

# Student Response Systems and Gender: An Evaluation of Its Success

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**Abstract** - *Student Response Systems (SRS) are becoming more popular in the classroom. The use of an SRS system provides students with an opportunity to control their learning. This study looks at the application and success of an SRS system when used with female students in an introduction to computing course.*

**Keywords:** Gender, student response systems, computer science courses.

## 1. Female Students in College

Many studies have been conducted in a variety of attempts to determine why women are not participating at higher levels in computer science programs. Some of the studies are looking at recruitment and retention issues while others are looking for specific reasons women have left a program. Still others have studied the levels and types of interactions of female students in the classroom.

Females stop participating in science, mathematics, and engineering (SME) programs throughout the educational process [20]. From elementary school through junior high, both sexes have approximately the same abilities in mathematics and science; yet by junior high, females are taking fewer mathematics and science classes [20]. This decline affects the number of females enrolled in college-level classes and programs. High school-level courses are frequently preparatory courses for college SME courses [20].

Prior to 1980, men had a higher level of education than women. By the early 1980s, women were equal to men in terms of achieving a high school education; and by the late 1980s, more women (90%) than men (87%) graduated from high school [16].

Women have made significant advances in closing the gap between the education level of men and women in the 1970s [2]. In 1980, boys were more likely than girls to plan to attend college (12% and 10%, respectively) [16]. In 1995, girls were more likely (22%) than men (16%) to attend college after high

school and to complete a bachelor's degree [16]. By 1996, women made up 56% of the student body for college undergraduates [16]. In a 1996 study, the National Center for Education Statistics reported that, across all fields, women accounted for more than 50% of the degrees awarded at the undergraduate level [15] and in their 2004 report on Trends in Educational Equity of Girls and Women, they found that 62% of high school females (compared to 51% of high school males) planned to attend college. However, the number of females enrolling in computer science programs was small. Approximately one-third of bachelor's degrees granted in computer science in 1996 were females and the number of females enrolling in computer science continues to decrease. In their 2004 report on Trends in Educational Equity of Girls & Women, the National Center for Education Statistics (NCES) stated that 27.7% of degrees awarded in computer and information sciences were granted to women.

### 1.1 Possible Reasons for the Inequity

A review of the literature finds several reasons why women may not enroll or remain in computer science programs at a higher rate than they currently do. Factors that may contribute to the low numbers of women in computer science include parental encouragement, peer pressure [5], student-teacher interactions, curriculum (in particular, high school mathematics and science courses), self-perception, mentors and role models, career aspirations, and resources in the home that are available to the students [2].

In a study conducted by Flowers [8] with women working in the field of technology education, he finds that there are still obstacles that make it difficult for women to remain in the field. These obstacles include stereotypes; lack of support; attitudes of counselors, students, and teachers; and a gender-biased curriculum. In addition, there are studies that suggest there are different learning styles for men and women that may influence the retention rate of women in computer science [21].

While women entering other fields that are primarily occupied by men face similar obstacles as described above, there are some unique issues specific to entering computer science [17]. The computer science field uses languages that are specific to the field (such as C++, JavaScript, and FORTRAN). These languages follow different rules and syntax from a human's natural language, and there may be different rules among the various languages [17]. In addition, computer science can be viewed as a very isolated field where computer scientists work individually and there is little interaction with other individuals [17].

In addition, the stereotype of someone interested in science or mathematics may be that of a "geek" or a "loner," who dresses poorly and wears glasses [13]. Girls, especially if they wish to be popular with boys and other girls may succumb to peer pressure and avoid the mathematics and/or science courses [7].

In the academic setting, females interested in studying science may also be influenced by males in the program who believe that females are not capable of pursuing the major [12]. Within the academic institution, there is also the chance that women may receive less support for any form of intellectual development, not just intellectual development in the sciences [3].

Teachers can influence and guide students academically. In the classroom, the instructor provides feedback on the student's academic ability [25]. It is also the instructor's support that has the strongest impact on academic achievement and self-esteem [25]. Encouragement by the instructor has a positive affect on a female's continued participation [7]. However, there have been studies that show that female college students receive less attention from instructors than do male students [3], [18]. In a summary of studies, Baxter Magolda [3] reports that instructors not only give female students less attention in the classroom, but when the attention is given it is of lower quality, and the female students are interrupted more often [3], [9], [18]. In addition, both men and women faculty may look directly at male students when they ask a question but not look at the female student who asks a question [9].

Wollam [24] reports that not only do instructors respond less often to female students but that they initiate fewer contacts with female students; however, much of the difference in the instructor's behavior to male and female students may be inadvertent [9]. An instructor's biases may appear normal to both the instructor and the students and may go unreported or noted by either group [9]. However, the behavior may produce subtle signals which may make the female students feel less confident about their skills, knowledge, or abilities [9]. Some of the signals that

may be given include ignoring female students, calling male students by name, or using a masculine pronoun (such as "he") to represent both males and females [9].

There may also be instances where the biased behaviors of male faculty are overt and come from the belief that women are both less capable and less serious students [9]. Some of the more overt behaviors appear in classroom examples showing a man in a position of power, using female images as assisting, or using male terms when presenting information [9]. It is important to note, however, that English speakers and writers have been taught to use the masculine pronoun when speaking or writing about a subject when the gender is unknown [22].

There are long-term affects that can occur from some of the overt and inadvertent behaviors. Below is a list of some of the potential long-term effects:

1. Little classroom participation
2. Less desire to seek assistance outside of the classroom
3. Greater chance of dropping classes, switching majors, or leaving the academic institution
4. Less chance of developing collegial relationships with faculty
5. Lower career goals
6. Lower level of confidence [9].

While much of the above behaviors may appear subtle, there are studies that show that females may be more attuned to nonverbal signals than are males [9]. Some of the nonverbal signals include eye contact, more eye contact with males than females; head nodding, agreeing to questions given by male students; and a look of attentiveness, making it appear that what a male student says is more important [9].

Finally, female students may also be intimidated by the material covered in the classroom, particularly if it is mathematics. Since more mathematics teachers are male [4], the intimidation may reinforce the belief that girls cannot do mathematics. A solution to this problem is to allow the students to see the teacher do the mathematics, even if it means the teacher must stumble through the process. If students see only a perfect process presented by the teacher, they may believe that only a genius can do mathematics, thus compounding any insecurity the students may feel [4].

## 1.2 Curriculum Issues

Prior to enrolling in a computer science course, male students frequently have had more exposure to computers than female students [1]. Lack of exposure to computers can increase the amount of computer anxiety that a student may feel. Frequent exposure to computers can reduce the level of anxiety [1]. In addition, computers have had a big impact on areas of

employment, such as clerical positions, that have traditionally been positions held by women. This impact has also increased the level of anxiety felt by many [6]. A 1990 study [12] finds that there is no difference between the genders with respect to anxiety or computer confidence. However, there appears to be an inter-correlation between computer confidence and interest in and enjoyment of computers [12].

There is some evidence that the style of teaching and learning in the classroom can also prove detrimental to female students as well as male students [14]. In a study at two technology institutes that were preparing to change the curriculum, it was found that technology is frequently taught using a “masculine education [19]. A masculine education can be identified in curriculum content, the organization of the class, and the values presented [19]. In addition, a masculine education can encourage competition among students (such as grading on a curve) and, as such, alienate some of the students [20].

Since most of the instructors in computer science are still men, the style of presenting information in a “masculine” format is perpetuated [19]. Women who have continued in computer science have succeeded because of their interest in technology. As teachers, however, they may perpetuate the masculine class format because they have successfully made it through the “masculine” education [19].

A different form of presenting information in a classroom is gender-inclusive. In a technology classroom, this means expanding the content outside the technical areas into ways the technology is used and its implications [19], including collaboration or teamwork in the classroom and for assignments [14], utilizing less lecturing [19], including more discussion [20], and by building and connecting subject matter from class time to class time [19].

## 2. Student Response Systems as a Possible Solution

### 2.1 What is an SRS?

An SRS allows students to provide immediate feedback to their instructor regarding their level of understanding of a topic. SRS systems range from hand-held, remote-control devices, where students can select responses to the use of a software system and standard PC computers which provide the input via a specific Website. Responses are transmitted, the data collected and tabulated, and forwarded on to the instructor. The instructor can, if she chooses, show a graphic representation of the collected responses and the data can also be saved for use at a later time by the instructor [10].

The SRS system (Numina II) in use at the University of North Carolina Wilmington (UNCW) is a Web-based student response system. The system uses wireless networks, handheld computers, and a data projector. Students submit their responses to question via a Website. On this Website, students see an answer pad specific to the question posed by the instructor and use this answer pad to respond to the instructor. The general form of Numina II resembles the audience participation portion of the TV show “Who Wants to Be a Millionaire?”

The Website allows students to submit responses to questions posed by an instructor. The instructor poses a question, using a variety of formats, and directs students to a Website that generates the appropriate answer pad on their computer or pocket-PC screens through which they submit their responses. A variety of question formats are possible. On the backend, a database stores the question’s responses. Since the students do not login to the system, there is no information about the student associated with the questions. Responses are completely anonymous [23]. Figure 1 shows one example of a student view.



Figure 1. Example of UNCW’s Numina II SRS student view [23].

Once questions have been presented, an image, such as in Figure 2 appears in the classroom view. When students respond, they see a graphical representation of the answers as shown on the right side of the figure. Students are presented, on the Website, with a simple view for selecting their answers.

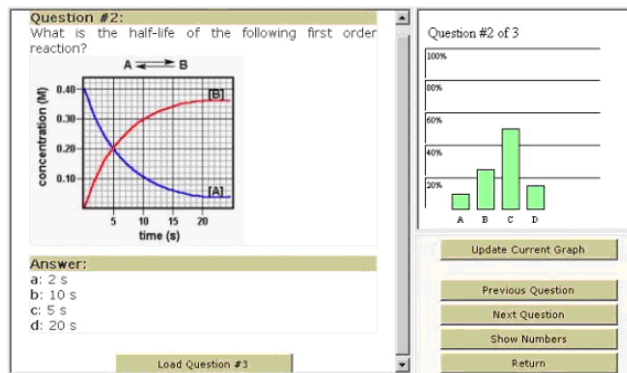


Figure 2. Example of UNCW’s Numina II SRS classroom view [23].

## 2.2 Use of an SRS in the Classroom

Use of a Student Response System (SRS) may help both students and the instructor in the active-learning classroom [10]. The rate for student participation in some courses at UNCW rose from only 30 percent of the students to nearly 100%.

The SRS system is more than an electronic “raising of the hand.” In many settings, students may be unwilling or uncomfortable to signal a lack of understanding through raising their hands. For an instructor, silence can be interpreted to mean that students understand the topic or information presented [11]. SRS, then, is an opportunity to express thoughts, questions, and concerns through a level of anonymity. In addition, as the instructor receives the input from the students, SRS becomes an opportunity to provide immediate feedback [10]. Through the use of SRS, the instructor (and the students) can see how people have responded to a question (what percent or number have answered “A,” “B,” and so on). Time is not lost while the instructor counts hands [10].

For female students who may be intimidated by male students in the classroom, who feel slighted by their instructors, or who are uncomfortable asking questions or for more information, the instant response capabilities and anonymity of the SRS system may be a salve.

## 3. Focus of the Study

To determine what role the SRS may play in the computer science classroom, a study was undertaken during spring semester 2005 in an introduction to computer concepts course. At the University of North Carolina Wilmington, many students take an introduction to computer concepts course to fulfill the institution’s computer-literacy-requirement. Frequently, 14 sections of this course are taught each semester. Topics in the course range from learning how to use productivity software to developing an understanding of computer concepts.

For some of the students, however, this material may be a repeat of information that was provided to them in high school (North Carolina has a high school computer literacy requirement as well). The use of Numina II SRS allows the instructors to control the speed at which information is provided. The instructor can also choose to either skip material or to delve deeper into the topic. Numina II is used by some of the instructors to question students’ understanding of the material and the speed at which it is presented.

To determine if the use of an SRS system in this course made a difference in student outcomes, four of the introductory courses taught during spring semester 2005 were compared. Two of the sections (n=52) were

taught using Numina II SRS and two sections (n=57) did not use Numina II. While the SRS sections were taught by one instructor and the other sections taught by a different instructor, the sections utilized the same lecture slides, class projects, and exams. Two different instructors were used to prevent possible “carry-over” in terms of speed, depth of discussion, etc. to the non-SRS sections. In each section, students were presented with three multiple-choice exams conducted over WebCT and used the same grading system. Student success rates, as defined by exam grades, were compared.

The lecture format of the course utilized PowerPoint slides to highlight points of interest from each chapter. The PowerPoint slides used were virtually identical among the four sections; however the slides for the SRS sections had prompts for the instructor to ask SRS questions. Based upon student responses, the SRS instructor would then vary her lecture to skip some topics, delve more deeply into others, or continue at her normal pace.

## 4. Procedures

The grades from all four sections were collected and listed in spreadsheet form. The grades of each of the groups were recorded in two spreadsheets to keep the information separate between the experimental (SRS) and control (non-SRS) groups. All exam grades were recorded, including those of students who failed the courses. Only students who did not complete all three tests (and had withdrawn from the course) were eliminated from the data. The means for each course were determined and a two-tailed independent samples t-test was used to compare the means of the experimental and control group samples. The t-test results were calculated in Microsoft Excel using the t-test for unequal variance.

### 4.1 Null Hypothesis

The null hypothesis created for this study was that there would be no statistically significant difference between the means of the exam grades of students enrolled in the SRS version of Introduction to Computing and Computer Applications course when compared to the exam grades of students enrolled in the non-SRS version of the course.

The above null hypothesis was tested at the level of .05 significance. This level of significance was chosen with some certainty that the results would fall within a 95% range of confidence.

#### 4.1.1 Region of Rejection

The region of rejection for the hypothesis described above was two-tailed. A two-tailed test was used since the research hypothesis is non-directional for

effect of instructional method on grade outcomes. The 5% region of rejection area was equally divided between the two tails.

#### 4.1.2 Statistical Tests

The arithmetic means of the final grades of each course were determined by adding all the corresponding letter grade values and dividing the result by the number of students who received a final grade. Once those values had been determined, the two-tailed independent samples t-test was used for comparing the means of the experimental and control group samples. The t-test was used because each of the courses was a small sample and was drawn from the same parent population. The means and standard deviations for each group were also determined. Results were kept separate for each of the different courses.

#### 4.2 Assumptions

There were several assumptions required by this study. First, it was assumed that the instructors for both the traditional and distance-education courses provided consistent instruction for each of the two groups. Second, it was assumed that the instructors used the same criteria for grading in each of the two courses. Third, it was assumed that the teaching style of both instructors was similar enough across the four sections to have been only a minor influence on the outcome. Fourth, it was assumed that all of the students registered in both sets of courses had an equal chance to pass the course. Fifth, it was assumed that each group entered the course with the prerequisite skills needed to complete the course.

### 5. And the Survey Says...

At the end of the semester, the various final exam grades were collected from both sets of courses and plotted in a spreadsheet format. The grades were collected with no names associated with them. Only after the names had been removed and the exam scores randomly sorted were the data provided.

The exam scores of each of the samples were recorded in an Excel spreadsheet to keep the information separate between the experimental (SRS) and control (non-SRS) groups. Each set of courses was given its own worksheet within the spreadsheet. There were no incompletes ("I") or unreported grades ("Z") associated with either set of courses. All grades were included, including those of students who failed the courses. The students who withdrew from the class with a "W" were not included in the final calculation. Only those students who completed all three exams were included. The grading for both groups followed a traditional plus/minus system.

The means for each course were determined and a two-tailed independent samples t-test was used to compare the means of the experimental and control group samples to determine if there was a statistically significant difference in exam scores between the experimental course and the control course.

Exam averages for each of the exams is shown in Figure 3. The average for Exams 1, 2, and 3 for the SRS sections is 72.2, 81.1, and 78.8 respectively with an overall grade of B or 83.2. For the non-SRS sections, the average for the three exams is 76.2, 73.0, and 77.0 respectively with an overall grade of B- or 80.9.

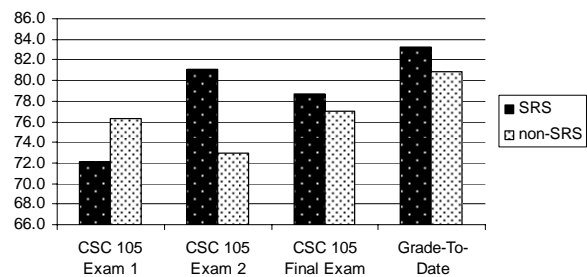


Figure 3. Exam averages for SRS and non-SRS sections.

Figure 4 shows the overall grade distribution for the two groups.

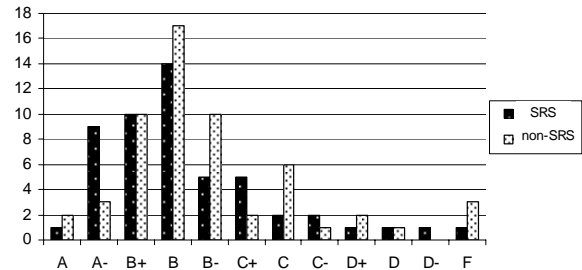


Figure 4. Grade comparison between the SRS and non-SRS sections.

#### 5.1.1 Overall Population

Initially, the entire student body's final grades were compared to determine if there was a significant difference between the two groups. A two-tailed region of rejection was used with  $\alpha = 0.05$  and a critical value of 2.04 at a degree of freedom of 108. The results ( $z = 0.996060003$ ) showed there was no statistically significant difference in the sections of the course when one section is taught using SRS and the other section is taught without SRS. The results were achieved using Microsoft Excel software and the values confirmed manually.

The null hypothesis for this study stated that there would "be no statistically significant difference

between the means of the exam grades of students enrolled in the SRS version of Introduction to Computing and Computer Applications course when compared to the exam grades of students enrolled in the non-SRS version of the course.” The null hypothesis failed to be rejected for two of the three exams.

### 5.1.2 Results by Gender

The students were then divided by gender and their results were compared. Because of the results for the overall population showed no statistical significance, the difference in instructor for the two groups was also viewed as having no statistical significance on the groups.

The t-test for the male students was conducted in Microsoft Excel using unequal variance as a factor. The probability ( $p$ ) result of this test was .695. Since this number is larger than the .05 that was identified as the region of rejection, the grades of male students between the two groups were not statistically significant and the null hypothesis would fail to be rejected.

For female students, however, the null hypothesis failed to be rejected. The t-test for female students was also conducted in Microsoft Excel using unequal variance as a factor. The probability ( $p$ ) result of this test was .037. Since this number is smaller than the .05 region of rejection, the grades of male students between the two groups is statistically significant.

## 6. Discussion

The results of this study do not support the evidence that students, in general, who take an active role in the classroom using SRS score statistically significant higher exam grades than those who do not use SRS.

To better compare these two types of teaching formats, as many as the variables as possible should be controlled or kept to a minimum [1]. This study controlled for textbook, semester in which the course was offered, exams, grade base, and PowerPoint lecture slides. The one area that was not controlled was for the instructor; however t-test results for the two groups suggested that the instructor did not play a large role for the section as a whole or for male students. The use of different instructors may have played a role in the results for female students.

Internal validity may also have been influenced by the small sample size. The total number of students compared in two groups was 52 and 57. The interpretation of the results should be done carefully with the small sample. With a comparison over time, when the population of students becomes larger, the end results may be different.

## 7. Conclusions

Two conclusions resulted from this study. The conclusions were the result of the research question that asked if there was a statistically significant difference between the exam scores of students in either the SRS based course or the non-SRS based course when controlling for the textbook, semester in which the course was offered, exams, grade base, and PowerPoint lecture slides. Results from the study showed there was no statistically significant difference between the two groups as a whole or for male students. The independent samples t-test results failed to reject the null hypothesis at a 0.05 level with regard to the independent variable or method of instruction.

For female students, there was a statistically significant difference between the two groups' overall grade. Whether this difference was the result of the use of a SRS system or the difference in instructors (or a combination of both) can not be determined by this study.

## 8. Recommendations

As a result of this study, several recommendations can be made. Because the t-test does not assess the quality of instruction between the two settings, it recommended that the quality of instruction between the two methods be compared. This comparison could be assessed through an evaluation of sections taught by the same instructor, using the same lecture notes and PowerPoint slides, assignment, and tests. The only difference would be the use of SRS to answer question, determine understanding, and adjust the speed of instruction.

A second recommendation would be to continue with additional comparisons of other courses utilizing both the SRS based and non-SRS based instruction. This continued comparison would provide information for future courses regarding the addition of SRS based instruction to its teaching format.

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