

Teaching Diagnostic Problem Solving: Principles Learned from Studies of the Diagnostic Pathfinder

A.S. Leaflet R2177

Jared A. Danielson, lecturer;
Pamela J. Vermeer, lecturer;
Eric M. Mills, lecturer;
Holly S. Bender, associate professor

Summary and Implications

Three quasi-experimental studies, and a survey-based study examining the effectiveness of and principles embodied in the Diagnostic Pathfinder, a software tool for teaching diagnostic problem solving in veterinary medicine. It appears that when students learn diagnostic problem solving in the context of authentic cases, are required to consider all potentially relevant information that they have identified in their solution, and receive immediate feedback, their ability to solve diagnostic problems improves.

Introduction

Diagnostic problem solving is difficult to teach and to learn. Yet it is critical that veterinarians be competent at diagnosing medical conditions based on information such as history, physical exam and laboratory data. Various strategies, such as using authentic cases and using computer-based practice tools have promise to help students learn these skills. However, it is important to identify the characteristics of such tools that make them effective.

Materials and Methods

The Diagnostic Pathfinder (dP) is a computer based tool that allows students to solve diagnostic problems involving animal patients. The dP involves four core learning interactions: 1. collecting data from the patient history (Figure 1), 2. examining laboratory data to identify data abnormalities (Figure 2), 3. synthesizing data into an outline-based solution called a diagnostic path (Figure 3), and 4. comparing the learner solution to an expert solution (Figure 4).

Four studies involving the use of the dP, and previously reported^{1,2} are summarized herein. Three related studies at three different institutions (Virginia Tech, UC-Davis, and UW-Madison), each employed a similar quasi-experimental design to explore the effectiveness of the dP. Equivalent groups of students used either the dP or a similar paper-based process for completing case based homework

assignments. Final exam scores on a paper-based, case-based final exam were then compared between groups.

In the related survey-based study, 640 students across 8 semesters of instruction at five colleges of veterinary medicine used the dP to varying degrees to practice case-based homework assignments. Learners responded to a 28 item survey regarding their experience with the dP. Responses to Likert scale for all participating institutions were summarized using descriptive statistics. Open-ended responses were analyzed using an open-coding technique to determine what aspects of the software tool produced its effect, from the students' perspective.

Results and Discussion

In all three quasi-experimental studies, students using the dP to complete their homework scored significantly higher on case-based, paper-based final examinations than students who used alternative methods for completing their homework. Final exam scores, numbers of participants, and p values are shown in Table 1. In the fourth study, students who used the dP overwhelmingly agreed that it increased the amount of laboratory data they considered in arriving at a solution, made their case solutions more precise, improved the effectiveness of the time spent doing homework, and helped them organize their thoughts about the cases. Open-ended response analysis revealed that students believe that the highest learning benefit came from the software's immediate feedback and the fact that the software forced them to consider all abnormal data. Many students also perceived benefit from the software's method of manipulating data while arriving at a diagnostic solution. Several implications for teaching diagnostic problem solving were presented. First, requiring a standard of completeness in data consideration motivated students to be more thorough and sophisticated in their data analysis. Second, providing students with immediate and detailed feedback in the same format in which they communicate their solution improves their learning associated with solving similar diagnostic problems.

Figure 1. Collecting Data from Patient History.

User: Bender, Holly Case: 17 Course: ISU VPTH 425, 2006

Course ISU VPTH 425, 2006

Signalment/History/Physical Exam Lab Data Construct Diagnostic Path Make Diagnosis Expert Diagnostic Path Submit For Credit

CASE 17

Picture by Dr. Jerry Roberson

You are called out to a local dairy farm to examine a 4-year-old, Holstein cow with a one day history of anorexia and a precipitous decrease in milk production. On physical examination the cow is depressed, febrile, and has a swollen and hot right rear quarter. Milk expressed from the affected quarter is serous and contains flakes. You draw blood and collect urine for evaluation and then treat her with parenteral antibiotics and intravenous electrolytes. You also recommend that the affected quarter is stripped out hourly and infused with intramammary antibiotics at the end of the day.

Record Observation

Observations and Data Abnormalities

- M > New Mechanism
- H > one day history of anorexia
- H > precipitous decrease in milk production
- H > depressed
- H > febrile
- H > swollen and hot right rear quarter
- H > Milk expressed from the affected quarter is serous and contains flakes

Figure 2. Identifying Data Abnormalities.

User: Bender, Holly Case: 17 Course: ISU VPTH 425, 2006

Course ISU VPTH 425, 2006

Signalment/History/Physical Exam **Lab Data** Construct Diagnostic Path Make Diagnosis Expert Diagnostic Path Submit For Credit

WBC	2.200	Low	4.0-12.0	n x 10 ³ /ul	leukopenia
SEG	14%	Low	0.6-4.0	n x 10 ³ /ul	neutropenia
BAND	8%	High	0.0-0.12	n x 10 ³ /ul	left shift
LYMPH	72%	Low	2.5-7.5	n x 10 ³ /ul	lymphopenia
MONO	1%	Low	0.025-0.85	n x 10 ³ /ul	monocytopenia
EOS	0	Normal	0.0-2.4	n x 10 ³ /ul	
BASO	0	Normal	0.0-0.2	n x 10 ³ /ul	
META	4%	High		n x 10 ³ /ul	metamyelocytosis
MYEL	1%	High		n x 10 ³ /ul	myelocytosis
OTHER	0	Normal		n x 10 ³ /ul	
PLT	650	Normal	100.0-800.0	n x 10 ³ /ul	
PLT EST	adequate	Normal			
PP	9.3	High	6.0-8.0	g/dl	hyperproteinemia
FIBR	1600	High	100.0-600.0	mg/dl	hyperfibrinogenemia

WBC MORPH
toxic change found in neutrophils, immunocytes

Observations and Data Abnormalities

- M > New Mechanism
- H > one day history of anorexia
- H > precipitous decrease in milk production
- H > depressed
- H > febrile
- H > swollen and hot right rear quarter
- H > Milk expressed from the affected quarter is serous and contains flakes
- D > rouleaux
- D > leukopenia
- D > neutropenia
- D > left shift
- D > lymphopenia
- D > monocytopenia
- D > metamyelocytosis
- D > hyperproteinemia
- D > hyperfibrinogenemia
- D > toxic change found in neutrophils

Figure 3. Creating a Diagnostic Path.

The screenshot displays a software application window titled "Faculty DP" with a menu bar including "Case", "Edit", "View", "Insert", "Tools", "Expert", and "Help". The status bar indicates "Case: 17" and "Course: ISU VPTH 425, 2006". The main interface is split into two panels:

- Construct Diagnostic Path (Left Panel):** This panel is organized into several categories, each with a set of buttons (A, B, C, D, E, M, H) and a text box:
 - Toxic mastitis:** Buttons A, M, >. Text box: "4-year-old, Holstein cow".
 - Fibrin response to infection:** Buttons -, M, >. Sub-items include "rouleaux", "hyperfibrinogenemia", "hyperproteinemia", and "hyperglobulinemia".
 - Tissue demand for PMNs:** Buttons -, M, >. Sub-items include "leukopenia", "neutropenia", "left shift", "metamyelocytosis", and "myelocytosis".
 - Monocyte response to neutropenia:** Buttons -, M, >. Sub-item: "monocytopenia".
 - Lymphocyte response to neutropenia:** Buttons -, M, >. Sub-item: "lymphopenia".
 - Clinically insignificant findings:** Buttons -, M, >. Sub-items include "cloudy urine", "hypersthenuria", and "ketonuria".
- Observations and Data Abnormalities (Right Panel):** This panel shows a list of findings with checkboxes and buttons (M, H, D) for selection:
 - New Mechanism:** Buttons M, >.
 - 4-year-old, Holstein cow:** Buttons H, >.
 - one day history of anorexia and a precipitous decrease in milk production:** Buttons H, >.
 - cow is depressed, febrile:** Buttons H, >.
 - swollen and hot right rear quarter:** Buttons H, >.
 - rouleaux:** Buttons D, >.
 - leukopenia:** Buttons D, >.
 - neutropenia:** Buttons D, >.
 - left shift:** Buttons D, >.
 - lymphopenia:** Buttons D, >.
 - monocytopenia:** Buttons D, >.
 - metamyelocytosis:** Buttons D, >.
 - myelocytosis:** Buttons D, >.
 - hyperproteinemia:** Buttons D, >.
 - hyperfibrinogenemia:** Buttons D, >.
 - toxic change found in neutrophils, immunocytes:** Buttons D, >.
 - cloudy urine:** Buttons D, >.
 - hypersthenuria:** Buttons D, >.
 - ketonuria:** Buttons D, >.
 - occasional epi/thpf:** Buttons D, >.
 - hyperglobulinemia:** Buttons D, >.
 - hyperproteinuria:** Buttons D, >.

Figure 4. Feedback – Student and Expert Solutions Compared.

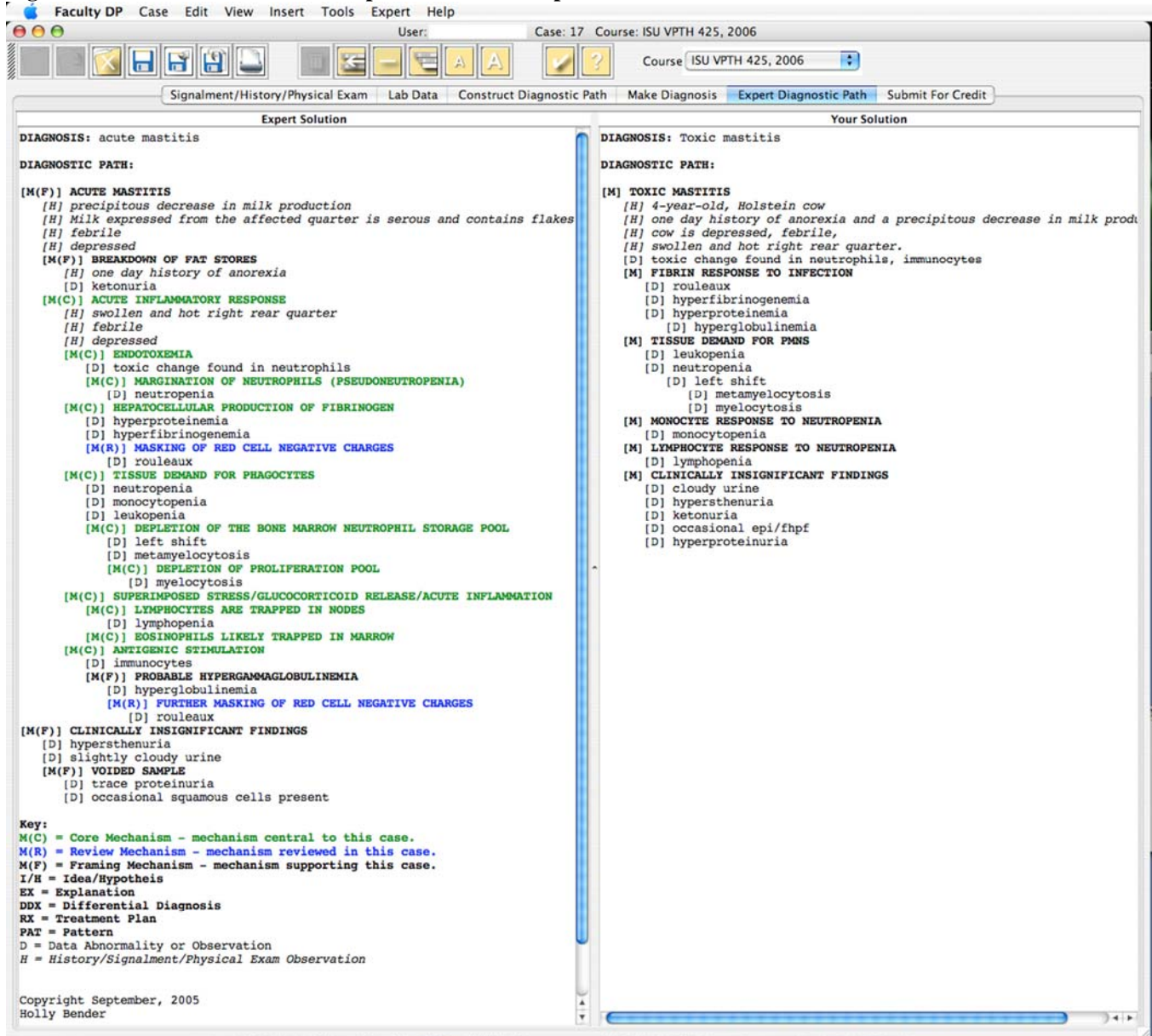


Table 1. Final exam scores for quasi-experimental studies at three institutions.

Institution	Control	DP	Significance
Virginia Tech	81.6 (n=334)	87.3 (n=173)	p < .0005 *
UC-Davis	85.0 (n=120)	90.1 (n=126)	p < .0005 *
UW-Madison	84.7 (n = 199)	87.0 (n = 113)	p = .002*

* Independent Samples t-test

Acknowledgements

The development of the Diagnostic Pathfinder was supported by the USDA Higher Education Challenge program and by a grant from the Learning Anytime Anywhere Partnerships (LAAP), a program of the Fund for the Improvement of Postsecondary Education (FIPSE), U.S.

Department of Education. However, these contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the Federal Government.