# Examining an Instructional Strategy: Relationships Between Feedback, Performance, and Self-Efficacy in a First-Year Mathematics Course

Marie Krbavac
M.A. Candidate, Simon Fraser University
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Many instructors, on their own or with the help of faculty developers, have made changes to the instructional design of their courses and have wondered about their impact on student learning. In this study, instructional changes made by one Mathematics instructor who completed the Course Design and Teaching Workshop (CDTW) at Simon Fraser University (SFU) are examined. The research questions focus on the instructor's objectives for making the changes, namely to provide additional feedback (using an on-line tool called LON-Capa) to the 400 students in his course in an effort to improve student's performance and self-efficacy in the course. The results of this study indicate that there are statistically significant correlations between feedback and performance, performance and self-efficacy, and feedback and self-efficacy.

## Introduction

Can you imagine teaching calculus to more than 400 1st year students? Realize that most of these students are in the course not because of a love of calculus or of math, but because it is a pre-requisite for entry into the highly competitive Business degree program. What methods would you use to give personalized feedback to each student? The Department of Mathematics at Simon Fraser University (SFU) believes that student-instructor contact plays a key role in helping students to succeed in mathematics. Over the years, different approaches have been used to maximize the amount of feedback provided to students. About 10 years ago, after cutbacks, the department switched from tutorials to an applied calculus workshop as this provided a better student-instructor (teaching assistant) ratio, which enabled students to receive more help. Recently the numbers of contact hours with students have been reduced again.

The course instructor of this calculus class, Dr. Jungic, attended the Course Design and Teaching Workshop (CDTW) at SFU with the primary objective of revising his course design so that students would receive more feedback. After learning more about the benefits of feedback and methods of incorporating feedback into his course design, Dr. Jungic began wondering about how to assess the impact of these changes on student learning. This paper describes a classroom study that was undertaken to evaluate the changes Dr. Jungic made to his course design.

## Background and Overview of Relevant Literature

### The Course Design and Teaching Workshop

The Course Design and Teaching Workshop (CDTW) is a 30-hour workshop usually offered over a 5-day period. It has been offered to professors for over ten years at one Canadian university and more recently has become an annual offering at two others (See Saroyan &

Amundsen, 2004 for a detailed description of all aspects of the Workshop). Theory and practice are combined as participant professors are led through a design (or redesign) of one of their courses. At the end of the workshop, a course outline, assessment plan, and an action plan for the implementation of the new course design is developed by all participants. These elements support the primary focus of the CDTW, which encourages participants to link teaching actions directly to student learning by incorporating a "reasoned and intentional approach to teaching…informed by reflective practice and peer critique" (Amundsen, Weston, & McAlpine, 2005, p. 3).

The CTDW strongly values the importance of merging generic teaching knowledge with subject-matter knowledge. By drawing upon each person's subject-matter understanding, the CTDW designers believe that it helps participants to view "student learning as an ongoing process of developing an understanding in the discipline rather than as mastering a sequence of topics within a particular course" (Amundsen et al., 2005, p. 3). Upon completion of the workshop many participants continue to question past teaching habits and disciplinary norms through participation in follow-up groups and classroom-based research. This analysis of teaching, in both formal and informal ways, is an intellectual exercise akin to what many professors do as scholars (Kreber, 2001; Shulman, 2000).

**Dr. Jungic's Redesigned Calculus Course**

Dr. Jungic believes that an instructional approach that enables students to receive immediate and frequent individualized feedback can increase student confidence and performance in mathematics. As mentioned above, he had become increasingly concerned about student learning in his large Calculus courses because fiscal pressures had decreased the amount of feedback students were given. To address his concern, he chose to undertake the redesign of his course by participating in the CDTW at SFU. Dr. Jungic tried to deal with his concerns by making changes to his grading scheme, adding additional assignments, and incorporating a web-based tool called Learning*Online* Network with Computer Assisted Personalized Approach (LON-Capa) that would immediately inform students whether they had correctly answered a question, and give them up to 8 chances (without penalty) to correctly answer the question.

Before Dr. Jungic participated in the CDTW, students completed a final exam (50%), 2 midterm exams (20% each), and weekly assignments (10%), and they were able to receive help from teaching assistants by going to the Applied Calculus workshop and from Dr. Jungic via email and during office hours. The typical format for grading the weekly assignments involved randomly selecting and then marking only 1 or 2 questions per assignment, with part marks given just for handing assignments in. After completing the workshop, students completed a final exam (50%), 2 midterm exams (15% for the 1$^{st}$ midterm and 20% for the 2$^{nd}$ midterm), weekly paper assignments (7%), and on-line assignments submitted using LON-Capa 3 times a week (8%). Additional help was available from the Applied Calculus Workshop personnel, the instructor, and was provided to students immediately by LON-Capa (when completing on-line assignments). Dr. Jungic chose this format because he believed that students would both benefit from the immediate feedback provided by LON-Capa, and by continuing use of paper-based assignments that enable students to achieve a proper understanding of mathematics.

After finishing the workshop, Dr. Jungic became interested in more formally investigating the changes he had made to his course. Specifically, he wanted to know if there would be a relationship between the changes he had made to increase feedback, and student self-confidence and performance in mathematics. He met with one of the workshop instructors and myself to outline his ideas. Our questions queried exactly what he meant by "self-confidence" and in what ways he expected to see changes in achievement. After our meeting, I went off to explore the literature to see if I could more clearly define the research questions.

**A Brief Overview of the Relevant Literature I Found**

It seemed to me, after some searching, that Dr. Jungic's description of what he meant by "self-confidence" closely matched Bandura's (1997) concept of "self-efficacy." Bandura defines self-efficacy as the "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments." At a subsequent meeting, I described Bandura's concept of self-efficacy to Dr. Jungic and he agreed that this matched what he meant. Furthermore, I told Dr. Jungic that Bandura related performance to self-efficacy, and argued that in order to change self-efficacy, people must have the ability (or knowledge) to make accurate assessments of their performance. This seemed to describe the feedback, performance, and self-efficacy link that Dr. Jungic believed to be the case.

There has been a lot of research related to higher education mathematics investigating the relationships between feedback and performance and performance and self-efficacy, but relatively little has been done in the area of feedback and self-efficacy. I will describe a few studies that address each of these in the following sections.

<u>Feedback and performance:</u> The use of the LON-Capa tool in Dr. Jungic's revised course design provides students with immediate individualized feedback and allows students 8 chances to correctly answer the question before a grade is submitted. Bandura's (1997) and Bloom's (1984) research found that such feedback increases people's performance in disciplines that are generally perceived as more difficult (such as mathematics). In Dr. Jungic's course, it was hoped that the feedback received through LON-Capa would provide students with knowledge about their own abilities and therefore support their mathematics self-efficacy and performance.

In our meetings with Dr. Jungic, we moved away from a focus on the LON-Capa tool, and instead focused on how this tool was used in combination with other instructional elements of the course design. My reading of the literature led me to understand that this is an important distinction. Many studies that have compared teaching and learning with technology versus teaching and learning without technology and have failed to find a strong causal relationship between media or media attributes and learning (Clark, 1994).

Clark (1994), after conducting a meta-analysis that analyzed thousands of media research studies, asserted that the lack of relationship between technology vs. non-technology is due to the studies not addressing differences in the aspect of instruction that has been proven to affect learning, namely the instructional strategy. Instead of focusing on the effectiveness of the instructional strategies (independent of the use of technology), they focused on comparing the use of technology with not using technology. One example referred to by Clark is a study by Kulik (1985) where there were no achievement differences between face to face instruction and computer-based teaching when both lessons were designed by the same instructional design team.

I found some studies that investigated the use of LON-Capa or tools like LON-Capa that provide feedback to students. Siew (2003) and Kashy, Thoennessen, Tsai, Davis, and Albertelli (2000) are examples of 2 higher education mathematics-related studies, both of which found that there were improvements in the class grades after the tool had been incorporated into the course design. As a result of using AIM, an on-line tool with features similar to those of LON-Capa, Siew reported that the number of students with less than 50% in the course decreased from 15 and 17 in 1999 and 2000 to 0 in 2001, and the number of students with 80% or more increased from to 21 in 2001 from 10 in 1999 and 0 in 2000. Kashy et al. also reported that after incorporating LON-Capa there was a decrease in the drop rate (exact number was not reported) accompanied by an increase in the percentage of students receiving a grade of 4.0. Prior to using the tool, less than 10% of students achieved a grade of 4.0, while after implementing the tool between 15 and 20% of students achieved this grade for the next 3 years. Interestingly, while both of these studies state that changes were made to the course design in order to incorporate the tool, they both focus on the tool and neither considers the potential impact of the change in course design to the instructional strategy.

<u>Self-Efficacy and performance</u>: Most of this research is framed by Bandura's (1997) concept of self-efficacy which states that there is a strong correlation between a person's self-efficacy beliefs about performing a specific task and how well they perform that specific task. Therefore, Pajares (2001) following Bandura's reasoning recommends that self-efficacy assessments be done by asking about the specific task one is assessing.

In a recent study by Pietsch, Walker, and Chapman (2003) that employed Bandura's (1997) definition of self-efficacy as well as Pajares' (Pajares et al., 2001) recommendations, the relationships between performance, general mathematics self-efficacy, and specific mathematics self-efficacy were analyzed. In this study, general mathematics self-efficacy information were obtained by asking students to rate their confidence for achieving results of 10%, 20%, etc. correct in specific areas. Specific mathematics self-efficacy information, on the other hand, was obtained by asking students to rate their confidence for correctly answering a specific question. The analysis of the responses provided by 416 students between the ages of 13 and 15 found that there was a positive correlation ($P<.05$) between a student's self-efficacy beliefs and both their general mathematics self-efficacy and their specific mathematics self-efficacy.

<u>Feedback and self-efficacy</u>: While this relationship has long been mentioned as an area for future research in studies that have found performance increases as a result of feedback, little has been done. In one study by Schunk and Swartz (1993) self-efficacy comparisons were made between students who experienced different instructional strategies: 1. process goal (a description of a strategy for improving their writing skills); 2. process goal and feedback; 3. product goal (a reminder about the specific task to be completed); and, 4. general goal (a reminder to "do your best"). The results of this study indicate that students who receive some direction (a process or a product goal) have larger increases in self-efficacy for the task than those who were only given a general goal, and that students who received specific feedback and direction (process goal plus feedback) had the largest increase in self-efficacy for the task.

The importance of providing personalized feedback that provides students with some direction is highlighted as a key element to increasing self-efficacy in the Schunk and Swartz (1993) study. Perhaps one reason why there has been relatively little research published in this area (none that uses technology to give feedback) is because technology is unable to analyze complex thought processes and provide the level of individualized feedback required to increase self-efficacy. It is expected that the results of my study will help to answer whether general feedback such as "you have correctly/incorrectly answered the question" is sufficient to increase self-efficacy.

### The research questions

After reviewing the literature, I again met with Dr. Jungic and another workshop instructor to talk about what I had learned, and to jointly develop the research questions. I began by describing research in all of the areas related to Dr. Jungic's instructional inquiry: instructional strategy; feedback; performance; self-efficacy; and, the relationships between each of these areas. We all agreed that in order to satisfy Dr. Jungic's desire to better understand the relationship between the changes he had made to increase feedback, student's mathematics self-efficacy, and student performance, the relationships between all of these areas would need to be examined. At this point, the following research questions were developed to address each area:

- *Impact of CDTW on instruction*: In Dr. Jungic's opinion, how did the CDTW influence the design of his course? And, were the desired outcomes achieved?
- *Feedback and mathematics performance*: Did the increase in feedback provided to students in Dr. Jungic's class effect class performance?
- *Mathematics performance and mathematics self-efficacy*: What was the relationship between performance and mathematics self-efficacy for students in Dr. Jungic's course? Did the relationship between performance and mathematics self-efficacy change during the semester?
- *Feedback and mathematics self-efficacy*: Did increasing the feedback given to students in Dr. Jungic's course effect students mathematics self-efficacy?

## Design of the Classroom Research Study

### Participants (students)

All students (500) enrolled in Dr. Jungic's introductory calculus course for the social sciences (Math 157) were asked to participate in this study on the first day of classes in the Fall 2004 semester at Simon Fraser University. On the consent form, students were asked to indicate whether they would like to be in the group that completed the "on-line assignments" worth 8% of their grade using LON-Capa (referred to as the on-line group) or on paper (referred to as the paper group). Students were told that the assignments would be exactly the same and that students in the paper group would receive a 1.5% bonus mark, up to a maximum of 8% of the "on-line assignment" grade. In addition, due to funding restrictions, students were also told that only 15 volunteers for the paper submission group would be randomly selected. The purpose of this design was to help differentiate between the affect of incorporating LON-Capa versus the impact of changing the instructional strategy.

One hundred and eighty-five out of 401 students who completed the course volunteered to participate in the on-line group for this study. An additional 9 students who completed the course and volunteered to participate in the paper group are not included in this analysis due to the low completion rate of this group. Ninety-nine students who agreed to participate in my research study completed the Computer User Self-Efficacy (CUSE) Questionnaire (described below) which was used to obtain demographic information about the students participating in my research study. Almost all students were 18 years old (M=19.26, SD=3.87, Min=17, Max=52), 97% owned a computer, 41.4% were male, and 58.6% were female. The majority of students, 83.8%, indicated using a 4-point Likert scale that they had “some experience” (42.4%) or “quite a lot of experience” (11.1%) using computers.

**Procedure (instructor)**

Dr. Jungic participated in two formal interviews, one at the beginning of the semester and one at the end of the semester. In both interviews he was asked questions about the course components and the use of LON-Capa to provide students with feedback. At the beginning of the semester, there were also questions regarding the planned changes to the instructional strategy and their expected results. End of semester interview questions inquired about the actual implementation of the changes, the perceived success of the changes, and other changes that were made during the course of the semester. At this time the interviews have yet to be analyzed and are not part of this paper.

**Procedure (students)**

The students were asked to provide information about their mathematics self-efficacy using 2 different instruments at different times during the semester. An additional practice self-efficacy questionnaire was also provided to students at the beginning of the semester (but not used in any analysis). The instruments used in this study were:

1. Mathematics Self-Efficacy (MSE) Questionnaire. This questionnaire was completed twice by students - at the beginning of the semester (referred to as beginning of semester mathematics self-efficacy questionnaire), and at the end of the semester (referred to as end of semester mathematics self-efficacy questionnaire). It asked students to use an 11-point Likert scale to rate their self-efficacy for each topic taught during the entire course. This questionnaire was completed using an on-line course management tool called WebCT.

2. Assignment Self-Efficacy Questions. On 10 on-line assignments completed using Lon-CAPA, students were asked to use an 11-point Likert scale to respond to self-efficacy questions before and after answering specific assignment questions. Before attempting to answer the question, students were asked

> “How sure are you that you can correctly answer the following question? Please rate your degree of confidence by entering a number from 0 to 10, where 0 = can not do it at all, 5 = moderately certain can do, and 10 = certain can do. Select a number.
>
> 0 1 2 3 4 5 6 7 8 9 10”

After answering the question, students were asked

"Please judge the likelihood your answer is correct by entering a number from 0 to 10, where 0 = absolutely sure it is wrong, 5 = not sure whether it is right or wrong, and 10 = absolutely sure it is correct. Select a number.

0 1 2 3 4 5 6 7 8 9 10"

3. Sample Mathematics Self-Efficacy test. This test was developed (following recommendations by Bandura (2001) to allow students to see the format of questions on the beginning and end of semester mathematics self-efficacy tests before taking those tests. This test was administered on-line through WebCT and was not graded or used for data analysis.

In addition to these instruments, I also obtained student grades on all assignments and exams in this course. The final grades for students who had taken this course in 2002, when it had previously been taught by Dr. Jungic, were also obtained.

## Results

**Research Question #1**: *In Dr. Jungic's opinion, how did the CDTW influence the design of his course? And, were the desired outcomes achieved?*

This question has not yet been analyzed.

**Research Question #2:** *Did increasing the feedback provided to students in Dr. Jungic's class effect student performance?*

This research study attempted to answer this question by using 2 different methods. The first, and most direct method, involved making performance comparisons between students in the on-line group and the paper group. Unfortunately, due to attrition in the paper group, it was not possible to complete the analysis using this indicator.

An analysis of another indicator of changes in performance, namely comparing grades to a previous course offering by Dr. Jungic, did reveal changes in the grades awarded at the top of the class (12.1% A+'s, A's, and A-'s in 2004 versus 11.3% in 2002) and at the bottom of the class (14.8% F's or N's in 2004 versus 17.5% in 2002) (see Table 1: Student Performance to view the complete grade distribution). There was also an increase in the class grade point average from 2.03 in 2002 to 2.13 in 2004. While this is an indirect method of assessing changes in performance, the results may be an indicator that the feedback provided by LON-Capa is related to the improvement in student grades.

**Table 1: Student Performance**

| | **Percentage of Students with Letter Grade** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **A+** | **A** | **A-** | **B+** | **B** | **B-** | **C+** | **C** | **C-** | **D** | **F & N** | **Total Students** |
| 2002 | 0.7 | 4.3 | 6.3 | 9.4 | 10.8 | 9.6 | 11.7 | 10.5 | 9.6 | 9.6 | 17.5 | 446 |
| 2004 | 1.9 | 3.4 | 6.8 | 12.3 | 12.1 | 11.6 | 9.7 | 10.4 | 8.9 | 8.2 | 14.8 | 414 |

**Research Question #3:** *What is the relationship between performance and mathematics self-efficacy for students in Dr. Jungic's course? Did the relationship between performance and mathematics self-efficacy change during the semester?*

Students were asked to provide mathematics self-efficacy information on 2 different instruments. The mathematics self-efficacy questionnaire, which asked students about their self-efficacy for each course topic, was used to obtain self-efficacy data about the general course concepts. The second instrument, assignment self-efficacy questions, was used to obtain self efficacy data about specific course concepts as it asked students to judge the likelihood that they had correctly answered a specific assignment question.

The beginning and end of semester self-efficacy questionnaire data was analyzed using responses from 52 students who completed both of these questionnaires. In this analysis, each student's response to the questionnaire items were further grouped into 3 categories: 1. concepts covered between the beginning of the semester and the 1$^{st}$ midterm; 2. concepts covered between the 1$^{st}$ and the 2$^{nd}$ midterm; and, 3. concepts covered between the 2$^{nd}$ midterm and the final exam. These groups were applied to responses on both questionnaires.

Comparisons between mathematics self-efficacy and performance were done using data provided at the beginning and at the end of the semester. The beginning of semester analysis used responses from the beginning of the semester to the 1$^{st}$ midterm collected on the beginning of semester survey. Pearson's correlation indicated no significant relationship between a student's mathematics self-efficacy at the beginning of the semester and their mathematics performance on the first midterm.

A second analysis using Pearson's correlation comparing performance at the end of the semester with responses to concepts covered between the 2$^{nd}$ midterm and the final exam on the end of semester mathematics self-efficacy survey indicated that this relationship was significantly correlated ($p<.01$) and relatively strong ($r=.455$). Therefore, at the end of the semester, a student's mathematics self-efficacy is correlated to their mathematics performance.

Data provided by 116 students who submitted responses using the second instrument, assignment self-efficacy questions, did not reveal any significant correlations ($p>.05$). An analysis of the assignment data revealed that most students received a score that was close to 100% on all on-line assignments. The average assignment self-efficacy scores were also similar throughout the semester (mean range 7.77 to 7.96, median range 8.0 to 8.5, mode equals 10) (refer to Table 2: On-line Assignment Self-Efficacy Mean Scores).

**Table 2: On-line Assignment Self-Efficacy Mean Scores**

| | | Start of Semester to Midterm 1 Average MSE Score on On-line Assignments | Midterm 1 to Midterm 2 Average MSE Score on On-line Assignments | Midterm 2 to Final Exam Average MSE Score on On-line Assignments |
|---|---|---|---|---|
| N | Valid | 116 | 106 | 123 |
| | Missing | 11 | 21 | 4 |
| Mean | | 7.91 | 7.77 | 7.96 |
| Median | | 8.00 | 8.00 | 8.50 |
| Mode | | 10.00 | 10.00 | 10.00 |
| Std. Deviation | | 1.57 | 1.66 | 2.13 |
| Minimum | | 3.25 | 3.33 | 1.50 |
| Maximum | | 10.00 | 10.00 | 10.00 |

**Research question #4*****: Did the feedback given to students in Dr. Jungic's course affect students' mathematics self-efficacy?***

This research study attempted to answer this question by using 3 different methods. The first, and most direct method, involved making self-efficacy comparisons between students in the on-line group and the paper group. Unfortunately, due to attrition in the paper group, it is not possible to complete the analysis using this indicator.

The second indicator of students mathematics self-efficacy employed were the mathematics self-efficacy questionnaires completed by 56 students at both the beginning and the end of the semester. The mean self-efficacy scores were higher on the survey given at the end of the semester (7.43) than on the survey at the beginning of the semester (5.16). Pearson's correlation indicates that the relationship between a student's self-efficacy score at the beginning of the semester and their self-efficacy score at the end of the semester is significant ($r=.41$, $p<.05$). This means that if a student had a high self-efficacy score at the beginning of the semester, they also had a high self-efficacy score at the end of the semester. Similarly, students with low self-efficacy scores at the beginning of the semester also had low self-efficacy scores at the end of the semester. Further testing using a paired samples t-test indicates that the difference between the mean self-efficacy scores at the beginning and end of the semester is also statistically significant ($t(56)=8.026$, $p<.05$). Therefore, it is unlikely that the increase in scores from the beginning of the semester to the end of the semester occurred simply by chance.

The third method of obtaining mathematics self-efficacy information, asking self-efficacy questions about specific assignment questions, did not indicate that there were changes in self-efficacy.

## Discussion

The objectives of this study were to explore the changes that Dr. Jungic made to his course, and to examine the relationships between giving feedback to students, their mathematics self-efficacy, and their performance in his course. Analysis of the 2 interviews with Dr. Jungic (yet to be done) will provide more information regarding the answers to questions such as "does Dr. Jungic believe that the changes to the instruction had the desired impact on student learning." In addition to the 2 initial interviews, I have recently decided to conduct a 3rd interview with Dr. Jungic after I have presented him with the results of this study. The purpose of this interview will be to learn more about issues such as: does Dr. Jungic believe that the changes made to the instruction had the desired impact on student learning; whether he learned what he wanted to; if he will continue to use this approach; and, how (if) the instructional changes and this study may lead to possibilities for formative change to Dr. Jungic's instructional beliefs and practices.

In the meantime, during an initial discussion, Dr Jungic indicated that he was pleased with the changes made to the course and he believed that the additional feedback had an impact on student's mathematics self-efficacy and improved their performance in the course as the percentage of A's increased and the percentage of F's and N's decreased from the previous time he taught the course. While Dr. Jungic appears to believe that LON-Capa was a major contributor to these benefits, it is not possible to determine if the same results could have been achieved if it had been possible to provide the additional feedback using teaching assistants.

The analysis of the relationship between feedback and performance of students in Dr. Jungic's class may indicate that feedback helped to improve performance as there was an increase in the percentage of A+'s, A's, and A-'s, and a decrease in the percentage of F's and N's. These results are consistent with findings from previous research that used this type of on-line tool to provide feedback to students in mathematics courses (Siew and Kashy). Unfortunately, neither my study nor the previous studies, created a situation which only provided some students in the course with feedback and then compared the grades of students who received feedback with those who did not receive feedback. This information would help to address the question of whether the grade increases were due to changes to the instructional strategy or the feedback provided by the tool.

The analysis of the relationship between students' mathematics performance and their mathematics self-efficacy indicates that at the end of the class, students' mathematics performance is strongly correlated with their self-efficacy about specific topics covered in the class. This indicates that in the beginning of the semester, students may not know the expectations for the class, but by the end of the semester they have a good idea of the grading standards as well as their knowledge of the course requirements.

An examination of the relationship between feedback and mathematics self-efficacy indicates that student's mathematics self-efficacy improved significantly between the beginning and the end of the semester. As there were no students who did not receive feedback, it is impossible to determine if the improvement in mathematics self-efficacy was due to the additional feedback. However, it is possible that student's mathematics self-efficacy improved as a result of feedback, as these results were found in research by Schunk and Schwartz (1993).

## Implications

Evaluation of instruction beyond student course evaluations and performance comparisons is important to the development of research in education. In this study, it appears that adding immediate feedback to the instructional strategy may have influenced the increases in student performance as there was a statistically significant increase ($p<.05$) in students' mathematics self-efficacy and a statistically significant correlation ($p<.01$) between mathematics self-efficacy and performance. These relationships can be further tested by research that compares mathematics self-efficacy before and after instructional changes are made, as well as research that uses the same instructional strategy but only provides some students with feedback.

Classroom-based research such as the study described in this paper, can vary in length and can range from analyzing the influence of an instructional change on student learning with respect to a specific learning objective within a course, to evaluating the achievement of program-wide learning objectives. In this study several questions are asked and a detailed analysis of each question was done. The scope of this type of research requires involvement from someone such as a faculty developer who is familiar with educational theories and practices. Shorter informal studies, on the other hand, have been undertaken by some instructors who have completed the CDTW. These studies have asked fewer, but very specific questions in an effort to further the instructor's knowledge about the effect of a specific instructional change on student learning. I believe that with a little encouragement, and possibly a little help from faculty developers, these types of studies should receive more recognition and be made widely available.

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