It's a SNAP: Student Note-taking Achieves Performance

Dr. Dennis A. Silage, Temple University

Dennis Silage received the PhD from the Moore School of Electrical Engineering at the University of Pennsylvania. He is a Professor of Electrical and Computer Engineering at Temple University, teaches electromagnetic field theory, digital data communication, digital signal and image processing and embedded processing systems. Dr. Silage is past chair of the Electrical and Computer Engineering Division of ASEE, recipient of the 2007 ASEE National Outstanding Teaching Award and the 2011 ASEE ECE Division Meritorious Service Award.

It's a SNAP: Student Note-Taking Achieves Performance

Abstract

The Student Note-Taking Achieves Performance (SNAP) concept is presented here with its utilization, observations and analysis as an alternative to other methods, such as homework problems, proffered to enhance learning. This educational initiative attempts to address the question of the formative skill for the reading of text and lecture material by a student and the immediate translation then to problem solving. SNAP is a short (15 minute) quiz using only the student's handwritten notes but no text or references. SNAP has been vetted over several semesters in diverse undergraduate Electrical and Computer Engineering courses and assessed by the comparative performance of their respective Course Learning Outcomes.

Try Something New

Conventional pretests coupled with posttests have been touted as a valuable tool for the assessment of educational objectives[1]. However, as such they are not intended to provide a direct intervention or permanent change in learning techniques during the course for the undergraduate Electrical and Computer Engineering (ECE) student.

What does an instructor want the student to do? Some important tactics would be for the student to read the text, references and posted lecture material before and after the lecture, think about the content and be thoroughly engaged with the course material.

There seem to be some students who do not adequately read the text and reference materials in preparation for conventional term examinations. In these instances they have even been observed to use the examination time to 'read the text', searching for formulas and concepts to solve the problem at hand.

Alternatively, homework problems assigned prior to the examination often do not serve this purpose because, if collected, some students mindlessly copy the work from others. What is even worse is when the same text problems are used for homework each semester. Thus homework in either of these cases is neither done at home nor represents any significant work by the students.

The Student Note-Taking Achieves Performance (SNAP) concept builds on the assessment technique of pretest and posttests but utilizes weekly quizzes. As conceived and executed, SNAP is a short (15 minute) quiz using only the student's handwritten notes but no text or references. SNAP is predicated on the learning processed expressed as the anonymous proverb:

I hear and I forget
I see and I remember
I do and I understand

Thus the student's requisite notes become a compilation of reading the text, hearing the lecture and self-organizing the course content and are seemingly an aid to learning[2, 3, 4]. Of course, the temptation is there to obtain the SNAP notes developed by another student in a prior semester or

to produce only a cursory compilation. However, it is soon discovered that the *I do and I understand* notion may be compromised. This effect as has been witnessed in advising sessions and becomes telling in many cases.

The short SNAP quizzes are complete ECE analyses to gauge understanding from formula and concepts written in their own notes and with their own comments. The SNAP quiz given nearly weekly is a prior evaluation of the student's preparation for the tri-semester term and final examinations. Thus the performance of the student on the examinations for the same material as in the SNAP quiz is a direct assessment of the educational objective[5].

The SNAP concept is intended to continuously organize the student's thoughts throughout the course as part of the Engineering method[6]. The SNAP quizzes also seemingly provide thoughtful discussions before and after the appropriate lecture while being a valuable preparation for the examinations in the course.

How Do You Do It?

This pedagogical approach was utilized in three upper-division ECE courses as diverse in concept as electromagnetic field theory, embedded system design and digital communication systems. These courses were taught initially with conventional term examinations every four weeks and a comprehensive final examination for as many as six semesters before the inception of the SNAP concept. Afterwards, now for as many as five semesters, there were three SNAP quizzes before each of the three term examinations and two SNAP quizzes before the final examination. A similar syllabus and text and the same reference materials were being used throughout the intervals of the pre and post SNAP introduction in each course.

The written SNAP quizzes are 15 minutes in length and given at the end of the lecture on Friday. Solutions are posted on *Blackboard* over the weekend and graded quizzes are returned at the next lecture on Monday. The eleven SNAP quizzes are 30% of the final grade of the course with the three term and final examinations providing the remaining 35% and 35% respectively. Thus the SNAP quizzes by design are a significant part of the course grade, unlike homework problems which often tend to be regarded dismissively.

But Does it Work?

The impact of the SNAP concept was assessed by relating the change in student grade performance on examination problems categorized by the Course Learning Outcomes (CLO) in each of the three courses. Here the student performance on the CLOs is a cohort longitudinal study of cognitive learning demonstrated by knowledge recall and intellectual skills[7]. CLOs have also been used in this manner for assessment, evaluation and continuous improvement across an undergraduate Engineering program[8].

A single CLO is a definitive statement that can be readily mapped to specific sections of the course material and thus to problems derived from those concepts. A collection of several CLOs represent the essence of the material in these three diverse ECE courses:

Electromagnetic Field Theory
Students will be able to:

1. Obtain solutions to Laplace's and Poisson's equations for configurations of materials and sources
2. Determine the capacitance of systems of conductors
3. Determine the self and mutual inductance of current carrying systems
4. Apply the basic principles of electromagnetic transformers, motors and generators
5. Determine power transfer by low loss transmission lines from source to passive load
6. Determine the reflection and transmission of power of uniform plane electromagnetic waves incident on low loss and conducting media

Embedded System Design
Students will be able to:

1. Apply the principles of behavioral synthesis of combination and sequential logic in Verilog
2. Utilize the controller-datapath construct for programmable gate array processing
3. Apply digital signal processing and digital communication in programmable gate array processing
4. Identify the societal and global issues of real-time embedded systems in process control and signal processing

Digital Communication Systems
Students will be able to:

1. Identify the sources of information and the concepts of modulation systems
2. Apply the principles of amplitude and angle modulation and demodulation
3. Apply the principles of random processes to error in information reception
4. Identify the societal and global issues in communication regulatory affairs

The performance on examination problems for these CLOs for the ECE courses in electromagnetic field theory, embedded system design and digital communication systems are used in this study to ascertain the efficacy of the SNAP concept. These three courses have approximately 25 students enrolled each semester and were taught by a single instructor throughout the intervals of the pre and post SNAP introduction.

There were typically six semesters of pre SNAP and five semesters of post SNAP utilization in these courses. Prior to the use of the SNAP concept, homework problems were not used because of their perceived efficacy and conventional example problems were presented.

These three upper-division ECE courses are conceptually diverse, are in the cognitive domain and represent an opportunity to gauge the SNAP concept. The course in electromagnetic field theory utilizes vector calculus and skill in spatial visualization. The course in embedded system design emphasizes the logical implementation of tasks in a programming language. The course in digital communication systems features the synthesis of concepts for analysis and design to specifications.

The change in the performance on examination problems categorized by the CLOs during the study is listed in the Table 1 for each course. The unpaired t-test is used to determine the statistical significance ($p < 0.01$) of the difference which indicates an overall improvement in performance.

The improvement in performance was evident in the majority of the instances listed in Table 1. However, there were some discrepancies that could be traced to either the material or the initial implementation of the SNAP concept in the ECE curriculum. In the course on electromagnetic field theory, there was only a marginal and less than significant improvement in performance noted for the concepts of self and mutual inductance of current carrying systems (CLO 3). This might be attributed to the visualization of the closed magnetic field and the prior but relatively simplistic analysis provided in the prerequisite course in Physics.

Electromagnetic Field Theory			
CLO	Prior mean ± sd n = 139	Post mean ± sd n = 118	
1	78.1 ± 8.9	84.2 ± 6.4	$p < 0.0001$
2	75.5 ± 7.7	81.2 ± 7.0	$p < 0.0001$
3	82.9 ± 6.7	84.1 ± 6.9	**$p \approx 0.1594$**
4	80.8 ± 6.8	85.9 ± 3.6	$p < 0.0001$
5	72.5 ± 9.2	80.1 ± 4.4	$p < 0.0001$
6	73.6 ± 8.3	81.5 ± 4.9	$p < 0.0001$

Embedded System Design			
CLO	Prior mean ± sd n = 104	Post mean ± sd n = 93	
1	82.2 ± 5.6	84.2 ± 5.7	**$p \approx 0.0139$**
2	80.1 ± 6.6	85.1 ± 4.5	$p < 0.0001$
3	77.3 ± 6.9	80.2 ± 5.5	$p \approx 0.0014$
4	83.9 ± 4.1	87.7 ± 2.9	$p < 0.0001$

Digital Communication Systems			
CLO	Prior mean ± sd n = 126	Post mean ± sd n = 137	
1	70.4 ± 8.8	77.2 ± 7.2	$p < 0.0001$
2	76.6 ± 7.1	81.3 ± 7.8	$p < 0.0001$
3	74.3 ± 8.1	83.3 ± 8.7	$p < 0.0001$
4	80.1 ± 8.5	82.1 ± 7.7	**$p \approx 0.0463$**

Table 1. Mean ± standard deviation of the grades on examination problems categorized by Course Learning Objectives (CLO) in three diverse ECE courses prior to and post introduction of the SNAP concept.

In the course on embedded system design, the principles of behavioral synthesis of combination and sequential logic in Verilog (CLO 1) were initially utilized in the first course on digital logic but two semesters prior to this course. Students seem to require remediation of the topic. Finally,

in the digital communication systems course, the societal and global issues in communication regulatory affairs (CLO 4) were only marginally improved. This may be due to the non-technical but germane nature of the material and the use of expository questions in the examination.

Surveys and Interviews

An indirect assessment of the SNAP concept has been by end of semester course surveys. This feedback has been used to assess the contribution of the SNAP concept to pedagogy in Engineering education. The consistent survey questions from the three upper-division ECE courses over as many as five semesters are listed in Table 2.

The average survey results from each of these three disparate courses were similar and the overall average of 294 respondents is listed in Table 2. The suggested responses were numbered from 1 - Strongly Disagree, 2 - Disagree, 3 – Neutral, 4 – Agree and 5 – Strongly Agree.

I found that the SNAP concept was a time consuming study routine.	3.2
I found that the SNAP concept prepared me to sit the three hour exams in this course.	4.6
My study routine in previous courses did not include extensively reading the text prior to the hour exams.	3.2
I will apply the SNAP concept in other courses because I believe that it can help me to study.	4.8
I believe that the SNAP concept would only be of use to me in technical courses.	2.6
My study routine in previous courses did not include preparing hand written notes prior to the hour exams.	3.8
I believe that I am more prepared to sit the final exam in this course because of the SNAP concept.	4.6
I read the text and prepared my notes in this course in advance of the lecture.	4.8
Hand writing notes in this course did not require me to extensively read the text.	1.8

Table 2. Course survey questions on the SNAP concept and the average numerical response in three upper-division ECE courses

Some of the survey respondents had been introduced to the SNAP concept in the earliest course in this sequence, Electromagnetic Field Theory, and then used in one or two of the latter two courses. The survey indicates that the SNAP concept was well received as a departure from the learning strategies applied in other ECE courses.

Observations

The performance results in Table 1 provide additional evidence that the organization of material with handwritten notes could be translated to problem solving[4]. However, the rapid cycle of concepts and analysis during the course provided by the nearly weekly SNAP quizzes is also

conducive to a classroom environment that is engaging and collaborative. This certainly also keeps students to a time-on-task schedule since the SNAP quizzes, which are a substantial part of the grade, are frequent. Even three term examinations can only be scheduled every four weeks.

The strong responses to the survey statements in Table 2 are encouraging. Students indicate that they actually did read the text and prepare their notes prior to the lecture. Subjectively, the environment of the lecture with the use of SNAP seemed to be electric. Students more than agree that the SNAP concept prepared them to sit the examinations. But most satisfying is that students responded that they would apply the SNAP concept on their own to their study in other courses.

The note-taking for the course, required to perform the SNAP quizzes, allows the student to make inquiries of what is useful and to decide what they need to know. They can see beneficial results and gain the development of metacognitive understanding[9]. The substantial amount of assessment over several semesters of the change in student grade performance on examination problems categorized by the CLOs in these three diverse ECE courses certainly makes a case for the consideration of the SNAP concept.

The question remains if the SNAP concept can be further extended to other courses in the ECE or even the Engineering, science and mathematics curriculum. Conceptually the SNAP concept is certainly applicable. However, the preparation and grading of SNAP quizzes in addition to the term and final examinations is one obvious hurdle. Another is the apparent loss of 15 minutes of lecture weekly. However, once implemented the SNAP concept seemingly provides a sea change in the learning environment from the staid lecture-homework-examination cycle of the typical course.

Bibliography

1. Bacon, D. (2004). "The Contributions of Reliability and Pretests to Effective Assessment," *Practical Assessment, Research & Evaluation*, 9: 303-309.
2. Kiewra, K.A. (1984). "Acquiring Effective Notetaking Skills: An Alternative to Professional Notetaking," *Journal of Reading*, 90: 299 -301.
3. Einstein, G.O., Morris, J., and Smith, S. (1985). "Note-taking, Individual Differences and Memory for Lecture Information," *Journal of Educational Psychology*, 77: 522-532.
4. Makany, T., Kemp, J., and Dror, I. E. (2009). "Optimising the Use of Note-taking as an External Cognitive Aid for Increasing Learning." *British Journal of Educational Technology*, 40: 619-635.
5. Angelo, T.A., and Cross, K.P. (1993). *Classroom Assessment Techniques: A Handbook for College Teachers*, San Francisco: Jossey-Bass.
6. Litzinger, T.A, Wise, J. C, Lee, S.H. (2005). "Self-directed Learning Readiness Among Engineering Undergraduate Students," *Journal of Engineering Education* 22: 122-128.
7. Bloom, B. S., ed. (1956) *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain.* New York: David McKay.
8. Mason, G., Dragovich, J. (2010) "Program Assessment and Evaluation Using Student Grades Obtained on Outcome-Related Course Learning Objectives," *Journal of professional Issues in Engineering education and Practice* 136: 122-131.
9. Case, J., Gunstone, R., & Lewis, A. (2001) "Students' Metacognitive Development in an Innovative Second Year Chemical Engineering Course," .*Research in Science Education*, 31: 313-335.