

GENERAL SYSTEMS THEORY: MUTUAL CAUSALITY AND THE EFFECTIVENESS OF UNIVERSITY E-LEARNING IN LEBANON DURING A PANDEMIC

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ABSTRACT

This study contains a literature review on how the concept of *general systems theory* has evolved throughout history and has led to a concept called *mutual causality*. From this, a case study on the effectiveness of e-learning at universities in Lebanon during a pandemic was done and the effectiveness was shown through a *causal loop diagram* which describes what is occurring in a system. Positive and negative feedback loops have been formulated to show the causality among variables, be it internal variables from within the education system or variables from the external environment. The study also formulated a thematic framework of the different elements of causality, some of which include: the pandemic, the financial and political distress, motivation, technology, stress, fatigue, unsatisfactory salaries, increase in the cost of living, and interruptions and distractions.

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1. INTRODUCTION

Everywhere you go, you hear claims that this causes that and that this is the effect of that, from politics, to weather, to the stock market, to personal relationships, etc. It is human nature to try and explain things. We always tend to create stories that make sense and find reasons to actions happening with us or around us. A Sufi tale tells of how a village of blind people declared that they knew what an elephant looked like by each grabbing one part of it. One felt its ear and said it was a fan, another felt its leg and said it was a pillar, a third felt its back and said it was a rug, and a fourth felt its trunk and said it was a snake. But, by only experiencing one part of it, each of the blind men was wrong. Daily in our lives we tend to look at parts rather than seeing the bigger picture of how the world around us functions. Why do we do that? Probably because we are used to such a way of thinking. When we were kids at school we took each subject separately—mathematics, sociology, economics, physics, literature, chemistry, arts, etc. This even continues to university level, where one majors in one discipline. But if we are to understand this world and how complex it is, we need to see a larger view. We have to think in systems, because complex problems require systems thinking. Systems thinking is about a perspective shift from parts to the whole. It is a method to help people approach a problem. To see a problem using systems thinking is to see relationships instead of objects, to map connections instead of measure them, and to use qualitative analysis rather than quantitative. This paper will use the concepts of systems thinking and causality theory to examine the relationships and impact of different parameters on the effectiveness of university e-learning in Lebanon during a pandemic.

2. LITERATURE REVIEW

2.1 General systems theory

To understand systems theory, it is best to look at where and when it first originated and how it came about in time. Ever since Aristotle talked about knowledge in terms of the whole and not the parts, a concept he called Holism, researchers have been trying to solve the mystery and complexity of the world we live in. “Aleksandr Bogdanov, the Russian revolutionary, philosopher and scientist, has a good claim to being regarded as the founder of systems theory” (Gare, 2000, p.341). Gare (2000) adds that “His ‘tektology’ (1926-28), that is, his new science of organisation, not only anticipated and probably influenced the ideas of Ludwig Von Bertalanffy—who must have been familiar with his work, but anticipated many of the ideas of the complexity theorists” (p.341). In 1940, Ludwig Von Bertalanffy developed a “General Systems

Theory.” He was all about the organism, truly fascinated by the many different parts or systems that seem to function within and around it. He believed that fellow theorists around the world should approach science and communication for that manner in a way that considers the environment in, within, and surrounding the organism. Bertalanffy (1968) said that science has always investigated phenomena “independently of each other, ... conceptions appear in contemporary science that are concerned with what is somewhat vaguely termed wholeness (emphasis added)” (p.36, para. 4) He adds that “systems of various orders are not understandable by investigation of their respective parts in isolation (emphasis added)” (p.37, para. 1). Meanwhile, systems theory was furthered by the work of three researchers who each discussed it through concepts of Game theory (Neumann and Morgenstern, 1947), Cybernetics (Wiener, 1948) and Information Theory (Shannon and Weaver, 1949).

2.1.1 Open and closed systems

“All things by immortal power, Near or far, Hiddenly to each other linked are, That thou canst not stir a flower, Without troubling of a star.” This poetic portion from Francis Thompson shows how nature in its complexity expresses unity, from small things like a flower to huge more sophisticated ones like a star. Just like the “butterfly effect” (Lorenz, 1963), in which little changes in initials—like the butterfly flipping its wings, provokes deep changes in results—like a tornado. These examples show the interrelatedness of nature and the universe, which is a key conceptual theory of open systems. Classical management theorists have always looked at organizations as closed systems neglecting the importance of the environment in which these organizations are (Rao & Krishna, 2009, p.68). Bertalanffy (1968) defined closed systems as “systems which are considered to be isolated from their environment” (p. 36). Open systems theory, on the contrary, emphasizes the importance of the environment. It defines organizations as “interrelated subsystems . . . [that] focus on the attempt to establish congruencies or ‘alignment’ between different systems” (Morgan, 1997, p. 42). Figure 1 shows how organizations are viewed in terms of the input they receive, which could be in the form of raw materials, for instance. This input is transformed into what we call output, which should satisfy a need or a goal, such as making a customer happy.



Fig. 1. Open System Concept

“Traditional approaches to organization theory have been dominated by the idea that change originates in the environment,” and that “there is agreement that the major problems facing modern organizations stem from changes in the external environment” (Morgan, 1997, p. 253). However, this agreement is “challenged by the implications of a new approach to open systems theory developed by two Chilean scientists, Humberto Maturana and Francisco Varela” (Morgan, 1997, p. 253). Maturana and Varela (1980) say that an organization’s environment is part of itself and that is why it is considered to be a closed system. They talked about a concept called autopoiesis that often means circularity. “In their terms, an autopoietic system is open in structure where components enter and leave, but is closed in its organization where its relations are closed as in a circle” (Razetto-Barry, 2012). Therefore, there is a belief that there is “no beginning and no end to the system because it is a closed loop of interaction” (Morgan, 1997, p.254).

2.1.2 Mutual causality (The second cybernetics)

The study of Autopoiesis has led more researchers to search for a better understanding of the concept of circular patterns. In 1990, a theorist by the name Peter Senge took open systems theory one step further and developed the idea of open systems thinking. He called it the “Fifth Discipline,” which is the ability to see the consequences of one’s own action—to see the connections in any situation and to better understand how things unfold over time. In essence, it is no longer advisable to think in linear forms; we rather need to think circularly. Maruyama (1961) discussed the same concept in a theory he called mutual causality or the second cybernetics. “The second cybernetics is of crucial importance in allowing cybernetic theory to break free of the steady-state models that dominated early development of the discipline” (Morgan, 1997). Wiener (1948), saw cybernetics in the form of mechanistic causality and defined it as “the scientific study of control and communication in the animal and the machine.” Therefore, the main difference among the two cybernetic terminologies is in the way one should think, that is, loops instead of lines. Thus, systems theory is all about causal feedback systems. Feedback, from what we know it and according to Cambridge Dictionary (n.d.), is “information or statements of opinion about something, such as a new product, that can tell you if it is successful or liked.” But according to Senge (1990) there isn’t a sole factor that is responsible for changes in a system. “Numerous cyberneticians have attempted to develop methodologies for studying mutual causality and how systems engage in their own transformation,” said Morgan (1997). Maruyama was one of those cyberneticians who focused on the concepts of positive and negative feedbacks and how those concepts affect change.

2.1.3 Causal loops: Positive and negative

In a causal loop, arrows are used to relate a cause to its necessary effect but in a circular way not in the traditional linear manner. An example of linear causality would be in Figure 2, where we have a problem, then an action is taken and the problem ends.



Fig. 2. Linear Causality

Causal loops show that the story doesn't really end there, but rather the end of the problem comes back and produces alternative action and the cycle goes on like in Figure 3.

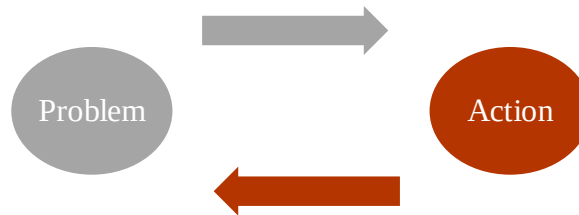


Fig. 3. Non-linear Causality

There are two types of loops: reinforcing or +ve (Figure 4) and balancing or -ve (Figure 5). When elements in a loop rise or fall in the same direction over time the loop is said to be reinforcing. And when elements oscillate by going up and down, the loop is said to be balancing.

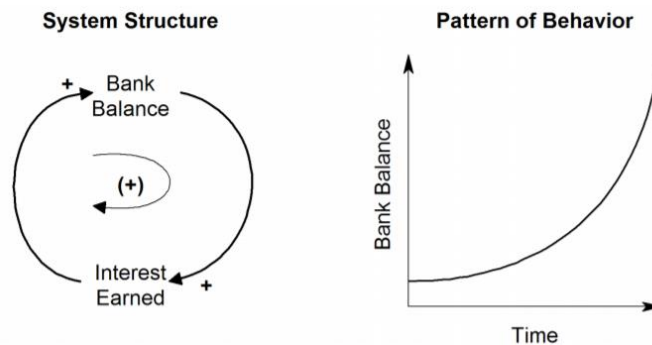


Fig. 4. Positive or Reinforcing Loop (source: Richardson and Pugh, 1981, p.3)

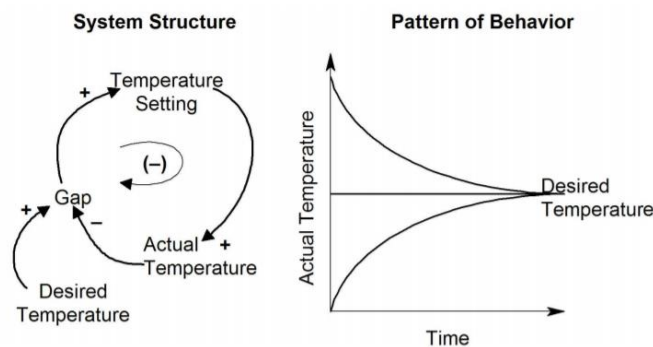


Fig. 5. Negative or Balancing Loop (source: Richardson and Pugh, 1981, p.3)

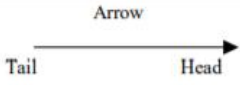
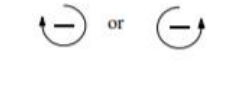
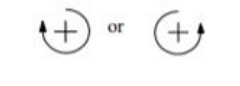
Symbol	Meaning
	The arrow is used to show causation. The item at the tail of the arrow causes a change in the item at the head of the arrow.
	The + sign near the arrowhead indicates that the item at the tail of the arrow and the item at the head of the arrow change in the <i>same</i> direction. If the tail <i>increases</i> , the head <i>increases</i> ; if the tail <i>decreases</i> , the head <i>decreases</i> .
	The - sign near the arrowhead indicates that the item at the tail of the arrow changes in the <i>opposite</i> direction. If the tail <i>increases</i> , the head <i>decreases</i> ; if the tail <i>decreases</i> , the head <i>increases</i> .
	This symbol (also B), found in the middle of a closed loop, indicates that the loop continues going in the same direction, often causing either systematic <i>growth</i> or <i>decline</i> , behaviour that unstable moves away from equilibrium point. This is called a <i>positive feedback loop</i> .
	This symbol (also R), found in the middle of a closed loop, indicates that the loop changes direction, causing the system to <i>fluctuate</i> or to <i>move toward equilibrium</i> . This is called a <i>negative feedback loop</i> .

Fig. 6. Summary of Concepts (source: Roberts et al., 1983)

In the sections to follow, we look at some literature on crisis management, its relation to universities, and how, together, they relate to the theory of mutual causality.

2.2 Crisis management in a pandemic

Pandemics have taken place periodically throughout history: the plague in the middle ages, cholera in the 19th century, and the multiple influenza epidemics in the 20th century. We cannot stop such outbreaks from happening, but what could be done is better preparedness to reduce their impact. When an outbreak is not detected and action is not taken properly and at the right time, the results are costly. Crisis management enables individuals, communities, emergency response organizations, companies, NGOs, and governments to anticipate effective responses to such pandemics. “The crisis management concept consists of rescue, preparedness, mitigation, and resilience efforts made by governments, volunteer organizations or other local departments (Petak, 1985).” “Unlike risk management, which involves planning for events that might occur in the future, crisis management involves reacting to negative events during and after they have occurred (Hayes, 2019).” Hayes (2019) adds that “Due to the unpredictability of global events, organizations must be able to cope with the potential for drastic changes in the way they conduct business.” In crisis management there is a requirement for decisions to be made very fast at the time of the crisis and even after. There are several steps that organizations need to do to have an effective crisis management plan. The first step is to build a team of experts from different fields be it health, strategy, risk management, academic, legislative, and even financial. The team will initiate the second step. They would prepare a plan that clearly states the strategies that the organization will follow. There will definitely be a shift from a comfortable state to an uncomfortable one, but provided that this uncomfortable state of anticipation and turmoil would not compromise achievements, the team is good to go. Lastly, after implementation, the team needs to continuously monitor the plan and most importantly adjust it as needed. “You may also find it useful to cultivate relationships with local health authorities so you know what their plan is, and their limitations, allowing you to best manage your operations (Druckman, 2006).”

2.3 E-Learning during a pandemic

Universities need to develop plans as well. Dittbenner (2009), discussed that one of the “elements of an effective pandemic planning process” is to “plan for continuity of operations.” He stresses the need to have a solid understanding of the threats that could arise from absenteeism, failure in the services, and interruptions (Dittbenner, 2009). During pandemics, universities must keep going. Those who fight the right fight will see the results after the pandemic has ended. The reputation of the university will be dependent on how it reacts during times of crisis as such. You need to keep going, that is true, but you need to do it effectively. E-learning in itself, provided in times of stability and control, has proved to be effective with certain limitations. Even face-to-face learning has its drawbacks. When in the US, talking about the “No Child Left Behind Act” and seeing that children are still being left behind, we cannot but say that reaching learning outcomes with zero failures is simply not reality. “The design process and the careful consideration of different design decisions have an impact on the quality of the instruction. And it is this careful design process that will be absent in most cases in these emergency shifts (Hodges, Moore, Lockee, Trust & Bond, 2020).” Therefore, the key characteristic of e-learning during a pandemic, which we need to differentiate from the regular well-monitored and carefully-planned e-learning, is the term emergency. We cannot judge the effectiveness of e-learning during a pandemic only by comparing it to

face-to-face learning or to regular online classes during healthy times. Effectiveness now has to be studied from a holistic point of view. By far, we saw how systems theory has evolved over time and has led us to the concept of mutual causality. Now, Mutual causality/Causal Loop Diagram will be used to formulate feedback loops on how the environment as a whole affects e-learning during a pandemic.

3. RESEARCH METHODOLOGY

The goal of this study is to better understand the factors that hinder student interaction, focus, participation and engagement in an online course during a pandemic and their "causal" relationships. To attain this goal, a qualitative approach was designed using two surveys. The surveys were meant to understand what causes positive and negative feedbacks on certain elements of e-learning. Questions asked in the survey and the results collected, helped draw links holistically and form a mutual causality/causal loop diagram (CLD).

4. DATA AND PARTICIPANTS

The first survey was distributed electronically to 130 university students currently enrolled in online classes. The students come from private and public universities across Lebanon which makes it fairer from a financial point of view. The second survey was distributed electronically as well, given the current pandemic and lockdown, to 40 university professors currently teaching online classes. The professors also teach in multiple universities all over Lebanon. Data from the surveys, prepared through Google Forms, were then transferred to SPSS software for analysis. Frequency tables were generated, and the results were used to generate a causal loop diagram using "Visual Paradigm", a software that helps transform data into models.

5. RESULTS AND ANALYSIS

5.1 Student survey results

Frequency tests were conducted and the results showed that the access to technology was not a problem, at least to 91.5% of students who mentioned that they either had access to a personal laptop or they had to share one. 83.1% of the students also had connectivity and data, but the speed of the internet was a problem to 81.5% of the 130 students. The internet speed is causing 71.5% to face visual or auditory problems with the media. Aside from internet connectivity, only 3.8% of students had no interruption problems compared to the other 96.2% who faced ones such as distraction in the house that resulted from noise, doorbells, chatting, electricity cut-down, and technology failures. These interruptions must have resulted as well from the fact that 53.9% of the students had no private space to study. 76.2% of students are finding it merely effective to not effective at all to understand the material taught through online platforms. Only 11.5% say they were highly engaged and 58.5% would want to go back to their face-to-face interactions. This must have affected the results to their level of motivation with 51.5% not motivated, opportunities they had to interact with the teacher with 35.4% rated unsatisfactory, and how isolated they felt from other students with 66.2% ranging from mild to complete isolation. The general quality of e-learning amidst economic, political, and healthcare turmoils was found to have 36.2% of dissatisfaction to high dissatisfaction, and only 19.2% of satisfaction to high satisfaction. The economic and healthcare (pandemic) situations are affecting 92.3% of students with 46.2% very badly affected economically and 56.9% very badly affected by COVID-19; whereas the political situation is affecting 80.8% with only 27.7% very badly affected. Two-tailed Pearson bivariate correlation tests were done and the results showed that the effect of the pandemic had moderately positive correlations with the general quality of e-learning ($p = 0.289$), with the internet speed ($p = 0.186$), with the motivation to work online ($p = 0.306$), with the economic situation ($p = 0.375$), with the political situation ($p = 0.384$), and with the effectiveness of understanding the material being taught ($p = 0.219$). An overall model system also known as causal model was also done through SPSS and showed the following links and interactions among the variables (Figure 7).

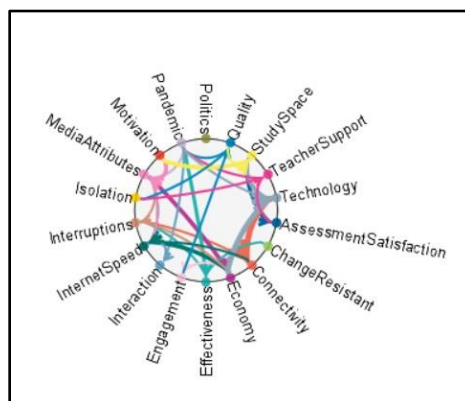


Fig. 7. Overall Model System (Student Survey)

5.2 Teacher survey results

Frequency tests were also made on the teacher survey data on SPSS and it showed that 42.5% of the professors had unreliable internet speed. Aside internet connectivity, 85% faced interruptions such as distractions in the house, electricity cut-down and technology failure leaving 15% who had no other interruptions. 30% of the professors had problems handling technology and 27.5% who had problems too but less often. The problems some professors wrote about were the preference of face-to-face than to sitting facing a laptop, others had problems understanding technology and platforms, and others simply hated it or disliked it and preferred books to laptops. 50% of the professors enjoyed teaching online, 15% were indifferent leaving 30% of professors who would rather go back to the classroom. 82.5% of professors said they needed more preparation time for an online class than is the time needed for courses taught in the classroom. None of the professors said that less prep time is needed. 57.5% of the professors' enthusiasm was affected to highly affected by the reduction in their pay check or the increase in the cost of living. When asked about the ease of assessing students through online platforms, 60% said it's very hard and 52.5% were somehow dissatisfied with the results of the assessments.

The economic, political, and healthcare situations are affecting to very badly affecting 82.5%, 80%, and 90% of professors respectively. However, 70% of them are highly satisfied with their performance during classes. In the same survey, professors were asked question about their students' level of enthusiasm and level of engagement, 70% and 67.5% said the students had low levels respectively. As for the level of difficulty in understanding the material being taught, 67.5% said their students had difficulties that ranged from moderate to very high. 37.5% of professors were satisfied to highly satisfied with the attainment of learning outcomes. Finally, all professors had 75 to 100% attendance in their online classes. In an open-ended question, when asked about improvements they would like to see happen to e-learning in Lebanon, most of the professors wanted that the government be more involved in better designing classes, have training for professors, and solve the quality of the internet. One teacher said that something to be done could be to "Improve/Create elements of e-learning process, such as: secured evaluation for independent assessment, easy storage and access to collected materials from online sessions and enhance technological support." Another said that "Students need to read better. They can't do online learning without it. And faculty need time to prepare, as being thrust into this with no time makes it hard."

Two-tailed Pearson bivariate correlation tests were done and the results showed that the effect of the pandemic had high positive correlations with the economic situation ($\rho = 0.648$), with the political situation ($\rho = 0.565$). It had moderate positive correlations with the reliability of the internet ($\rho = 0.296$), performance of the teacher ($\rho = 0.295$), the students' enthusiasm ($\rho = 0.195$), the students' engagement ($\rho = 0.263$), and the attainment of learning outcomes ($\rho = 0.253$). An overall model system also known as causal model was also done to the teacher survey results and showed the following links and interactions among the variables (Figure 8).

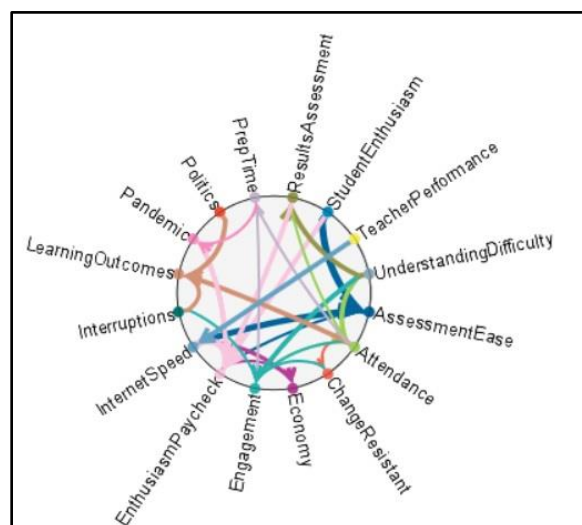


Fig.8. Overall Model System (Teacher Survey)

5.3 Causal loop diagram and discussion

Mutual causalities were drawn based on the data retrieved and analyzed, in addition to some personal experience in the field (see figure 9 below). Red arrows designate negative feedbacks while blue arrows designate positive ones. Figure 9 depicts 2 main elements being influenced by the pandemic, the professor and the student, around whom data has been gathered. Another element of importance, which I would name the "end" is the e-learning quality and how the pandemic and other means have led to this end. It also points to 5 main loops. "Loop 1" shows how less student motivation yields less participation which in turn reduces performance, then lack of performance encourages the students to work harder and get

motivated again. "Loop 2" shows how less interaction yields less knowledge being shared which then yields slow feedback from the teacher. "Loop 3," similar to the first loop, shows how less teacher motivation yields less enthusiasm to work hard which in turn yields less performance that in itself encourages teachers to be motivated to work harder. "Loop 4" shows how more preparation time for the courses leads to increased fatigue and stress that decreases motivation, then decreased motivation would reduce the amount of prep time the teacher puts because he/she are not motivated to work harder. Finally, "Loop 5" shows how the lack of technology aptitude hence disliking technology or having problems with it, increases the difficulty of being able to assess students online which in turn reduces satisfaction in online assessment techniques and student results.

With the Pandemic as a start point, the diagram shows that the repercussions of this crisis has generated positive feedback on the amount of stress the students are facing. This increase in stress has generated a negative feedback loop on their motivation to work hard that resulted in Loop 1. From Loop 1, their performance have been reduced which led a negative feedback on result satisfaction which in turn led to Loop 5. In addition, this decrease in motivation has led to negative feedback on the quality of e-learning. Going back to the Pandemic factor, we see that it has also generated positive feedback on the amount of isolation which in turn generates a negative feedback on interaction that leads to Loop 2. With reduced knowledge from Loop 2, we see that this results in a positive feedback on unattainable learning outcomes that in turn result in a reduced quality of e-learning. Moreover, the Pandemic factor has caused positive feedback on the amount of fatigue and stress the teacher is facing, leading to both Loops 4 and 3 respectively. When the teachers enthusiasm in Loop 3 diminishes, his/her interaction with students diminishes too bringing us back to Loop 2.

With the Economic and Political Distress as a start point, the diagram shows that positive feedbacks have been generated as well. The first was on the reduced paychecks or increase in the cost of living, which drives motivation backwards and increases teacher stress leading again to both Loops 4 and 3. These turmoils are causing increases in student stress as well leading to Loop 1. With both Interruptions or Distractions and Unreliable Internet as start points, the diagram shows that they have a negative effect on the motivation of the student to work hard thus leading to Loop 1 again. Unreliable Internet has caused more auditory and visual problems during the course too. Both factors increase student and teacher stress. With E-Learning as a start point, the diagram and results from professor surveys show that it requires more prep time compared to preparations for courses given inside the classroom. More prep time leads Loop 4. Thus, e-learning is negatively affected by unattainable learning outcomes, student motivation and teacher motivation.

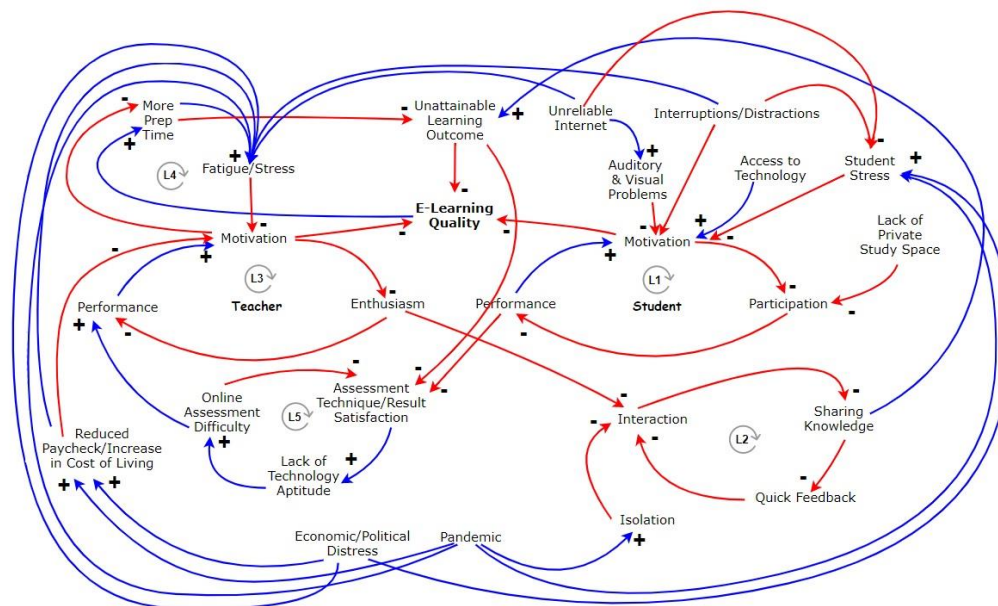


Fig.9. Causal Loop Diagram on the effectiveness/quality of e-Learning

Table 1. CLD Thematic Framework

Factor	Positive Feedback	Negative Feedback
	Isolation	
Pandemic	Student Stress	
	Teacher Fatigue/Stress	
	Reduced Paycheck/Increase in COL	
Economic/Political Distress	Student Stress	
	Teacher Fatigue/Stress	
Interruptions/Distracton	Student Stress	Student Motivation
	Teacher Fatigue/Stress	
Unreliable Internet	Student Stress	
	Teacher Fatigue/Stress	Student Motivation
	Media Problems	
Unattainable Learning Outcome		E-Learning Quality
E-Learning Quality	More Prep Time	
More Prep Time	Teacher Fatigue/Stress	
Teacher Fatigue/Stress		Teacher Motivation
Teacher Motivation		Teacher Enthusiasm
		E-Learning Quality
Teacher Enthusiasm		Teacher Performance
		Interaction
Teacher Performance	Teacher Motivation	
Reduced Paycheck/Increase in COL	Teacher Motivation	
	Teacher Fatigue/Stress	
Lack of Private Space to Study		Student Participation
Student Motivation		E-Learning Quality
		Student Participation
Student Participation		Student Performance
Student Performance	Student Motivation	Assessment Result Satisfaction
Lack of Technology Aptitude	Online Assessment Difficulty	Assessment Result Satisfaction
Isolation		Interaction
Interaction		Sharing Knowledge
Sharing Knowledge	Unattainable Learning Outcome	Quick Feedback
Quick Feedback		Interaction

6. LIMITATIONS AND FUTURE RESEARCH

Although the study allows for a clearer history of general systems theory and its time line, in addition to providing a clear diagram of variables and factors affecting the effectiveness of e-learning in Lebanon, it has its limitations and from them it formulated recommendations for future researchers and practitioners:

1. Statistics show that the number of students registered in higher education in Lebanon total 210,720 students back in 2018 with a growth rate of around 5% yearly (Students in Higher Education, 2018), which leaves the sample size of the study minimal. Recommendation: Increase sample size to reach a bigger number of students as well as teachers from multiple universities.

2. The data collection process was done during the pandemic and with a limited time frame. The results of this study proved that the pandemic has direct effects on stress levels and this itself might have caused students and professors to give different feedback than they would have during normal situations. Recommendation: Collect data after the pandemic is over and compare results when the timing is more suitable.
3. Due to forced lockdown, the research methods were limited to online surveys. Recommendation: Conduct personal interviews or focus groups with open-ended discussions.
4. The study was looked upon from a pandemic view, whereby e-learning could have more variables knotted to it. Recommendation: Study more variables to e-learning such as the teacher's experience, topic interest, test fear, complexity of topic, etc.

7. CONCLUSION

Exploring the different factors and variables that play a role in addressing the effectiveness of e-learning at universities in Lebanon during the COVID-19 pandemic was the main aim of this research. To understand the interaction between those multiple factors, the research used the concept of mutual causality rooted back to the concept of general systems theory. The study had data collected from surveys distributed to university professors and university students. Data was transferred to SPSS for analysis and sent further to Visual Paradigm for formulating a causal loop diagram. The results of the study showed the interdependency among different variables. These relationships moved in circular positive or negative feedback loops. In conclusion, the CLD diagram showed that factors influencing the effectiveness of e-learning and its quality are: the pandemic, the financial and political distress, motivations of both teachers and students, technology aptitude, stress, fatigue, unsatisfactory salaries, increase in the cost of living, interruptions and distractions, etc. This study will help future researchers, current and future teachers, and students understand that the e-learning system is not a standalone, it is affected by other systems around it and thus cannot be determined by its parts alone.

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