Data-based Learning Outcomes Analysis of Online Learning — A Case Study of English Course in a Shanghai University during COVID-19

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Abstract: As COVID-19 swept the world leading to massive education disruptions in most countries and regions, higher education institutions were driven online, with or without good preparation. The evolving and lingering of the pandemic has made online learning integral to higher education now, of which the outcomes evaluation is essential to whether this challenge can be transformed into opportunities for future education. The study reviewed and analyzed from statistic perspective the learning outcomes of an English course taught online only at a university in Shanghai during the lockdown in 2022, with the aim to provide some empirical evidence to the existing qualitative research or surveys. The examination focuses on the accessibility, applicability and adaptability of digital learning journey. The statistical analysis in SPSS 26 demonstrates the easy connections to online platforms, effectiveness of immediate responses to the rapid online shift and possible existence of cheating in online only teaching in this case. The findings also illustrate the necessity of: a) clear education road map to be articulated based on learning outcomes and customized for online teaching settings, b) effective evaluation methods elaborately designed and organized using digital tools, and c) supporting online community with a range of teaching formats and recourses.

Keywords: online learning, learning outcomes, outcome-based education, statistical analysis

1. Introduction

The COVID-19 has become an ongoing viral pandemic across the world since its outbreak in early 2020, triggering a series of extraordinary responses, from campus shutdown to online learning at all levels. Countries and higher education institutions have to take measures to ensure safety of students and faculty while maintaining the operating of universities. By October 2021, 32% of the world's universities and schools were closed, either fully or partially, with 75% of total class time moving online [1]. More than 1,300 colleges and universities in all 50 states in US deployed online-only learning in the first semester of 2020 and 44% remained so in fall despite the efforts to expand the in-person instruction [2].

In China, Shanghai has been the entrance of almost 40% of international arrivals to the country and hosted a large number of imported COVID-19 cases since early 2020 [3]. However, the Omicron variant posed great challenges to Shanghai's anti-virus responses and measures in 2022, causing the outbreak and widespread of the pandemic after two years' great endeavors to eliminate the coronavirus. On March 12, 2022, around three weeks after the spring semester began, all schools and universities in Shanghai closed campuses and shifted to online [4]. Nearly 2.15million K12 and university students, 1.603 million and 540.7 thousand respectively, logged online almost at the same time to have remote instructions [5].

Such unprecedented large scale of online-only classes all over the world aroused great concerns about the quality of instructions since universities are "significantly lagged behind other industries in moving to a more digitally-driven, outcomes-focused business model" [6]. In a survey of 70 teachers and 407 students in Bangalore, 55.7% colleges and universities students have difficulties in connecting the Internet due to power cut, broadband, audio/video facilities, platforms or applications being used, disrupting their classes [7]. Students logging online through cell phones experienced constant disruptions caused by incompatibility of smartphone with applications or teaching content [8]. Apart from connectivity, digital capabilities of universities, technology competence of faculty and students' willingness to be engaged in are crucial factors affecting the effectiveness of online learning [9]. Students

and teachers were driven to switch back and force between external commercial web platforms like Microsoft 360, Moodles, QQ Classroom, etc. and integrated applications such as Google Classroom, Chaoxing, etc., since few universities were well equipped physically and mentally with digital transformation [10]. Those who were tech savvy could handle the overnight migration in a relatively easier way while the others had to devote much more efforts to the adaption, sometimes at the cost of academic performance of student and heavy workload for teachers. Insufficient interaction between students and instructors during video conferencing can hardly complement the effective non-verbal communication in face-to-face classroom, significantly impacting the efficiency of digital lecturing [9].

Even after moving online, considerably designed online education is different from emergency-responsive actions [11]. Teaching, together with student assessments, moving online on an untested and unprecedented scale caused a lot of trial and uncertainty for everyone. The problems of whether the teaching content is compatible to all the platforms, applications or software, whether the same teaching materials as were used in conventional offline teaching environment can be used without any modification for online lecturing, whether pedagogy needs to be adjusted and how to assess and evaluate students' performance virtually still remain to be discussed. Surveys focusing on students' satisfaction and psychological health provided evidence that lack of social connection created and enhanced their stresses and anxiety [12]. Showing affection during online lecturing would alleviate the psychological stress and increased satisfaction and engagement of remote learning [13].

All the challenges and obstacles as virtual learning has encountered during the social isolation, COVID-19 is still lingering and evolving, making digital education stay [14]. But "which aspects of digital teaching will universities keep" [15] is worth exploring.

Outcome-based education (OBE), a prevailing teaching framework in many areas of the world in recent years, highlights learning goals and outcomes as the basis on which a program or a course is to be designed and carried out. Its aim is to transform from training students to remember to leading them to think critically, with students being the center of teaching while teacher being the facilitator [16]. To achieve that, having adequate knowledge of specific learning outcomes is the prerequisite. Course outcome as the minimum unit of learning outcomes provides a view of fulfillment of desirability or objectives of a course that consists of a program. Examining attainment of the outcomes qualitatively and quantitively help provide prediction before implementing and reference to future course and program progress as well.

2. Aim

The study aims to examine the learning outcomes of online instructing during COVID-19 shutdown from real experiences to: 1) see the effectiveness of online-only learning in higher education sectors from a quantitative analysis; 2) provide evidence and reference for further outcome-based education (OBE) online-only or blended teaching mode design

3. Method

3.1. Data Collection

1) Learning outcomes of a class of 56 students (28 female and 28 male) of University English II course at a university in Shanghai during the lockdown from March 12 to June 5, 2022 were collected. All the students were attending online-only class in that period. 33.92% (N=19) students were in humanities while 66.07% (N=37) were engineering students.

2) The learning outcomes of the 56 students included not only the scores of the course final exam, but also the learning process involving assignments and tests of listening, reading, writing skills and vocabulary building.

3) The score of final exam of University English I course, the prerequisite course of University English II, which was taught in-person class a semester prior to the lockdown (from September 10 to January 1, 2021) of these 56 students were collected.

4) The information about origins of the students (in Chinese: 生源地), English scores of National College Entrance Exam (Gaokao or NCEE), facilities students used for online class, after-school learning activities were obtained through students' self-report in a survey.

3.2. Data Analysis

SPSS 26 was used for data preparation, management and analysis to see the statistical relations of students learning outcomes. Data analysis was in accordance with the questions the study wanted to explore.

4. Results and Discussion

4.1. Device and Facility Impact on Online Learning Outcomes

4.1.1. Data Analysis

Hardware devices and facilities are the prerequisites for implementing live online learning. Whether students have access to Internet and how that is related to students' academic performance is of great concern of teachers. Thus, do the device and facilities students use influence their scores of listening and vocabulary exercises?

It was first analyzed with students' vocabulary test score as the dependent variable. Table 1 shows the descriptive statistics of the result. There seemed to be a *Device* effect: on average, 'computer' students got 61.15, whereas 'cell phone' students got 54.69, and 'iPad' students got 56.50. There also appeared to be a *Facility* effect: on average, students attending online class through WIFI got 59.91, compared with 56.22 for those who used Mobile Network.

Table 1: Statistic description of students' vocabulary score as to devices and facilities they used.

Descriptive Statistics				
Dependent Variable:	Vocabulary Score			
WIFI * Mobile		Mean	Std. Deviation	N
WIFI	computer	61.9722	21.75643	36
	cell phone	57.2222	28.04807	9
	iPad	35.0000	2.82843	2
	Total	59.9149	22.99700	47
Mobile	computer	51.3333	22.27854	3
	cell phone	49.0000	33.03533	4
	iPad	78.0000	7.07107	2
	Total	56.2222	26.32859	9
Total	computer	61.1538	21.68742	39
	cell phone	54.6923	28.51136	13
	iPad	56.5000	25.21243	4
	Total	59.3214	23.34571	56

The assumption was that there might be an interaction between Device and Facility since the mean differences in scores by devices varied between facilities. For example, students using cell phone through WIFI (WIFI * Cell Phone) tended to have higher scores than those using iPad through WIFI (WIFI * iPad), but this trend was reversed for students using 'Mobile Network * Cell Phone' and 'Mobile Network * iPad'. To see whether there were differences for each pair of factor level, post hoc test was then conducted. As $p > 0.05$ in this case (see Table 2), the differences among the devices of 'computer', 'cell phone', or 'iPad' students used for vocabulary test seemed to be not significant.

Table 2: Post hoc tests of students' vocabulary score by Facility and Device.

Multiple Comparisons						
Dependent Variable: vocabulary score						
Tukey HSD						
(I) devices	(J) devices	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
computer	cell phone	6.4615	7.46756	.664	-11.5758	24.4988
	iPad	4.6538	12.24202	.924	-24.9158	34.2235
cell phone	computer	-6.4615	7.46756	.664	-24.4988	11.5758
	iPad	-1.8077	13.33227	.990	-34.0107	30.3953
iPad	computer	-4.6538	12.24202	.924	-34.2235	24.9158
	cell phone	1.8077	13.33227	.990	-30.3953	34.0107
Based on observed means.						
The error term is Mean Square(Error) = 543.704.						

To explore the combined impact of Facility and Device, estimated marginal means and standard errors of vocabulary test were run. See Table 3.

Table 3: Marginal means and standard errors of vocabulary test by interaction of Facility and Device.

WIFI mobile * device					
Dependent Variable: vocabulary score					
WIFI mobile	devices	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
WIFI	computer	61.972	3.886	54.166	69.778
	cell phone	57.222	7.772	41.611	72.834
	iPad	35.000	16.488	1.883	68.117
mobile	computer	51.333	13.462	24.293	78.373
	cell phone	49.000	11.659	25.583	72.417
	iPad	78.000	16.488	44.883	111.117

The result showed that a student who use computer through WIFI was expected to get score of about 61.97, while one who have class on iPad through WIFI was expected to get around 35. A student who had online class by using computer through Mobile Network was expected to have a score of 51.33, while one who used iPad through Mobile Network was expected to get 78. Thus, there was a difference between 'computer' and 'iPad' students, depending upon the facility they used. This suggests an interaction effect between Facility and Device.

The profile plot in Figure 1 (left) illustrates the strong interaction effect, where the difference in vocabulary scores between 'cell phone' and 'iPad' students is higher for mobile network users, as the line for WIFI users slopes downward and that for Mobile network users slopes upward. To check its significance, the between-subjects effect was tested and it was not statistically significant ($p > 0.05$). Therefore, there is no statistically significant difference in students' vocabulary scores using different facility and device to have online class.
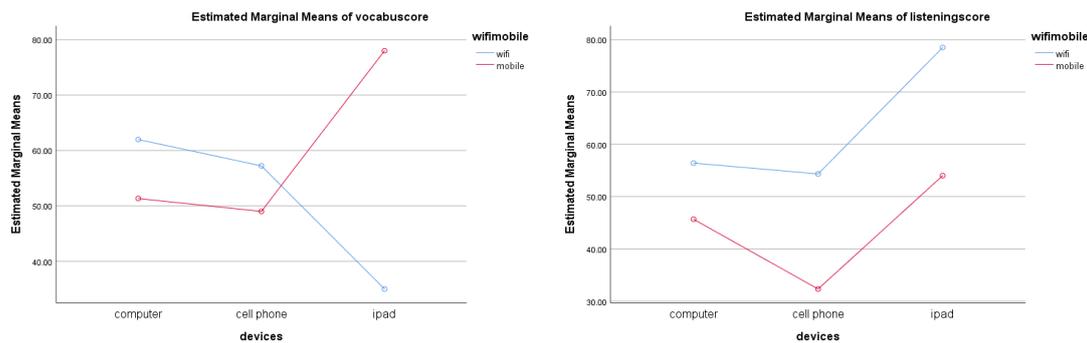

Figure 1: Estimated Marginal means of vocabulary and listening test score by facility and device.

However, students' listening score was checked in the same way and the profile plot suggested significant difference between students who logged onto Internet through WIFI and through mobile network. The former had higher scores than the latter, regardless of the devices they used, as shown in the right of Figure 1. Tests of between-subjects effects echoes the results ($p = 0.034 < 0.05$).

4.1.2. Discussion

The development of internet infrastructure and widespread popularity of smartphones attributed to the growth of China's Internet usage. The number of people using Internet in China reached 900 million as of March, 2020, an increase of 75 million from the end of 2018, ranking first in the world, followed by India with 560 million and the US with 313 million. China's Internet penetration rate has reached 64.5%, up 4.9% from 2018 (see Figure 2). Of all Chinese Internet users, 44.7% are young people under the age of 29 [17]. They almost live their lives online. Being savvy netizens supported by sound Internet infrastructure, students in Shanghai have not difficulty accessing and using online platforms and video conferencing applications during the lockdown.

But on the other hand, whether facility and device have influence on students' performance depends on what kind of exercises students are doing. In this case, for listening test, which is more demanding on the stability and speed of Internet, facility and device have a significant effect on students' score, while for vocabulary test that is less demanding, infrastructure is not that vital. For using cell phone or iPad

through Mobile network, students had higher scores on iPad, due to its larger screen that provide better vision.

Data source: CNNIC. https://n2.sinaimg.cn/finance/a2d36afe/20210827/FuJian1.pdf
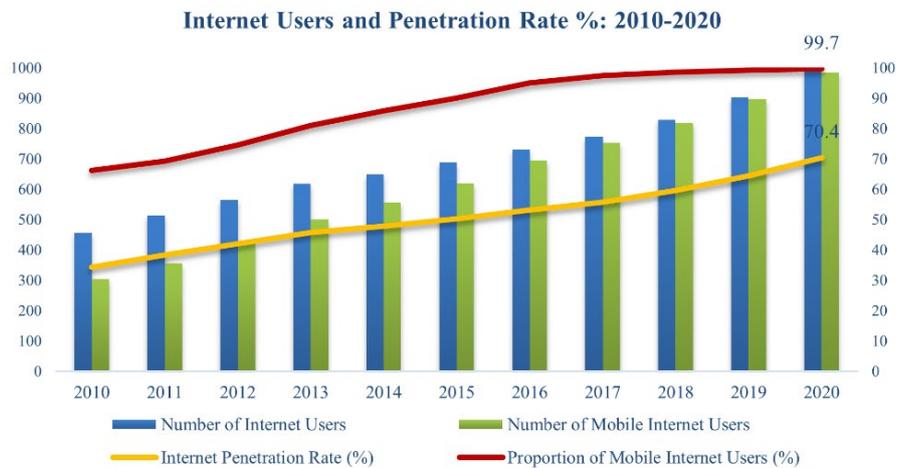
Figure 2: China Internet Users and Penetration Rate 2010-2020.

4.2. Teaching Content Impact on Online Learning Outcomes

4.2.1. Data Analysis

Teachers were not well prepared for the online teaching due to the sudden outbreak of the coronavirus. To attract students' attention, the lecturer designed and added some in-class quizzes, most of which were vocabulary tests in accordance with what was being taught and discussed simultaneously and were done in the middle or at the end of each online class. Then, are there any difference in students' vocabulary quizzes and reading comprehension tests at the beginning and middle of the term?

Paired T test was run in SPSS and result (see Table 4) showed that, for vocabulary, there was significant average difference between students' beginning and middle scores ($t = 8.259$, $p_{vocabulary} = 0.00034 < 0.05$), with scores at the middle of the term being 29.8 points higher than that that at the beginning (95% CI [22.57, 37.03]), whereas for reading, there was no significant average difference between students' beginning and middle scores ($t = -1.756$, $p_{reading} = 0.085 > 0.05$).

Table 4: Paired Sample T Test of vocabulary quizzes and reading test.

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	middle voc – beginning voc	29.80357	27.00466	3.60865	22.57168	37.03547	8.259	55	.000
Pair 2	middle reading – beginning reading	-4.58182	19.35506	2.60984	-9.81422	.65059	-1.756	54	.085

Nonetheless, students are more likely to cheat in online assessment settings, either copying answers from others or referring to digital tools [18]. To verify the hypothesis, students' performance of first semester final exam (done in early January, 2022) was first compared with that of their online in-class quizzes, including listening, vocabulary and reading (done in mid April, 2022), assuming that origin location of the students was a key factor that influence their score.

Linear Regress was tested to see the correlation between city tiers classification of original place of students and first term exam. City tiers were categorized as 1 = first tier, 2 = second tier, 3 = third tier, 4 = forth tier, 5 = fifth tier and 6 = others, according to the city-tier classification [19].

The ANOVA result showed the significant value $p = 0.009 < 0.05$, indicating that the regression model predicting the outcome variable was statistically significant (See Table 5). The critical value of F calculated verified the result: F $_{Critical}$ = F.INV.RT(5%,1,52) = 4.026, $F_{stat} = 7.351 > F_{critical} = 4.026$.

Table 5: ANOVA correlation of city tiers classification of original place and first term exam.

ANOVAᵃ						
	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1026.899	1	1026.899	7.351	.009ᵇ
	Residual	7264.435	52	139.701		
	Total	8291.333	53			
a. Dependent Variable: first term						
b. Predictors: (Constant), original location						

The profile plot visualized the significance of correlation of city ranking with students' scores in General Linear Model. The city tier was positively correlated with students' scores of their first term exam. See Figure 3.

We then applied Linear Regress to test the original city ranking with students' listening, vocabulary and reading scores respectively to see if there were correlations. The ANOVA tests showed no evidence of correlations between city rankings and students' score, either for vocabulary, reading or listening, with p being 0.085, 0.288 and 0.665 according, larger than 0.05, which is different from that of the first term. Plots are shown in Figure 4.
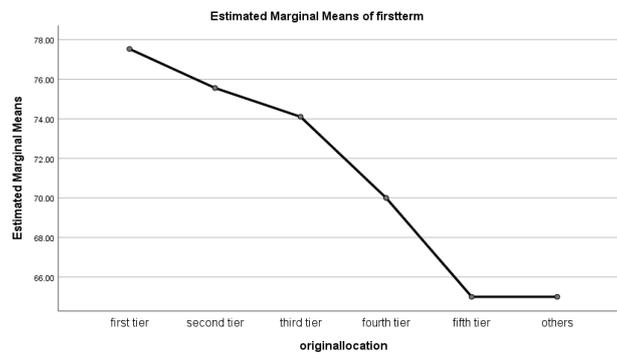

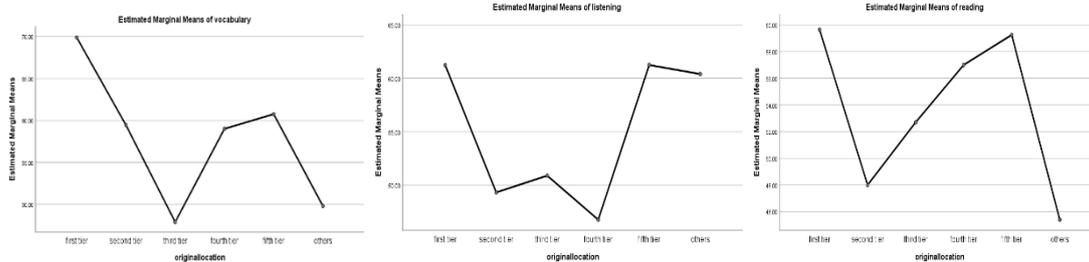*Figure 3: ANOVA correlation plot of city tiers and first term exam.*

Figure 4: ANOVA correlation plot between city tiers and vocabulary, reading and listening tests during lockdown.

4.2.2. Discussion

The vocabulary exercises done by students right after each instruction were designed by the instructor to hold students' attention and to get informed of students' learning state during online classes. It is effective in improving students' vocabulary learning in short term, but invalid for reading comprehension that requires more comprehensive language ability than instant attention and memory, at least from statistic perspective.

Meanwhile, according to data from World Bank, 2017, a consistently positive correlation between English proficiency and a range of indicators of human and economic development is found by some institutions [20]. This is identical with the result of students' first term exam that was taken in physical classroom. When, however, the relation between demographic metrics and online learning performance is examined, its result violates the assumed correlations statistically. There is only three-month interval between the two sets of scores collected and English proficiency seemed impossible to be improved in such a short time on a large scale. The most likely reason is that some of the students used digital tools or recourses while having online quizzes or tests. The finding also corresponds with some students' answers in the stated survey who admitted copying others' answers while doing the online tests.

As pointed out by Charles Hodges, emergency remote teaching is in essence not online learning [11]. How well the online teaching is prepared and developed matters. Productive online learning depends on thoughtful teaching design, adequate consideration and careful selection of teaching content in accordance with the specific course subject. Systematic planning coupled with flexible content delivery in light of strategies involving teaching modality, class size, pacing, methods of assessments and ways of interaction and feedback also counts. This takes time, usually as long as 6 to 9 months prior to the instruction [11]. This conjointly explains why, as a response to the abrupt shift, the in-class vocabulary quiz didn't make for a concrete improvement of students' reading ability despite the temporary solution to their vocabulary building.

4.3. Pedagogy Impact on Online Learning Outcomes

4.3.1. Data Analysis

Listening comprehension session of the course was taught in audio lab with quality audio and video devices prior to the pandemic. During the lockdown, this session had to be canceled due to some sound delay or damage caused by traffic congesting on video conferencing applications. To achieve the desired learning outcomes for conventional offline learning, students were recommended by the instructor to watch films, TV series or news in English to practise listening skills after class. How well they did was assessed by listening tests every two weeks that were organized on an external online platform till the end of the semester. Then is the substitute method effective in improving students' listening skills?

Liner aggression was applied to explore the correlation between listening test scores with English movies and TV series watching. In the 'Stepwise Method', 10.0% ($R^2 = 0.100$) total variation in the dependent variable can be explained by the independent variable of 'English Movie', accounting for the majority of the total amount of 31.6% ($R^2 = 0.316$). Using ANOVA, the significant value is $p = 0.02 < 0.05$, suggesting that the method was effective to listening score. See Table 6-7.

Table 6: Correction model summary of listening score and English movie.

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.316[a]	.100	.083	19.18609
a. Predictors: (Constant), English movie				
b. Dependent Variable: listening score				

Table 7: ANOVA correlation of listening score and English movie.

ANOVA[a]						
	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2125.295	1	2125.295	5.774	.020[b]
	Residual	19141.520	52	368.106		
	Total	21266.815	53			
a. Dependent Variable: listening score						
b. Predictors: (Constant), English movie						

4.3.2. Discussion

Watching English movies or news helped students get familiar with authentic pronunciation with different accents and intonation, and how vocabulary and grammar were used by native speakers in more natural and actual scenarios. A daily contact contributed much to the students' listening skills in a four-month period. The aural and visual environment a film or news created [21] where semantic meaning of words and phrases were animated in actions not just facilitated students understanding but engaged them in a bidirectional interaction where speaks' facial expressions and gestures were involved. This complemented what was lack in online lecturing and motivated and impassioned students psychologically.

The result also illustrated, in line with Charles Hodges, etc., that productive online learning requires an integrated learning community where cocurricular incorporation and learners' engaging are essential apart from instructors' lecturing [11]. Learning as a process of transforming experience into knowledge [22] may occur in both well-designed, goal-targeted formal process and individual non-formal or informal everyday social experiences [23]. As an immediate response to sudden public health crisis, the English movies and series served to form at least in part an ecosystem for the course, assisting the informal

learning of individual student. For the long run, when considerate designing and planning are possible, identifying and building online learning communities is necessary for sound digital education.

5. Conclusions

Thanks to the technology advancement and improving facilities, the technological infrastructure students rely on to access Internet for online live class on a regular basis doesn't affect their academic performance in Shanghai. Although teachers cannot keep tabs on what students are doing during live online classes, some simultaneous exercises according to what is being taught in class is effective in holding students' attention. Nevertheless, online learning provides students more opportunities and ease to cheat. Self-discipline becomes more important than ever for live online classes and the key factors that influencing the online learning outcomes. Supplementary exercises or methods like watching English movies or TV series can improve students' specific language skills and abilities, but overall proficiency such as comprehensive reading requires more efforts. Such approaches as creative solution to unexpected response to education disruptions can be retained and refined for future blended or hybrid learning.

Far from just moving class to the cloud with printed content and teaching materials becoming digital, effective online learning, regardless of its modality, calls for detailed curriculum design and elaborate content selection based on systematic review and analysis of existing research, appropriate decision and application of instructional strategies. These should also be implemented in alignment with online study features, varied course attributes, good knowledge of technologies concerned, effective use of tools to adapt the delivery, and efficient methods of assessment due to the limited feedback from the audience in digital setups. It is an ecosystem with sufficient digital teaching recourses rather than an individual enterprise that can make virtual learning more captivating. As online learning has become indispensable in this digital era, outcome-based curricula upgrade specific for online or blended learning is essential for transforming higher education for the better.

Acknowledgements

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