A New Meaning to "Click Here" in a Computer Class

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Abstract – According to results from an in-class student survey, "clickers" incorporated into a computer applications class using Mathcad as a programming language helped to enhance the students' classroom experience with material that they considered to be difficult. Clickers, also known as response pads, are handheld devices that allow instructors to view student responses to True/False, Yes/No, multiple choice, or numerical questions. 94% of the students surveyed believed that the use of clickers was helpful to their understanding of either loops or subscripted variables in loops or both. Students rated clicker use highly in helping them to maintain their attention (4.4/5.0), maintain their interest (4.1/5.0), and retain the course material (4.0/5.0). In a list of six teaching tools or techniques, students ranked the use of clickers in helping them to understand loops and subscripted variables only behind the value of doing a Mathcad assignment. 96% of the students said that they would like to see clickers used in future civil engineering classes and 87% indicated that they would not be opposed to extending the use of clickers to several classes during the same semester.

Keywords: programming, Mathcad, loops, clickers.

INTRODUCTION

Over the years, a number of teaching techniques have been used to help create interest and enhance understanding in the Computer Applications in Civil and Environmental Engineering class offered in The Citadel's Department of Civil and Environmental Engineering. Techniques used in the past include team teaching, active learning, hands-on electronic workbook, frequent tests and assignments, flow charting, pseudocode, and debugging features. The most recent addition to the class involves the use of interactive student equipment (i.e., "clickers") to increase student attention, interest, and retention in the lecture portion of the class. A clicker is a handheld device from which responses to questions posed by the instructor can be submitted (see Figure 1). Immediate feedback on the collective response from the class can be shown to the students within seconds, enabling the professor to begin addressing conceptual problems during the same class. This gives clickers a powerful advantage over traditional tests and quizzes in which problems may be addressed only after a test or quiz has been graded and returned. The purpose of this paper is to describe how clickers were used in a computer applications class and to assess the impact on student interest and learning.

Figure 1. "Clicker" manufactured by eInstruction Corp. (see Ref. [11])

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BACKGROUND

Clicker Technology in the Classroom

Technology for actively engaging students through interactive student equipment has been available for some time. A classic example of developing classroom experience with these systems has been described by Eric Mazur [1,2], a physics professor at Harvard University. Beginning with a show of hands, a progression to flash cards was made, then in 1993 a wired network of handheld calculators was installed. Graphing calculators and palmtop or laptop computers used in small groups were part of their early experience with handheld devices. Mazur's use of handheld response systems is integrated into his interactive approach called *Peer Instruction*, which uses *ConcepTests* to enhance students' understanding of fundamental concepts.

In recent years, the use of these type systems has dramatically increased as a variety of devices became more commercially available. Although various names have been employed for these devices, they will be primarily referred to as "clickers" in this paper. As clicker use has become more widespread, many purposes and benefits have been reported for clickers in the classroom. For example, in the most outstanding zone paper presented at the 2005 American Society for Engineering Education (ASEE) National Conference, de Grazia *et al*. [3] used clickers in a cooperative learning environment for grading *ConcepTests* to improve participation and motivation. Increased feedback for students and teachers and higher attendance were among the advantages listed. Instantaneous feedback allows professors to address student problems immediately and helps students assess their understanding of course concepts. Czekanski and Roux [4] and Fan and van der Blink [5] also note benefits associated with rapid feedback in the classroom.

An advantage clickers have over non-electronic methods of obtaining feedback from students is that clicker use promotes anonymity. According to the study by Czekanski and Roux [4], responses by hand raising can be influenced by the lack of anonymity. Fan and van der Blink [5] reported that student participation was enhanced by anonymity. Other uses and benefits associated with clickers include administering and grading pop quizzes [6], evaluating student portfolios [6], performing outcomes assessment [7], testing students recall of required reading [8], testing students' synthesis abilities [8], evaluating students' mastery of topics through participation in group projects [6], and enhancing attitude during lecture [8].

One question being explored in the literature is whether benefits to learning are associated with use of clickers. In a study involving two classes [5], one with clickers and another using hand raising, the clicker class scored higher on the final exam but the difference was not statistically significant. Nevertheless, students who used clickers felt that clickers helped them to learn the course information. Probst and Waterman [9] used a pre- and post-test based on the Force Concepts Inventory in their study, which investigated clicker effectiveness for teaching physics concepts to non-science majors. A significant difference was found for sets of questions involving material taught with clickers. No significant difference was found for sets of questions on material taught without clickers. In the study by Czekanski and Roux [4], three sets of three class sections of an environmental science class were used, one with clickers, one with hand raising, and a control group. Exam review questions were given to the two experimental groups. No significant difference was found between results from the three groups, and the study concluded that use of clickers did not affect long-term retention. Regardless of the impact on retention, it would appear that clickers can be a valuable tool in the engineering classroom for both professors and students.

Teaching Mathcad Programming Topics

In the Fall of 1996, the Department of Civil and Environmental Engineering changed its computer applications and programming environment to Mathcad after many years of experience with traditional languages. Mathcad has provided the department with a flexible environment that may be used not only to teach programming but to additionally offer students a wide variety of mathematical and graphical tools, symbolic processing, and text editing. With many features available that can be valuable to students, it has been necessary to strike a careful balance between traditional programming topics and engineering tools and applications. For this reason, teaching of programming topics such as looping and use of subscripted variables has frequently been noted as an improvement item for the next year's course offerings.

One of the shortcomings with earlier versions of Mathcad was that no simple way existed for students to monitor values of function variables changing within a loop. Monitoring variables required learning how to use subscripted variables, which took time to develop. Thus, in the lessons that preceded introduction of subscripted variables, students were taught how to manually track the values of variables using a pencil and paper. However, when version 13 of Mathcad became available, new debugging features included with the software allowed students to monitor variables during the execution of a function.

The debugging features were fully incorporated into the course during the Fall of 2006. An assessment of student feedback [10] demonstrated that the debugging features were valuable in teaching concepts associated with looping and subscripted variables. However, while useful, the debugging features were not as helpful to students as other teaching methods that were already being employed. Additional emphasis was placed on the debugging features in the Fall of 2007, but with little noticeable improvement in the results. Although the potential benefits were evident, the students did not show enthusiasm for spending extra time learning the syntax of the debugging statements. In addition, sprinkling of debugging statements throughout a function seemed to detract from a student's understanding of the looping features being taught.

When the Citadel student chapter of the American Society of Civil Engineers (ASCE) donated clickers to the department in the summer of 2008, it provided an opportunity to explore the effectiveness of clicker technology in enhancing the teaching of loops and subscripted variables. To provide some basis of comparison with the use of debugging tools introduced in Fall 2006, instruction on the use of debugging functions was effectively replaced with new teaching modules using clickers. An assessment similar to the one used for evaluating the debugging features [10] was used in this study to evaluate the impact of clickers on teaching programming topics associated with looping and subscripted variables.

INCORPORATING CLICKERS INTO MATHCAD CLASSES

In the past, two sections of Computer Applications for Civil and Environmental Engineering have been taught in the fall semester. There were two sections when the Mathcad debugging feature study [10] discussed above was conducted. In 2008, for the first time, there were too many students for two sections, and a third section had to be added. In previous years, voluntary team teaching had long been the practice to facilitate instruction and answering of questions. With three sections being taught in two class periods, it was no longer possible to maintain team teaching in all classes. During one class period, all professors could attend the section, but during the second class period, it was necessary for one professor to divide time on an "as-needed" basis by floating between two sections offered simultaneously. Although each of the three classes was taught by a different instructor, an effort was made to keep teaching in all classes similar with respect to the format of the classes and the information presented.

Since Mathcad was introduced in the fall of 1996, the computer applications class has been a two-credit hour course, with a one-hour lecture followed by two one-hour laboratories. During Fall 2008, a weekly lesson was taught in three 50-minute segments on Monday, Wednesday, and Friday. Topics were introduced during the lecture on Monday, assignments were distributed on Wednesday, and assignments were collected and a weekly test given on Friday. Loops and subscripted variables were taught over eight weeks, with each week representing a lesson of instruction. Lessons involving loops and subscripted variables included *iteration (range variables) and graphing*, *programming with the **if** statement*, *programming with the **for** statement*, *programming with the **while** statement*, *vectors and vector operations*, *programming with vectors* (single loops, one subscript), *more programming with vectors* (nested loops, one subscript for input vector, two subscripts for the matrix returned by the function), and *programming with matrices* (nested loops, two subscripts for input and output matrices). In previous years these same topics had been taught over seven weeks, but some reorganization of the last portion of the class allowed an additional week to be devoted to these topics.

For the lessons listed above, the first time that true loops (e.g., loops constructed with a **for** or **while** statement) are encountered is in the lesson involving *programming with the **for** statement*. The first two lessons are included in the above list since *range variables* may be used to define a **for** loop and **if** statements may often be included in a **for** loop. For purposes of data collection, it was decided to use clickers during the period corresponding with instruction on true loops and subscripted variables. Therefore, clickers were used during a five-week period, beginning with the lesson on **while** loops. Clicker exercises the first week involved both **for** and **while** loops.

The clickers used in this study are part of the Classroom Performance System (CPS) manufactured by the eInstruction Corporation [11]. The system includes software, radio frequency response pads, and a receiver. Predefined questions can be delivered either with the CPS software, a presentation package such as PowerPoint or Keynote, or from an application package such as Mathcad. Questions can also be delivered spontaneously in an Oral or "Whiteboard" mode.   If desired, specific clickers can be assigned to each student, allowing reports to be generated on individual student performance. The system can accommodate team activities as well as individual activities. After each question is delivered and responses have been received, an anonymous display of the responses can be immediately shown to the class, allowing a professor to address any problems during the same class period. Question types include True/False, Yes/No, multiple choice up to 8 choices, or numeric responses with whole numbers.

The clicker exercises were conducted in two different classrooms. All clicker exercises were run from a computer at the instructor's station and projected with an LCD projector onto a large screen in front of the class. In one classroom, the instructor's computer ran CPS version 5.01 on Windows XP. In the other classroom, CPS 1.5 for Mac ran on a 24-inch iMac using OS X 10.5. Clicker packs in sets of 30 were used for the class. The same clickers worked for either the Apple or the Windows machines.

Clicker exercises were incorporated into the lecture classes on Monday. All classes used the same questions. All exercises were designed to support one of the course goals. The primary course goals associated with loops and subscripted variables are:

- Recognize and define iteration, conditional, and branching constructs and employ these in engineering problems.

- Manipulate data elements within vectors and matrices.

- Combine appropriate programming constructs (loops, conditions, matrix operations, and other features as needed) to develop programs in the Mathcad environment.

The course is designed to teach course goals at an appropriate level of Bloom's taxonomy, which in this case is application (or Level 3). Since students are usually encountering new material on a Monday, clicker exercises were constructed at Levels 1 and 2 (knowledge and comprehension) and primarily supported the first two goals listed above. The number of questions used in a class period ranged from three to six, for a total of 22 questions over the five-week period. Of the 22 questions, 13 were multiple-choice, eight were numeric, and one was True/False.

Since much of the instruction is accomplished in the Mathcad environment, the questions were delivered from the Mathcad environment instead of using a presentation package such as Powerpoint. This permitted all the features normally available in Mathcad to be used in designing questions. Mathcad features used for clicker exercises included vector and matrix notation; vertical bars that define the scope of functions, loops, or branching structures; a feature that disables the answer from displaying until students have entered a numeric response; and areas which may be collapsed to hide questions until ready to present a clicker exercise.   Example clicker exercises developed by the authors in the Mathcad environment are shown in Figures 2 and 3.

SURVEY AND STUDENT RESPONSES

To help assess the impact of clicker use on the students' learning experience, students in the three sections of the Computer Applications in Civil and Environmental Engineering course completed a survey developed for this study. The survey is included in the Appendix. Student perspectives on the relative difficulty of eight selected topics associated primarily with loops and subscripted variables were explored in Questions 1 and 2. In Questions 5 and 6, the students rated teaching tools and techniques used in the course, including clickers. The remaining questions were primarily associated with clicker use. Average responses for each class section and for the combined sections are shown in Table 1.   The survey was designed to be as comparable as possible to the Fall 2006 survey on Mathcad debugging features [10].

The four topics rated by the students in the combined sections to be the most difficult were nested loops, matrices (use of multiple subscript variables), the **while** statement, and the **break** and **continue** operators. These are the

$$\textbf{Effluent\_BOD} := \begin{pmatrix} 12 & 14 & 36 & 17 \\ 15 & 12 & 29 & 16 \\ 18 & 8 & 22 & 18 \\ 24 & 12 & 18 & 11 \\ 31 & 16 & 16 & 12 \\ 25 & 28 & 15 & 17 \\ 18 & 32 & 14 & 15 \end{pmatrix}$$

What would be displayed as a result of the following Mathcad statement (enter number on Clicker)?

$$\textbf{Effluent\_BOD}_{5,2} = \blacksquare$$

Figure 2. Clicker Exercise with Numeric Response

same four topics that were identified by students to be the most difficult in the 2006 survey (although not in the same order), indicating that overall student perspectives on the difficulty levels of topics have remained relatively consistent. It should be noted, however, that two other topics were included in the four most difficult topics by individual class sections. These include **for** loops and vectors (single subscript variables). Question 2 provides additional insight on student perception of the difficulty level of working with loops when they initially encountered them. In response to the question as to how difficult loops were initially, students specified a number between 1 and 5, with 5 representing the greatest difficulty level and lower numbers representing relatively lower difficulty levels. The difficulty rating of 3.4 for the combined classes indicated that students perceived working with loops to be moderately difficult when the topic was introduced in the lesson on **for** loops. Based on the rankings in Question 1, the difficulty level had apparently risen by the time nested loops were introduced since nested loops were ranked as a more difficult topic than **for** loops. Clearly, use of teaching tools and techniques that benefit the learning of this material would be of great value to students. These are explored in the next section of the survey.

Responses to Questions 3 and 4 show the widespread perception that a large percentage of the students (94%) believed that use of clickers was helpful to their understanding of either loops or subscripted variables in loops or both. When the survey on Mathcad debugging features was conducted, the response rate on similar questions about the benefit of debugging features was 69%, indicating the relatively high regard that students had for the use of clickers compared to use of the debugging feature. In Questions 5 and 6, students were asked to assign a "helpfulness rating" from 1 to 5 for each of the six listed items associated with understanding of loops (Question 5) or understanding subscripted variables (Question 6). The average helpfulness ratings shown in Table 1 are listed in order from highest to lowest for the combined enrollment only. Five of the six items were given a helpfulness rating greater than 3, indicating the high value that the students placed on these items. For the combined class sections, the use of clickers in helping students to understand loops and subscripted variables in loops was ranked only behind doing a Mathcad assignment. The use of clickers, then, was perceived by the students to be among the most beneficial teaching techniques used in the computer applications class.

Class Example

$$\texttt{Exceed\_Permit}(\mathbf{BOD}) := \begin{vmatrix} j \leftarrow 0 \\[4pt] \text{for } r \in 0..\big(\text{rows}(\mathbf{BOD}) - 1\big) \\[4pt] \quad \text{for } c \in 0..\big(\text{cols}(\mathbf{BOD}) - 1\big) \\[4pt] \qquad \text{if } \mathbf{BOD}_{r,c} > 30 \\[4pt] \qquad \quad \begin{vmatrix} \mathbf{EP}_{j,0} \leftarrow r \\[4pt] \mathbf{EP}_{j,1} \leftarrow c \\[4pt] \mathbf{EP}_{j,2} \leftarrow \mathbf{BOD}_{r,c} \\[4pt] j \leftarrow j + 1 \end{vmatrix} \\[4pt] \text{return } \mathbf{EP} \end{vmatrix}$$

assign   r   c   BOD $_{r,c}$

$$\mathbf{EP}_{j,0} \quad \mathbf{EP}_{j,1} \quad \mathbf{EP}_{j,2}$$

$\mathbf{EP}_{0,0}$	$\mathbf{EP}_{0,1}$	$\mathbf{EP}_{0,2}$
$\mathbf{EP}_{1,0}$	$\mathbf{EP}_{1,1}$	$\mathbf{EP}_{1.2}$
$\mathbf{EP}_{2,0}$	$\mathbf{EP}_{2,1}$	$\mathbf{EP}_{2,2}$

$$\texttt{Exceed\_Permit}(\mathbf{Effluent\_BOD}) = \begin{pmatrix} 0 & 2 & 36 \\ 4 & 0 & 31 \\ 6 & 1 & 32 \end{pmatrix}$$

Follow-up clicker exercise

Which of the following would produce a function output in this form: $\begin{pmatrix} 36 & 0 & 2 \\ 31 & 4 & 0 \\ 32 & 6 & 1 \end{pmatrix}$

A)

$$\begin{vmatrix} \mathbf{EP}_{j,0} \leftarrow c \\[4pt] \mathbf{EP}_{j,1} \leftarrow r \\[4pt] \mathbf{EP}_{j,2} \leftarrow \mathbf{BOD}_{r,c} \end{vmatrix}$$

B)

$$\begin{vmatrix} \mathbf{EP}_{j,1} \leftarrow r \\[4pt] \mathbf{EP}_{j,2} \leftarrow c \\[4pt] \mathbf{EP}_{j,0} \leftarrow \mathbf{BOD}_{r,c} \end{vmatrix}$$

C)

$$\begin{vmatrix} \mathbf{EP}_{j,1} \leftarrow \mathbf{BOD}_{r,c} \\[4pt] \mathbf{EP}_{j,2} \leftarrow r \\[4pt] \mathbf{EP}_{j,0} \leftarrow c \end{vmatrix}$$

D)

none of the answers provided in A, B, or C is correct.

Figure 3. Multiple Choice Clicker Exercise in Mathcad

Questions 7 through 9 focused on the use of clickers and how beneficial they are to students. Other aspects of the class such as use of on-line lessons, etc. were not explored in this section. The most important benefit appears to have been to help students keep their focus on the class, as shown by a 4.4 out of 5.0 rating in Question 7. However, students also believed that clickers were effective in helping them to maintain an interest in the course material (4.1 out of 5.0) and in helping them to retain course material (4.0 out of 5.0). In response to Question 10, almost all the students indicated that they would like to see clickers used in future civil engineering courses (96%). One question that the faculty had about expanding use of clickers to a number of classes was if clickers would lose their value to students through overuse. According to the response from students in Question 11, a large majority of them did not believe that they would be opposed to the use of clickers in several classes simultaneously.

Table 1. Summary of Student Responses

1	Please rank the following Mathcad features or topics in order of increasing difficulty to understand: (1 - least difficult to 8 most difficult)	Average Ranking			
		Sec 01 n = 22	Sec 02 n = 15	Sec 03 n=16	Combined n = 53
	for loops	4.0	4.1	4.0	4.1
	while statement	5.0	5.4	4.9	5.1
	Nested loops	6.0	7.1	5.6	6.2
	Vectors – use of single subscript variables	3.6	3.3	4.6	3.8
	Matrices – use of multiple subscript variables	4.7	5.2	5.6	5.1
	If statement in multi-line functions (conditionals)	3.5	3.3	3.9	3.6
	Use of subscripted variables in loops	3.8	3.5	3.8	3.7
	The break and continue operators in loops	5.3	3.5	4.1	4.4
2	How difficult were loops to understand during the first week that you encountered them. [Rate 1 to 5 most difficult]	3.5	3.3	3.4	3.4
3	Did classroom work with clickers help your general understanding of loops?	Yes – 91%	Yes – 93%	Yes – 94%	Yes – 92%
4	Did classroom work with clickers help your understanding of subscripted variables in loops?	Yes – 95%	Yes – 86%	Yes – 94%	Yes – 92%
	Those answering Yes to #3 **or** #4	Yes – 95%	Yes – 93%	Yes – 94%	Yes – 94%
5	Using a scale of 1 to 5, how useful were the following techniques or features in helping you to understand loops in general. (5 most helpful)	Sec 01	Sec 02	Sec 03	Combined
	Doing a Mathcad assignment	4.2	4.5	4.2	4.3
	Using clickers to respond to in-class questions	3.9	3.7	3.7	3.8
	Using pencil and paper to track the value of variables through a loop	3.8	3.8	3.6	3.8
	Preparing for weekly tests	3.5	4.0	3.3	3.6
	On-line lessons	3.3	3.7	3.4	3.5
	Flowcharts	2.9	3.1	2.8	2.9
6	Using a scale of 1 to 5, how useful were the following techniques or features in helping you to understand subscripted variables in loops. (5 most helpful)	Sec 01	Sec 02	Sec 03	Combined
	Doing a Mathcad assignment	4.2	4.5	4.4	4.3
	Using clickers to respond to in-class questions	3.7	4.1	4.1	3.9
	Using pencil and paper to track the value of variables through a loop	3.8	3.9	3.5	3.7
	On-line lessons	3.6	3.7	3.4	3.6
	Preparing for weekly tests	3.5	3.7	3.2	3.5
	Flowcharts	2.7	2.6	2.3	2.5

Table 1 (continued).   Summary of Student Responses

7	How effective were clickers in helping you keep your focus on the class (5 most effective)?	4.4	4.3	4.4	4.4
8	How effective were clickers in helping you keep your interest on the course material (5 most effective)?	4.1	4.0	4.3	4.1
9	How effective were clickers in helping you retain the course material (5 most effective)?	4.0	3.9	4.0	4.0
10	Would you like to see clickers used in your future civil engineering classes? Yes/No	Yes – 100%	Yes – 86%	Yes – 100%	Yes – 96%
11	Would you be opposed to the use of clickers in several civil engineering classes in the same semester? Yes/No	No – 91%	No – 79%	No – 88%	No – 87%

Many of the students provided comments on their initial experience with clickers. These comments addressed a wide range of benefits and concerns associated with clickers. A few representative comments will illustrate many of the issues that the students felt were important:

- Active learning: "they are a good tool to help with involvement and participation in the class."

- Keeping students focused: "I would like to see them used more often - helps keep on task in class."

- Anonymous responses: "It is a good change of pace than the traditional grumble from the class to say they understand. Most times they don't and want it better explained. Clickers can allow that b/c the answer is private."

- Retention: "The clickers provided me personally a way to be more active with the class which helped me retain the information better."

- Immediate feedback: "Clickers help because the teacher can see the average score of the class and determine if he needs to further explain something before the test."

- Not all students find clickers to be helpful: "I felt that I didn't learn anything while using the clickers. I understand much more thoroughly when actually going through the problems instead of multiple choice."

- High percentage of involvement: "The clickers themselves aren't what help to learn the material. It's the quizzing that is the biggest help on learning certain easily forgotten facts, etc. The direct question makes me think and the clicker provides a way for me to form an answer, even if it's wrong. In this way everyone is quizzed easily and quickly; not just one person answering a verbal question. I think the clicker is a good tool for the job."

CONCLUDING REMARKS

Students found clicker use to be a positive addition to the Computer Applications for Civil and Environmental Engineering class. According to the survey results, in learning course material that they found to be difficult, students perceived that clickers helped them to stay on task, helped them maintain interest in the course material, and helped them to retain the course material. Students found the clickers to be more valuable than several other teaching techniques that had been successfully used in the past for teaching loops and subscripted variables. They wanted to see more use of clickers in the future and did not feel that overuse would be an issue. While it was not possible in this study to determine whether there was a significant difference in retention that could be attributed to the clicker use, the high degree of student satisfaction with clickers would be more than enough to justify its continued use not only in this course, but in other courses as well.

It should be noted that it did take extra time each week (usually one to several hours) to adapt the material to a format in which clickers could be used and to prepare the exercises. This was in part due to the need to keep the

presentation of the clicker-based sessions as nearly identical as possible. It is anticipated that more time will be needed in future years to more fully take advantage of clicker use. However, it appears based on the results of the survey that the time invested paid excellent dividends and that the development of instruction with clickers should be continued in the future.

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APPENDIX
CIVL 209 – Loop & Subscripted Variable Assessment

1) Please rank the following Mathcad features or topics in order of increasing difficulty to understand. Place a 1 in the blank corresponding to the least difficult Mathcad feature, a 2 in the blank corresponding to the next most difficult, etc.
(Rank 1 – 8 use each number only once)
__ for loops
__ while statement
__ nested loops
__ vectors — use of single subscript variables
__ matrices — use of multiple subscript variables
__ if statement in multi-line functions — conditions
__ use of subscripted variables in loops
__ the break and continue operators in loops

2) Using a scale of 1 to 5, how difficult were loops to understand during the first week that you encountered them (**5 is the most difficult**)?   Least 1 2 3 4 5 Most

3) Did classroom work with clickers help your general understanding of loops? Yes   No

4) Did classroom work with clickers help your understanding of subscripted variables in loops? Yes   No

5) Using a scale of 1 to 5, how useful were the following techniques or features in helping you to understand loops in general (**5 is the most helpful**)?
Less - More
1 2 3 4 5 — Flow charts
1 2 3 4 5 — Using pencil and paper, tracking the value of variables through a loop
1 2 3 4 5 — Using clickers to respond to in-class questions
1 2 3 4 5 — Doing an assignment in Mathcad
1 2 3 4 5 — On-line lessons
1 2 3 4 5 — Preparing for weekly tests

6) Using a scale of 1 to 5, how useful were the following techniques or features in helping you to understand subscripted variables in loops (**5 is the most helpful**)?
Less - More
1 2 3 4 5 — Flow charts
1 2 3 4 5 — Using pencil and paper, tracking the value of variables through a loop
1 2 3 4 5 — Using clickers to respond to in-class questions
1 2 3 4 5 — Doing an assignment in Mathcad
1 2 3 4 5 — On-line lessons
1 2 3 4 5 — Preparing for weekly tests

7) On a scale of 1 to 5, how effective were clickers in helping you keep your focus on the class (**5 is the most effective**)?   Least 1 2 3 4 5 Most

8) On a scale of 1 to 5, how effective were clickers in helping you keep your interest in the course material (**5 is the most effective**)?   Least 1 2 3 4 5 Most

9) On a scale of 1 to 5, how effective were clickers in helping you to retain the course material (**5 is the most effective**)?   Least 1 2 3 4 5 Most

10) Would you like to see clickers used in your future civil engineering classes?   Yes   No

11) Would you be opposed to the use of clickers in several civil engineering classes in the same semester? Yes No

12) Please provide any comments or suggestions that you may have on the use of clickers in this class: