ABSTRACT

Deming’s PDSA cycle is used to develop a tool to continuously improve the classroom processes that lead to student satisfaction with their learning environment. We focus on student satisfaction with the goals of creating a better learning environment for the student, a better teaching environment for the instructor, and improving student retention.

The model uses critical success factors as process variables, student satisfaction as the outcome variable, and Relative Proximity Theory as the measurement tool to implement the PDSA cycle. Preliminary results show that the model can be a powerful tool for managing classroom activities in a purposeful manner.

KEYWORDS: Transactional Distance, Student Satisfaction, PDSA Model, Relative Proximity Theory, Critical Success Factors

INTRODUCTION

The definition of “success” in higher education changes depending on the stakeholder that is being considered. A parent might consider an education to be a success if their child graduates and gets a job. A school/college/university might consider an education to be a success if the student just stays in school and graduates. For the student, success can simply be how satisfied s/he is with the educational experience. In this paper, we will concentrate on the student equating success with satisfaction with his or her learning environment.

As instructors, our primary focus is providing students the opportunity to learn and to assess whether they have done so. By saying we provide an “opportunity” to learn, though, we are recognizing that our students will choose whether they will engage in meaningful learning. Thus, from not just an institutional point of view, but also a personal point of view, the issue of student satisfaction is important since it is unlikely that a student who is not satisfied with his or her learning experience will persist. This is not to say that students should be pandered to but rather that instructors should understand what barriers exist to a student’s engagement with meaningful learning and be able to manage those barriers, understanding that fewer obstacles lead to less frustration and, ultimately, more satisfaction.
If student satisfaction is accepted as a measure of success, then it is important to deal with any issue that affects that measure. In the business world, these are referred to as “Critical Success Factors.” It has been shown that transactional distance, as defined by Michael Moore (1980) and Aixiu Zhang (2003), is strongly related to student satisfaction. Zhang developed the “Scale of Transactional Distance” to “measure” transactional distance. Swart, MacLeod, Paul, Zhang and Gagulic, (2014) combined Zhang’s scale with needs assessment methodology to develop “Relative Proximity Theory” as a means to measure the gap between actual and ideal online course delivery.

The objective of this research is to define and implement a continuous process improvement model, based on Deming’s PDSA cycle (https://www.deming.org/theman/theories/pdsacycle) in which:

1) The process variables are the Critical Success Factors defined by Transactional Distances

2) The quality or outcome variable is Student Satisfaction

3) The measurement methodology is Relative Proximity Theory.

The purpose of this research is to provide instructors with a tool for managing their in-class instructional activities so as to purposefully achieve continuous improvement in student satisfaction which will yield a better learning environment for the student, a better teaching environment for the instructor, and increased student retention for the administration.

LITERATURE REVIEW

PDSA Cycle

“The PDSA Cycle, shown in Figure 1, is a systematic series of steps for gaining valuable learning and knowledge for the continual improvement of a product or process. Also known as the Deming Wheel, or Deming Cycle, the concept and application was first introduced to Dr. Deming by his mentor, Walter Shewhart of the famous Bell Laboratories in New York. The cycle begins with the Plan step. This involves identifying a goal or purpose, formulating a theory, defining success metrics and putting a plan into action. These activities are followed by the Do step, in which the components of the plan are implemented, such as making a product. Next comes the Study step, where outcomes are monitored to test the validity of the plan for signs of progress and success, or problems and areas for improvement. The Act step closes the cycle, integrating the learning generated by the entire process, which can be used to adjust the goal, change methods or even reformulate a theory altogether. These four steps are repeated over and over as part of a never-ending cycle of continual improvement” (https://www.deming.org/theman/theories/pdsacycle).

Figure 1: Deming’s PDSA cycle (https://www.deming.org/theman/theories/pdsacycle)
Critical Success Factors

Ronald Daniel (1961) first defined “Success Factors” as “key jobs (that) must be done exceedingly well for a company to be successful.” John Rockart (1979) expanded on that idea, stating “Critical success factors, however, are the areas in which good performance is necessary to ensure attainment of those goals.” Since then, many authors have applied CSFs in a variety of settings, but we will focus on education. Menchaca, M. and Bekele (2008) reviewed twenty articles published from 2000 to 2008 which listed between one (Howell and Wilcken, 2005, Shih, et. al (2006) or Yan (2006) and seven (Lammintakanen and Rissanen, 2005) success factors. They grouped the factors into technology-related, user characteristics, course-related factors, learning approach, and support services. Cheawjindakarn, et. al. (2012) provided a literature review of CSF, focusing on online distance education in higher education. Their review showed similar variations, identifying from three (Volery and Lord, 2000, or Vate-U-Lan, 2007) up to seven (Papp, 2000, or Govindasamy, 2002) items variously called CSFs, quality benchmarks, quality factors, resources, or success indicators. Taking all of this, Cheawjindakarn synthesized the following five CSF:

- Institutional management,
- Learning environment,
- Instructional design,
- Services support, and
- Course evaluation.

Both papers take these broad factors and break them down into myriad sub-categories, from which it is possible to see a large degree of similarity in the factors they define. Menchaca and Bekele also reference a model created by Bekele (2008), shown in Figure 2 that shows an influence diagram relating five factors (Human, Technology, Course, Leadership, and Pedagogic) to seven success measures (learning outcomes, student satisfaction, higher
learning, faculty satisfaction, sustainability, scalability, and rate of return). This model is used to explain the diversity of factors recorded in the literature, arguing that the model’s consideration of multiple, simultaneous factors and success measures makes it a more comprehensive framework.

Figure 2: Model of success and success factors in Internet-supported learning environments (Bekele, 2008, p. 57).

Transaction Distance

Moore (1973) first articulated a distance education theory and called it the Theory of Transactional Distance (Moore, 1980). This work presented a paradigm shift from viewing “distance” as a physical point-of-view to viewing it from a social science point-of-view. Zhang (2003) extended Moore’s work into the complex on-line learning environment that was beginning to emerge at that time. Defining transactional distance as “barriers to learning,” Zhang’s theoretical model listed four dimensions of transactional distance (TD): between student and student (TDSS), between student and teacher (TDST), between student and content (TDSC) and between student and the interface (TDSI). Zhang went further and developed a survey instrument called the “Scale of Transactional Distance,” shown in Appendix A, as a tool to measure each of the four constructs based on student’s perceptions. Confirmatory factor analysis and exploratory analysis indicated good fit between the data and the scale. Structural equation modeling indicated the proposed model of transactional distance was acceptable. Zhang also included elements on her survey to determine three measures of
student outcomes (Appendix B): student learning (“I have learned a great deal in this class”), achievement of learning goals (“I have made tremendous progress toward my goal in the subject area of this class”), and student satisfaction (“Overall, I am satisfied with this course”). Zhang’s results showed correlation between the four constructs of transactional distance and the three measures of student outcomes.

Relative Proximity Theory

Swart, et al. (2014) developed “Relative Proximity Theory” by using Zhang’s instrument as the basis for measuring how “close” actual course delivery was to what the student considered to be an “ideal” course delivery. Students were asked to rate each element of Zhang’s four constructs (TDSS, TDST, TDSC, and TDSI) twice, first for the student’s actual experience, and then for what the student would consider an ideal experience. While the concept of an “ideal” course delivery is somewhat nebulous, this approach provided quantifiable and operational data, and by breaking the information down into each of Zhang’s construct elements, the evaluation is made more concrete for the students. They showed that the relative proximity of transactional distance, measured by Zhang’s Scale of Transactional Distance instrument, correlated strongly with the relative proximity of student satisfaction. Their results also showed a high degree of correlation between the three learning outcomes, so their work focused on only one outcome, student satisfaction.

THEORETICAL DEVELOPMENT/MODEL

In Figure 2, student satisfaction is identified as a success measure impacted by five success factors. Zhang’s 2003 work showed a significant statistical correlation between transactional distance and student satisfaction, which was confirmed in the RPT work of Swart, et al. (2014). Examining the elements of Zhang’s Scale of Transactional Distance (Appendix A), TDST (student-teacher) would appear to correlate with the Pedagogic factors of the Bekele model shown in Figure 1, while TDSC (student-content) matches well with the Bekele’s Course factors. TDSS (student-student) relates, albeit less closely, with the Human factors that Bekele lists, and TDSI (student-interface) clearly relates to Bekele’s Technology factors. Similarly, Zhang’s output measures are represented in Bekele’s success measures “Satisfaction” and “Learning outcomes”.

In essence, Bekele’s model provides the foundation that allows for TD’s to be considered as CSF, albeit only those that a directly focused on achieving Student Satisfaction. Furthermore, Zhang’s Scale of Transactional Distance provides a tool that can be applied to measuring these TD’s. A process for identifying specific aspects of transactional distance that can be decreased is outlined below, using the Swart, et al, RPT.

The model validated by Swart, et al., recorded an actual (A) and an ideal (D) response from each respondent (k) for each element, or question (i), under each construct (j) developed by Zhang (2003). Thus, |Dijk – Aijk| represents the relative proximity (Gijk) of the two ratings (absolute value is used to allow for the reverse-coded questions where the “ideal” rating is a low 1 rather than a high 5). Whatever the ideal rating, the relative proximity ranges between zero (actual meets ideal) and 4 (actual is as far as possible from ideal). The relative proximities can be summed by respondent, k, to determine the average relative proximity for that student, or by each element, i, to determine the relative proximity for the entire class for that element, or by transactional distance construct, j, to determine the relative proximity for an entire class for that construct. Similar definitions were used to record the values for the outcomes (Sense of
Learning, Learning Goals, and Student Satisfaction). Using these definitions, they hypothesized and confirmed a relationship between the relative proximities of the constructs to the relative proximities of the outcomes using 183 valid responses to the survey instrument. They found high correlations between the constructs and the outcomes, confirming the results Zhang reported in 2003. Further, they found high correlations between the outputs, with Student Satisfaction showing the highest correlation with the constructs.

While Swart, et al., reported several comparisons for interpreting the output, we will focus on determining the impact of first the constructs, and then the individual elements, on student satisfaction. Using their variables and definitions

\[ \Delta \text{T}DSS \equiv \text{relative proximity of student-student construct} \]
\[ \Delta \text{T}DST \equiv \text{relative proximity of student-teacher construct} \]
\[ \Delta \text{T}DSC \equiv \text{relative proximity of student-content construct} \]
\[ \Delta \text{T}DSI \equiv \text{relative proximity of student-interface construct} \]
\[ \Delta \text{S}S \equiv \text{relative proximity of student satisfaction} \]
\[ \text{SUMMER} \equiv \text{dummy variable for condensed summer session (Yes = 1)} \]

They found a robust \( r^2 = 0.721 \) equation given by:

\[ \Delta \text{S}S = 0.772 \Delta \text{T}DST + 0.583 \Delta \text{T}DSC + 0.173 \Delta \text{T}DSS + 0.407 \text{SUMMER} \]  \( (1) \)

They noted that \( \Delta \text{T}DSI \) was not significant, and hypothesized that the increased student confidence in using web-based technologies since Zhang’s original work was responsible. For their data, it is more effective for the teacher to focus on changing the relative proximity for the student-teacher transactional distance (0.772) than for either student-content (0.583) or student-student (0.173).

Having identified the construct that showed the most promise for having an impact on Student Satisfaction, the final step they proposed was to evaluate the relative proximity of the individual elements of the TDST construct. For their data:

<table>
<thead>
<tr>
<th>Element Number</th>
<th>Element Description</th>
<th>Relative Proximity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The instructor generally answers the students’ questions</td>
<td>0.30000</td>
</tr>
<tr>
<td>2</td>
<td>The instructor pays no attention to me</td>
<td>0.03333</td>
</tr>
<tr>
<td>3</td>
<td>I receive prompt feedback from the instructor on my academic performance</td>
<td>0.63333</td>
</tr>
<tr>
<td>4</td>
<td>The instructor is helpful to me</td>
<td>0.63333</td>
</tr>
<tr>
<td>5</td>
<td>The instructor is available to answer my questions</td>
<td>0.36667</td>
</tr>
</tbody>
</table>
They recommended that for this data set, the instructor could best increase student satisfaction by focusing on returning graded material in a timelier manner (3) and by being more helpful (4). Our research will test this hypothesis by comparing data from different semesters where the instructor has made a change that should impact one or more aspects of transactional distance.

**METHODOLOGY**

Our research uses the RPT format developed by Swart, et al, and Zhang's Scale of Transactional Distance survey instrument, as shown in Appendix A.

Considering each construct separately, under TDST, the questions directly confront the actions and responses of the teacher to the student. Any large gap between actual and ideal on items 1 through 6 are largely under the control of the instructor. Table 2, below, provides remedies that might serve to decrease the gaps noted for the TDSI construct.

<table>
<thead>
<tr>
<th>Item</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Instructor creates time for Q&amp;A sessions or sets up discussion boards</td>
</tr>
<tr>
<td>2</td>
<td>Instructor schedules one-on-one interaction times for each student</td>
</tr>
<tr>
<td>3</td>
<td>Instructor returns graded items faster</td>
</tr>
<tr>
<td>4</td>
<td>Instructor increases interaction through discussion boards or video conferencing</td>
</tr>
<tr>
<td>5</td>
<td>Instructor schedules office hours at more convenient times</td>
</tr>
<tr>
<td>6</td>
<td>Instructor creates channels to receive students questions</td>
</tr>
</tbody>
</table>

Items 7 to 12, for TDSC, begin by dealing with the relevance of the course topics and then deal with higher order concepts, as identified through Bloom’s taxonomy, such as synthesizing, making judgments, and application of theory. Increasing focus on problem-based learning (Prince, M., 2004) in higher education can help address gaps on these items. Even introductory courses can make use of cases in addition to teaching the simple material. Given the high correlation between active learning and student satisfaction (as confirmed Zhang, 2003 and Swart, et. al., 2014), any gap in this area might require a lot of work on the instructor's part, to integrate cases into the existing lecture plans, but it would be anticipated that the results would be substantial.

Items 13 through 23 deal with TDSS, the interactions between the students. At first glance, these items might appear to be beyond the instructor's control, but recent emphasis in higher education toward training students to work in teams (Bolton, M., 1999) might argue that even these gaps can be addressed by proper course design. Finally, items 24 through 31 relate to TDSI, the transactional distance caused by the student – interface barriers to learning. Given the plethora of options (e-mail, web sites, learning management systems, video conferencing, etc.), free or otherwise, available to an instructor for working with online students, it is not difficult for an instructor to find options that work well with the course material and his or her teaching style. The important concept is that regardless of the source of the transactional
distance, there are steps the instructor can take to reduce that distance, and thus to increase student satisfaction.

As with most systems, a one-time change is not going to fix all the problems. Rather, a continuous-improvement process is needed.

With the identification of transactional distance as a CSF, and RPT instrument for evaluating both TD and student satisfaction, we have all the pieces to begin the PDCA cycle:

<table>
<thead>
<tr>
<th>Study</th>
<th>Students complete RPT instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Act</td>
<td>Analyze the elements of the construct to find the greatest impact on TD</td>
</tr>
<tr>
<td>Plan</td>
<td>Determine a strategy to change some aspect of the class to address that element</td>
</tr>
<tr>
<td>Do</td>
<td>Implement the strategy and repeat the cycle</td>
</tr>
</tbody>
</table>

RESULTS AND DISCUSSION

Using the RPTD instrument, the relative proximities for a professor and course were gathered over multiple semesters to measure the transactional distances and resulting student satisfaction. Using this insight, the professor adjusted the course to attempt to change the transactional distance and thus the student satisfaction. The data is in the process of being gathered and analyzed. Our findings will be presented at the 2015 Annual Meeting of the Decision Sciences Institute.
## APPENDIX A

### Zhang's Scale of Transactional Distance

#### TDSI = Transactional Distance between Student and Instructor

- The instructor generally answers the student’s questions
- The instructor pays no attention to me
- I receive prompt feedback from the instructor on my academic performance
- The instructor was helpful to me
- The instructor is available to answer my questions
- The instructor can be turned to when I need help in the course

#### TDSC = Transactional Distance between Student and Content

- The content of this course is of great interest to me
- I don't know why I have to learn this
- The examinations in this course have challenged me to do my best work
- This course emphasized SYNTHESIZING and organizing ideas, information, or experiences into new, more complex interpretations and relationships
- This course emphasized MAKING JUDGEMENTS about the value of information, arguments, or methods such as examining how others gathered and incorporated data and assessing the soundness of their conclusions
- This course emphasized APPLYING theories and concepts to practical problems or in new situations

#### TDSS = Transactional Distance between Student and Student

- I learned a lot from observing the interactions among the students
- The students in this online class challenged me to do my best work
- I get along well with my classmates
- I feel valued by the class members in this online class
- My classmates in this online class value my ideas and opinions very highly
- My classmates respect me in this online class
- I am good at working with the other students in this online class
- I feel a sense of kindred spirit with my fellow classmates
- The class members can be turned to when I need help in the course
- There are students I can turn to in this online class
- The class members are supportive of my ability to make my own decisions

#### TDSI = Transactional Distance between Student and Interface

- It is difficult to pay attention to the instructor in the web environment
- I have adequate access to the web resources I need
- The fact that I am online does not inhibit my class participation
- An efficient system is provided for students and instructor to exchange materials
- I am comfortable using the computer
- I hate using the web
- It was easy for me to use the technology involved with this online class
- The technology used in this course is difficult to learn and use

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**Zhang's Model**
Appendix B: Zhang’s Outcomes

\[
\begin{align*}
\text{SL} &= \text{Student Learning} \\
&= \text{I have learned a great deal in this online class} \\

\text{LG} &= \text{Learning Goals} \\
&= \text{I have made tremendous progress towards my goal in the subject area of this course} \\

\text{SS} &= \text{Student Satisfaction} \\
&= \text{Overall, I am satisfied with this course}
\end{align*}
\]

REFERENCES


