



# Constructivism in Online Course Design of Skilled-based Courses and Its Impact on Student Achievement

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#### **Abstract**

The following monogram presents a research case study involving two sections of an asynchronous online college algebra course which aimed at exploring the potential impact (or lack thereof) of the traditional one-size-fits-all online course design ideology for the development of skilled-based courses at a large higher education institution in Florida, USA. At the principal author's institution, as appears to be the case in many other sister institutions, constructivism is the philosophical framework upon which all online courses are being built - that occurs without the consideration that the impact of constructivist elements of course design may have little to no effect on student achievement when applied to largely or strictly skilled-based courses. Empirical observations, as well as past experiences in this field, have pointed to the realization that there are many skilled-based courses "sprinkled" with myriads of "little" tasks aimed at conforming to the constructivist ideology that do not appear to add any value in terms of the actual objectives of learning. Therefore, adding such tasks for the mere satisfaction of or adherence to a particular educational ideology may pose an inappropriate, ineffective, and inefficient way to provide and assess learning. Hence, it was the authors' impetus to investigate what empirical observations in online skilled-based courses alluded to in a structured academic research manner and ascertain mathematically whether such a misalignment exists so as to inform future practice. Results obtained confirmed empirical observations that adding constructivist elements in the asynchronous online college algebra courses analyzed made no difference in overall student success.

Keywords: Constructivism, Online Math Course Design, Skilled-Based Course Design

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# 1. INTRODUCTION

In order to provide high quality, efficient, and appropriate learning opportunities to online students, alignment of the course design, structure, and final objectives is a necessity. This is mandated not only by "simple logic" but also by widely accepted standards of online course design, such as Quality Matters, and organizational efficiency standards (from the business point of view). Even though there is no strict standard or guideline as to what ideology one can use when developing and structuring a new online course, it appears that there has never been a consideration that the one-size-fits-all approach may lead to unnecessary time and effort expenditure on behalf of the students/learners as well as on behalf of those responsible for the development of the course itself. This creates a dual type of inefficiency, both organizational and student/user.

Since, as a matter of fact, the large percentage of students at the principal author's institution can be considered "working adults", it is expected that unnecessary tasks, especially tasks that bear minimal credit toward the class grade would be simply considered "busy work". From long-term experience in facilitating online mathematics courses, it was observed that there are courses with myriads of "little" tasks that do not appear to add any value in terms of learning. In addition, the aforementioned tasks are also assigned minimal credit earnings not commensurate with the time and effort required to complete them. These types of tasks



can be easily categorized as "busy work" that add no real value to the course and are not aligned with the official course objectives. Therefore, adding such tasks for the mere satisfaction of or adherence to a particular educational ideology, poses an inappropriate, ineffective, and inefficient way to provide and assess learning.

Quality Matters (whose standards are supposed to have been adopted for all online course development at the principal author's institution) puts a large focus on alignment of course tasks with course objectives, and it is therefore important to ensure that this is taking place. Hence, it appears that there is a need to investigate what empirical observations in online mathematics courses may allude to in a structured academic research manner and ascertain mathematically whether such a misalignment exists and inform future practice. The project described herein is in alignment with institutional core values as will be explained in the following section.

#### 1.1. Literature Review

Despite the popularity of online education, attrition remains a problem faced by many institutions of higher learning (Bowden 2008). This issue has persisted for ages since, quite often, final course success is unrelated to knowledge and skill but instead it is a reflection of a lack of persistence or disengagement by the student. Multiple studies have been published regarding the "best" teaching methods for the online education environment as discussed by Hart (2012). Among the main ideas behind course development and delivery are constructivism and skill-based learning. These two represent distinct approaches to education, each with its own implications for student performance in online environments.

Constructivism posits that meaningful knowledge and critical thinking are actively constructed by learners. It emphasizes that individual learning is an active process involving cognitive, cultural, emotional, and social engagement (Thompson, 2020). Key ideas that characterize this ideology are active participation by the learners and mediation by instructors facilitating the construction of knowledge.

Skill-based learning, on the other hand, focuses on acquiring specific skills or competencies. It often follows a pre-prescribed approach, where instructors (on in the case of online courses, developers) define course objectives and arrange content systematically (Rathod, 2023). In asynchronous learning environments, which is the main delivery approach to most online courses at the principal author's institution (as well as most other post-secondary institutions), the content, course objectives, activities, and structure are all pre-developed and pre-prescribed with little to no ability by instructors to adjust or modify while courses are live. Skill-based learning assumes an objective reality that students must understand, such as in the case of mathematical processes or skills. Online mathematics courses include a predefined body of knowledge which students are expected to study with a major goal of the courses being the changing of learner behavior based on specific skills.

As Hart (2012) posits, although students generally report being satisfied with the online environment, while learning outcomes are similar to those of the traditional classroom, challenges exist which can result in an inability to complete a course and, in turn, an inability to complete their program of studies. This fact is well supported in literature (Ivankova & Stick, 2007; Levy, 2007; Müller, 2008; Park & Choi, 2009; Roubides, 2017, 2019) Various studies have also been conducted to determine what factors are positively related to student success (Harrell & Bower, 2011; Levy, 2007; Roubides, 2016). Other studies have assessed which factors interfere with success, and how students' attitudes are related to course completion (Holder, 2007; Müller, 2008; Park & Choi, 2009).

Researchers (Cochran et al, 2016; Stavredes, 2011; Tokarski, 2011) point to a discontent by online students of "busy work" activities and related elements that may have no clear purpose in their course and learning objectives. Some students even perceive online course discussions simply as "busy work" and in the principal author's own experience some students stated (in writing) that they would rather skip activities they consider "busy work" even though they were aware that these activities carry a certain grade weight. In other words, in such cases, students chose to self-penalize in terms of potential class grades than spend time on what they considered "busy work". The question then naturally arises, when deciding on the specifics of course development for courses that are skill-based, such as the online mathematics courses at the principal author's institution, does adding constructivist elements improve final course outcomes (i.e., academic performance metrics)?

## 2. METHODS

The study described herein was based on an experimental quantitative design. This was deemed the most appropriate research design to employ, given that it was necessary to change the environment in the experimental group so as to make comparisons or draw conclusions about factors affecting performance between the experimental and the control group. As Fischer et al. (2023) indicated, such research designs are best when the goal of the study is to determine potential effects of one or more independent variables on a dependent variable, while minimizing the impact of confounding variables that could distort results.

In this study, anonymous data from two sections of MAC1105 College Algebra at the principal author's institution was collected, organized, described, as well as used in hypothesis testing to draw conclusions. Hence, both descriptive and inferential statistics were employed. MAC1105 is an online gateway mathematics course taught in various formats, and the format chosen for this study was the accelerated (8-week) asynchronous online course format. The sample size was expected to be approximately 60-70 students for the two sections in the experimental group (37 being the current maximum class size per section) and upon implementation of the project the final usable sample size was 63 students, which was within the expected range.

Data collected for the study was anonymized data provided by the online course learning management system, which in this case was D2L/Brightspace. The data simply involved final course outcomes (the aggregate successful course completion figures for students enrolled in the target courses) as defined by the principal author's institution (i.e., completing the course successfully as indicated by grades of A, B, or C, or not completing the course successfully as indicated by grades of D and F). The data was then analyzed and used to conduct a hypothesis test in order to compare the success proportions of the experimental courses to the historical data of available analogous traditional courses.

The study conducted attempted to discover and support (or disprove) mathematically whether adding constructivist elements in an online math course (whose course objectives are entirely skill-based) would improve its intended final outcomes (i.e., improve students' academic performance metrics). To answer this question, or at least inform course development practice for skilled-based courses (or even incite a debate about the "one-size-fits-all" course design approach), the authors conducted a statistical study:

- over the course of two terms,
- involving two sections of MAC1105 College Algebra,
- in time-restrained 8-week accelerated terms,
- involving the removal of all constructivist class activities from grade consideration (only),
- and comparing final course performance of these experimental sections to the final course performance from historical data from similar courses, on similar terms, with the traditional design/delivery approach (i.e., including both skilled-based activities and constructivist-based activities).

The research question formulated was deemed an important question to explore because it is directly related to improving the environment in which students are expected to succeed. By supporting (or disproving) mathematically whether skilled-based activities in skilled-based courses may suffice to elicit the intended success metrics and whether adding constructivist elements in the design of such courses contributes (or not) to expected course outcomes, can have a big impact in many different ways. For example, time, effort (and hence financial) savings from both organizational efficiency standpoint and student standpoint, as well as student satisfaction, can be significant if we know how to optimize the time and effort required for course development of skilled-based courses. It can further support student success by preventing student disengagement, loss of credit, or incorrect assessment of student learning.

# 3. LIMITATIONS

As with all research studies, there are several factors that affect the ability to generalize results obtained. First and foremost, this study can be categorized as a case study given that it was conducted on data from only two course sections which was in itself limited to a maximum number of students. As such, the sample size used can be considered a limitation. Given the rather small sample size, the students in the section used for this study, may not have been entirely representative of the population of the institution and even possibly not entirely representative of the subset of students who have to take this course.

In addition to the limitation of using data from a small subsection of available course sections offered, the courses were also facilitated by the principal researcher and author of this monogram. This may be an additional limitation in the sense that students in these courses may have had slightly different behaviors than normal based on the pedagogical approach used, the communication style, even grading of classwork, and other characteristics that are unique to the facilitator that can be considered "researcher bias." However, historical data used for the control group to conduct the study were also facilitated by the same author and so the extent to which this fact may be a confounding variable may be arguably not significant.

#### 4. RESULTS AND DISCUSSION

The data collected for this study involved two asynchronous, online sections of MAC1105 College Algebra, one in each of two successive 8-week terms in a recent fall semester at the principal author's institution. As shown in Table 1, the total sample size for this experimental group was 63. A total of 55 students completed the course successfully, representing a proportion of successful completion of 55 out of 63, or 0.873 (87.3%), leaving 8 out of 63 students who did not complete the course successfully, or 0.127 (12.7%). The proportion of students who completed the experimental sections of MAC1105 successfully was quite a bit higher than the usual success rates for such courses.

The above data was compared with historical data collected from four traditional/constructivist, asynchronous, online sections of MAC1105 College Algebra, from similar successive 8-week terms from the previous two semesters. This data was the control group used for this study and is also shown in Table 1. The sample size for this group was 109 indicating a significant number of students had dropped (or were dropped from) the course for various, not known, reasons. In this control group, 78 students completed the course successfully, representing a proportion of successful completion of 78 out of 109, or 0.716 (71.6%), leaving 31 out of 109 students who did not complete the course successfully, or 0.284 (28.4%).

Skill-based Constructivist-based **MAC1105 MAC1105** Number of Sections 2 4 Sample Size 63 109 55/63 = 0.87378/109 = 0.716Proportion of Success 8/63 = 0.12731/109 = 0.284Proportion of Not Success ■Success ■ Not Success ■ Success ■ Not Success

Table 1. Descriptive Statistics for Both the Experimental and Control Groups

Even though it appears that the proportion of successful completers in the experimental group was higher than the proportion of successful completers in the control group, it is not known if this difference is simply based on chance or if it is statistically significant. Hence, a statistical test was necessary to make such a determination. A z-test for proportions was the hypothesis test chosen for this purpose. The assumptions necessary to validate this test are that the samples were independent, i.e., that the samples were selected randomly and represent the populations, that the probability for the tested events within each group was identical, and that the number of successes and failures in each sample would be large enough to use the normal approximation. The above assumptions were met; therefore, a hypothesis test for the two proportions at the 0.01 level of significance was set up as follows:

$$H_0$$
:  $\hat{p_1} = \hat{p_2}$ 

$$H_1$$
:  $\hat{p_1} \neq \hat{p_2}$ 

where pî and p2 represent the proportions of successful course completion for the experimental and control group respectively. The test statistic for this hypothesis test is as shown in Equation 1 below:

$$\frac{\widehat{p_1} - \widehat{p_2}}{\sqrt{\widehat{p}(1-\widehat{p})\left(\frac{1}{n_1} - \frac{1}{n_2}\right)}}\tag{1}$$

The p-value in this test was computed to be 0.01753. This means that the chance of a Type I error, i.e., rejecting a correct H<sub>0</sub>, is too high (1.75%). Since the p-value is greater than the established level of significance (0.01753 > 0.01), the null hypothesis H<sub>0</sub> cannot be rejected. This means that the experimental, strictly skill-based group's proportion of success cannot be considered different from the control, constructivist-based group's proportion of success. In other words, the sample difference between the proportions of skill-based and constructivist-based proportion of success is not big enough to be statistically significant. This result may sound counterintuitive simply judging from raw data or even negative, however, this experiment was set out to show that removing constructivist elements from a skilled-based course does not negatively impact the final course outcomes, i.e., student success. As such, the study confirmed the empirical observations of the authors, i.e., that adding constructivist elements in asynchronous, 8-week, online MAC1105 College Algebra courses makes no difference in student success.

On the contrary, the raw data appear to show that the experimental group may potentially have had higher rates of successful course completion than the historical, control group data. Though the authors never intended to diminish the value of the traditional course design and delivery of this course, and never was any claim made that removing constructivist course design elements may be better or more beneficial for student success, it was still rather interesting that the data showed such a possibility. To that end, a separate hypothesis test was conducted mainly out of curiosity of the possibility rather than to justify any particular claim. The new hypothesis test, also at the 0.01 level of significance, was set up as follows:

$$H_0$$
:  $\hat{p_1} = \hat{p_2}$ 

$$H_1: \hat{p_1} > \hat{p_2}$$

where pî and p2 represent the same proportions of successful course completion for the experimental and control group respectively as previously.

The p-value in this secondary test was computed to be 0.008763. This means that the chance of a Type I error, i.e., rejecting a correct  $H_0$ , is too small (0.88%). Since the p-value is less than the established level of significance (0.00863 < 0.01), the null hypothesis  $H_0$  can be rejected. This means that the experimental, strictly skill-based group's proportion of success can be considered statistically larger than the control, constructivist-based group's proportion of success. In other words, the sample difference between the proportions of skill-based and constructivist-based proportion of success is big enough to be statistically significant.

The above result confirms what empirical observations and raw data seemed to indicate, i.e., that it is possible that removing constructivist elements that students perceive as "busy work" from the design and delivery of such a course, can in fact result in increased rates of successful course completion. As noted earlier, this experiment only set out to assess whether removing all constructivist elements from a strictly skilled-based course did not hinder the potential of success of students enrolled in it. From this perspective, the experiment can be considered successful, and it is the authors' belief that it may be sufficient to at least incite a conversation about how online course design at the course, program, and institutional level is approached.

## 5. FURTHER DISCUSSION

When debating the benefits or challenges of skill-based education versus constructivist-based education, there is rarely one approach that can be declared "winner." Instead, success of any philosophical or pedagogical approach is usually dependent on many factors, and as such, designing any course or program at any level ought to be more dependent on a variety of factors than a result of administrative (or in some cases, legal or legislative) decisions or preferences. Some disciplines, such as mathematics, can be

considered more skilled-based than other disciplines and because of that the results in this case study may not come as a big surprise.

According to Doolittle (1999), "constructivism is a theory of knowledge acquisition, not a theory of pedagogy; thus, the nexus of constructivism and online education is tentative, at best." Many aspects of this underlying philosophy may not fare well in the online environment and can become less effective depending on the type of knowledge acquisition necessary. Moreover, in the constructivist approach to learning, it is the learners who are considered primary managers of their own learning and are assumed to own certain self-regulatory skills, such as task management, which frequently they do not (Roubides, 2016). In online environments, clear and specific structures are required, a need that is more fitting with an objectivist approach in order to be successful.

That said, there are still too many limiting factors to declare one particular approach much better than another, and usually a mix of approaches is required in order to address the maximum of learners' individual needs (Vrasidas, 2000), but also to dismiss any, or add social elements in skilled-based courses that may have no real effect on sought-after outcomes, is also not effective. On the contrary, despite good intentions on providing the "best" possible courses we can design, there is a potential of adding instead large inefficiencies, even resulting in poorer overall outcomes. To ensure that results are objective, this research can be expanded to a larger set of sections in the same course, as well as other similar courses, or any discipline that involves strictly skilled-based courses, and a larger-scale departmental or even institutional-wide study could result in a library of courses whose online equivalents require a different approach for their development and implementation.

### 6. CONCLUSION

The study presented herein was conducted as an exploration of the impact (or lack thereof) of the traditional one-size-fits-all online course design ideology based on social constructivism for the development of skilled-based courses at the principal author's institution. The study stemmed from empirical observations, as well as similar past experiences in this field, all of which had pointed to note that a lot of courses being built and offered include many tasks that students view as mostly "busy work" and offer little to no value in terms of the actual objectives of learning.

The investigation was meant to ascertain mathematically whether such a misalignment exists between the type of development being used and the expected course performance outcomes. The results obtained confirmed prior empirical observations that adding constructivist elements in the asynchronous online college algebra courses analyzed made no difference in overall student success. It should be noted that the above study was not meant to reach any conclusion about a "best" approach to course design but instead to inform decision makers on course design of the lack of evidence that exists when deciding to choose the "one-size-fits-all" for all courses in all disciplines. In the end, a decision must be made about the real goals of each course offered that is in the best interest of the students, maximizing performance outcomes, and to avoid redundancy, inefficiency, and ineffectiveness on what is sought-after.

**Research Ethics.** All procedures were conducted in accordance with applicable laws and institutional regulations; the study was exempt from any relevant institutional research board approval.

Data Availability Statement. Data can be obtained from the corresponding author with institutional approval.

Conflicts of Interest. There are no conflicts of interest to declare.

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