

The Application Of Documented Problem Solving In College Introductory Statistics Courses


Hong Zhuang, Indiana University South Bend, USA

ABSTRACT

Introductory statistics is an important part of the undergraduate curriculum in business and economics education. A pedagogical method, documented problem solving, is applied in the undergraduate statistics course. This assessment method actively engages students in learning via reflecting their thinking process that helps stimulate metacognition and develop critical thinking and problem-solving skills.

Keywords: Statistics Education; Documented Problem Solving

I. INTRODUCTION

 Statistics is an important part of the curriculum in business and economics education at the university level. One of the goals for introductory statistics courses is to foster problem-solving skills so that students are able to apply what they learn to real-world situations. Traditional pedagogical approaches in many college statistics classes include lecturing and doing assignments in textbooks or in computer labs. However, students are not learning what we want them to (Garfield, 1995).

Documented problem solving is adopted in introductory statistics courses to help students develop effective problem-solving skills.

II. DOCUMENTED PROBLEM SOLVING AND METACOGNITION

Documented problem solving is a classroom assessment technique originally described by Angelo and Cross (1993). This technique requires students to document detailed steps that they take in attempting to solve representative problems. The documented problem solving technique “prompts students to keep track of the steps they take in solving a problem – to “show and tell” how they work it out” (Angelo & Cross, 1993, p. 222). By analyzing students’ description of each step teachers can obtain insights into their students’ problem-solving routines.

Problem solving requires metacognition (Angelo & Cross, 1993). Metacognition is defined as “an appreciation of what one already knows, together with a correct apprehension of the learning task and what knowledge and skills it requires, combined with the ability to make correct inferences about how to apply one’s strategic knowledge to a particular situation, and to do so efficiently and reliably” (Taylor, 1999, p. 34). To enhance metacognitive abilities, it is necessary for students to acquire and be aware of three types of knowledge, including declarative, procedural and conditional (Pierce, 2003). Declarative knowledge is the knowledge of factual information that can be spoken or written (Pierce, 2003). An example is knowing the formula for calculating sample standard deviation. Procedural knowledge is the knowledge of performing steps in a process to achieve something (Pierce, 2003); for example, knowing the steps necessary to calculate sample standard deviation. Conditional knowledge is the knowledge about under what circumstances to use a procedure and why a procedure is preferred than another (Pierce, 2003). For example, students need to recognize that a problem requires the calculation of sample standard deviation as part of its solution and understand why standard deviation is preferred to variance.

Students in introductory statistics do not gain metacognition or problem-solving skills instantly when the instructors deliver the lecture or demonstrate examples. Students may encounter several errors with learning. Nickerson, Perkins, and Smith (1985) discussed several types of problems with learning. For example, students may miss important data or not separate relevant from irrelevant data. Students may fail to select the right subskills to apply or divide a task into subtasks. Furthermore, students may misrepresent the task.

However, it may not be always clear to the instructors what kind of errors that students are making in their thinking process. A good way is to get students to document step by step how they are going about the task (Pierce, 2003). By knowing how students conduct a cognitive task, an instructor can detect where they make mistakes. Asking students to describe their thinking process forces students to think what they already know, what task presented by the problem, what skills are needed to solve the problem, and how to execute the calculation to obtain the answer. This practice fosters students' metacognitive abilities – a very necessary skill to improve thinking and therefore gain problem-solving skills ultimately.

In addition to metacognition, students also experience expert-novice learning and transfer of learning during the process of writing the documented problem solution. Bransford, Brown, and Cocking (2000) stated "... experts have acquired knowledge that affects what they notice and how they organize, represent, and interpret information in their environment. This, in turn, affects their abilities to remember, reason, and solve problems" (p. 19). Similarly, when working on the documented problem solving assignments, students need to probe into knowledge related to the question, apply the appropriate procedure to reach reasonable outcomes and write the interpretation in an organized format (Wilson, Casolari, Townsend-Merino, & Easton, n.d.). Therefore, students gain some "expert" qualities in the process of completing the assignment using the documented problem solving approach. Transfer of learning is defined as "... the ability to extend what has been learned in one context to new contexts" (Bransford, Brown, & Cocking, 2000, p. 35). In line with metacognition, the documented problem solving approach encourages students to apply prior knowledge to a different problem setting as they write out their solution process.

In summary, the literature of learning science supports documented problem solving as a prominent technique to improve student's learning outcomes.

III. APPLICATION OF DOCUMENTED PROBLEM SOLVING IN INTRODUCTORY STATISTICS COURSES

Students in introductory statistics courses often have difficulty in applying statistical formulas and effectively solving problems when questions are changed. However, during the lecture students seem comfortable with the solving process and do not raise questions in class. The contradicting responses frustrate the instructor. The opportunity to understand students' problem solving routines and the thinking process is important to help instructors improve students' learning outcomes. Documented problem solving provides a way whereby the instructor can discover students' thinking process (Wilson, Casolari, Townsend-Merino, & Easton, n.d.).

Therefore, documented problem solving is adopted in introductory statistics courses. Documented problem solving is integrated as part of homework assignments. Students are asked to write down all the steps they use in order to solve a problem or answer a question. The steps should include what students are thinking as they go through the process (Wilson, Casolari, Townsend-Merino, & Easton, n.d.). Considering that step-by-step documentation is time consuming, representative problems are assigned using documented problem solving in each assignment. Points are not deducted from the homework grade if the student's process is flawed in order to motivate students to practice documented problem solutions in the homework assignment. Furthermore, feedback is provided on each misstep that students make in documented problem solving. Finally, step-by-step solutions are posted on the course website so that students can review after the assignment is returned.

Documented problem solving is helpful in my classes as the class size is 33 students on average. First, the large class size makes it difficult for each student to ask questions during class. Second, students fail to ask questions because they are not confident to speak up in front of their classmates in such a large class. Third, students may think that they understand the material well that there is no need to ask questions. By writing every step of the

thinking process and comparing with the answers, documented problem solving helps students identify missteps they make. Therefore, students can review the materials that they miss. This method helps improve learning and enhance the retention of knowledge. Moreover, students show that they begin with the information that they know from previous lectures and combine with the new information; that they choose the proper formulas and execute the calculation process properly. This process helps students become more aware of their own problem-solving strategies, stimulate metacognition, and develop critical thinking and problem-solving skills.

Documented problem solving also allows instructors to view how students solve problems and become more knowledgeable about student misconceptions. Therefore, the instructor can readdress concepts that are unclear in the following lectures and clear up misconceptions before the exam. Furthermore, by providing feedback on the documented problem solutions, the instructor is able to communicate with students in a direct and timely manner and help enhance student's learning outcomes (Garfield, 1995).

IV. CONCLUSION

Statistics educators expect students to develop effective problem-solving skills and the ability to adapt problem-solving routines to deal with real-world situations. To achieve this purpose, the documented problem solving approach is adopted in the introductory statistics course. Through the practice, students are actively engaged in learning via reflecting their thinking process. Such reflection is closely linked to metacognition and thus develops the problem-solving skills of students. Furthermore, this approach can help instructors identify misconceptions so that additional explanations can be used to clarify misconceptions in the following class meetings.

The future phases of this research will select two sections of introductory statistics courses and implement documented problem solving in one section. A comparison of exam scores throughout the semester will be helpful to determine if the documented problem solving approach improves students' knowledge and academic performance.

AUTHOR INFORMATION

Dr. Hong Zhuang is an Assistant Professor of Economics at the Judd Leighton School of Business and Economics, Indiana University South Bend. Dr. Zhuang received her PhD from the University of Oregon, Oregon, U.S.A. She currently conducts research in international economics, economic development, economic and business education. Contact information: Judd Leighton School of Business and Economics, Indiana University South Bend, 1700 Mishawaka Ave, South Bend, IN 46634-7111. Tel: 574-520-4634; Fax: 574-520-4866. E-mail: zhuangh@iusb.edu.

REFERENCES

1. Angelo, T. A., & Cross, K. P. (1993). *Classroom Assessment Techniques. A Handbook for College Teachers*. San Francisco, CA: Jossey-Bass.
2. Bransford, J. D., Brown, A. L., & Cocking R. R. (Eds.). (2000). *How People Learn: Brain, Mind, Experience, and School*. Washington D.C.: National Academy Press.
3. Garfield, J. (1995). How Students Learn Statistics. *International Statistical Review*, 63, 25-34.
4. Nickerson, R. S., Perkins, D. N., & Smith, E. E. (1985). *The Teaching of Thinking*. Hillsdale, NJ: Erlbaum.
5. Peirce, W. (2003). Metacognition: Study Strategies, Monitoring, and Motivation. Retrieved from: <http://academic.pg.cc.md.us/~wpeirce/MCCCTR/metacognition.htm>
6. Taylor, S. (1999). Better Learning Through Better Thinking: Developing Students' Metacognitive Abilities. *Journal of College Reading and Learning*, 30, 34-45.
7. Wilson, L., Casolari, A., Townsend-Merino, K., & Easton, T. (n.d.) Documented Problem Solving. Retrieved from <http://serc.carleton.edu/econ/dps/index.html>

NOTES