from memory, no options were provided (Problem solving test). The assessment test was administered 1-2 days after the short answer test. In the last week, the students were given the post-test which used the same instructional format and questions used in the pre-test. In the post-test, the students were provided an alphabetical list of possible diagnosis that was covered in the course as well as the review program from which to pick from.



Appendix 2: The Scenario Based Review Unit

### Participants

The study consisted of thirty-six 11<sup>th</sup> grade students from a Health Science II course at a local high school. Of the thirty-six students involved in the study 22.2 % were male and 77.8 % were female. Participants were randomly assigned to two groups. The control group (n=17) were provided standardized instruction in pathophysiology and diagnosis. The research group (n=19) were provided with the on-line scenario based study system in addition to the standardized instruction.

### Procedure

The study lasted 12 weeks. In the first week, all study participants received a pre-test which used a scenario based format. In the pre-test, the student was provided written scenarios in which they had to evaluate the signs and symptoms and render a diagnosis from a group of possible options. All participants were then provided equivalent instruction over the following ten weeks

Test items were extracted directly from the explicit instructional units by expert teachers not associated with the school. The test questions were validated through prior administration to an advanced Health Science class of fifteen students not involved in the study. Test question validation was implemented six months prior to the study.

### Findings

Initially a one way MANOVA test was conducted to examine impact of an on-line problem focused pathophysiology review system on student's critical thinking in the area of medical diagnosis. When we compare the mean scores of the control group versus the research group in the Descriptive Table (Table 1) for the scenario, short answer, and post-test scores we do see a difference in the mean scores. On average the Research group means score was 48% higher than that of the Control group for all tests. The results of the MANOVA analysis showed a significant difference between

the research group and the control group in post testing where  $F(1,34) = 78.311$ ,  $p < 0.001$ .

Dependent Variable	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Unit 1 Short Answer	Control	37.706	4.843	27.864	47.547
	Research	71.263	4.581	61.954	80.572
Unit 1 Scenario	Control	22.059	7.242	7.341	36.776
	Research	63.158	6.85	49.237	77.079
Unit 2 Short Answer	Control	52.235	4.539	43.012	61.459
	Research	77.789	4.293	69.065	86.514
Unit 2 Scenario	Control	38.824	5.801	27.035	50.612
	Research	85.263	5.487	74.112	96.414
Post-test	Control	39.118	3.918	31.156	47.08
	Research	86.842	3.706	79.311	94.374

**Table 1:** Control Group Versus the Research Group (Descriptive Table).

A Levene’s Test for Homogeneity of Variances (Table 3) was conducted to ensure that the variability of scores for each group was similar where (sig. > 0.05), in all cases the results were not significant. The strength of the variation for the short answer tests, scenarios tests and the post-test was supported by the values reported for Partial Eta Squared (Table 2) which all show a large effect size ( $\eta^2 > 0.14$ ). When we look at the Between Subject Factors (Table 2) we see that there is a statistically significant effect (sig. < 0.05) between both groups for short answer, scenario based and the post- test.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Group	Unit 1 Short Answer	10103.536	1	10103.536	25.342	0	0.427
	Unit 1 Scenario	15155.283	1	15155.283	16.998	0	0.333
	Unit 2 Short Answer	5859.006	1	5859.006	16.731	0	0.33
	Unit 2 Scenario	19349.845	1	19349.845	33.825	0	0.499
	Post test	20435.348	1	20435.348	78.311	0	0.697

**Table 2:** Between Subject Factors.

	F	df1	df2	Sig.
Unit 1 Short Answer	1.826	1	34	0.186
Unit 1 Scenario	3.119	1	34	0.086
Unit 2 Short Answer	1.492	1	34	0.23
Unit 2 Scenario	1.751	1	34	0.195
Post test	0.003	1	34	0.956

**Table 3:** Levene’s Test Homogeneity of Variances.

After evaluation of the results an ANCOVA analysis was conducted using the pre-test as a covariate and the post-test as the

dependent variable. The intent was to determine if there was an overall statistically difference in the post -test scores between the two groups once their means had been adjusted for the pre-test scores. In the Tests of Between Subjects (Table 4) we see that there is a statistical significant difference between groups when adjusted for the covariate (sig. < 0.05). This is better understood by the difference between the means for both in the Descriptive Statistics Table (Table 5) when compared to the adjusted means in the Estimates Table (Table 6). The difference between the pre-and post-test can be visually highlighted by the box plot graphs based on the adjusted means (Graph 1 & 2).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	21285.860a	2	10642.93	43.783	.000	0.726
Intercept	10994.118	1	10994.118	45.228	.000	0.578
Pretest	850.512	1	850.512	3.499	.070	0.096
Group	17506.227	1	17506.227	72.017	0	0.686
Error	8021.779	33	243.084			
Total	178175	36				
Corrected Total	29307.639	35				

Dependent Variable: Post - test.  
R Squared = .726 (Adjusted R Squared = .710)

Table 4: Tests of Between-Subjects Effects.

Group	Mean	Std. Deviation	N
Control	39.1176	16.79242	17
Research	86.8421	15.56443	19
Total	64.3056	28.93719	36

Dependent Variable: Post- test.

Table 5: Descriptive Statistics.

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	40.341a	3.838	32.533	48.149
Research	85.748a	3.624	78.374	93.121

Dependent Variable: Post - test. a-Covariates appearing in the model are evaluated at the following values: Pre-test = 30.8889

Table 6: Estimates.

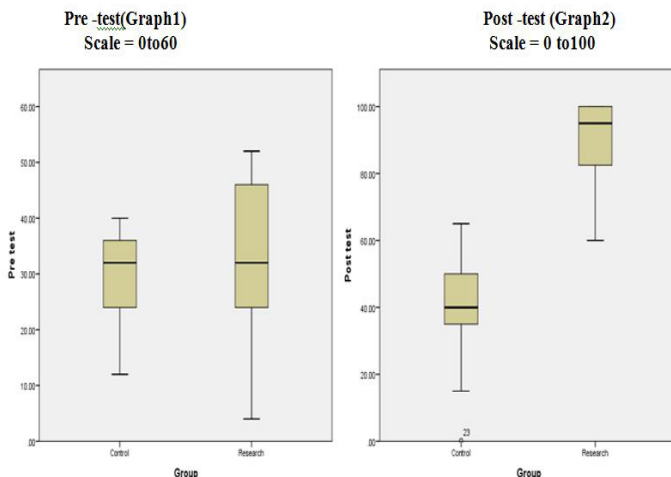
Research group. This was determined by the significantly higher mean on the scenario, short answer, and post-test scores as compared to the Control group. In regard to critical thinking, the Research group demonstrated significantly higher mean scores on the scenario based testing as compared to the Control group. It is these scenarios based tests that demonstrate not only the understanding of pathophysiology but the ability to think critically in order to determine a medical diagnosis from the evidence or information provided.

As we look at prior research discussed in the literature review, the results of this study confirm the difficulty students can have with critical thinking as it relates to solving medical based problems. The introduction of this learning system also substantiates the need to use various methodologies and strategies of instruction to teach critical thinking skills, especially in the area of medical based instruction. The importance and success of explicit instruction is also supported by the results of this study based on student performance in both the factual knowledge and problem-solving tests.

This study also supports our present understanding of the positive impact technology based learning has on improving critical thinking skills. Especially when used in a system such as this which includes the application of solving real world problems in the process. In the field of health care the ability to think critically is of paramount importance in order to function effectively and safely in the area of patient care. The goal of training high school students to competently work in health care after graduation is a daunting responsibility. To meet these responsibility educators must use multiple resources to help accomplish this goal.

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Graph 1: Pre -test and Graph 2: Post -test.

## Conclusion and Discussion

The on-line problem focused pathophysiology review system did have a positive impact on the student's learning within the

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