A system modeling approach to simulate post-COVID-19 student intention to use online learning platforms

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Abstract

The purpose of this paper is to simulate future platform usability for using online learning platforms in the post-COVID-19 scenario basis their experience with the online learning platform during the lockdown. A holistic model encompassing enablers and constraints for platform usage has been constructed from the primary data collected through a survey of 163 respondents.

Considering factors holistically it has been observed that it will be difficult to continue to use online education if solutions to problems of product features, internet, quality of content, and teacher-student interaction are not resolved. The implication of this study is to improve the online learning product, connectivity, and communication so that students are enthusiastic to use online learning platforms in the future.

1. Introduction

According to a study conducted by UNICEF, 90% of the world's student population has been affected by battered education delivery in the Pandemic but with help of the internet, such adversity has been converted into an opportunity to continue education delivery virtually. Platforms like Google classroom, Zoom, Microsoft team enabled that the connection between student and learning is not halted (Chen et al., 2020). The combination of learning and assessment provides the design of an effective learning environment for students in the intended direction (Geitz & de Geus, 2019). Online learning is defined as the use of the Internet as a technological tool that enables users to interact with the content; with other users, and to get support during the process of learning so that they can acquire knowledge, construct personal meaning, and experience learning (Mulyono,

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n.d.). Online learning platforms lack an important part of the student learning experience which is the in-person interaction of students and teachers (Saba, 2012). Other challenges of virtual learning & assessment which were reported across the globe were connectivity interruptions, delay in transmission due to a slow network, unavailability of ample amount of devices, limited data packs, computer illiteracy, lack of operational knowledge (Dhawan, 2020a). Online learning is a part of the education system but a system in itself. Hence we can say that the online learning platform is a subsystem of the education system (Moore & Kearsley, 2011). E.g., the planning of online classes is a different subsystem of the online learning system and from these elements, few elements positively influence the system like enhancers of online learning systems usage and a few create negative influences like challenges, negative emotional experience, etc. In this paper systems dynamics model has been constructed to understand the elements which are the enhancers to increase the usability of online learning platform among students and challenges affecting the same using students' responses collected in a survey.

2. Literature Review

Literature review is divided into the following sections from 54 readings:

Elements of online learning subsystems

Many studies have included FODA, TAM, TPB, ECM, UAT, and other theoretical models and theories to evaluate the continuity intention for virtual mode education delivery, (Al-Emran et al., 2020; Tam et al., 2020; Tawafak et al., 2020) (Daneji, Ayub & Khambari, 2019). A study based on the multi-analytical approach and SEM model has included 'satisfaction' as one of the main variables (Pozón-López et al., 2020). But in most of the literature, authors have selected the perceived usage of the platform and expectation of using the platform as one of the major contributors. The difference between these theories and systems approach is that for a holistic view, factors like individual learning curves, in- dividual learning preferences, self-pace of learning etc. are also considered in the systems approach for distance learning preferences which is lacking in the above-mentioned theories since these theories consider one-size fits for all approach and every individual is having different dynamism to approach online learning. (Saba, 2012). Table 1 has been prepared to identify variables listed in previous work to facilitate the preparation of systems model.

Utility features of online learning platforms

The main reason for use of google classroom as a primary mode of learning & assessment platform was that it gives ample space for enrolling students up to 250 students at no cost in one class and allows study material exchange, announcements without any difficulty. The easy operations and availability at no cost made google classroom a preference for instant adoption. (Ansong-Gyimah, 2020). However, a study conducted by (Kumar & Bervell, 2019) suggested that there is no relationship between facilitating conditions and the use of google classroom. To start virtual classes it is also suggested that a technical checklist before commencing with virtual learning mode should be

circulated among students and teaching faculties (Schlenz et al., 2020). It was also found that students experienced a mix of emotions due to isolated learning, selective peer communication, technical difficulties, lack of training for setting up of online learning platform. (Kee, 2021). Some authors also recommended that only when students are comfortable with the use of such online platforms only then it should be used for enhancing students' performance. (Al-Emran et al., 2020).

Institution and stakeholder responsibility for continued education

Universities should arrange for keeping students updated with technology, and provide counseling to relieve psychological and emotional issues and they should also keep students updated on important communication from the university side (Kee, 2021). Real-time tech- support from such online learning platform also helps students, hence institution should engage in such after-sales services which provide supports to students if they face any setting related issues from online learning platforms. (Salim Muljana & Luo, 2019). Only theoretical courses should be taken up for online learning and those topics which involve particle should be done in-campus visits. Though covid was such a time which made us reflect even into 3D simulated practices in worst-case scenarios where passing lab practical were necessary for higher education courses. (Khoramshahi & Billard, 2019)

Variables collected from previous studies on student's intention to future use

The following variables are found & listed below from existing research material published during 2019-20.

Table 1 – Variables identifies by authors

S.No.	Variables	Authors
1	Actual use	(Kumar; Bervell, 2019)
2	Affordances	(Kumar; Bervell, 2019)
3	Announcement	(Al-Emran; Arpaci; Salloum, 2020)
4	Attitude (at)	(Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019)
5	Autonomous learning	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
6	Autonomous motivation	(Tawafak; Malik; Alfarsi, 2020)
7	Behavior intention	(Kumar; Bervell, 2019) , (Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019)
8	Cognitive presence	(Al-Emran; Arpaci; Salloum, 2020)
9	Competition collaboration	(Wang; Lew; Lau; Leow, 2019)
10	Computer efficacy	(Daneji, Ayub, Khambari, 2019)

11	Confirmation	(Tam; Santos; Oliveira, 2020), (Tasnim Wan Hussin; Harun; A. Shukor, 2019)
12	Content	(Kumar; Bervell, 2019), (Tawafak; Malik; Alfarsi, 2020), (Turki; Salloum, ; Al Kurdi; Abdel Monem; Shaalan, 2019)
13	Content quality	(Tam; Santos; Oliveira, 2020)
14	Continuance intention	(Tawafak; Malik; Alfarsi, 2020), (Turki; Salloum, ; Al Kurdi; Abdel Monem; Shaalan, 2019), (Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
15	Controlled motivation	(Sihvonen, 2020)
16	Course assignments performance	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
17	Course quality	(Turki; Salloum, ; Al Kurdi; Abdel Monem; Shaalan, 2019)
18	Cultural differences	(Waheed; Hassan; Aljohani; Hardman; Alelyani; Nawaz, 2020)
19	Distinction-fail	(Ansong-Gyimah, 2020)
20	Distinction-pass	(Ansong-Gyimah, 2020)
21	Ease of use	(Kumar; Bervell, 2019)
22	Effort expectancy	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
23	Emotions	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
24	Entertainment	(Tasnim Wan Hussin; Harun; A. Shukor, 2019)
25	Environment	(Al-Emran; Arpaci; Salloum, 2020)
26	Expectation confirmation (EC)	(Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019)
27	External communication tools	(Kumar; Bervell, 2019)
28	Facilitating condition	(Tam; Santos; Oliveira, 2020), (Sihvonen, 2020)
29	Feedback grades	(Dhawan, 2020)
30	Gamification	(Kumar; Bervell, 2019)
31	Google Classroom: usage intentions, usefulness, Mobile learning	(Ansong-Gyimah, 2020), (Kumar; Bervell, 2019)
32	Habit	(Kumar; Bervell, 2019), (Tam; Santos; Oliveira, 2020)
33	Hedonic motivation	(Kumar; Bervell, 2019), (Tam; Santos; Oliveira, 2020)
34	Higher education	(Turki; Salloum; Al Kurdi; Abdel Monem; Shaalan, 2019)
35	Information quality quality of the system	(Salim Muljana; Luo, 2019)
36	Institutional level	(Tasnim Wan Hussin; Harun; A. Shukor, 2019)
37	Instructor	(Salim Muljana; Luo, 2019)

38	Instructor level	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
39	Interactivity	(Tasnim Wan Hussin; Harun; A. Shukor, 2019)
40	Interface	(Schlenz; Schmidt; Wöstmann; Krämer; Schulz-Weidner, 2020)
41	Intrinsic value	(Özhan; Kocadere, 2020)
42	Learners	(Tawafak; Malik; Alfarsi, 2020)
43	Of course	(Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019)
44	Pedagogical knowledge	(Al-Emran; Arpaci; Salloum, 2020)
45	Perceived behavioral control (PBC)	(Özhan; Kocadere, 2020)
46	Perceived ease of use	(Turki; Salloum; Al Kurdi; Abdel Monem; Shaalan, 2019), (Tawafak; Malik; Alfarsi, 2020), (Al-Emran; Arpaci; Salloum, 2020)
47	Perceived usefulness	(Tawafak, Ragad M; Malik, Sohail Iqbal; Alfarsi, Ghaliya, 2020), (Wang; Lew; Lau; Leow, 2019), (Al-Emran; Arpaci; Salloum, 2020)
48	Perceived usefulness (PU)	(Kumar; Bervell, 2019)
49	Performance expectancy	(Schlenz; Schmidt; Wöstmann; Krämer; Schulz-Weidner, 2020), (Tam; Santos; Oliveira, 2020)
50	Plot	(Tam; Santos; Oliveira, 2020)
51	Price value	(Ansong-Gyimah, 2020)
52	Access to course material	(Al-Emran; Arpaci; Salloum, 2020)
53	Behavioral intentions	(Daneji, Ayub, Khambari, 2019)
54	Communications	(Daneji, Ayub, Khambari, 2019)
55	Content knowledge	(Schlenz; Schmidt; Wöstmann; Krämer; Schulz-Weidner, 2020)
56	Continuance intention	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
57	Didactic benefit	(Tam; Santos; Oliveira, 2020)
58	Ease of use	(Waheed; Hassan; Aljohani; Hardman; Alelyani; Nawaz, 2020)
59	Effort expectancy	(Tasnim Wan Hussin; Harun; A. Shukor, 2019)
60	Initial perceptions of students	(Tawafak; Malik, Sohail; Alfarsi, 2020)
61	Interactivity	(Özhan; Kocadere, 2020)
62	Learner	(Sihvonen, 2020)
63	Online classroom learning	(Dhawan, 2020)
64	Online Teaching	(Waheed; Hassan; Aljohani; Hardman; Alelyani; Nawaz, 2020)

	learning	
65	Pass-fail	(Wang; Lew; Lau; Leow, 2019)
66	Perceived ease of use (PEOU)	(Daneji, Ayub, Khambari, 2019)
67	Perceived usefulness	(Ansong-Gyimah, 2020)
68	Quality of work	(Daneji, Ayub, Khambari, 2019)
69	Satisfaction	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020), (Salim Muljana; Luo, 2019), (Wang; Lew; Lau; Leow, 2019), (Waheed; Hassan; Aljohani; Hardman; Alelyani; Nawaz, 2020)
70	Screening	(Tawafak, Ragad M; Malik, Sohail Iqbal; Alfarsi, Ghaliya, 2020)
71	Self-learning	(Tawafak; Malik, Sohail; Alfarsi, 2020)
72	Service quality	(Kumar; Bervell, 2019)
73	Social engagement	(Wang; Lew; Lau; Leow, 2019)
74	Social influence	(Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019), (Tam; Santos; Oliveira, 2020)
75	Social presence	(Schlenz; Schmidt; Wöstmann; Krämer; Schulz-Weidner, 2020)
76	Student level	(Al-Emran; Arpaci; Salloum, 2020)
77	Subjective norms (SN)	(Turki; Salloum, ; Al Kurdi; Abdel Monem; Shaalan, 2019)
78	System characteristics	(Sihvonen, Mika, 2020)
79	Teacher subject knowledge	(Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019)
80	Teaching presence	(Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019)
81	Technological knowledge	(Schlenz; Schmidt; Wöstmann; Krämer; Schulz-Weidner, 2020)
82	The motivation of students' perspectives	(Turki; Salloum, ; Al Kurdi; Abdel Monem; Shaalan, 2019)
83	The technology acceptance model User beliefs	(Tasnim Wan Hussin; Harun; A. Shukor, 2019)
84	Time flexibility	(Turki; Salloum, ; Al Kurdi; Abdel Monem; Shaalan, 2019)
85	Tool	(Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019)
86	Understanding expectations	(Kumar; Bervell, 2019)
87	Uniquely	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
88	Usefulness	(Kumar; Bervell, 2019)

89	User experience	(Pozón-López; Kalinic; Higueras-Castillo; Liébana-Cabanillas, 2020)
90	Vividness of Content	(Waheed; Hassan; Aljohani; Hardman; Alelyani; Nawaz, 2020)
91	Withdrawn-pass	(Cacheiro-Gonzalez; Medina-Rivilla; Dominguez-Garrido; Medina-Dominguez, 2019)

Variables considered in the study:

Online Platform. One of the opportunities during Covid-19 adversity was the availability of the alternative option of online classes for education continuity. Policymakers were aware of its advantages but the full potential could only be witnessed during the lockdown. (Cacheiro-Gonzalez et al., 2019; Mulyono, n.d.). With ever-emerging digitalization in technology, these online platforms should keep updating and maintain at par features by incorporating user-suggested improvement. (Almeida et al., 2020)

Student user experience. An empirical study for finding user satisfaction of google classrooms, done in China the ground zero of COVID-19, found that learning needs, usage feelings, and online learning attraction compared to in-campus class was disappointing. (Chen et al., 2020). One of the studies mentioned the age factor for retention of students during online classes, according to which, online learning experience retention was only found in third-year students. (Sihvonen, n.d.)

Intention to use in the future. The intention of future use purely depends upon actual user experience. (Al-Emran et al., 2020). A holistic approach also mentions factors like updated technology, teaching staff engagement skills, Blended mode of education delivery to be evaluated for forecasting future intention. (Saba, 2012). An empirical study was done to predict future continuity of online learning platforms mention agile systems, computer literacy, and efficacy as one of the factors of future intention to use. (Wang et al., 2019)

Learning. In Pandemic times institutions were able to provide a continuity plan to jump into online learning-teaching mode through the online learning platform. As their responsibility institutions, lawmakers, and every other stakeholder including students supported this online education delivery method. (Teräs et al., 2020). The term learning here is being referred to concerning the model variable, it refers to flexibility, ease of use of the online platform which helps students in learning. (Dhawan, 2020b).

Assessment. Assessment of student submission of assignment, real-time supervision of tests, automated results sharing is some of the few benefits of the latest online learning platform which helps in creating a user-teacher relationship online. (Tasnim Wan Hussin et al., 2019)

Emotional state. Emotional state is the condition of students' thought process in which they are attempting to learn while being isolated due to lockdown (Özhan & Kocadere, 2020). The degree of fear and anxiety might vary but every individual felt the COVID19 situation as a threat to existential being, which limited social interactions thus bringing the movement near to zero. This negatively impacts the emotional state of mind, During these times online

classes were therapeutic for a few of the students (Kee, 2021)

Challenges. Challenges were mainly settings on online learning platform related and internet connection related. In some cases, it was infrastructure, unequal internet distribution, lack of training on online learning platform usability, or exhaustion of data packs. (Mirata et al., 2020)

3. Research Methodology

Applied systems research methodology helps in dealing with real-world problems and seeking solutions to resolve them. (Revered Prof. P. S. Satsangi, Founder, Systems Society of India). The same methodologies are used for other systems models for research (Singh et al., 2020) Figure 1. After identifying the area for research, the literature review was done to strengthen the study, identify relevant variables, and construct survey questions. Then a causal loop diagram to reflect future intention to use the online learning platform. Thereafter data collection and analysis were done. The findings of this survey were used as input values in the stock-flow model. After the initial simulation, different scenarios were tested for model validation and for achieving the desired state. Based on the results of the simulation, suggestions have been given for product improvement and improvement in areas of connectivity, communication, etc.

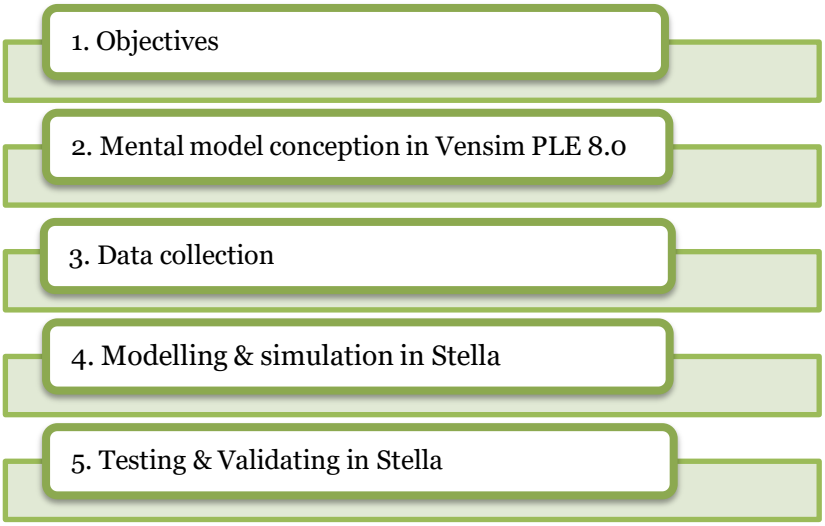

Chart 1: Steps of Systems research methodology

Objectives

1. To identify enhancers and constraints of user experience in using the online learning platform
2. To propose a systems model to simulate the dynamics of usability of the online learning platform.

Mental Model

Based on availability, ease of use, and features of google classroom including learning mode and assessment mode, students were informed by teachers of the decision to use the same. Once students started learning through this approach, their assessment and evaluation were also done through the same mode and platforms like Google forms, survey websites, video presentations, scanned copies of handwritten assignments, etc. Based on responses and comments received in the survey mixed feedback was seen hence the same has been depicted in the model. This causal loop diagram has been prepared using Vensim PLE software for educational purposes.

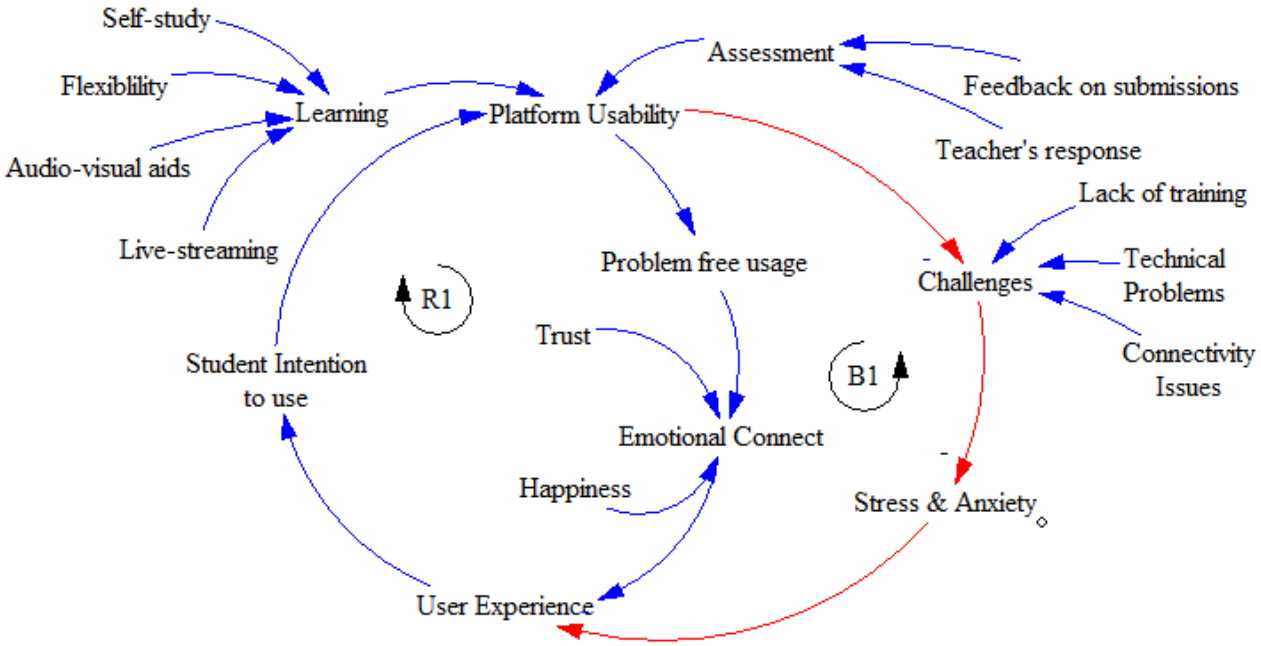

Figure 1 *- Mental model of platform users experience*

In this mental model (Figure 2),

- R1 is depicting a reinforcing loop as a cascading effect (Bala et al., 2017) Platform usability> problem-free usage>emotional connect> user experience>Student intention to use>platform usability.

- B1 is the balancing loop (Bala et al., 2017) and depicting Platform usability>Challenges>Stress & Anxiety>User experience>student intention to use>platform usability.

List of variables with their polarity signs is given in Table 2

Table 1 *- List of variables used in causal loop diagram*

S. No.	Variable Name	Polarity	Information Flow type
1	Assessment	+	Enabler
2	Audio-visual aids	+	Enabler
3	Emotional Connect	+	Enabler
4	Feedback on submissions	+	Enabler
5	Flexibility	+	Enabler
6	Happiness	+	Enabler
7	Learning	+	Enabler
8	Live-streaming	+	Enabler
9	Problem-free usage	+	Enabler
10	Self-study	+	Enabler
11	Teacher's response	+	Enabler
12	Trust	+	Enabler
13	Challenges	-	Constraint
14	Connectivity Issues	+	Constraint
15	Lack of training	+	Constraint
16	Stress & Anxiety	-	Constraint
17	Technical Problems	+	Constraint
18	Platform Usability	+	
19	User Experience	+	
20	Student intention to use	+	

The stock-flow model is representing data collected percentage as value for simulating and forecasting results. Based on total responses received (163 in this case) learning & assessment features of the virtual platform were used and outflow of user's feedback of these platforms can be seen as contributing variable to the intention of future use.

Data Collection

The Survey questions were a mix of dichotomous questions having statements, comments, and general information of respondents necessary for analysis. The data from respondents collected has been refined for further analysis in an excel spreadsheet. Based on judgemental sampling a total of 163 responses were received which is 54% of the total strength of the targeted group of MBA course strength at Dayalbagh Educational Institute, Deemed University, Dayalbagh, Agra 282005. (see Table 3 - Data Collection.

Table 2 *- Data Collection*

Tools for Data Collection	Survey through questionnaire
Sampling frame	Students using online platforms
Sample Size	163 Respondents
Data	Primary Data
Analysis	Systems dynamic Modeling

4. Modeling & Simulation Stella Software

There is plenty of software available for the simulation of systems models in the market based on functionality and area of use, (Fitzgerald & Larsen, 2009). Here we have used STELLA 9.1 for educational purposes. With help of Stella here we have created the model with the rate of variables which are either online learning system enablers or constraints with help of data collected, after completion of the construct of the model, it has been simulated, tested, and re-run. (Lindfield, 1992).

The first order of business for representing the state of any system is to define system boundaries. The system boundary for this simulation is the usability factors of the virtual learning platform. These online platforms were instructed by the institute to be used for online learning during the lockdown. The variables used in stock and flow modeling are taken from the construct of survey questions designed in this study. The responses received were converted into percentages and put as the value in this model (Figure 3).

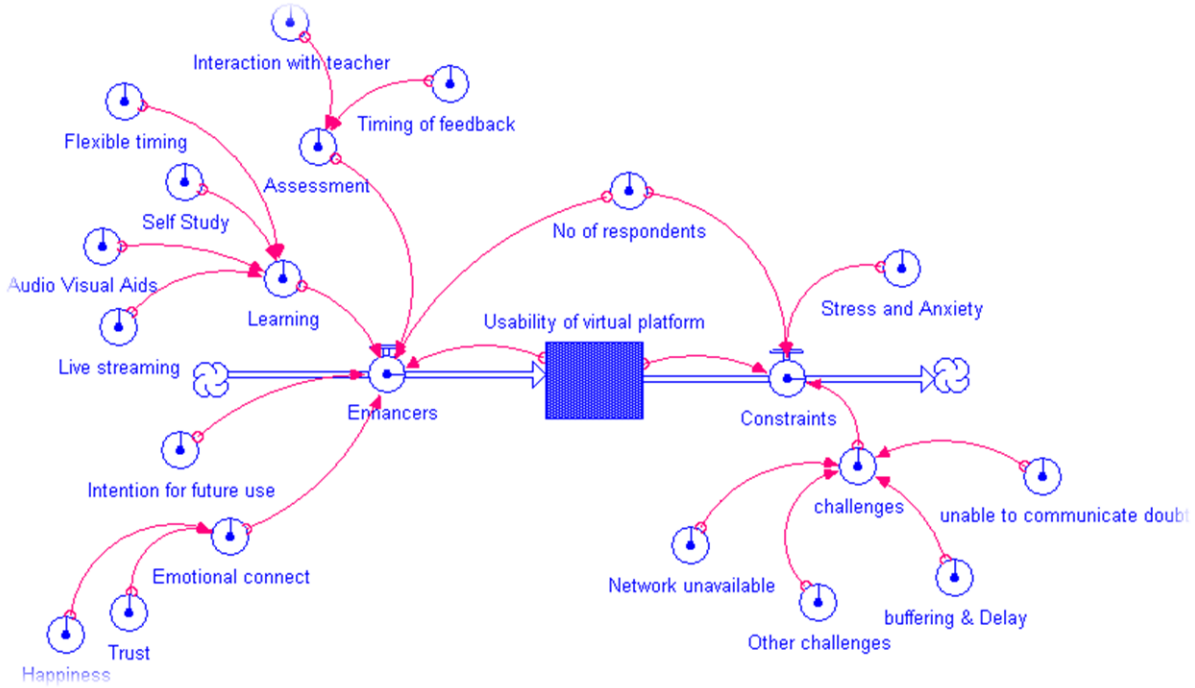

Figure 2 *- Stock flow diagram of virtual platform usability*

For documenting the model, a list of mathematical equations has been given in Table 4. A list of variables, their reference from survey questions, total no of responses, and percentage value put into the model has been tabulated in Table 5. In the end, details of stock variable as total responses received have been mentioned in Table 6.

Total 22 variables are included with 1 stock, 1 inflow, 1 outflow, and 19 auxiliary variables. The stock variable of usability of virtual platform is the initial percentage which is expected to grow with usages. Inflow for the responses is the virtual platform features that were used by students during lockdown for learning & assessment. Feedback as an outflow from total responses received was determined by auxiliary variables of emotional state and challenges faced.

Table 3 *- Equations and units used of variables*

Variable Name	Variable Category	Unit	Equation
Usability of the virtual platform	Stock	%	Usability of virtual platform (t - dt) + (Enhancer - Constraints) * dt
Enhancers	Infow	%	Assessment*Learning*Usability of the virtual platform*Emotional connect*Intention for future use/No of respondents
Constraints	Outflow	%	Usability of virtual platform*challenges*Stress and Anxiety/No of respondents
Assessment	Auxiliary	%	Interaction with teacher+Timing of feedback
Challenges	Auxiliary	%	Network unavailable+buffering & delay+unable to communicate doubt+other challenges
Emotional connect	Auxiliary	%	Happiness + Trust
Learning	Auxiliary	%	Audio Visual Aids+Flexible timing+Live streaming+Self Study

Auxiliary variables mentioned in below table 6 contain the statements and questions construct from which variables have been chosen, its total respondents, and percentage value out of 163 responses. All units of this model are in percentage.

Table 4 *- Values and Unit of variable*

Variable Name	Variable Category	Question statement	No. of Responses	Value in model	Unit
Audio-Visual Aids	Auxiliary	The online platform could be used creatively to do things in the physical space and share in online mode	144	0.91	%
Network unavailable	Auxiliary	Challenges	63	0.38	%
Flexible timing	Auxiliary	The online platform allowed me the flexibility to learn at the convenience	134	0.85	%
Happiness	Auxiliary	Emotional State during COVID-19 online classes	46	0.28	%
Buffering & delay	Auxiliary	Challenges	22	0.13	%
Interaction with teacher	Auxiliary	The online platform allowed me to respond to the teacher if required	145	0.88	%
Live to stream	Auxiliary	I was able to keep in touch with the class through the online platform	131	0.81	%
unable to communicate doubt	Auxiliary	Challenges	19	0.11	%
Intention for future use	Auxiliary	Intention to use google classroom	113	0.6	%
Other Challenges	Auxiliary	Challenges	59	0.36	%
Self-Study	Auxiliary	I believe I have learned many new aspects of the course since I joined the online platform	121	0.77	%
Stress & Anxiety	Auxiliary	Emotional State during COVID-19 online classes	41	0.25	%
Timing of feedback	Auxiliary	The online platform allowed me to check my grades	142	0.89	%
Trust	Auxiliary	Emotional State during COVID-19 online classes	13	0.07	%

Table 5 - *Stock variable value and unit*

Variables	Initial Value in model	Unit
Usability of the virtual platform	.1	%

The initial simulation of the stock and flow diagram is depicting a promising picture (Figure 4). In the graph, it is seen that upon simulation the situation of the system is improving by reduced constraints at around 7-8 months over one year. Hence based on the model constructed and data used to simulate the use of virtual learning mode, the constraints can be reduced by applying actual solutions to internet and connectivity issues only.

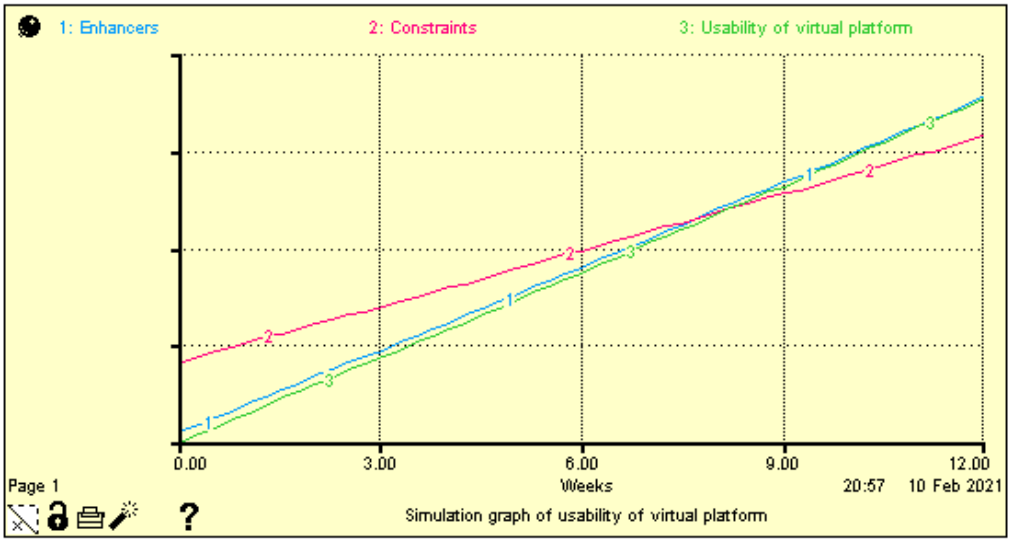

Figure 3 *- Simulation graph of the initial condition*

5.Testing & Validating the Model

Validating the model means testing if the model is representing the true state of the systems or not. an extreme condition test for model validation has been done by assigning extreme values to the input variables of this model.

Scenario 1. The value of auxiliary variable no. of respondents was changed from 163 to an extreme value of zero. Which resulted in no simulation result and validating the variable used in the model in Figure 5.

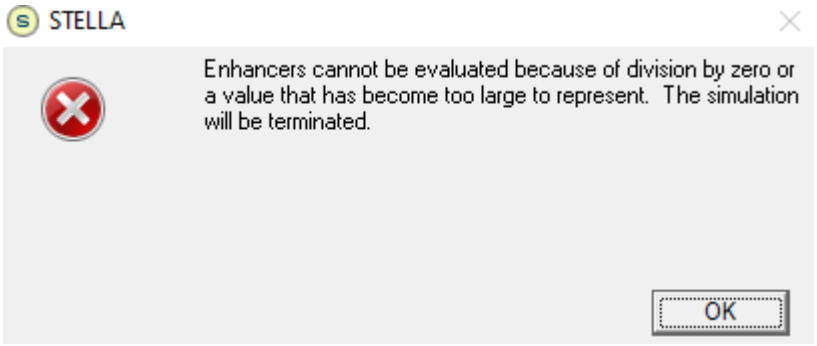

Figure 5: *Dialogue box for no Simulation of Scenario 1 for validation*

Similarly, in Figure 6, for **Scenario 2** we changed the value of the variable 'future intention to use' from 0.6 to zero which resulted in a decline in the usability of the platform in the future and constraints, which confirms if there is no desirability for future use the usability and constraint will reduce. Hence indicating that the model is representing the current situation in the most realistic way.

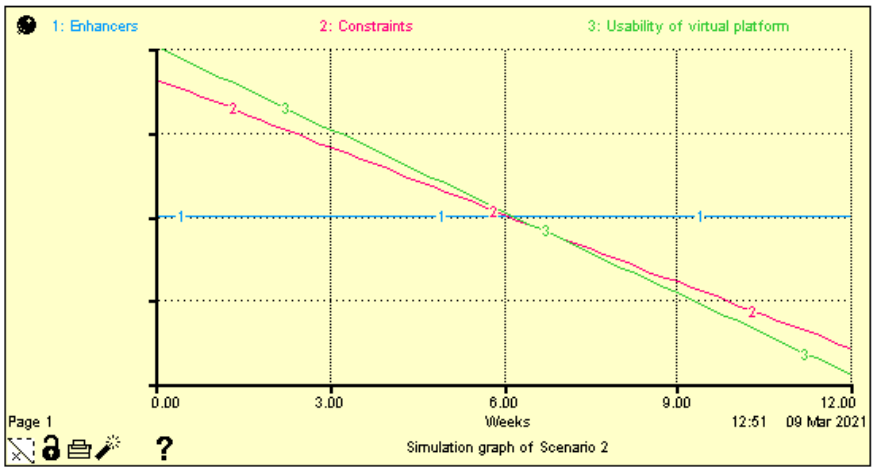

Figure 6 *- Simulation graph of scenario 2 (Extreme condition test)*

We also ran a third scenario Figure 7, for testing any behavior anomaly test, where simulation results for the usability of virtual platforms were improved upon removing the technical challenges from the model. This gave the desired scenario for post-covid-19 continued usage of the online platform, below is the simulation graph of the same.

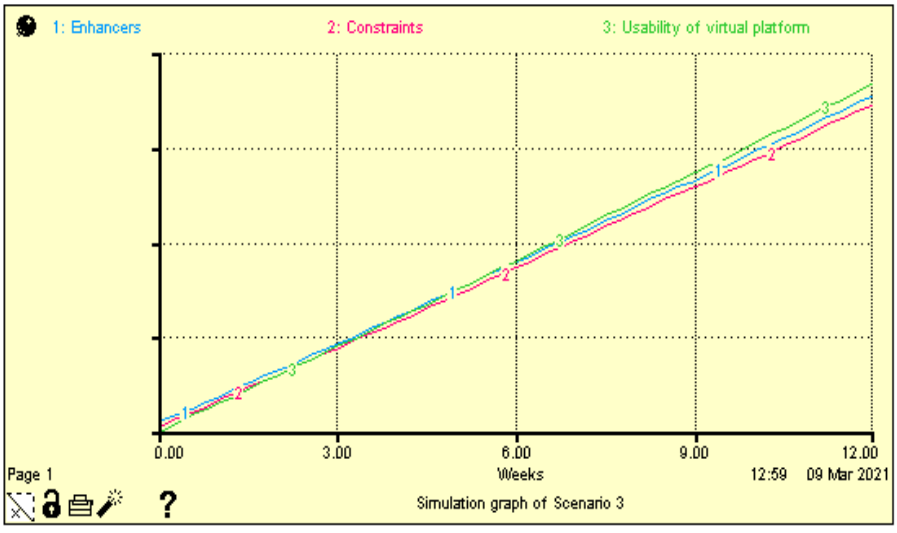

Figure 4 *– Simulation graph of scenario 3 (Behavior Anomaly test)*

Suggestions for improvement

This quantitative study is an eye-opener and gives an insight into student's feedback in various areas for future research. And if efforts are made to reduce the challenges, they are happy to continue learning over virtual platforms. (Almeida et al., 2020). The future areas of research may be identifying variables in enhancing the model to build more practical enhancers and constraints along with improved variables in the model. For an online learning platform to reach the last mile all stakeholders must collectively put efforts for improvement where necessary to reach desired usability intention.

A. Product Improvement

Suggestions like to improve navigation features for search capability on google classroom streams, integrating shortcuts of google calendar, google meet, google keep and google task list on side panels of google classroom for ease of access, adding radio button to mark daily attendance in google meet must be used to enhance product features.

B. Other Improvement areas

Connectivity improvement . Internet connection issues were the main cause of stress and anxiety, faced during online classes. To resolve these issues internet service provider should provide student data pack while verifying their student ID proofs and provide more data available for classes, for stable internet bandwidth, a network router must be installed for better reception of the network.

Communication improvement . The institution must make their notices and announcements available to every student, same of goes for teachers for clearing doubts, student counselor to meet with students in regular intervals and be available in case student needs counseling.

These suggestions are the actionable and practical implications as well following which will help to bring down the stress and anxiety levels significantly in students as internet connectivity issues and non-availability if telecommunication infrastructure stands as a major barrier in online education continuity (Ouma, 2019).

Limitations

The findings of this study were limited to the students of DEI. To generalize the model and seek its applicability, this study may be suggested for replication in other universities. Secondly, only students' user experience has been captured. The study may be expanded to take into account for capturing feedback of teachers and parents. Thirdly, it is focusing on google products only, other platforms like apple classroom, canvas are not considered. And the last one is that it is limited to the Indian context only.

Conclusion

A holistic approach has been considered here to understand the dynamics of decision variables that could. Online learning has been useful for education and the teaching community, New uses of the classroom can be found out by using other consensus-building techniques like AHP, NGT, to figure out more uses when COVID-19 is over.

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