Student Think-Alouds As An Instructional Technique

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Introduction

The Problem-solving Examples with Narration for Students (PENS) project is creating and assessing instructional materials that target one of the central skills required for success in the STEM fields: problem-solving. Instead of focusing solely on the refined end product of problem-solving, written solutions, students are instructed on how to focus explicitly on the problem solving process, with particular attention paid to self-regulation. To make what is essentially an internal thought process explicit, students and instructors record think-alouds that are then included in mathematics, chemistry, physics and teacher preparation courses.

Context

The course where the PENS materials were implemented was the first semester of physics for life sciences- classical mechanics and some fluids and thermodynamics. Twenty-five students were enrolled in the section. Students' average score on the Classroom Test of Scientific Reasoning was $75 \pm 16\%$ and their pre-instruction FCI average score was 9.3 ± 3.3 (out of 30). Course textbook was Randy Knight, Brian Jones and Stuart Field's *College Physics*

Technology

Think-alouds are recorded using Livescribe smartpens, in which there are embedded computers and microphones. When used with Livescribe Dot paper, a pen records and synchronizes pen strokes and audio to create a "pencast." Recorded pencasts can be transferred to a computer via a USB connection. From there, the recordings can be emailed or posted online.

Each student was given a pen with which they were to solve all of their homework problems. This allowed them to become comfortable with making think-alouds. Also, it facilitated asynchronous discussions outside of class as students could email the instructor any solution with which they were struggling.

In-Class Activities

Working in pairs (and sometimes groups of four), students would be assigned roles for problem solving.

• *Solver*- Talk through the reasoning process while attempting to solve the problem.
• *Listener*- Encourage the solver to think aloud, describing the steps to solve the problem. Ask the solver to clarify statement or steps if they are unclear. (They could be unclear to you or an imaginary groupmate who is struggling.) If the solver is quiet for more than 3 seconds, ask him/ her to explain what they are thinking about.
  ° Responsibilities do not include correcting the solver. Do not give hints.
  ° Do not solve the problem yourself.
  ° Do not tell the Solver how to correct an error.

In later activities, the Listener role was changed into a *Skeptic* who would ask the solver to defend their solution as they crafted it. While still not charged with correcting the solver, the Skeptic is meant to represent the active monitoring that students should do while solving problems.

Out-of-Class Activities

Watching Previously Recorded Think-Alouds
Several homework assignments asked students to view and critique previously recorded think-aloud pencasts. Initial assignments asked students to focus their feedback on the quality of the think-aloud. (How well did the student verbalize his/ her thought process?)

Later assignments asked students to focus on the problem-solving process presented in the recording. How much time did each student spend on "understanding the question"?

Responses were collected via the online course management system and discussed in the following class period.

Recording Think-Alouds
Students were asked to record all of their practice using the Livescribe smartpens using the think-aloud protocol. However, only three assignments asked for specific think-aloud to be submitted to the instructor. Students could choose to submit any recording to the instructor for feedback.

Problem-solving Model

Activities encourage students to self-monitor/ self-regulate throughout their process. At each step of the Polya-like process, students are taught to ask themselves whether or not they are prepared to go to the next step, or if there is an error or shortcoming. This leads to an iterative process where students may revisit each step multiple times. This iterative approach is significantly different than the one used in typical textbook examples.
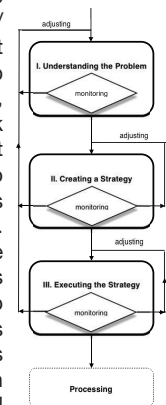
Conclusions

Many students reported that the think-aloud activities did positively influence their problem-solving techniques.

We are in the process of coding the recorded think-alouds with the hope of supporting the students' view. However, we are struggling with inter-rater reliability as we attempt to assess self-regulation in problem solving.

The Livescribe PENS facilitated the recording and sharing of think-aloud recordings.

We are collecting the recordings in a searchable database that will be available to instructors and trainers of K12 teachers, who can use recordings to give the candidates insights into the challenges they will soon face in the classroom.

http://myweb.lmu.edu/jphillips/PENS

Student Feedback

When asked at the end of the semester what they thought about think-alouds and the associated technology, most students were positive about the experience. Several students commented that the activities improved their problem-solving skills.

• I actually did enjoy making pencasts. I thought that it greatly improved my problem-solving strategies and helped organize my thoughts a lot more than they would've been without pencasts.

• Making pen casts was helpful in that it made me really question my methods when solving problems. This questioning was often frustrating (to say the least), but it helped me learn how to solve problems in a way that was much less passive.

• It made me slow down and really try to understand the problem long before I simply grab numbers and equations and try to plug them all into each other.

• I learned to take several steps in order to help me be successful in solving the problem. I made sure to ask myself right off the bat WHAT exactly it was that I was trying to find out in the problem, and then make a plan how to get there instead of panicking and letting my random thoughts run wild on the paper.

• I quickly learned that the thought process explanation via voice recording can only help me when it came to getting assistance and guidance for solving problems from Dr. Jeff, so I tried to set aside more time for that. I did like making the pencasts, though. The problems I was allowed to "talk out" were often solved much more quickly than if I tried to think silently in my head.

• At first, I really didn't enjoy making pencasts. I felt that they were very awkward and it messed me up having to say all of my thoughts out loud. However, as time went on I realized that the more I was able to talk out the problem and explain my thinking process, the more I was able to understand concepts. My highest grade on the test came when I did the most practice problems with my Pencast (who would have thought!).

Most complaints were about how recording think-alouds reduced the number of places they could study, mostly because talking was not allowed (library or sleeping roommate).

• Every time I did them I felt somewhat pressured. I became more comfortable as the semester went on, but I still did not like the feeling as if I was "being watched."

• While I did not dislike making the pencasts, I feel that they slowed me down. Especially at first, I was distracted by the fact that I was being recorded. While I eventually got over this, I never felt that thinking out loud was worth the amount of time it took.