



**Integrating student engagement with the DeLone & McLean model to assess the effectiveness of Online Learning System during COVID-19 pandemic**

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### **Abstract**

The Coronavirus pandemic has created significant challenges for higher education institutions and rushed them toward the utilization of IT resources to practice online learning as a replacement of the face-to-face classrooms. This study aims to assess the effectiveness of the online learning system (OLS) in driving student engagement and generating positive performance impact during the Coronavirus outbreak. A conceptual model is proposed by adopting the D&M model to examine the impact of the OLS overall quality dimensions (system quality, information quality, and service quality) on student's performance impact and to study the mediating effect of actual use, student satisfaction, and student engagement on this relationship. By depending on a sample of 781 students at both ungraduated and postgraduate levels enrolled at public universities in Egypt, using a self-administrated online survey to collect the data and SEM-PLS to analyze the data. The results indicate the significance of OLS quality dimensions direct effect on actual use, student satisfaction, student engagement and performance impact. Also, student engagement has the highest direct effect on performance impact and indirectly it enhances the relationship between overall quality dimensions and performance impact. These findings suggest several theoretical and managerial implications which specifically highlight the importance of overall quality and student engagement as determinants of OLS effectiveness.

**Keywords:** Online Learning system, student engagement, performance impact, D&M model

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### **Introduction**

On 20 March 2020 universities were closed in response to the COVID-19 pandemic and more than 890 million students in 114 countries were affected. The closure raised a significant number of challenges faced by higher education institutions in different areas including financial risks and funds, recruitment of students and admissions for the new academic year, housing and accommodation, quality standards of delivered service, assessment and evaluation of current students and support of student mental health issues (Araújo et al., 2020; Hubble & Bolton, 2020). Universities have been forced to consider larger-scale preventative measures to keep their students, staff and academic members safe and avoid infections from being materialized on their campus. Moreover, educational institutions are less prepared today to face the long-term impact of Coronavirus and help students during the outbreak. Consequently, faculties are rushed to the online learning; converting curriculum to the online environment using a mindful of technology and websites (Crawford et al., 2020). The online learning environment is overcoming the time and place boundaries and remove the burden of physical attendance comparing to face-to-face (Aldholay et al., 2018; Bond et al., 2020); therefore, taking the advantage of technology in higher education is now a must than ever before.

Online learning (OL) is used interchangeably with distant learning or e-learning, it refers to the digitalization of the education system, that is using internet and information technology to deliver the service (Isaac et al., 2019). Without exceptions, the growth of OL is among public and private, for-profits and not-for-profit institutions, and online teaching is now the new routine for students. Inherently, information technology is playing a crucial role in higher education given that it has the potential to make teaching and learning processes more intensive, increase its flexibility and convenience and enhances its quality (Isaac et al., 2019). The use of

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digital technology in higher education increases digital literacy and develop student's ICT, interdisciplinary and collaborative skills (Bond et al., 2020). Learners are encouraged to discover different self-perspectives through remote incorporation in activities and to improve their self-regulation and self-efficacy.

Despite the technological innovation and wide broadband accessibility, several challenges are presented such as social inequality and inaccessibility of learners to such type of education. However, in the short term, colleges and universities must continue to solve these profound complexities (Araújo et al., 2020). At this transitional period, the main response is the necessity to digitalize the educational system without compromising the quality of the academic service provided and meeting the standards of the curriculum.

It is important to assess the effectiveness of the provided OLS during the Coronavirus outbreak. By revising the literature, there are plenty of studies on online learning, the majority of these studies are focusing on investigating the factors affecting the users' attitudes (satisfaction) toward the system (Alves & Raposo, 2007; Ijaz et al., 2011; Liaw et al., 2007; Montesdioca & Maçada, 2015; Nadiri et al., 2009; Yilmaz, 2017a), intentions (Cheng, 2012) and actual use (Lin, 2007; Lwoga, 2014a). Another group of studies extend the effects of the actual use of OLS and evaluate the IT usage on net benefits at both the organizational level and individual level. Among which is the study of (Chen, 2010) that tests the transfer of acquired skills from OLS to the work context and investigates the transmission of OLS effectiveness on job outcomes. Whereas, at the individual level, the studies focusing on the evaluation of OLS effectiveness and benefits examine the effects of system use on student's academic performance exhibited by grades (Islam, 2013; Ortiz et al., 2004). The advancement of new technologies is improving the efficiency and effectiveness of individual and organizational performance impact. Nevertheless, a handful of studies broadly described

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performance to embrace other competencies such as knowledge acquisition, decision and communication qualities (Isaac et al., 2019), quick task accomplishment, improvements in job performance, enhancement of job effectiveness and quality of work, elimination of error, control over work (Daud, 2011).

The effectiveness of OL and its ability to promote better learning requires student engagement. Active learners who are intrinsically motivated to interact with the system and getting deeply involved in the learning environment and its activities are most likely to get benefited from its intended outcomes (Bond et al., 2020; Jung & Lee, 2018). IT resources provide multiple ways to digitalize education that can be categorized into traditional education technology including online discussion boards, general websites, Moodle-based teaching platforms and other designed college software, and social media applications on different social network sites such as Facebook and Twitter (Rueda et al., 2017).

The raising importance of the concept of engagement across different disciplines led to the development of a growing number of studies at the last decade which attempt to explore the predictors and outcomes of student engagement with OL technologies. By mapping the extant literature of student engagement with OL technologies, students initiative to engage with a system depends on actual usage and attitude (Francescucci & Rohani, 2019; Rueda et al., 2017), learner characteristics (Hew & Cheung, 2014), self-efficacy and other intrinsic motivations (Tseng & Tsai, 2010); while, the great focus is on the positive impact of student engagement on academic achievement and course grade (Cronin et al., 2000; Francescucci & Rohani, 2019). Also, inconsistencies exist among these studies in terms of the aspects depicting engagement with OL due to the lack of validated scale, and its definition. Most researches are using engagement interchangeably with usage and measure it with related activities such as number of visits and length of time spent logged in (Dunn & Kennedy, 2019).

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This research attempts to associate the use of OLS in higher education during Coronavirus outbreak with the learning outcomes, determine its effectiveness by student engagement, and compare different weighted effects of predictors on performance. To fulfill these objectives, a conceptual model is developed following the D&M IS success model to examine the impact of extrinsic factors related to the overall quality of OLS on the system usage and its consecutive outcomes; while considering the mediating role of student engagement. The D&M is one of the most widely cited IS model that depends on the qualities of an information system to measure its effectiveness. Besides, the model is well researched to predict the behaviour of an individual in different settings for example electronic commerce (Hsu et al., 2014; Liang & Chen, 2009), mobile banking (Tam & Oliveira, 2016, 2017). It is believed that using the D&M model in educational settings will contribute to the assessment of online learning success, unlike other theories for technology acceptance and use, such as the TAM. Since the D&M IS model goes beyond user behavior and provides the theoretical support to the relationship between OL and outcomes; net benefits (organizational and individual impact) (Islam, 2013). Hence, it is reasonable to expect that student performance and engagement with the online learning system will depend on their perceptions of the IS qualities.

Therefore, this study fills the gap in the literature and makes three contributions. First, it extends and unlimited the impact of OLS usage on grades and focuses on performance impact broadly based on resources (cost, time, and effort) savings, knowledge acquisition, skills development, elimination of errors, performance improvement, enhancement of effectiveness and creation of innovative ideas. Second, it assesses the effectiveness of OL by student engagement rather than focusing on academic achievement solely. Third, it uncovers the mediating role of student engagement, measured by a validated scale developed with respect to online learning, in the relationship between OL system quality aspects and its benefits.

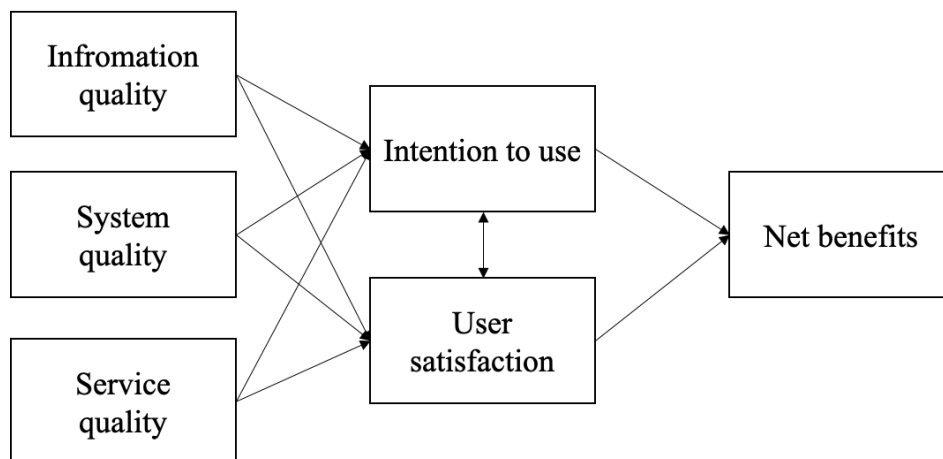
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## Theoretical background

### DeLone and McLean model

The D&M model (1992) remains one of the successful frameworks that better explain the outcomes of technology usage in information systems; particularly along with its updated version in 2003 (Delone & Mclean, 2003). The model, as shown in figure 1, describes the quality of IS as a construct of three dimensions that comprise system quality, information quality and service quality.



*Figure 1: The updated DeLone and McLean IS success model*

System quality refers to the enjoyable use of the system generated from the ease of use, connect and learn the system (Isaac et al., 2017). Information quality described as the accuracy, timeliness, completeness, relevance, consistency of the information provided by the online system (Halonen et al., 2009). Service quality entails the responsiveness, attractiveness, organizing, empathy and appealing interface provided by the online IS (Delone & Mclean, 2003; H. F. Lin, 2007a). According to Tam and Oliveira (2016), the

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user attitude influences the impact of online IS on performance. Thus, the general theory of IS postulates that the correspondence between system quality, information quality and service quality will have a positive impact on performance with respect to the end user satisfaction and intention to reuse the system (Iivari, 2005)

However, the empirical examination of the theory provides mixed results. While, Iivari (2005) found that system quality and information quality have a significant positive impact on user satisfaction and have no effect on system use, Jagannathan et al., (2018) found system quality has no impact on user satisfaction; whereas, information quality significantly affects user satisfaction. According to Lin (2007), the impact of system, service and information quality on actual use of OLS depends on the user satisfaction and behavioral intention to use the system. Lwoga (2014b) has adopted the model to examine students' antecedents to use web-based learning system; however, the results unexpectedly confirmed no relationship between service quality and information quality from one side and user satisfaction from the other side. However, Chen (2010) and Cheng (2012) indicated the positive impact of system quality, information quality and service quality on user satisfaction, learners' intention to use an e-learning system and perceived usefulness.

Several studies have used the D&M model as a theoretical foundation; however, the importance of such IS model to be adapted in the OLS increases during the current COVID-19 pandemic. The need to provide an effective learning environment that breaks space limitations and provide high-quality distance learning during the current pandemic repeat shine to the D&M model. Indeed, few studies investigated the model in learning success systems (e.g. Cheok & Wong, 2015; Isaac et al., 2017; Lin, 2007), however, this

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study is another empirical examination for such important theory during crisis time that impose on all parts whether universities or students to use the OL system. Furthermore, it is worthwhile to investigate the model in a new context to provide solid empirical evidence to the contradictory results.

### **Engagement in higher education**

Engagement is one of the most cited predictors for educational success; therefore, many endeavors have been done to examine how best to foster engagement in higher education. Hence, promoting engagement among learners has been emphasized as one of the main goals by most universities; particularly with the advent of digital technology that drove the growth of e-learning and distance learning (Kong & Song, 2015). Engagement is defined as “*the amount of physical and psychological energy that the student devotes to the academic experience*” (Astin, 1984, p.297). Engagement in higher education is described as student investment of time, commitment and resources towards learning activities (Krause & Coates, 2008). However, Trowler (2010) extended the engagement definition to include the investment of time, commitment and relevant resources for both students and their universities to enhance students' experience and optimize learning outcomes and develop students' performance that increases institution's reputation. However, due to the growing trend of learners centered activities (Kong & Song, 2015), more researches even this research focus on student engagement. The comprehensive definition of engagement from the student point of view converges to cover three important interrelated aspects cognitive, behavioral, and affective or emotional (Handelsman et al., 2005). The cognitive aspect refers to the psychological investment that student advocates for academic work, feelings of control and educational goals (Lawson & Lawson, 2013).

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While, behavioral aspect is objectively observed that entails participation, attendance and completion of an assignment, the affective or emotional aspect is more subjective related to student perceptions of learning activities and support (Maguire et al., 2017). Other scholars (e.g., Appleton et al., 2006; Fredricks et al., 2004) have added one more aspect for student engagement to be four interrelated distinct aspects: academic, behavioral, cognitive and emotional. However, the three-component model for student engagement is the most widely accepted model (Ding et al., 2017).

Consequently, for the current COVID-19 pandemic, student engagement concept will be restricted to distance learning away from teacher-student classroom interaction. Therefore, behavioral engagement could be in the form of online participation or interaction with teacher or peers' posts. According to (Goggins & Xing, 2016), the amount of discussion posts is an indicator for behavioral engagement. Cognitive engagement in OL activities *"involves the use of higher-order thinking skills (e.g., analyzing, critiquing, and reasoning) and self-regulated learning strategies, in reading and composing posts in online discussions"* (Ding et al., 2017 p.128). Emotional engagement in OL system entails students' enjoyment in online discussions, well presented and visualized materials and the social interactions with their peers and teachers (Ding et al., 2017).

To emphasize, many benefits for student engagement have been drawn by many scholars. For instance, there is a positive significant impact for engagement in higher education on student retention (Kuh et al., 2008); academic performance (Pascarella et al., 2010); high grades and learners' satisfaction (Carini et al., 2006; Chen et al., 2008); skills development (Quaye & Harper, 2014). Despite the fact of empirically confirmed benefits of the student

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engagement and the massive stream of the studies that establish practices that enhance the concept in higher education (Kuh & Schneider, 2008b) the student engagement concept is left relatively weakly theorized (Kahn, 2014). According to Kuh and Schneider (2008a), the active collaboration between students, students-faculties and supportive environment enhance and contribute to student engagement but such discourse needs to be profoundly theorized. Furthermore, (Carini et al., 2006), have relied the variations of students' learning outcomes to the divergent of students' engagement in education activities.

Given the importance of the lack of attention to the theoretical foundation of student engagement in higher education (Kahn, 2014); and the number of researches that confirm the benefits of such an important concept and degree of variation between different learners, it is worth scrutinizing the application of further theoretical viewpoints. In looking to add to the theoretical foundation for student engagement in this paper, we initially looking to the D&M model and how perceived student overall quality affects the level of student engagement that consequently affects student performance.

### **Performance impact**

Enhancing performance is the ultimate goal for most of the educational activities (e.g. Ding et al., 2017; Goggins & Xing, 2016; Isaac et al., 2017; Krause & Coates, 2008; Lin, 2007b; Pascarella et al., 2010; Tam & Oliveira, 2016). According to Picciano (2002), student performance might be measured in various ways and its definition translates the development of students' knowledge, skills, grades, and successful course completion. Different ways used universally to measure students' performance, all of it aims to evaluate the achievement of course objectives (Francescucci &

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Rohani, 2019). Performance impact can be seen as the extent to which OLS use helps in improving students' performance, reinforcing students' efficiency, completing tasks effectively, exerting task control and eliminating mistakes (Isaac et al., 2016). In view of the current COVID-19 pandemic that moves learning systems away from the traditional way to the online and distance learning, the current emphasis is on determining the impact of such challenges on students' performance. Thus, in this research, the performance impact is described based on knowledge acquisition, competence, productivity and resource savings (Isaac et al., 2017)

### **Conceptual framework and hypotheses development**

#### **Overall quality**

Quality in social sciences one of the extremely difficult terms to define particularly in the context of e-services. Santos (2003) described the concept as a judgement of excellence and overall benefits received by the customer. Furthermore, the concept has been evolved in educational institutions (Brochado, 2009), due to the challenging environment that enforce universities to put more efforts to cope with the competitive environment and deliver quality of their educational services (Ijaz, et al., 2011). Particularly, as a result of the current COVID-19 challenges and sophisticated OLSs that arouse the need to deliver functionally quality service. Therefore, the students' evaluation of the delivered educational e-service has now become crucial. In particular, student satisfaction, student engagement, student actual use and student performance supposed to be consequences for delivering high OLS. A meaningful positive link between the service quality and satisfaction has been drawn by many scholars. Universities have explored that educational services should be treated as a business in terms of focusing on their

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customers; therefore, they must consider their students' expectations and perceived quality (Ijaz et al., 2011). According to Cronin et al., (2000), a causal link exists between educational service quality, student satisfaction and performance. Furthermore, student engagement (Ding et al., 2017) and actual use (Isaac et al., 2019) have been as outcomes for the high quality delivered educational service. Cheng (2012), emphasized that using mobile learning enhance engagement and communication through providing immediate access to information. Therefore, it is worth investigating whether the quality of OLS still has the same effect or not. This research suggests that the greater overall quality of the OLS, the higher student satisfaction, the higher student engagement, the higher actual use and higher performance.

**H1:** Overall quality significantly and directly influences student satisfaction.

**H2:** Overall quality significantly and directly influences student engagement.

**H3:** Overall quality significantly and directly influences actual use

**H4:** Overall quality significantly and directly influences performance impact.

#### **Student satisfaction**

In the higher education sector, satisfaction considered one of the most important antecedents of superior performance whether from students' point of view or from the faculties' point of view (Nadiri et al., 2009). When it comes to students, their satisfaction will depend on meeting or exceeding their expectations regarding the course, materials, instructor and teaching method (Rueda et al., 2017). While several studies (Isaac et al., 2017; Stefanovic et al.,

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2016) have emphasized the positive impact of user satisfaction on performance in numerous contexts, Daud (2011) cut down the significant relationship between satisfaction and performance impact. However, understanding the various levels of students' satisfaction explain the divergent levels of students' performance (Yilmaz, 2017b). Furthermore, high levels of satisfaction have been firmly connected to desired levels of outcomes. According to Alves and Raposo (2007), the consequences of satisfaction in higher education go beyond the consequences in other service sectors. The researchers emphasized the positive impact of satisfaction on loyalty and positive word of mouth. Since our focus in this research is the student, it is reasonable to expect student satisfaction to affect performance. Additionally, *"higher system quality is expected to lead to higher user satisfaction use, leading to positive impacts on individual performance"* (Kuh & Schneider, 2008a; p.11).

**H5:** Student satisfaction significantly and directly influences performance impact

**H6:** Student satisfaction mediates the relationship between overall quality and performance impact

#### **Student engagement**

Student engagement can be understood by the active participation of students during learning activities. According to Kuh (2008), student engagement one of the important factors for learning that has many positive outcomes for students. *"it is an umbrella term which brings together students' degree of attention, curiosity, interest and willingness to employ their language proficiency and a repertoire of learning skills to make progress"* (Zhang & Hyland, 2018; p. 91). Therefore, some evidence of positive student outcomes has been positively linked to student engagement (Pascarella et al.,

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2010). Students who are engaged, are intrinsically motivated to learn, participate in study activities, ask questions, enjoy learning challenges which push them to achieve superior performance (Bakker et al., 2015). Enhancing student engagement increases students' abilities of critical thinking and improve problem-solving skills (Liaw et al., 2007). However, vast majority of the studies have examined student engagement in classrooms whether these studies concentrated on the antecedents of student engagement (Kuh & Schneider, 2008a) or consequences of student engagement (Chen et al., 2008; Kuh et al., 2008; Pascarella et al., 2010; Quaye & Harper, 2014). In the present study, we investigate the engagement during distance learning and its impact on student performance. Moreover, we follow the D&M model of IS where we suppose the higher perceived overall quality leads to higher performance impact if students more engaged.

- H7:** Student engagement significantly and directly influences performance impact
- H8:** Student engagement exerts a mediating effect on the association between overall quality and performance impact

#### **Actual use**

Actual use refers to the extent to which individuals can use information system functions (DeLone & McLean, 2016). When it comes to online learning, actual use reflects the frequency of use and the period of use (Kim et al., 2007). While some studies have utilized using of OLS online as a final dependent variable (Islam, 2013), other researchers investigated the impact of real usage on user satisfaction and performance (Son et al., 2012). However, a significant positive association between actual use and performance as well as satisfaction was established (Isaac et al., 2017). On

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contrary, other researchers have reported the insignificant impact of actual use on satisfaction and performance (Cho et al., 2015; Wu & Wang, 2006). We argue that understanding and using the online system plays an antecedent role for student satisfaction and performance. According to Islam (2013), actual use of e-learning system helps students to learn easily where they need to do a minimal effort for learning activities. Furthermore, actual use of e-learning system increases learning outcomes in three ways: boosts engagement (Liaw et al., 2007), fasts information sharing (Ortiz et al., 2004); and enhances self-learning opportunities (Leidner & Jarvenpaa, 1995). Islam (2013) consistently reported that the use of e-learning systems leads to students' effectiveness by providing them with self-learning opportunities. It is thus reasonable to expect that actual use of the OLS will positively enhance student satisfaction, performance and amplifies the impact of overall quality on performance.

**H9:** Actual usage significantly and directly influences student satisfaction.

**H10:** Actual usage significantly and directly influences performance impact.

**H11:** Actual use mediates the relationship between overall quality and performance impact.

The proposed model and developed hypotheses are presented in the following figure.



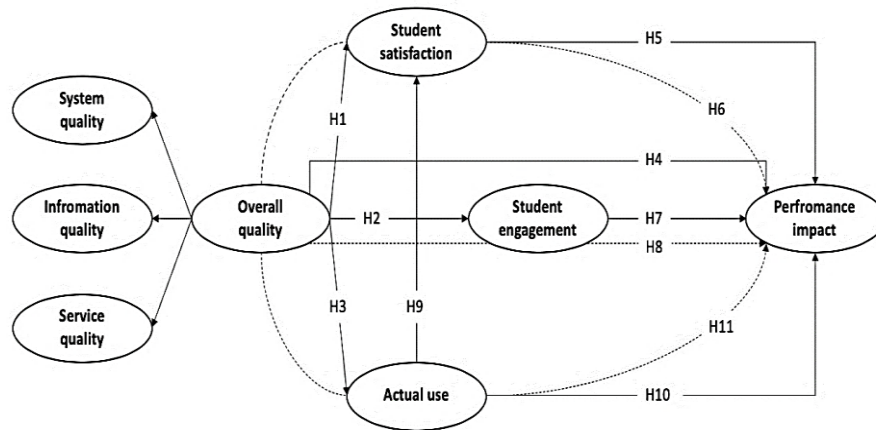


Figure 2: Conceptual model

## Research methods

### Sample and data collection

The subjects of this study are students enrolled in public universities in Egypt at both undergraduate and postgraduate levels. At a confidence level of 95%, the calculated sample size is 384 which is more than the minimum sample size of 300 required to use the SEM in data analysis. This study relied on convenience sampling. The data is collected using online self-administrated survey, an invitation was sent to respondents on WhatsApp with the access link to the online survey. Direct translation was used to translate the questionnaire from English language to Arabic. Data was collected over a period of one-month starting from the first of April 2020, the survey was thus spanning during these four weeks. It worthwhile that the data collection started shortly after the suspension of education in the Universities due to the Coronavirus; therefore, students at both levels; undergraduate and postgraduate, were oriented toward the use of e-learning system. During this

period all the students were experiencing distant learning using the e-learning system provided by the Public Universities in Egypt. The final sample (N=781) consists of 353 female and 428 male constituting 45.2% and 54.8% respectively. The majority of the students are undergraduate representing 59% of the sample.

### **Measures**

All the measurement scales were drawn from prior studies. The questionnaire was developed in two-sections: the first section included questions relating to the key study constructs, while the second section comprised questions pertaining to the respondent's demographic information, their faculties and experience with using online learning. All the items were measured on 7-point Likert scale ranged from "strongly disagree" (1) to "strongly agree" (7)

### **Data analysis and results**

#### **Measurement model**

The data was analyzed using SmartPLS method, as a prerequisite the validity and reliability were firstly assessed. The constructs convergent validity was evaluated by assessing the factor loading. Of the 37 items used, only 33 items had loading estimates higher than 0.5 with significant t-values ( $p < 0.001$ ). The average variance extracted (AVE) was above the minimum of 0.5 for all constructs. The internal consistency was considered good, both Cronbach alpha and composite reliability estimates were above the threshold of 0.7 indicating acceptable reliability. Table 1 provides supportive data for convergent validity and internal consistency reliability. The comparison of AVE values with the square of the

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correlation estimate between constructs verified the existence of discriminant validity for most of the constructs but two. The two constructs of student engagement and performance did not meet the Fornell and Larcker criterion of discriminant validity. Accordingly, the new HTMT (Heterotrait-monotrait) ratio evidenced with high sensitivity rates was used to identify discriminant validity effectively unlike the Fornell and Larcker criterion suffering from having an unacceptable low sensitivity. We first use HTMT as a criterion with threshold 0.90, all the values for all pairs of reflective constructs were below this figure. Second, the bootstrapping procedure was applied for examining the confidence intervals for the HTMT, the results support the alternative hypothesis ( $H1: HTMT < 1$ ); thus, validating that the two constructs are empirically distinct (Kock, 2015). The HTMT results are shown in table 2.

In the context of SEM-PLS, common method bias is caused by the measurement method. The validation of convergent and discriminant validity is not effective to verify the lack of common method bias; however, the full collinearity test is proposed to be an alternative method.

Accordingly, it is proposed that the occurrence of a variance inflation factors (VIFs) is an indication of method biasedness. The results indicate that the model is free of common method bias as the values of VIFs resulting from full collinearity test met the cut-off point ( $\leq 3.3$ ).

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**Table 1: The measurement model statistics**

Indicators	Descriptive statistics		Factor loading	AVE	Composite reliability	Cronbach alpha
	Mean	SD				
System quality						
Sysq_1	2.3378	1.08928	0.904	0.810	0.927	0.883
Sysq_2			0.906			
Ssysq_4			0.890			
Information quality						
Infq_1	2.3953	1.25625	0.851	0.728	0.930	0.900
Infq_2			0.794			
Infq_3			0.864			
Infq_4			0.865			
Infq_5			0.890			
Service quality						
Serq_1	2.2431	1.09324	0.889	0.778	0.934	0.900
Serq_2			0.882			
Serq_3			0.903			
Serq_5			0.855			
Satisfaction						
Satis_1	1.8974	1.13504	0.926	0.838	0.939	0.803
Satis_2			0.925			
Satis_3			0.894			
Actual use						
Actuse_1	1.8801	1.21833	0.932	0.851	0.945	0.812
Actuse_2			0.926			
Actuse_3			0.909			
Performance impact						
Spei_4	2.1136	1.19301	0.936	0.758	0.969	0.864
Spei_5			0.929			
Spei_7			0.932			
Spei_8			0.908			
Spei_9			0.945			
Spei_10			0.936			
Engagement						
Seng_1	1.09324	2.2431	0.883	0.782	0.962	0.953
Seng_2			0.901			
Seng_3			0.911			
Seng_4			0.923			
Seng_5			0.896			
Seng_6			0.900			

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**Table 2: Discriminant validity (HTMT-results)**

	Overall quality	SATIS	ACTUSE	SPEI	SENG
Overall quality					
SATIS	0.834				
ACTUSE	0.899	0.853			
SPERI	0.884	0.807	0.821		
SENG	0.807	0.814	0.853	0.842	

**Hypotheses testing**

The structural model was assessed to test the hypotheses developed. The explanatory power of the model is 86%, which means that predictive power of the predictors (actual use, student satisfaction and student engagement) explains a significant amount of variance for student performance impact. All the hypotheses were supported at a significant level of 0.01, as reported in table 3.

**Table 3: Hypotheses testing**

Hypotheses	Path	$\beta$	t-value	p-value
<b>Direct impacts of overall quality</b>				
H1	Overall quality $\rightarrow$ student satisfaction	0.474	11.937	0.000
H2	Overall quality $\rightarrow$ student engagement	0.867	62.927	0.000
H3	Overall quality $\rightarrow$ actual use	0.84	51.315	0.000
H4	Overall quality $\rightarrow$ performance impact	0.109	2.428	0.016
H5	Student satisfaction $\rightarrow$ performance impact	0.128	2.751	0.006
H7	Student engagement $\rightarrow$ performance impact	0.51	11.235	0.000
H9	Actual use $\rightarrow$ student satisfaction	0.469	11.525	0.000
H10	Actual use $\rightarrow$ performance impact	0.225	5.544	0.000
<b>Indirect impacts</b>				
H6	Overall quality $\rightarrow$ student satisfaction $\rightarrow$ performance impact	0.061	2.56	0.011
H8	Overall quality $\rightarrow$ student engagement $\rightarrow$ performance impact	0.442	11.044	0.000
H11	Overall quality $\rightarrow$ actual use $\rightarrow$ performance impact	0.189	5.43	0.000

### **Test of significant paths**

As expected, the system's overall quality measured by three dimensions: system quality, informational quality and service quality, has a significant direct positive influence on student satisfaction with ( $\beta=0.474$ ,  $p<0.001$ ,  $t\text{-value}=11.937$ ), student engagement ( $\beta=0.867$ ,  $p<0.001$ ,  $t\text{-value}=62.927$ ) and actual use ( $\beta=0.84$ ,  $p<0.001$ ,  $t\text{-value}=51.315$ ). Thus, supporting hypotheses H1-H3. The overall quality substantially explains 67.8%, 60.6% and 59.4% of the variations in satisfaction, engagement and actual use respectively. With respect to the relationship between overall quality and performance impact, the results reveal the significant direct impact of overall quality on performance impact ( $\beta=0.109$ ,  $p<0.01$ ,  $t\text{-value}=2.428$ ); supporting H4. Additionally, performance impact was also found to be significantly and directly affected by student satisfaction ( $\beta=0.128$ ,  $p<0.01$ ,  $t\text{-value}=2.751$ ), student engagement ( $\beta=0.51$ ,  $p<0.001$ ,  $t\text{-value}=11.235$ ) and actual use ( $\beta=0.225$ ,  $p<0.001$ ,  $t\text{-value}=5.544$ ); thus, supporting H5, H7 and H10. Actual use has a positive direct impact on student satisfaction ( $\beta=0.469$ ,  $p<0.001$ ,  $t\text{-value}=11.525$ ), H9 is supported as well. The indirect relationships were also significant. The results support the mediation of student satisfaction, engagement and actual use in the relationship between overall quality and performance impact. The hypotheses H6 ( $\beta=0.061$ ,  $p=0.011$ ,  $t\text{-value}=2.56$ ), H8 ( $\beta=0.442$ ,  $p=0.000$ ,  $t\text{-value}=11.044$ ), and H11 ( $\beta=0.189$ ,  $p=0.000$ ,  $t\text{-value}=5.43$ ) are all supported. From the path coefficients of direct relationships, among the four predictors of performance impact, student's engagement has the highest the relative importance, followed by actual use, then student satisfaction and finally overall quality. However, the mediation effect increases the total effects of overall quality on performance impact to 0.551 when mediated by student engagement. While, the mediation of student satisfaction and actual use increase the effect of overall quality on performance impact to 0.17 and 0.298 respectively.

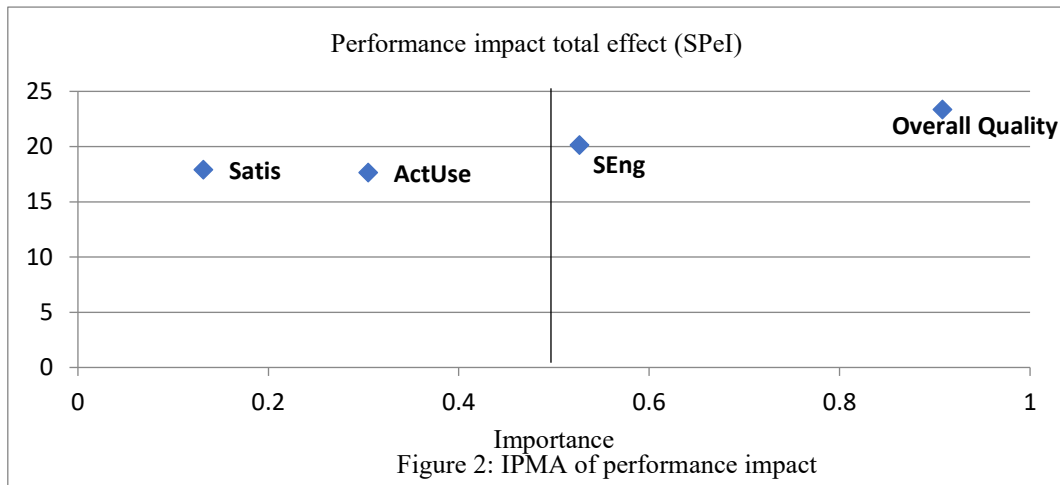
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## **IPMA**

The importance-performance map analysis, examines the importance and performance of an exogenous variable in anticipating the target endogenous variable by estimating the total unstandardized effect (Höck et al., 2010). As indicated in figure 2, the importance-performance map of student's performance impact, the x-axis reflects the importance of the construct measured by the total effects whereas the y-axis reflects its performance with the mean value of scores ranging from 0–100. The results revealed that all the latent variables have low performance below the average; however, the importance of overall quality and student engagement are above the average. The total effect of 0.908 indicates the importance of overall quality; hence, an increase in overall quality by one unit will increase the performance of students by 0.908 points. The student engagement construct with total effect of 0.527, indicates its high importance as well. It is suggested that in order to increase student performance, priority should be given first to the overall quality of the OLS followed by enhancement of student engagement.





**Figure 2:** IPMA of performance impact

### Discussion

This study adopts the D&M model to go beyond the actual use to assess the quality of the OLS and its impact on student engagement and their performance. Based upon, the overall quality dimensions; identified by the system quality, information quality and service quality, are defined as individual's beliefs about the e-learning system that affect their attitude toward the system and behaviors. The model was thus extended and used to understand the student's psychological state of being involved in the e-learning system and his/her performance. In the proposed model, the e-learning overall quality aspects were used as the extrinsic factors affecting student's intrinsic motivations to experience the system, reflected by engagement, which in turn will affect the performance. The model was empirically tested and validated, and the results support the followings.

Firstly, the study supported the beliefs–attitude–use relationship expressed in the D&M model, as the results reveal the positive direct significant impact of overall quality on students’ satisfaction and actual use. It thus came into consistent with prior studies that utilize the D&M model in the context of online or distant learning (Cronin et al., 2000). The success of the e-learning system is accredited to the dimensions of overall quality including system quality described by reliability, accessibility and usability, information quality described by accuracy, relevancy, completeness, trendiness and personalization, and finally service quality described by tangibility, functionality, interactivity and responsiveness. To improve the success of e-learning implementation and its use, these are dimensions that should be assessed closely. Similarly, (Bagozzi (1992) supports in his study the direct and indirect paths of quality aspects. The direct relationships add value to the importance of the overall quality of the e-learning system emphasized by the technical, semantic and service provider success. While, it plays a significant role in shaping user’s perceptions toward the system; hence it is considered an important criterion in decision-making process for students. The successfulness of the e-learning system increases student’s satisfaction and intentions to use or actual use which in turn increases the net benefits of the system and its effectiveness reflected in student performance.

Secondly, the study demonstrates the significance of integrating student engagement to the D&M model and supports its impact on performance impact; thus, explore engagement antecedents and outcomes. The results refine the measurement of student engagement and emphasis two aspects; the cognitive and emotional. The importance of these two aspects over other the academic and behavioral engagement has been highlighted in the study of (Chen et al., 2008). They noted that cognitive and emotional engagement are related to intrinsic motivations in response to several

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contextual factors and are associated with positive learning outcomes. Consistently, the findings of this study support the role of the e-learning system in motivating students to interact with it and got engaged in the learning process; thus, enhancing their performance. Student engagement with distant learning is effective and satisfactory than campus-based education (Kuh et al., 2008; Zhang & Hyland, 2018)The high levels of engagement foster the academic achievements and its persistence to the extent that it can diminish the varying impact of previous experiences and background. These levels can be attained by student interactions with the e-learning system, the content and the programs, and by the interventions and practices of teachers or staff members.

Thirdly, the antecedents of student performance using the e-learning system were examined in this study. Actual use and satisfaction are having a meaningful direct effect on performance impact; additionally, the relationship between actual use and satisfaction was also revealed to be significant. Thus, it is suggested that the rate of use and the longest duration students tend to spend on e-learning system will create a positive attitude toward the system and improve academic proficiency. Also, the greater the satisfaction with the e-learning system and the service provider in meeting student expectations will eventually improve performance. The direct effects of satisfaction and actual use and the indirect effects; mediating the relationship between the overall quality and performance impact (net benefits at the individual impact), are validated in the D&M model. However, the findings contribute to the extant literature by revealing the relative importance of student engagement over satisfaction and actual use directly and indirectly. Student engagement direct impact on performance is higher than actual use and satisfaction, it also enhances the total impact of the system's overall quality on performance. Although, the findings of Rueda et al. (2017) reveal a weak direct effect of traditional

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education technology on student engagement; however, the mediating role of student engagement linking OLS use and benefits, is starting to get a wide support (Francescucci & Rohani, 2019). The academic performance of students using OLS is a function to their level engagements and interactions with the system, attitudes and behaviors, and is an indicator to the effectiveness of the system itself.

### **Theoretical implications**

First, this study empirically verifies the D&M model in the field of online learning. The model in higher education sector; however, it was not investigated during crisis times in which there are no alternatives for OL or distance learning. Our study validates students' perceptions for overall quality of OLS and addresses the link between the overall quality and student engagement, student satisfaction, actual use and performance impact.

Second, this study enriches the literature of the information system by incorporating student engagement in the model. Our study extends the D&M model through the addition of student engagement. The use of student engagement as a mediating construct is one of the first attempts within the distance learning context. It may, therefore, be classified as a significant contribution to the information system model.

Third, our study explains theoretically and demonstrates empirically antecedents and outcomes of student engagement in distance learning, and demonstrated the importance of the cognitive and emotional aspects of student engagement over the behavioral aspect. Moreover, it emphasizes how online education quality increases student satisfaction and the actual use of the e-learning system. With respect to the variation in students' academic performance that can be attributed to previous experiences and background, the study theoretically explained how high levels of student engagement foster academic achievements. Additionally, the

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performance impact is not determined by the academic achievement captured only by course grades, but the study investigated how the use of OLS can enhance an individual performance, competence, knowledge, decision making and communication skills. Therefore, the value of depending on technology-based learning has a long-term impact that extends beyond the course grades and academic success to affect the effectiveness and efficiency of job at the organizational level.

Fourth, valuable indirect relationships have been theoretically contributed and empirically demonstrated by this research. For instance, the outcomes have addressed the mediating role of student satisfaction in the relationship between overall quality and performance impact. According to (Rueda et al., 2017), meeting or exceeding student expectation determine the level of student's satisfaction; however, the various levels of students' satisfaction explain the divergent levels of students' performance (Yilmaz, 2017a). Furthermore, there is a mediating impact for actual use in the relationship between overall quality and performance impact. According to Islam (2013), the actual use of the e-learning system increases students' effectiveness. This effectiveness supposed to be reflected in the superior performance which has been demonstrated by the results of this research. Finally, there is an indirect impact of overall quality on the performance impact mediated by the level of student engagement.

#### **Managerial implications**

The managerial implications of this research are quadruple. First, the results of this research help universities and quality assurance bodies to realize the overall OLS quality perceived by the students in which they can know the aspects of development. Secondly, the extended D&M IS success model provides a deeper understanding of the key success dimensions and their

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interrelationships. It also implies that a good beneficial system is not only determined by the actual use but also on its ability to motivate learner engagement; hence, universities are recommended to promote student engagement to make the most of OLS quality impact on students' performance. Thirdly, the findings encourage policy makers to promote the use of distance learning even in normal times where there are no crises (e.g. COVID-19 pandemic). Such hectic times could be repeated in the future; thus, universities would be ready to deal with it. Therefore, the model of this study should be promoted and supported for future policy not only at the organizational level but also at the national level. Finally, the findings of this research have emphasized that student satisfaction is a consequence for the actual use of the system; therefore, students, universities, and interested authorities are advised to use and promote the OLS first before judging students' satisfaction.

#### **Limitations and future research**

It is acknowledged that there are various limitations in this research that open new avenues for future research. First, despite the comprehensive definition of student engagement has been observed to cover three interrelated aspects cognitive, behavioral, and emotional or even four distinct aspects: academic, behavioral, cognitive and emotional. This study has considered only the emotional and cognitive dimensions to verify validity and reliability limitations. Thus, further research needs to incorporate the other dimension(s) to satisfy the comprehensive definition of student engagement. Second, the data of this research were collected using an online self-administrated survey due to the constraints of coronavirus that cut off all kind of face-to-face communications. Qualitative research methods that adopt in-depth interviews could be used in future examinations. Conducting semi-structured interviews

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with students about their perceptions of OL system quality will generate data that direct instructional universities to the ways in which they improve educational service quality. Furthermore, measuring student satisfaction qualitatively by doing semi-structured interviews could validate such important and frequently used measurement appropriately. Third, the study was carried out with both ungraduated and postgraduate students enrolled at public universities in Egypt. Further research would make a comparison between public and private universities. It would be useful to measure students' perceptions of OLS quality, students' engagement, students' satisfaction and students' performance in private universities and compare it with the public universities where the private ones have more resources, facilities and capabilities than the public ones. Finally, this research was conducted within the higher education sector in one country (Egypt). While this study introduces valuable contributions, it may not be generalizable to all education systems. It is worth further research to replicate this study across different education systems (primary, secondary), different student circumstances (part-time, full time), different age groups, different student disciplines (medical students, business students, education students, etc.) with a representative sample that include and compare the performance variation for each discipline. Replicating this research in a different geographical domain or collecting data from more than one country would be valuable as well to expand the scope of the study and generalizability considerations.

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دمج مشاركة الطلاب مع نموذج ديبلون وماكلين لتقييم فعالية نظام التعليم عن بُعد  
أثناء جائحة كورونا Covid 19

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**الملخص:**

لقد خلقت أزمة كورونا (COVID-19) العديد من التحديات لمؤسسات التعليم العالي مما دفعهم إلى السعي نحو توظيف واستخدام تكنولوجيا المعلومات للقيام بالعملية التعليمية عن بعد بدلاً من الشكل التقليدي للتعليم من خلال الفصول الدراسية. لذلك تسعى هذه الدراسة إلى تقييم فعالية نظام التعليم الإلكتروني في تحسين اندماج الطلاب في العملية التعليمية وأثر ذلك على أداء الطلاب في ظل أزمة كورونا. يُبنى النموذج المقترح للدراسة على نموذج نظم المعلومات المقدم من Delone and Mclean. بشكل أكثر تحديداً، تسعى هذه الدراسة إلى اختبار أثر الجودة الكلية لنظام التعليم الإلكتروني (جودة النظام، جودة المعلومات، جودة الخدمة) على أداء الطلاب؛ كذلك اختبار أثر الدور الوسيط لـ الاستخدام الفعلي للنظام، رضا الطلاب، اندماج الطلاب في العلاقة بين الجودة الكلية للنظام وأداء الطلاب. تم تجميع بيانات هذه الدراسة باستخدام الاستقصاء الإلكتروني من عينة مكونة من ٧٨١ طالب من طلاب المستوى الجامعي وطلاب الدراسات العليا بالجامعات الحكومية المصرية، وتم تحليل بيانات الدراسة باستخدام أسلوب نمذجة المعادلات الهيكلية -SEM- PLS. وقد توصلت الدراسة إلى وجود تأثير معنوي ذو دلالة إحصائية للجودة الكلية لنظام التعليم الإلكتروني على كل من: الاستخدام الفعلي للنظام من قبل الطلاب، رضا الطلاب، اندماج الطلاب، أداء الطلاب. كذلك توصلت الدراسة إلى أن اندماج الطلاب له أعلى تأثير معنوي مباشر على الأداء كذلك له تأثير معنوي غير مباشر في العلاقة بين الجودة الكلية للنظام والأداء. أخيراً، تقدم هذه الدراسة مجموعة من التوصيات النظرية والعملية التي تعزز من أهمية جودة النظام الكلي للتعليم الإلكتروني على اندماج الطلاب وفعالية نظام التعليم الإلكتروني.

**الكلمات المفتاحية:**

نظام التعليم الإلكتروني، اندماج الطلاب، الأداء، نموذج Delone and Mclean لنظم المعلومات