A New Instructor-Student Collaboration Model that Applies to College Mathematics Teaching

Dr. Shtukar, U
Assistant Professor
North Carolina Central University
USA

Abstract

A new instructor-student collaboration model was created to stimulate productive student activity and improve student performance in all of the mathematics classes offered at the college and university level. This model integrates both the instructor-student and student-instructor directions into a single process. The model consists of two traditional methods (i.e., make-up tests/quizzes plus individual help for each student) and three new non-traditional methods that were based on students' notes. This article addressed the efficacy of the collaboration model by comparing students' final grades from the classes that employed the collaboration model with those from the same classes that did not employ this model. Students' final grades from the classes that implemented the new model were better than those from the classes that did not utilize this model.

Keywords: instructor-student collaboration; new collaboration model; effectiveness of the collaboration model

Introduction

The educational process is a complicated system consisting of a large number of variables. Currently, there is not an appropriate model describing the entire process that accounts for all of the variables, yet not all of the variables are needed to create a working model. An examination of the factors that play important roles in the educational process reveals two of importance, as follows: the instructor's role and the student's role. Instructors are an important part of the educational process. Several methods employing "instructor-centered teaching" were created during the 1950's – 1970's to enhance this traditional form of education. The professionalism of the instructor is an important factor in education, as reflected by the well-known axiom. However, this factor is not sufficient for providing a successful education. The role of students is as important as the role of instructors. Recently, new teaching methods have been created that focus on the students' role. Scientists have developed "learning-centered teaching" methods that differ from the traditional instructor-centered teaching methods. Weimer, M. (2002) provides a good introduction to these methods in his book. Additionally, constructivist theories have been created to engage students in the active learning process (Alexander & Murphy, 1998; Straits & Wilke, 2007). Even when all of the students in a given class are proficient, their instructor still has to utilize special methods to encourage them to learn more effectively. Felder, R. and Prince, M. (2007) proposed an inductive teaching/learning method to engage students in the educational process and improve their outcomes, which differed from the traditional deductive method. When there are weak students in class, instructors should utilize additional methods to help each student individually. Students typically demonstrate a spectrum of qualities in a real class and instructors should understand their differences to help all of them (Felder & Brent, 2005). The methods discussed previously (and some that were not mentioned) may serve as the basis for a future analysis of the educational process. Unfortunately, some methods only work in the classroom, some are unidirectional, and some are difficult to utilize. This manuscript presents a two-directional general model for higher mathematics education that integrates a number of concepts into one process and demonstrates in detail how the new model functions.

The New Instructor-Student Collaboration Model

The instructor-student collaboration model for mathematics education was created to enhance educational effectiveness and improve students' final results in the classes that implemented this model. The collaboration model is bidirectional, as it can be applied in a classroom (i.e., instructor-student direction) and after class when a student comes to an instructor's office with questions (i.e., student-instructor direction).

This model allows instructors to incorporate any special methods that had already been created into the collaboration model such that they can be utilized in each direction. Moreover, this model does not contradict previous methods as it permits the incorporation of new ideas into the model. Instructors can utilize individual methods while working with students in the educational environment to address the student-instructor direction. This model provides all students with the opportunity to earn better grades than they would have obtained in a traditional class that did not employ the model. The principal questions to be discussed here are the following: “What are the basic elements of the model?” and “How does the model work?” There are no issues with the instructor-student direction as involving students in positive activities during classes is beneficial. To obtain the productive student-instructor direction, all types of communication (e.g., e-mail, phone calls, blackboard, etc.) can be utilized after class, yet the best way to stimulate students’ visits to instructors’ offices is to discuss problems. This is one preferable way to initiate the collaboration model, and it is important to determine the best way to initiate students’ visits.

The following five methods typically encourage positive students’ activity after class:

1. Instructors offer make-up tests/quizzes that are administered in the office for students who had mistakes and were interested in the solutions to improve their grades.
2. Instructors offer individual help for students by providing the solutions to a number of problems from their homework.
3. Instructors provide extra credit points for students who help solve problems in the classroom.
4. Instructors provide extra credit points for students who took high quality personal notes during class.
5. Instructors provide opportunities for students to reference their personal notes during tests and quizzes.

This list is not exhaustive, as there are other ways to encourage students’ visits that may be integrated into the instructor-student collaboration model. One recommendation is that instructors should record students’ visits and control the dynamics of the visits. The author has calculated the total number of students’ visits and the average number of visits per student across all of the experimental classes and found a positive effect of the model on students’ activity after class (see **Statistics and examples** next). For all of the experimental classes, the 1st and the 2nd visits were recorded, yet all other visits should also be recorded to provide a total picture. If a student receives help when visiting an instructor’s office, this student may return more often. The model appears to be very clear and simple; however, it just a general scheme. When utilizing the collaboration model, an instructor may encounter specific communication problems with students if they require help solving all of the problems in a test or quiz. The author recommends determining all of the mistakes that these students have committed and to then provide an unlimited amount of time for them to find the solutions in the instructor’s office using their personal notes. This is a very specific element within the collaboration model that requires a significant amount of time; however, it yielded perfect results for all of the students in a class that implemented this model.

Statistics and Examples

The instructor-student collaboration model was utilized at *** University during the 2012 – 2013 and 2013 – 2014 academic years. Table 1 presents the students’ visits to the instructor for the Linear Algebra I class (MATH 4410) during the 2012 and 2013 Fall semesters. Table 2 presents the students’ visits to the instructor for the Calculus III class (MATH 2030) during the 2013 Spring semester. Table 3 presents the students’ visits to the instructor for the class Finite Mathematics class (MATH 1210) during the 2013 Spring and Fall semesters. The data are based on the recorded information regarding the students’ visits, which the author wrote about in the special journal to provide a valid and reliable analysis with regard to this model.

Table 1: MATH 4410-01, FALL 2012 & FALL 2013

The number of students enrolled in the class	The number of students dropped from the class	The number of students finished the class	The number of students passed the class	The total number of all student visits to their instructor	The number of student visits for make-up tests or quizzes	The number of student visits for homework problems	The average number of visits per student
16	1	15	15	60	41	19	4.00
17	2	15	15	46	35	11	3.07

The average number of visits per student is defined as the ratio m/n in which m is the total number of students' visits for a class (column 5) and n is the number of students who finished the class (column 3). This number m/n can be referred to as the index of students' activity after class. For the MATH 4410 class, the index of students' activity after class was equal to 4.0 during the Fall semester of 2012 and equal to 3.07 during the Fall semester of 2013.

Table 2: MATH 2030-01, SPRING 2013

The number of students enrolled in the class	The number of students dropped from the class	The number of students finished the class	The number of students passed the class	The total number of all student visits to their instructor	The number of student visits for make-up tests or quizzes	The number of student visits for homework problems	The average number of visits per student
12	0	12	11	38	30	8	3.17

For the MATH 2030 class, the index of students' activity (out of the classroom) was equal to 3.17, as shown in the last column of Table 2.

Table 3: MATH 1210-06, SPRING 2013 & MATH 1210-04, FALL 2013

The number of students enrolled in the class	The number of students dropped from the class	The number of students finished the class	The number of students passed the class	The total number of all student visits to their instructor	The number of student visits for make-up tests or quizzes	The number of student visits for homework problems	The average number of visits per student
26	6	20	14	57	38	17	2.85
27	2	25	23	62	40	22	2.48

For the MATH 1210 class, the index of students' activity was equal to 2.85 during the Spring semester of 2013 and equal to 2.48 during the Fall semester of 2013.

The next three individual stories provide insight into how this model functions and why it does not always function successfully. The stories were provided by students enrolled in classes that implemented the model.

The first student, named X, had an average level of mathematical preparation at the beginning of the Math 1210-04 class during the Fall semester of 2013. Throughout the semester, this student wrote good notes, which should have supported success in the class according to the model. The student visited the instructor's office 9 times to complete make-up quizzes and tests during the semester. This student was positively active in all classes according to the instructor's notes. In addition, this student asked a number of questions via e-mails to the instructor that characterized this student positively. This information suggests that student X had utilized all of the opportunities proposed by the model. As a result, student X earned a final grade of an A for the class.

The second student, named Y, had a good level of mathematical preparation, which is better than an average level, at the beginning of the same Math 1210-04 class during the Fall semester of 2013. Unfortunately, this student never visited the instructor's office to complete make-up quizzes or tests, which was a large mistake. Even if the student had not taken notes, the model suggests that completing make-up quizzes/tests is sufficient. One possibility is that this student thought that having a good level of basic preparation automatically lead to a positive outcome at the end of the class. This may be why this student ignored the benefits proposed by the model.

The instructor informed all of the students about each possible opportunity, yet student Y never engaged with any of these opportunities. According to a standard evaluation (which included low current grades), student Y earned a final grade of a C. This example presents the contexts in which the model should be utilized, particularly when students do not have consistently positive results on exams.

The third student, named Z, had a less than average level of mathematical preparation at the beginning of the Math 2000-01 class during the Spring semester of 2014. This student was constantly writing notes during each class and these notes were comprehensive according to the instructor. This student only visited the instructor's office once to make-up a test.

This was a specific choice on behalf of the student as there is always a opportunity for a better result when retaking an exam, and each student is able to utilize the opportunities proposed by the model. This student did not utilize all of the opportunities; however, this student's exam grades were positive, and the final grade for student Z was a B for the class.

Effectiveness of the Instructor-Student Collaboration Model

During the Fall semester of 2011**,** there were 11 students enrolled in the Linear Algebra I class, and the final grades consisted of three A's, two B's, one C, three D's, and two NW. This class did not implement the Collaboration Model, as the author used traditional teaching methods. However, during the 2012 and 2013 Fall semesters of the same Linear Algebra I class, the Collaboration Model was implemented, and the final grades improved compared to those in the Fall semester of 2011. The more recent classes had 33 students enrolled, and the final grades consisted of 11 A's, 10 B's, 9 C's, and 3 NW. For the class during the Fall semester of 2011, only 67% of students passed the class, which did not implement the Collaboration Model, whereas for the same class during the Fall semesters of 2012 and 2013, 100% of students passed the class, which had implemented the Collaboration Model. It is important to note that the percentages were evaluated for the students who had finished the classes.

During the Spring semester of 2013, there were 12 students enrolled in the Calculus III class, which implemented the Collaboration Model, and the final grades consisted of one A, 4 B's, 6 C's, and one F. Unfortunately, the index of students' activity was only 3.17, as shown in Table 3.

During the Spring semester of 2011, there were 19 students enrolled in the Finite Mathematics class (MATH 1210), and the final grades consisted of no A's, 3 B's, 2 C's, six D's and F's, and 8 NW. This class did not implement the Collaboration Model, as the author used traditional teaching methods. However, during the Spring and Fall semesters of 2013, there were 53 students enrolled in the same MATH 1210 class that had implemented the Collaboration Model, and the final grades consisted of 6 A's, 8 B's, 23 C's, 8 D's, and 8 NW. Only 45% of the students who completed the class in 2011 passed the class, whereas 82.2% of the students who finished the same class in 2013 passed the class.

Summary

Across all of the experimental classes, the instructor-student direction was implemented according to standard teaching methods, which were similar to the classes that did not utilize the Collaboration Model, with the addition of a number of active elements. Therefore, the improvement in final grades that was evident in the experimental classes was due to the implementation of special methods (i.e., the 1st, 2nd, and 5th methods) related to the student-instructor direction. The results for the experimental classes demonstrate the positive effectiveness of the Collaboration Model. Currently, the author is utilizing this Model in all of the classes he teaches to determine whether this results in improvements in grades. This article aims to share this new Collaboration Model with the field given that it is a powerful tool for generating positive results in mathematics classes.

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