

Evaluation of Student Outcomes in Remote Learning using Structural Equation Modelling: The Philippines Settings during COVID-19 Pandemic

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Abstract

COVID-19 pandemic hampered the global economy and movement of people. Education which is traditionally delivered in face-to-face settings was severely affected. This led to the temporary closure of schools and universities around the world. To ensure continuity of teaching delivery, academic institutions adopted full online learning. The sudden adoption of remote learning gained different feedback from various stakeholders. The Philippines, as one of the developing economies in Southeast Asia, had reached the mark in terms of the total no. of cumulative cases, placing the country in the 11th to 20th bracket. Due to this prolonged mode, students shared increasing dissatisfaction towards remote learning. This research aims to understand the causal relationship of dissatisfaction factors namely: 1) Academic Teaching, 2) Academic Support, 3) Accessibility, 4) Learner and 5) Community Social through Structural Equation Modelling (SEM) and 12 Engineering program outcomes designed by the Commission on Higher Education (CHED) in terms of knowledge, skills, and attitude. Results show that all dissatisfactions factors have a direct influence on specific program outcomes. SO1, SO2, SO3, SO5, SO9, and SO11 were identified to be critical and need to be attended by HEIs.

Keywords

Outcomes-Based Education, Program Outcomes, COVID-19, Structural Equation Modelling, Service Systems

1. Introduction

The COVID-19 (Coronavirus) pandemic has affected day to day lives of people. The impacts of this predicament were seen and felt in the (1) healthcare, (2) economic, (3) social aspects of the economy. Indeed, the challenge to strengthen global healthcare systems to cope with the alarming rate of cases is difficult. Financial implications to businesses such as disruption of supply chain, poor cash flow in the market, and significant decrease in the revenue growth are evident as well. Service sectors are hampered in delivering properly their intended services, closure of places, schools, postponement of social activities were experienced by different countries (Haleem & Javaid, 2020). Since the start of COVID-19 pandemic, the global economy has been abrupt. This resulted in closure of schools around the world (Henaku, 2020). To ensure continuity of education, school and universities adopted full online learning. The sudden shift to distance learning brought by the pandemic challenged Higher Education Institutions (HEIs) especially

professors to be innovative in teaching-learning delivery for their students (Lapitan et al., 2020). The prolonged closures of schools impacted both students, families, and educators to adopt distance learning. Moreover, the closure of schools brought a physical and emotional toll due to the withdrawal of nonacademic support (Hoffman & Miller, 2020).

The Science, Technology, Engineering, and Mathematics strand posted a declining student engagement. Converting laboratory and research courses to virtual settings became a heavy challenge (Brancaccio-Taras et al., 2021). This was evident in a national study conducted in the Philippines, only 41% of medical students considered themselves engaged physically and mentally engaged in online learning. The respondents identified their learning barriers as technological, individual, domestic, institutional, and community. Moreover, it was pointed out that difficulty in adopting learning systems, home responsibilities, and poor communication are most frequently encountered (Baticulon et al., 2021). During July-August 2020, a study conducted in Indonesia to measure the level of students' satisfaction on remote learning for higher education, only 19% showed very satisfaction. It was identified that limited internet access, low lecturer guidance is the main cause of dissatisfaction (Surahman & Sulthoni, 2020). An assessment study conducted in the Philippines of undergraduate nursing students in their experience of online learning. The survey was conducted in January 2021 which show, 11.1 had very low satisfaction, 37% had low satisfaction and 46.3% had moderate satisfaction. Based on their academic performance, 3.7% answered very poorly, 37% assessed poor and 50% shown fair. In terms of satisfaction with their current academic performance, 11.1% answered not very satisfied, and 42.6% responded not satisfied (Oducado & Estoque, 2021).

The struggle of the country to cope with the immediate and long-term effects of the pandemic has been taxing its local and global resources. The delivery of education in the country was greatly hampered. In fact, the Philippines was tagged with one of the longest temporary closures of schools and universities of onsite teaching operations or face-to-face classes due to current pandemic conditions. Considering that Primary, Secondary and Tertiary students, who are the younger members of the populace, are at great risk of possible transmission of the virus, the country through its governing agencies: (1) Department of Education, and (2) Commission on Higher Education decided to fully implement remote learning. As of April 2021, the country is now in its 13th consecutive month of alternative mode of teaching delivery. The sudden shift towards full remote learning brought mixed feedbacks from its stakeholders – students, parents, and educators.

A preliminary study was conducted in one of the largest engineering schools in the country in terms of the student population to map their collective journey of remote learning. It is evident that third-year Engineering students posted declining feedback of their remote learning experience. Furthermore, a 4-point Likert scale satisfaction assessment on achieving program outcomes during remote learning was conducted among the respondents of the preliminary study. Figure 1 shows that 16% of the students are very dissatisfied, 28% are dissatisfied; 16% are satisfied and none are very satisfied.

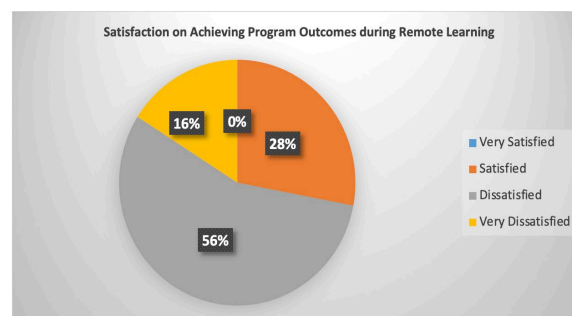


Figure 1. General Students' Satisfaction on Achieving Program Outcomes during Remote Learning in University X

Students as the primary customers of the education service system, there is a high threat posted of having unachieved satisfaction of program outcomes. Thus, Higher Education Institutions (HEIs) are confronted to devise strategies to prevent worsening the situation. While there has been a broad amount of literature in responding to improve the quality of remote learning, most strategies and solutions lack the ability to directly address the identified causes of

dissatisfaction. There is also an absence of exploring community restrictions as a possible cause of dissatisfaction. Moreover, existing strategies and responses provided by HEIs in Engineering, students still find ineffective. In the implementation of the Outcomes-Based Education in remote set-up, existing related literature do not use the achievement of specific program outcomes as a measure of quality remote learning. Thus, there is a misalignment of using a generic “Student Satisfaction” measure to address the quality of student remote learning. Therefore, it is imperative to develop a decision support tool (DST) that considers the following: (1) significant dissatisfaction factors towards remote learning, (2) specific program outcomes that are critical in students’ satisfaction towards remote learning, and (3) specific strategies and actions that address both dissatisfaction factors and specific program outcomes towards quality remote learning.

1.1 Objectives

The relationship of the variables in the study wherein the Dissatisfaction in Achieving of Program Outcomes will be processed through hypothesis testing is shown in Figure 2. The set of factors was identified and shortlisted through an extensive review of related literature. Factors were consolidated and checked together. Moreover, to investigate more of the literature factors, a preliminary study was conducted in a local university that offers Engineering programs. Additional and unique factors were identified too. Meanwhile, the relationship of the program outcomes will be tested of attainment during the remote learning. These will be measured using a 4-point Likert scale.

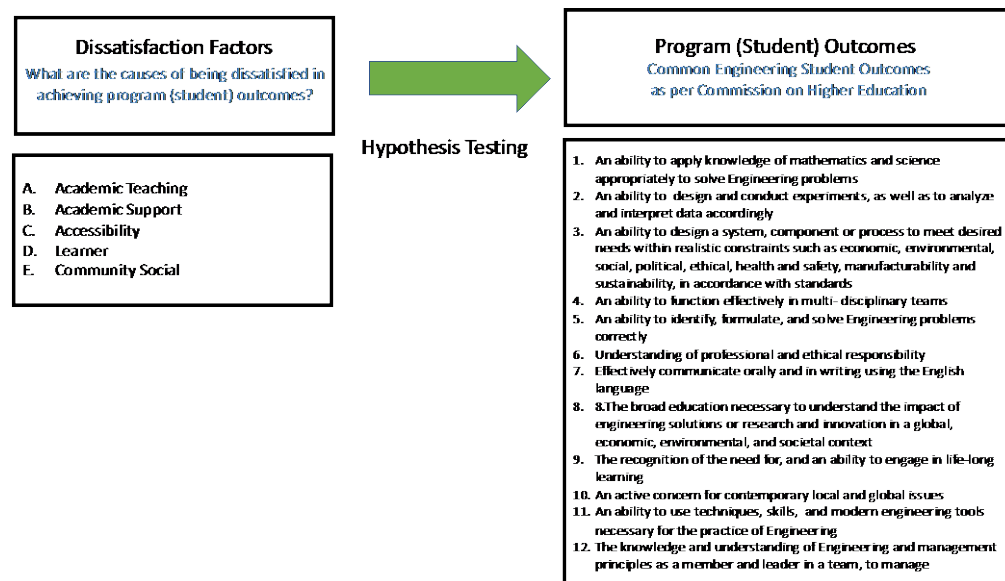


Figure 2 – Relationship of the Variables in the Study

This study aims to aid HEIs in responding to Engineering students’ increasing dissatisfaction with their attainment of program outcomes as a measure of quality remote learning. This research aims to accomplish the following:

- 1) To assess the remote learning experience of Engineering students during pandemic; and
- 2) To identify and analyze the causal relationship among dissatisfaction factors and program outcomes.

2. Literature Review

The term "remote learning" or "distance education:" refers to a teaching method in which the student and the teacher are physically separated. It can make use of a variety of technology, including email, audio, video, computers, and the Internet. Distance education's main goal is to provide educational opportunities to those who are underrepresented or who do not have access to a traditional educational institution (Kentnor, 2015). It is also an alternative system for traditional education due to its ability to reach the masses (Urgan & Kurubacak, 2021). The novel coronavirus pneumonia (COVID-19) outbreak that began in early 2020 has so far affected more than 200 countries and regions around the world. The global economy, education, and public life have all been severely impacted, with the greatest effect on university teaching and research operations, as well as colleges with the highest mobility of staff (Yao, Li, Yohannes, & Song, 2021).

In the Philippines, the Department of Education (DepEd) planned to end the school year for basic level institutions in late March 2020, but classes were cut short in the middle of the month due to COVID-19. The suspension of face-to-face education is extended beyond the school year 2020–2021 due to the pandemic thus, the Department of Education has launched the DEPED Commons Project, which will serve as an online platform for virtual lessons that teachers and students across the country can use as an alternative. However, this is still in the trial stage and is not mandatory. Similarly, the Commission on Higher Education (CHED) suspended classes in the same month but recommended that available distance learning and alternative modes be used instead, which has yet to be implemented because virtual learning is still new to the Philippine educational system (Talidong & Toquero, 2020).

Despite the rapid growth of online tertiary education, it is evident that educators and students face several obstacles that compromise the overall standard of distance learning (Markova, Glazkova, & Zaborova, 2017). Electronic learning (e-learning) is a wider approach to learning that opens new learning and teaching opportunities in a variety of fields outside of the conventional classroom setting (Rodrigues, Almeida, Figueiredo, & Lopes, 2019). Students recommended that changes be made in places where they were dissatisfied, such as improving network instability, activating connections by improving unilateral interactions, and holding face-to-face classes for hands-on classroom activities (Shim & Lee, 2020).

Students face some learning challenges, particularly in terms of successful teaching practices and communication habits, even though degree students generally rate their distance learning experiences positively. Low self-organization, teacher lack of control, lack of successful interaction, and a sense of isolation are all factors that contribute to their dissatisfaction with their online learning experience. The results back up the hypothesis that faculty play a critical role in information creation, and they can help all tertiary sector stakeholders find ways to optimize the ICT potential in distance tertiary education (Markova, Glazkova, & Zaborova, 2017).

While online learning is proving to be beneficial in protecting students' and faculty's health in the face of the COVID-19 pandemic, it is not as successful as traditional learning. The study's findings revealed that in underdeveloped countries like Pakistan, where most students are unable to access the internet due to technological and financial barriers, online learning is unable to yield desired results. Other concerns raised by higher education students included a lack of face-to-face contact with the teacher, response time, and the absence of typical classroom socialization. (Adnan & Anwar, 2020).

The growing number of students enrolled in distance education supports online learning as a viable alternative to conventional classroom. As a result of the various geographical locations used for the studies, accessibility problems such as internet connectivity, using compatible smartphones and laptops have been described as a significant challenge to online learning. According to the findings of a study conducted in Ghana, students were not prepared for an online learning environment in this pandemic period. Another important consideration is that the students are already used to the conventional teaching system. People are also attached to accepted pedagogies and propositions, according to research, so implementing new trends or modifying an existing one is likely to face resistance (Aboagye, Yawson, & Appiah, 2020).

A study in India found that the biggest problem identified by participants was technical constraints. Lack of access to internet would exclude some of the learners from the online courses. Slow connections will make it difficult to access course platforms and materials. The respondents also expressed concern about a lack of culture. It is difficult to create a welcoming learning atmosphere or a sense of community in an online setting. The instructor's incompetence was also shown by the survey. The teacher should try to make lectures enjoyable and successful to maintain the learner's interest (Muthuprasad, Aiswarya, Aditya, & Jha, 2021).

Teaching and learning are dynamic processes that are affected by factors other than the teaching method. Professional education and teacher preparation, especially in e-learning systems, must be prioritized. E-learning/blended courses should be designed to facilitate coherence between online and offline activities, campus-related and practice-related activities, and interactions between students, instructors, and materials. Specific course designs must be created to be applicable in a specific setting. In terms of educator roles and relationships, educators, and higher education institutions (HEIs) should encourage strong educator involvement in online settings as well as the development of online learning communities that foster positive relationships (Nortvig, Petersen, & Balle).

Stated by (Mortazavi, Salehabadi, Sharifzadeh, & Ghardashi, 2021), virtual education has generated a negative experience among students for numerous reasons, including the lack of distance learning facilities and the lack of a standard for preparing quality content. Dissatisfaction factors with the virtual teaching include weakness of the uploaded educational contents, lack of substantive input due to the offline virtual teaching and inability of discussion with the teachers, communication & channel problems (ISP issues – cost, bandwidth) and lack of preparedness of the receiver of the message.

All education stakeholders' comprehensive approach to teaching and learning is impacted by remote learning. Faculty and students stated that they were unable to teach and learn practical and clinical work using online learning modalities. They were only able to teach and evaluate the information portion. Teachers were unable to determine students' comprehension during online lectures due to a lack of immediate feedback. Students also mentioned their short attention span and the resource-intensive nature of online learning as drawbacks. Some teachers have reported that students misbehaved and attempted to access online tools during tests while studying online (Mukhtar, Javed, Arooj, & Sethi).

Indeed, the pandemic disrupted the service industry. Education being one of the largest service industries globally, was required to transform its delivery to remote set-up. Various HEIs have adopted different types on delivering their education service. The adoption of remote learning has mixed acknowledgements. Most of the research, posted its implementation is not well received by students. Students develop dissatisfaction towards remote learning. Government and HEIs responses have made but none of these try to provide specific for the remote learning process, addressing the dissatisfied factors.

Considering the Philippines as a developing country, particularly the Engineering education sector, received alarming unsatisfied feedback from their students towards the remote learning. From the existing studies, the researchers would want to investigate the following factors(See Table 1) that cause dissatisfaction on attainment the program outcomes.

Table 1– Summary of Factors and Indicators through Review of Related Literature and Preliminary Study

Code	Factors and Subdimensions	Description	References
Academic Support			
ASUPP1	Lack of effective communication from the institution	Limited networking with college personnel (faculty, staff, and peers)	(Park, Park, Jackson, & Vanhoy, 2020)
ASUPP2	Lack of assistance from the institution	Lack of campus socialization and communication channel problems; Universities lacked the immediate infrastructure and resources to facilitate online education	(Adnan & Anwar, 2020); (Mortazavi, Salehabadi, Sharifzadeh, & Ghardashi, 2021)
Accessibility			
ACC1	High cost of internet bundle	Unable to access the internet due to technical as well as monetary issues.	(Adnan & Anwar, 2020)
ACC2	Unavailability of digital resource/incompatibility of devices	Unable to take advantage of online learning because of accessibility issues in using compatible smartphones, laptops, and other electronic devices for learning	(Adnan & Anwar, 2020)
ACC3	Instability of the learning management system network used	Unavailability of institutional learning and management systems / longer response time for communication via e-mail or other online platforms	(Adnan & Anwar, 2020); (Park, Park, Jackson, & Vanhoy, 2020)
ACC4	Limited internet access	Lack of access to fast, affordable, and reliable internet connections	(Adnan & Anwar, 2020)
Academic Teaching			

ATEAC H1	Low quality of online materials/unclear materials	Materials provided by the lecturer are poor	(Adnan & Anwar, 2020)
ATEAC H2	Lack of clear learning expectation	Weakness in providing learning expectations from students	(Mortazavi, Salehabadi, Sharifzadeh, & Ghardashi, 2021)
ATEAC H3	Low patterns of guidance from lecturers	Professors not paying enough attention to educating students due to declining motivation	(Mortazavi, Salehabadi, Sharifzadeh, & Ghardashi, 2021)
ATEAC H4	Lack of constructive feedback on student works	Lack of feedback over the presented virtual teaching due to impossibility of face-to-face discussion with the instructors	(Mortazavi, Salehabadi, Sharifzadeh, & Ghardashi, 2021)
ATEAC H5	Online pedagogy skills of lecturers	Competency of the instructor in adapting new technology	(Mortazavi, Salehabadi, Sharifzadeh, & Ghardashi, 2021); (Muthuprasad, Aiswarya, Aditya & Jha, 2021)
ATEAC H6	Lack of interaction	Missed real-time sharing of ideas, knowledge, and information in the digital learning world	(Adnan & Anwar, 2020)
Learner			
LEARN1	Lack of Self- Motivation	Self-organization and student's unfamiliarity with a remote-learning environment.	(Markova, Glazkova, & Zaborova, 2017); (Park, Park, Jackson, & Vanhoy, 2020)
LEARN2	Unconducive Home Learning Environment	Comfortable environment for learning; Lack of system at home and not being accustomed to reading on a digital device	(Muthuprasad, Aiswarya, Aditya & Jha, 2021); (Mortazavi, Salehabadi, Sharifzadeh, & Ghardashi, 2021)
LEARN3	Threatening Health Issues (Physiological & Mental)	Increased stress levels for students that ultimately impact wellbeing, academic emotions, and college retention exacerbated by academic stress, psychological stressors other stress factors	(Park, Park, Jackson, & Vanhoy, 2020)
LEARN4	Unpreparedness of students to instantly shift to remote learning	Unpreparedness of students for an online learning experience	(Muthuprasad, Aiswarya, Aditya & Jha, 2021)
LEARN5	Sense of Isolation	The concern over a lack of community or a sense of community in the online environment.	(Muthuprasad, Aiswarya, Aditya & Jha, 2021)
LEARN6	Worsening financial issues	The emotional toll on thinking their own financial situations due to economic effect of pandemic	Preliminary Study
LEARN7	Fear of Infection	The anxiety of contacting the COVID-19 virus in daily basis	Preliminary Study
Community Social			
COMS1	Poor implementation of community restrictions	Government's implementation on the community quarantine restrictions that affected the delivery of education	Preliminary Study
COMS2	Increasing fatality	The surge on COVID-19 fatality cases	Preliminary Study

These factors will undergo interactional analysis towards dissatisfaction of the attainment of program outcomes. The general factors will be considered as latent constructs.

3. Methods

The research methodology is mapped out in Figure 3. The process starts with research topic selection and concludes with presentation of the conclusion and recommendation. The initial phase of the study covers iterative process of extensive review of related literature, problem recognition and definition. Furthermore, researcher develops the research design and sampling plan. The secondary phase of this research covers data gathering, data cleaning and structural equation and modeling, and provision of conclusion and recommendations. Meanwhile, the below figure presents the complete list of factors both from related literature and preliminary study to be used in this research.

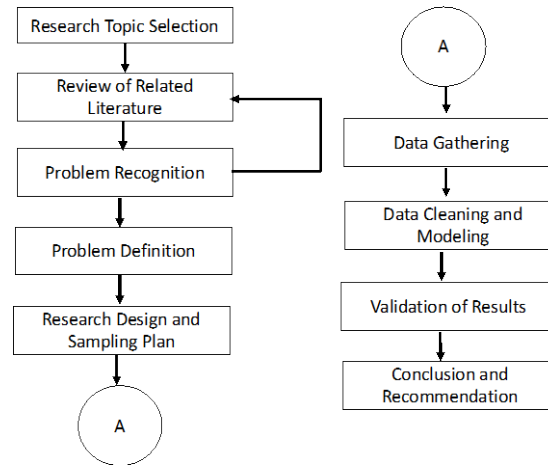


Figure 3 – Research Methodology Flowchart

3.1 Hypothesis Testing

The researchers have adopted the hypotheses below for this study:

Hij: general factor *i* will have a direct positive influence on the dissatisfaction on achieving the program outcome *j* during remote learning

where:

i: general dissatisfaction factors (1= academic, 2 = academic support, 3 = accessibility, 4 = learner, 5 = community social)

j: program outcomes (1...12)

4. Data Collection

The researchers considered graduating students in the new Philippines Engineering Curriculum (as of 2017) as its main respondents. Table 2 shows the demographic profile of the 287 respondents. A Google Form survey was developed and distributed electronically. As presented, students came from the five different universities which qualified to the following criteria:

- 1) Resides in National Capital Region,
- 2) Has at least 2 Engineering programs with Commission on Higher Education Recognition – Center of Excellence / Center of Development,
- 3) Is PAASCU/PACUCOA, PTC or ABET Accredited, and
- 4) With a Learning Management System in place.

Table 2 – Demographic Profile of the Respondents

HEIs	Count
University A	234
University B	17
University C	9
University D	15

University E	12
Gender	Count
Male	163
Female	124
Present Address	Count
Within Metro Manila	195
Outside Metro Manila	92

5. Results and Discussion

5.1 Modeling

Using SPSS AMOS, the researchers were able to develop its initial model as shown in Figure 4 (left). With the end goal to produce a fitted model, modifications were observed such as checking the standardized regression weights for the indicators for both dissatisfaction factors and program outcomes, effect bootstrap confidence for latent variables, and modification indices for errors. Through modifications, the Final SEM is presented in Figure 4 (right).

From the 12 program outcomes used as variables in the study, only 6 emerged as directly influenced by specific dissatisfaction factors. These are SO1 (An ability to apply knowledge of mathematics and science appropriately to solve Engineering problems), SO2 (An ability to design and conduct experiments, as well as to analyze and interpret data accordingly), SO3 (An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability, in accordance with standards), SO5 (An ability to identify, formulate, and solve Engineering problems correctly), SO9 (The recognition of the need for, and an ability to engage in life-long learning), and SO11 (An ability to use techniques, skills, and modern engineering tools necessary for the practice of Engineering).

As shown in Table 3, for Academic Teaching, ATEACH2, ATEACH4, ATEACH5, and ATEACH6 were identified as the largest significant measured variables. Only ASSUP1 and ASSUP2 were determined for Academic Support. ACC3 and ACC4 remained significant for Accessibility. For Learner, LEARN1, LEARN2, LEARN3, and LEARN4 remained as significant measured variables. Both CS1 and CS2 were identified to be significant indicators of Community Social.

Table 3 – Summary of Factor Loading of

		Factor Loading	
		Initial	Final
Academic Teaching	ATEACH1	0.55	-
	ATEACH2	0.91	0.91
	ATEACH3	0.41	-
	ATEACH4	0.80	0.81
	ATEACH5	0.79	0.80
	ATEACH6	0.85	0.86
Academic Support	ASUPP1	0.87	0.90
	ASUPP2	0.81	0.83
Accessibility	ACC1	0.60	-
	ACC2	0.55	-
	ACC3	0.89	0.92
	ACC4	0.88	0.90
Learner	LEARN1	0.84	0.86
	LEARN2	0.80	0.81
	LEARN3	0.83	0.83
	LEARN4	0.88	0.90

	LEARN5	0.55	-
	LEARN6	0.35	-
	LEARN7	0.39	-
Community Social	COMS1	0.90	0.92
	COMS2	0.83	0.83

Table 4 presented the different variable path relationship. The said paths were retained to be significant since its p-value is less than 0.05. For SO1, it was Learner which has the larger effect with 0.92. For SO2, Academic Support has the larger effect with 0.92 also. Meanwhile, Academic Teaching has 0.69 effect to SO3. Learner has 0.21 effect to SO5. Academic Teaching has 0.39 effect to SO9. Lastly, Accessibility has the largest effect to SO 11 with 0.90.

Table 4 – SEM Direct, Indirect and Total Effects

Number	Variable	Direct Effect	P-value	Indirect Effect	P-value	Total Effects	P-value
1	AT → SO1	0.89	0.001	-	-	0.89	0.001
2	AT → SO3	0.69	0.001	-	-	0.69	0.001
3	AT → SO11	0.50	0.003	-	-	0.50	0.003
4	AS → SO2	0.92	0.001	-	-	0.92	0.001
5	AS → SO9	0.41	0.001	-	-	0.41	0.001
6	A → SO2	0.74	0.001	-	-	0.74	0.001
7	A → SO11	0.90	0.012	-	-	0.90	0.012
8	L → SO1	0.92	0.001	-	-	0.92	0.001
9	L → SO5	0.21	0.006	-	-	0.21	0.006
10	CS → SO1	0.89	0.003	-	-	0.89	0.003
11	CS → SO11	0.66	0.012	-	-	0.66	0.012

5.3 Model Fit

The model fit of the research is presented in Table 5. All parameters for goodness have passed the suggested minimum cut-off. The final SEM is reliable.

Table 5 – Model Fit

SEM Goodness of Fit Measures	Parameter Estimates	Minimum Cut-off	Reference
Goodness of Fit Index (GFI)	0.909	>0.80	(Hair et. al, 2014)
Adjusted Goodness of Fit Index (AGFI)	0.852	>0.80	(Hair et. al, 2014)
Comparative Fit Index	0.960	>0.90	(Hair et. al, 2014)
Incremental Fit Index (IFI)	0.960	>0.90	(Hair et. al, 2014)
Tucker Lewis Index (TLI)	0.946	>0.90	(Hair et. al, 2014)

5.4 Model Validation

Upon generating the final SEM model, a validation process was observed through focus group discussions (FGDs). The whole model validation is a two-phase process wherein the first phase is focused on individual FGD, and the second phase is collating the results of all FGDs. The researchers conducted 5 focus group discussions with 8 members (graduating Engineering students) each. During the validation process, most of the focus groups recommended ACC2 (Unavailability of digital resource/incompatibility of devices) to be included as significant variables under Accessibility. The researchers adopted this as counterintuitive. On the other hand, one focus group recommends

Academic Teaching for SO5 as a significant factor, however, it fails to meet most of the validation process criteria. Meanwhile, all results of SO1, SO3, SO9, and SO11 were validated and confirmed by all focus groups.

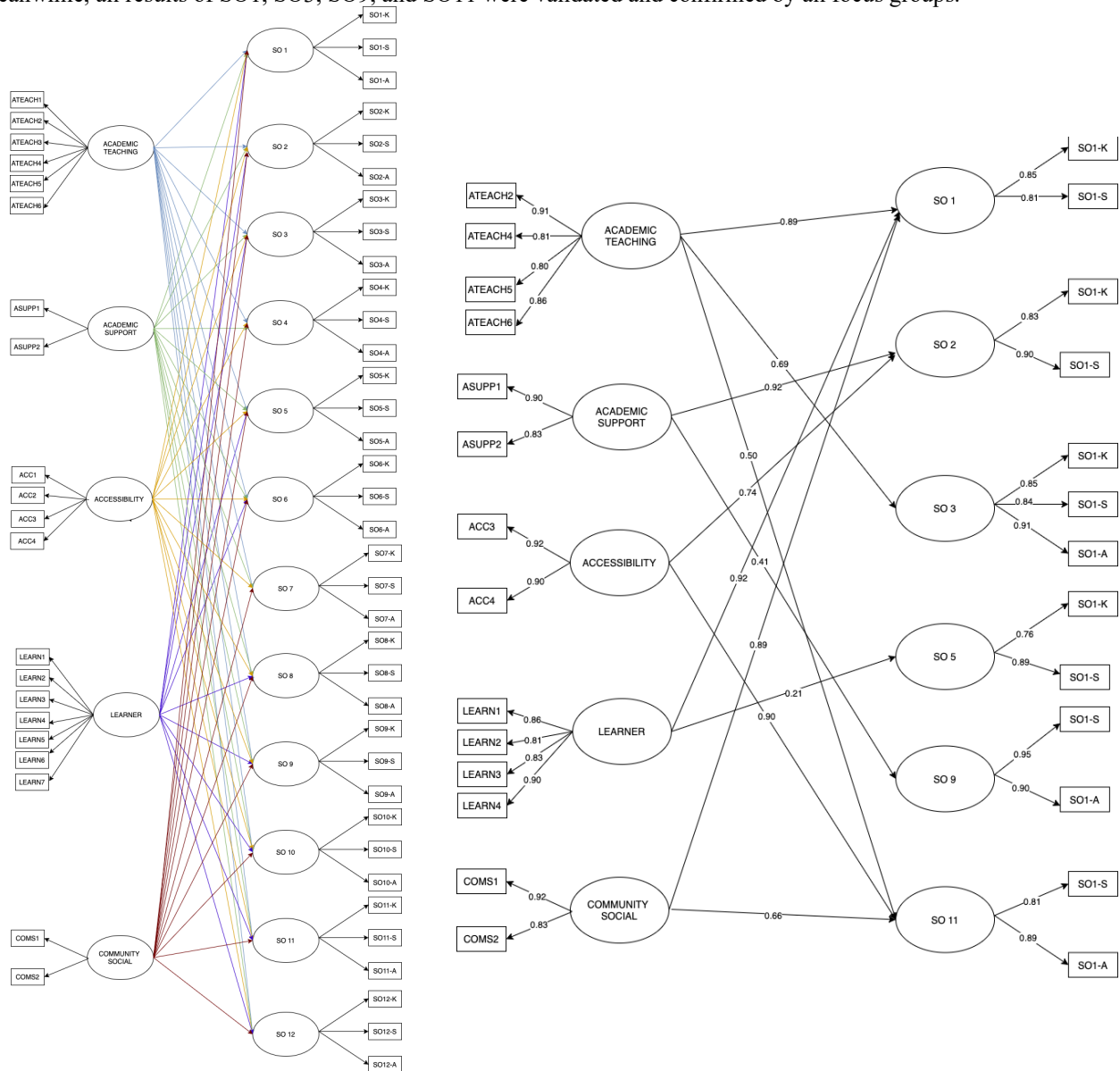


Figure 4 – Initial SEM (Left) and Final SEM (Right)

6. Conclusion

The COVID-19 pandemic explicitly affected the usual way of delivering education which is through face-to-face classes. With the situation in the Philippines still uncertain, Engineering students are at risk of not attaining the expected program outcomes. The call to provide effective solutions to address this concern should be addressed scientifically and logically. The instant shift of education physical classroom delivery to remote set-up posted unpreparedness of the education service sector. Engineering as a practical program that is more valued through hands-on exercises, demonstrations, and simulations faced a great risk of producing graduates that are less competent with the identified student outcomes. From the developed relationship in SEM, HEIs could investigate devising ways to cope with the increasing dissatisfaction towards the attainment of the identified 6 program outcomes. Service recovery actions are necessary to ensure the competence and quality in terms of skills, knowledge, and attitude of Philippine

engineering students As per recommendation, technology acceptance and usability of the learning management system which was not part of this research could also be investigated.

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Biographies

Gabriel C. Bucu is a candidate for Master of Science in Industrial Engineering graduate student at De La Salle University - Manila. He earned his Bachelor of Science in Industrial Engineering at University of Santo Tomas (UST). Presently, he is the Laboratory Supervisor and Instructor at UST Department of Industrial Engineering. He is a Certified Industrial Engineer (CIE) awarded Philippine Institute of Industrial Engineers (PIIE) and an Associate ASEAN Engineer (AAE) awarded by the ASEAN Federation of Engineering Organizations (AFEO). Concurrently, he is serving as the organization adviser of Operations Research Society of the Philippines – UST Chapter since 2017. He is currently specializing in Service Engineering and Management. His additional research interests include Optimization and Simulation, Design Thinking, and Supply Chain Engineering and Management.

Richard C. Li is an ASEAN Engineer and a Professional Industrial Engineer. He obtained his MSIE degree from De La Salle University (DLSU) in 1993 and is currently a PhD IE degree candidate from the same university where he is an Assistant Professor in the Department of Industrial Engineering. He was the Department chairperson from 2007-2009 and from 2012-2016. He is also the appointed University Solar Car Project Manager from 2012 to the present time. He was a Board Member of the Operations Research Society of the Philippines (ORSP) from 2002-2006 and remains a member of the ORSP to this day. He also represented DLSU Solar Car Project team as an active member in the regular board meetings of the Sikat Solar Challenge Foundation Inc. His specialization is in operations research, specifically in mathematical programming (linear and mixed integer linear programming) that involves decisions and optimization in inventory management, inventory planning and inventory cost control, material/process selection and distribution/logistics/warehousing in a product supply chain context, value chain analysis, among others. Research interest also includes performance measurement in service industries or service-intensive activities using variations of the SERVQUAL instrument and Data Envelopment Analysis. His industry projects and training engagements involve both the public and private sectors and have revolved around the areas of Systems Modeling and Optimization, Systems Evaluation and Improvement, Business Process Management, Design and Streamlining, Process Mapping and Documentation, Total Quality Management and Continuous Process Improvement, Service Quality Improvement, Warehouse and Inventory Management, Financial Analysis and Industry and Market Research.

Anthony S.F. Chiu is a University Fellow, Distinguished Full Professor, and Professorial Chairholder at De La Salle University. He works in the areas of Industrial & Systems Engineering, Sustainable Consumption and Production (SCP), Resource Efficient and Cleaner Production (RECP), and Eco-industrial Development (EID). He is past president of the Asia Pacific Roundtable for Sustainable Consumption and Production (APRSCP), Asia Pacific Industrial Engineering and Management Society; and Secretary (2010-2014) of the International Society for Industrial Ecology (ISIE). Currently he serves as the Secretary-General of the International Foundation for Production Research (IFPR). He authored / co-authored nearly 200 UN manuscripts and indexed journal articles in these areas. Anthony served in the Ministry of Environment and Natural Resources (DENR) as Adjudication Board Member in 2004-2016. He was speaker at the Rio+10 Science Forum and represented the Philippine government in various UN summits, including the Rio+20, SDG Roadmap, and UNCRD 3R & Circular Economy Fora. He is a member of the UNEP International Resource Panel, UNIDO-UNEP RECPNet regional executive (2013-15) and UNIDO Green Industry Technical Advisory member, adviser of Elsevier Atlas Sustainability Award, and a Steering Committee member of the Future Earth KAN on Systems of Sustainable Consumption and Production. Currently, he serves as the editor-in-chief of the Journal of Cleaner and Responsible Consumption [Elsevier].