

# Flipped Classrooms and COVID-19 Disruption: Empirical Results

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*Global educational systems had not anticipated that one day, overnight, they would have to move their traditional teaching to online learning. This move was disruptive and highlighted the need for future educational systems designed to bridge the gap between face-to-face (f2f) and online learning with minimal disruption. We present statistical evidence that learners in flipped f2f classes did not experience disruption when moved fully online. On the contrary, we found that our two measures of disruption, student satisfaction with learning and student engagement, improved when the flipped classes were moved fully online. This we attribute to the focus on student learning using computer-based materials that is part of flipped learning. While there are classes unsuitable for flipping, the pandemic has demonstrated that all classes can be taught online. This suggests that a greater emphasis on using computers for learning in traditional f2f classes will make them less vulnerable to future natural or man-made disasters that may force an unexpected transition to online learning.*

*Keywords: cooperative/collaborative learning, distance education and online learning, pedagogical issues, post-secondary education, teaching/learning strategies*

## INTRODUCTION

### Global Interest

The world was unexpectedly struck by the COVID-19 pandemic in 2020. All facets of life were impacted. Schools had to be closed and over 1.2 billion students and their teachers in 186 countries had to adapt to learning at a distance (Suprenant, 2020).

Prior to the global pandemic, some teachers experimented with blending technology into their teaching. Arguably, the most promising and certainly the fastest growing blended approach was flipped learning. Flipped learning, also referred to as the flipped classroom or inverted learning, is a pedagogy that provides

students with technology based learning materials, including video-lectures, to study outside of class and uses class time for instructor supervised active learning to reinforce what students learned outside of class. It has attained a global following. By 2017, the Flipped Learning Global Initiative estimated that around 16% were flipping their classes, 35% wanted training on how to flip their classes, and 46% of principals wanted new teachers who knew how to flip a classroom (Noonoo, 2017). The global flipped classroom market valuation in 2018 was US\$971 million and at the time was forecast to grow to US\$1.9 billion by 2024 (IMARC Group, 2019).

The sudden and unexpected requirement to move from traditional to online learning was disruptive. A survey involving school systems from 59 countries sponsored by the Organization for Economic Cooperation and Development (OECD) focused on how this disruption is changing education world-wide. A clear consensus is that the knowledge and experience gained with various modalities of remote learning during this time are lessons learned that need to be systematically collected and evaluated for possible implementation (Reimer et al., 2020). While reasonable (if not obvious), such a recommendation makes the erroneous assumption that pre-COVID-19 traditional education was homogenous – e.g., all teachers taught their classes the same way. Given the number of teachers that were flipping their classes in 2017 – a number that is certain to have grown by 2020, based on the forecasted growth in the flipped market valuation – it can be assumed that at least that number of teachers in the U.S. were using the flipped classroom when the pandemic forced all classes, including the flipped classes, to go entirely online.

The OECD survey was unequivocal regarding the disruption to the worldwide educational systems caused by COVID-19. While overwhelming, descriptions of the disruption are anecdotal and do not discriminate whether a class before COVID-19 was taught as a traditional lecture class or whether it was taught as a flipped class. This, we believe, is a crucial distinction. A flipped class uses technology-based learning materials. Thus, students develop the discipline to actively learn (using computers) as opposed to being passively taught. This should ameliorate their disruption when being moved to fully online, as compared to traditionally taught students.

To investigate whether flipped students suffered disruption when their classes were moved entirely online, data is needed. COVID-19 was not anticipated, hence planned quantitative research to determine the impact of COVID-19 disruption using pre-post pandemic data does not exist. We, however, collect data every semester in our flipped classes to support our ongoing continual improvement efforts (MacLeod and Swart, 2019), so we did have comparable data available for the fall of 2019, before the pandemic, and for the spring of 2020, during the pandemic. While not specifically targeted at the pandemic, our ongoing data collection provided a pool of information that can be analyzed to identify such impacts. Our data included student satisfaction and engagement, thus we decided to define disruption as the difference in these two variables before and during COVID-19. This gave us a unique opportunity to conduct a data-based pre-post COVID-19 assessment of its impact on student disruption.

## Study Overview

Our ongoing data collection measures the Relative Proximity of Transactional Distance (RPTD) (Swart et al., 2014). It is based on Michael G. Moore's Theory of Transactional Distance (1980) as was later updated by Zhang (2003), who defined transactional distance (TD) as cognitive, psychological, social, cultural, behavioral, and/or physical distance between learners and the other elements of their learning environment. Operationally, TD is defined as barriers to a student's active engagement with learning. Several scales have been developed to measure TD, which will be discussed in the next section. Our overarching research question was whether there was a change in student engagement and/or satisfaction with learning before COVID-19 (fall 2019) and during COVID-19 (spring 2020). We were also interested in knowing whether COVID-19 was a unique and significant predictor of student satisfaction. This led us to the following research hypotheses:

### *Research Hypothesis 1:*

*H<sub>01</sub>: Student satisfaction with their learning before COVID-19 (fall 2019 semester) = Student satisfaction with their learning during COVID-19 (spring 2020 semester).*

*H<sub>a1</sub>: Student satisfaction with their learning before COVID-19 (fall 2019 semester) ≠ Student satisfaction with their learning after COVID-19 (spring 2020 semester).*

*Research Hypothesis 2:*

*H<sub>02</sub>: Student engagement with their learning environments (RPTD) before COVID-19 (fall 2019 semester) = Student engagement with their learning environments (RPTD) during COVID-19 (spring 2020 semester).*

*H<sub>a2</sub>: Student engagement with their learning environments (RPTD) before COVID-19 (fall 2019 semester) ≠ Student engagement with their learning environments (RPTD) during COVID-19 (spring 2020 semester).*

*Research Hypothesis 3*

*H<sub>03</sub>: COVID-19 is a unique and significant predictor of student satisfaction with learning.*

*H<sub>a3</sub>: COVID-19 is not a unique and significant predictor of student satisfaction with learning.*

The rest of the paper is structured as follows: in the next section we review the pertinent literature to this research. This is followed by a description of the study design, including methodology and data collection, leading to our results and their discussion. We end the paper by discussing the lessons learned from the pandemic and how they can help mitigate the impact of future disruptions.

## LITERATURE REVIEW

### The Flipped Classroom

Bishop and Verleger (2013) define the flipped classroom as an educational technique that consists of two parts: interactive group learning (IGL) activities inside the classroom, and direct computer-based individual instruction outside the classroom. Swart (2017), notes that an infallible set of principles that will assure that flipped learning will work does not exist. Hence, before implementing flipped learning, the instructor must design the course considering a host of issues that include, but are not limited to:

- 1) Deciding how to effectively design/utilize the learning space and instructional technology that is provided
- 2) Plan the out-of-class learning activities, prepare the appropriate materials, and motivate students to use them effectively so as to be prepared for the f2f IGL activities
- 3) Plan the in-class IGL activities, prepare the appropriate materials, and ensure that students work effectively as teams
- 4) Determine how student-faculty interaction will take place during the IGL activities; and,
- 5) Plan and prepare assessments for the daily IGL activities and develop exams that are consistent with the flipped learning process.

Since every instructor contemplating flipped learning may decide to do any of the above their way, the results of flipping a class are unpredictable.

The instructors of the courses included in this research wanted to find a common “best way” to flip their courses through a continual process improvement process (MacLeod and Swart, 2019). While the specific practices varied slightly based on the course, they had agreed to flip their f2f classes, as described in Swart and Wuensch (2016). Generally, students were given reading material and video lectures to read at their convenience prior to coming to class. In class, students were assigned to teams to collaborate on solving a problem requiring the knowledge contained in their out-of-class assignment. During this process, the instructor served as learning coach and consultant. Once the team found a solution to the problem, each team member took an individual quiz to demonstrate mastery of the material.

While the focus of the study is the effects on the face-to-face (f2f) students, our study included both face-to-face and online sections. Our goal is to provide our online students with as similar an experience as possible to our flipped face-to-face students. Early attempts at flipping online courses consisted primarily of injecting a synchronous component into an online course (Carver et al., 2013; Galway et al., 2014).

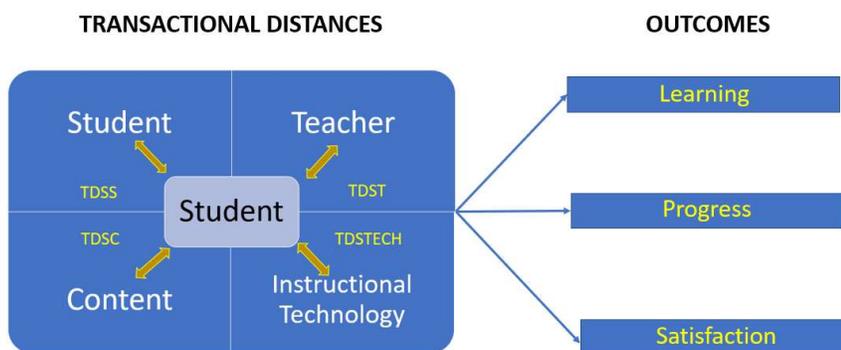
Recent attempts have more closely emulated a flipped learning environment. Stohr et al. (2020) found that in their graduate courses, average performance in face-to-face and online flipped courses was similar however, the spread in performance, which they called *oscillation*, was greater in the online flipped sections. Swart and MacLeod (2020), flipped their undergraduate and master level courses and found no significant difference in student engagement and satisfaction. We adopted the Swart & MacLeod (2020) approach to flipping our online courses. The same materials were used in the f2f and online version of each class. The only difference was that all communication was carried out virtually. Teams collaborated virtually and all quizzes were online. The instructor acted as a virtual consultant and learning coach. The online course schedules had to be modified to accommodate asynchronous communication necessary as a result of the online student having to balance jobs, family, and other external activities.

The important point is that our implementation of flipped learning for both our f2f and online classes occurred before the COVID-19 disruption. If that similarity made the transition to all online courses after COVID-19 less disruptive and our data supports that, we might have learned a valuable lesson for weathering future disruptions, that the flipped classroom has benefits beyond those detailed in the literature.

### Transactional Distance, Relative Proximity, and Their Measurement

Transactional Distance Theory was developed by Michael G. Moore (1980). It was the first attempt to define distance education and to articulate a distance education theory. It brought about a paradigm shift in viewing the construct of “distance” from a social science viewpoint instead of physical one. Zhang (2003) expanded and adapted the theory to include online learning environments and operationalized the definition to stating that transactional distances are the barriers to a student’s active engagement with learning. She posited that transactional distance has four dimensions, each representing a potential source of barriers to student engagement with their learning environment. The sources that could create barriers to student engagement included the student’s interaction with fellow students (TDSS), the student’s interaction with the teacher (TDST), the student’s interaction with the course content (TDSC), and the student’s interaction with the available instructional technology (TDSTECH). She postulated that the effect of these transactional distances would manifest itself in three outcomes, learning, progress, and Satisfaction. Figure 1 depicts these relationships.

**FIGURE 1  
ZHANG’S T.D. MODEL**



Zhang developed and validated the 32 element Scale of Transactional Distance. One of her significant findings was that there was a high correlation between each of her three outcomes, Learning, Progress and Satisfaction. This led to the use of “Satisfaction” as the single outcome measure.

The decade after Zhang’s work experienced substantial changes in technology and instructional systems that led to contemporary open, flexible, distance education courses as well blended modes of course delivery, including flipped classrooms. These led to an update of Zhang’s scale, the Revised Scale of Transactional Distance (RSTD) which possessed excellent factorial validity and reliability, yielded better

fit statistics and consisted of only 12 elements making it easier and less time consuming to administer (Paul, Swart, Zhang & MacLeod, 2015). However, the scale was counter-intuitive in that TDSTECH (interaction between student and technology) was eliminated from the model because of lack of statistical significance.

Weidlich & Bastiaens (2018) argued that since technology and modern education, in particular online education, are inextricably linked, TDSTECH must be a factor. To that end they introduced a new set of questions to measure the effects of technology and an expanded set of questions to measure Satisfaction to the RSTD scale. While they obtained good results, they noted that their revisions were not validated on a separate data set. They recommended that their revisions to the RSTD be tested on a different data set with a larger N. We have followed up on their suggestion in this paper.

Both Zhang's original Scale of Transactional Distance and its subsequent variations discussed above provide measures of T.D. - a number indicating what your "distance" is. Unfortunately, it does not answer the question, "distance from where?" Thus, respondents have no frame of reference for their response. Relative Proximity Theory (RPT), also referred to as "Strategic Gap Analysis" in business, measures the gap, or difference, between actual and ideal transactional distance elements, as perceived by students. Thus, applying RPT consists of asking the students each survey question twice, once answering the question for their current course, and then again as if they were experiencing an ideal course. Before processing the questionnaires, the "ideal" response would be subtracted from the "actual" response to obtain the "relative proximity" between the actual and ideal responses (Swart et al., 2014).

## METHOD

### Instrument

To follow up on the suggestions by Weidlich & Bastiaens (2018), we added their newly introduced items to the validated RSTD scale (Paul, et al., 2015). These eleven (11) new items for the Transactional Distance between Students and Instructional Technology (TDSTECH) component and the six (6) new items for Satisfaction with Learning (Satisf.w/Learning) were analyzed for kurtosis effects. All but three items (TDSTECH 7, 8 and 11) were found to have extremely high Kurtosis values (>5 to 43.6) indicating the presence of extreme outliers in one tail (or skewness). Further investigation of each item's distributions confirmed this with almost all subjects indicating their comfort (5's and 4's) for each item. A cursory glance at these items suggests that some of them were rudimentary, e.g., "confident in using office programs like Word and Excel" and "comfortable using the technology available in the course." Several others were too general, e.g., "instructional technology was helpful." These items were consequently dropped from the analysis. Thus, our initial, modified measurement model included three (3) TDSTECH items in addition to the RSTD measures. There were no significant Kurtosis issues noted with any of their six (6) new Satisf.w/Learning elements. Consequently, all of them were retained in the scale.

Modification indices were examined to assess our initial measurement model's fit and evaluate opportunities to improve the model fit. Incremental modifications (Chen, 2001) were made by removing items with very low commonalities (< 0.6) and/or very high Modification Indices (>10) or covariance between the errors for same factor. This analysis resulted in the removal of one item from the RSTD scale – ST1. The resulting "best fitting" measurement model, which we refer to as the RSTD-20, consists of four sub-constructs with a total of 14 items and is shown in Appendix 1. The Composite Reliability (C.R.) scores for the four sub-constructs were as follows: S.T. – 0.843, S.S. – 0.914, SC – 0.821, and STECH – 0.819. These are well above the minimum threshold of 0.7 indicating reliability in our sub-constructs (Nunnally, 1978).

To measure the relative proximity of transactional distance, the RSTD-20 scale was transformed to an RPTD scale by gathering two responses for each question: one response for the current course and one for what the response would be in an "ideal" course. The RPTD's were then calculated by subtracting the "ideal" responses from the "actual" responses, with these new values shown with a "Δ" before the construct's name, as in ΔTDST as the relative proximity of transactional distance between the Student and Teacher. The relative proximity denotes how "far" a measurement is from the ideal, so the closer the Actual

response is to the Ideal response, that is, the smaller the relative proximity, the better the result. For the rest of this paper, it is important to remember that the *smaller RPTD measures are better*.

### Participants

Three College of Business instructors, one from the Department of Management Information Systems and two from the Department of Marketing and Supply Chain Management participated in this study. Each taught the same courses before COVID-19 (Fall 2019) and during COVID-19 (Spring 2020). They each taught sections of their courses online as well as face-to-face. They included graduate as well as undergraduate courses. The graduate courses are required courses in the MBA program, which primarily enrolls working professionals who prefer to enroll in online classes (our program has 800 MBA students and 700 take courses exclusively online). The breakdown of students by semester, gender, level, and mode of delivery is shown in Table 1.

**TABLE 1  
STUDY PARTICIPANTS BY SEMESTER, GENDER, MODE OF DELIVERY, AND LEVEL**

Gender	2019						2020						TOTAL
	F2F			O/L			F2F			O/L			
	Grad	U/G	total										
M	11	14	25	61	21	82	3	8	11	53	23	76	194
F	5	26	31	56	9	65	4	23	27	69	27	96	219
Totals	16	40	56	117	30	147	7	31	38	122	50	172	413

### Setup

Before COVID-19, our f2f classes were flipped, as described in Swart & Wuensch (2016), and our online classes were also flipped, as described in Swart & MacLeod (2020). For the f2f flipped classes, students were provided with online lecture notes and video lectures to study out of class. Class time was devoted to interactive group learning – student teams were assigned a problem whose solution required the knowledge contained in the lecture notes and video lecture(s) assigned for that class. The instructor served as a learning coach and consultant to student teams. Upon completion of the problem, students were given an individual online quiz to assess their mastery of the material. The online flipped classes used the identical materials as the f2f classes. However, instead of f2f collaboration with team members, collaboration was virtual. While WebEx was the official collaboration platform, student teams could use the collaboration platform of their choice (Zoom, Google Docs, et.). Coaching and consultation between faculty and students and faculty and student teams also took place virtually in the online courses.

After COVID-19, the face-to-face flipped classes were switched online. Because the materials were identical between the face-to-face and online flipped classes, the transition consisted of adjusting the schedule of the former face-to-face course to that of the online course. The primary difference is that all collaboration now had to take place online. Instead of requiring teamwork to be done during the former scheduled class time, students were given a due date by which the online quizzes had to be completed. This gave them time to schedule virtual collaboration and choose when to meet, either synchronously or asynchronously. Faculty originally scheduled in the f2f course had to make themselves available as in a regular online course.

### ANALYSIS AND RESULTS

Data was collected by administering RSTD-20 (Appendix A) and transforming it to RPTD's. SPSS 26 was used for all statistical procedures.

### Research Hypothesis 1

Table 2 shows the mean RPTD of student satisfaction with learning ( $\Delta$ Satisf.w/Learning) pre and post COVID-19. Recalling that the smaller the value of RPTD, the closer the actual is to ideal, thus, directionally, we see that on the average students are more satisfied with learning during COVID-19 than before. To determine whether this difference is statistically significant, we wanted to conduct an independent sample t-test. However, Levene's Test for Equality of Variances failed to support the null hypothesis. Consequently, we applied the Kruskal-Wallis non-parametric test showing that the difference in means is statistically significant, as shown in Table 3. Thus, Research Hypothesis 1 is not supported. Student satisfaction with their learning is greater after COVID-19 than before.

**TABLE 2**  
**AVERAGE RPTD OF STUDENT SATISFACTION WITH LEARNING PRE AND DURING COVID-19**

	pre-COVID-19		COVID-19	
		$\Delta$ Satisf.w/ Learning		$\Delta$ Satisf.w/ Learning
<b>FACTOR</b>	<b>N</b>	<b>MEAN</b>	<b>N</b>	<b>MEAN</b>
COVID-19	203	0.372	210	0.217

**TABLE 3**  
**RESULTS OF THE KRUSKAL-WALLIS NON-PARAMETRIC TEST**

<b>FACTOR</b>	<b>Kruskal-Wallis H</b>	<b>df</b>	<b>Asymp. Sig.</b>
COVID-19	5.164	1	0.023

### Research Hypothesis 2

The purpose of Research Hypothesis 2 was to determine if the disruption caused by COVID-19 during the Spring 2020 semester was reflected in their engagement with their learning environment, as determined by the relative proximity of their transactional distances, measured by  $\Delta$ TDST,  $\Delta$ TDSS,  $\Delta$ TDSC, and  $\Delta$ TDTECH, before and during COVID-19.

We had planned on performing a MANOVA on our data, but instead conducted the Levene's Test for Equality of Error of Variances to test the null hypothesis that the error variance of the dependent variable is equal across all groups. The null hypothesis was rejected at the 5% level of significance across all groups. Since our principal variable of interest was COVID-19, we decided to conduct the non-parametric Kruskal-Wallis test on that variable. The results are exhibited in Table 4 and indicate that  $\Delta$ TDSTECH is significantly different before COVID-19 than after COVID-19. Thus, Research Hypothesis 2 is not supported for  $\Delta$ TDSTECH. Students are more engaged with the instructional technology after COVID-19 than before. However, Research Hypothesis 2 is supported for  $\Delta$ TDST,  $\Delta$ TDSS,  $\Delta$ TDSC. Thus, student engagement with their fellow students, their instructor, and the material has not increased. However, we neither have a reason to believe that it has decreased.

**TABLE 4**  
**KRUSKAL-WALLIS TEST ON THE RPTD FACTORS FOR THE VARIABLE 2020**

Grouping Var.	DTDSC	DTDSS	DTDST	DTDSTECH
COVID-19				0.002

**Research Hypothesis 3**

The purpose of Research Hypothesis 3 is to determine which factors are unique and significant predictors of student satisfaction with learning. Factors considered include all RPTDs, and 0-1 indicator variables for COVID-19, Gender, Online, and Graduate (a value of 1 denotes a “yes” while 0 denotes “no”). The results of a stepwise multiple regression are shown in Table 5. The regression prediction model is robust with explained variance of  $R^2=0.565$  and it differs significantly from the residual model  $F(5,407)=105.714$ ,  $p<.001$ . According to the VIF values, it has no indication of multi-collinearity.

**TABLE 5**  
**STEPWISE MULTIPLE REGRESSION RESULTS**

Model	Coefficients <sup>a</sup>										
	Unstandardized Coefficients		Standardized Coefficients		t	Sig.	Zero-order	Partial	Part	Tol	VIF
B	Std Error	Beta	Beta								
(Constant)	0.106	0.040			2.655	0.008					
DTDST	0.301	0.027	0.433	0.433	11.236	0.000	0.642	0.487	0.367	0.719	1.390
DTDSTECH	0.186	0.024	0.268	0.268	7.790	0.000	0.437	0.360	0.255	0.903	1.108
DTDSC	0.276	0.037	0.279	0.279	7.509	0.000	0.527	0.349	0.245	0.772	1.295
COVID-19	-0.088	0.037	-0.080	-0.080	-2.395	0.017	-0.141	-0.118	-0.078	0.961	1.041
Grad	-0.088	0.038	-0.078	-0.078	-2.322	0.021	-0.143	-0.114	-0.076	0.957	1.045
a. Dependent Variable: DSatisfw/Learning											
R=.752	R <sup>2</sup> =.565	F=105.714	Df-regression=5	Df-residual=407							

All RPTD factors *except*  $\Delta$ TDSS are unique and significant predictors of the dependent variable  $\Delta$ Satisf.w/Learning. Furthermore, COVID-19, has a negative B, meaning that the occurrence of a disruption caused by COVID-19 (e.g., when it has a value of 1) is predicted to make student satisfaction with learning closer to ideal than before its occurrence. Similarly, the negative B for Grad indicates that, overall, graduate students can be predicted to be more satisfied with their learning than their undergraduate counterparts. Having COVID-19 be a unique and significant predictor of student satisfaction does not support H<sub>03</sub>.

## DISCUSSION

The COVID-19 pandemic affected 1.2 billion students in 186 countries. It came at a time when flipped learning was receiving growing world-wide attention in practice and research. Flipped learning is a form of blended learning in which students use computers to learn the information traditionally conveyed via lectures at their convenience prior to coming to class. During class, they engage in interactive group learning. Groups, under the supervision of their teacher, who acts as a learning coach and consultant, help each other to scaffold their learning. Scaffolding involves students reaching to achieve stretch goals by attempting to use their team members for teaching/learning purposes while the instructor acts as a resource when needed (Lin et al., 2011).

The COVID-19 pandemic created worldwide disruption in educational systems when face to face instruction was summarily cancelled and teaching and learning had to occur online. There was no time to plan how this switch in educational modality was to take place. Teachers world-wide were left to their own devices as to how to make this happen. For traditionally taught classes, this meant a switch from live lectures to computer mediated learning. Thus, teachers and students had to become familiar with unfamiliar technology in the teaching/learning process. For flipped classes, students were already familiar with using computers to learn subject matter. For them and their teachers, interactive group learning had to become virtual. Virtual communication between peers through social media is a norm and not an exception. Thus, our research hypotheses centered at determining whether the switch from face to face flipped learning to online learning created disruption as measured by student satisfaction and student engagement.

Because the COVID-19 pandemic was unexpected, no one collected pre-Covid-19 data followed by data collected during the COVID-19 pandemic to provide data-based answers to questions about the impact of the move face to face teaching to online teaching. However, coincidentally, we were engaged in collecting data every semester for another purpose – continual improvement of our flipped teaching – that would allow us to quantitatively assess whether there were changes in student satisfaction and engagement before and during the pandemic. We found that student engagement and satisfaction were not negatively impacted by the switch from flipped to online learning. We found that students were *more* satisfied with their learning during COVID-19, when their classes were totally online. We also found that students were more engaged with the instructional technology used in their course during COVID-19. Finally, consistent with our other results, our data indicated that COVID-19 was a unique and significant *positive* predictor of student satisfaction – e.g., predicted student satisfaction is greater during COVID-19.

Because of the widely reported negative disruption caused by the switch from face to face to online learning, we expected similar results for the flipped classes. However, in retrospect, flipped classes use computers to deliver course information to students in the form of video-lectures and lecture notes delivered via the institution's learning management system. While students could access these materials at their convenience, they had to be accessed by given due dates so they could participate in the flipped course's interactive learning activities. This required self-discipline to learn contrasts with the imposed discipline of a lecture that requires the student to be at a particular classroom at a particular time. We conjecture that releasing the flipped students to be in a specific class at a specific time to engage in interactive group learning and allowing them to collaborate virtually also contributed to the findings that students were more satisfied during COVID-19.

All the instructors in this study had taught their courses as online and as face to face flipped courses several times before the pandemic. As a matter of good practice, we also tried to mirror what we did in one modality in the other, including using the same learning materials. This familiarity with both instruction

modalities allowed for a smooth and seamless transition from flipped to online when the pandemic demanded it.

## LIMITATIONS

Flipped classes have been implemented from primary to post-secondary levels. Our results were obtained at the collegiate level. Applicability to lower educational levels with less mature students requires additional research.

Our data did not meet the assumptions required by more traditional statistical techniques such as ANOVA and MANOVA. This limited our results to main effects. We believe that there may be interesting interaction effects that can only be studied with better/more data. Hopefully, we will not be faced with another pandemic or major disaster causing disruption and such data will not become available.

The flipped classroom as used in this research is defined according to Bishop & Verleger (2013) as “an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom.” Whether the flipped classroom can be adapted to environments that have no access to advanced technology and whether our results would hold in such environments also requires additional research.

## CONCLUSIONS

This research is the first and, to our knowledge, only research that provides empirical evidence that a particular use of computers in education, the flipped classroom, is “disruption proof” when natural or man-made disasters force a sudden and unexpected transition from face to face to online learning. However, it being so will be facilitated by certain necessary but not sufficient conditions:

1. Flipped learning should become the norm, not the exception for face-to-face learning. This is supported by a body of research and was underscored by a BBC News article titled “Shouldn’t lectures be obsolete by now?” (Pickles, 2016).
2. Teachers should be trained on how to flip their classes.
3. Administrators should require all teachers to have taught their course online as well as face to face. The online course should mirror the flipped face to face course as much as possible.
4. Teachers should be trained on how to teach online.

We acknowledge that there are classes for which the flipped format may not work. However, the pandemic *has* demonstrated that all classes can be taught online. Thus, all teachers should be required to have taught their class face to face as well as online. And administrators must find ways to incentivize their teachers to become proficient at flipping classes and teaching online. Whatever the cost, it will be far less than the cost of another disruption.

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**APPENDIX**

**THE RSTD-20 SCALE**

<b>TD FACTOR</b>	<b>TD ELEMENT</b>	<b>ELEMENT DESCRIPTION</b>
<b>TDSC</b>	TDSC1	This course emphasized SYNTHESIZING and organizing ideas, information, or experiences.
	TDSC2	This course emphasized MAKING JUDGEMENTS about the value of information, arguments, or methods.
	TDSC3	This course emphasized APPLYING theories, and concepts to practical problems or in new situations.
<b>TDSS</b>	TDSS1	I get along well with my classmates.
	TDSS2	I feel valued by class members in this class.
	TDSS3	My classmates in this class value my ideas and opinions highly.
	TDSS4	My classmates respect me in this class.
	TDSS5	The class members are supportive of my ability to make my own decisions.
<b>TDST</b>	TDST1	I receive prompt feedback from the instructor on my academic performance.
	TDST2	The instructor was helpful to me.
	TDST3	The instructor can be turned to when I need help in the course.
<b>TDSTECH</b>	TDSTECH1	I experienced frustration using the instructional technology available in the course.
	TDSTECH2	I had to consciously think about how to use the instructional technology available in the course.
	TDSTECH3	I find it pleasant to use the instructional technology available in the course.
<b>OUTCOMES</b>		
<b>Satisf/L</b>	Satisf/L1	I benefited from this course.
	Satisf/L2	This course met my expectations.
	Satisf/L3	I experienced and learned new things in this course.
	Satisf/L4	The content covered in this course was NOT interesting.
	Satisf/L5	I would like to take more courses like this one.
	Satisf/L6	I wish other courses were more like this one.