RESEARCH ARTICLE                                    Higher Education Quarterly   WILEY

# Reconceptualise a dynamic framework of the learning constructs in higher education

Gretchen Geng[1] ⓘ   |   Yue Zhu[2] ⓘ   |   Leigh Patrick Disney[3] ⓘ

[1]National School of Education, Australian Catholic University, Melbourne, Victoria, Australia

[2]School of Teacher Education, Zhejiang Normal University, Jinhua, China

[3]Faculty of Education, Monash University, Melbourne, Victoria, Australia

**Correspondence**
Gretchen Geng, National School of Education, Australian Catholic University, 115 Victoria Parade, Fitzroy, VIC, Australia.
Email: gretchen.geng@acu.edu.au

## Abstract

This paper reconceptualised the interrelated learning constructs in higher education based on the Dynamic Systems Theory (DST). The university students' learning experience before, during and post the Emergency Online Learning (EOL) was investigated to explore the dynamic changes among the learning constructs in higher education. A case study of a Chinese university was conducted, and one hundred and ninety-three university students participated in the questionnaire. The data collected from this empirical research identify different hierarchical constructs of the conceptualised learning environment and reconceptualise the period of system reformation influenced by the EOL. The key findings include the identifications of the attractors and repellors framed by the DST and the impact on the changes in the learning constructs. The results of this paper contribute to further understanding of the university constructs' changes to better plan and support students' active learning in higher education.

**KEYWORDS**
dynamic systems theory, emergency online learning, learning constructs, learning engagement, learning experience, learning resources

# 1 | INTRODUCTION

The learning constructs are commonly used in higher education to provide a framework for teachers and students to enhance student's ability to evaluate their learning in more depth and improve their resilience and perseverance (Ali et al., 2019; Posthuma et al., 2017). The framework of learning constructs in higher education is comprehensive as it involves understanding all the attributes, including university- and student-level constructs driven by diverse forces, contributing to the academic teaching process, students' learning experience and outcomes. Since the Coronavirus outbreak (COVID-19) in December 2019, most countries have responded to this community-transmission virus with lockdown restrictions on people's movement to curtail the spread of the virus (Mgutshini et al., 2021). The restrictions, consequently, include the closure of face-to-face educational environments in universities, resulting in a temporary pause of all physical meetings or classes with students in campus classroom buildings. Lectures, examinations, seminars, and research meetings were moved to an emergency remote or online context, causing interruption to all academic activities and reassessing operating procedures in higher education.

Previous research literature has investigated the impact of influential factors of the pandemic on teaching and learning contexts at the university level. However, limited research has, in scope, explored the dynamic changes happening within the interacted learning constructs in higher education caused by Emergency Online Learning (EOL) during COVID and consequently after the pandemic.

Thus, this paper starts with using the Dynamic Systems Theory (DST) as the theoretical underpinning to understand the attractors and repellors in the learning constructs, with the goal of enhancing students learning experience and outcomes in a higher education context. Then the literature view of the theoretical context and current research on learning constructs was conducted to reconceptualise the multi-level learning constructs and frame the research questions. The research design of the case study of one Chinese university was shown, and 193 university students participated in investigating their learning experience and use of learning constructs before, during and after the EOL. This paper contributes to exploring the interrelated learning constructs in higher education and whether the interrelation has an impact on the student's learning outcomes.

# 2 | LITERATURE REVIEW

## 2.1 | The theoretical basis of this study: The dynamic systems theory (DST)

Most universities offer a structured range of teaching and learning facilities (predominantly face-to-face, online and blended learning) to enhance learners' academic performance and course satisfaction. However, emergency circumstances, such as the outbreak of the COVID-19 pandemic, require higher education institutions to reconsider how these facilities are offered. Such variations in offerings make dynamic changes to the learning environment, positively or negatively impacting the learning constructs in higher education. These changes are triggered by various forces inside and outside of the universities. Recently, Huber and Helm (2020) used Dynamic Systems Theory (DST) to review current and previous research regarding the learning process, and how they impact learning outcomes, including academic performance and learning satisfaction. Moreover, according to Cupit (2007), different from a linear system, dynamic systems adhere to their *parameters* and allow an agent (e.g., a university student) to develop sudden phase transitions from less functional to more stable learning habits and patterns. These are organised by *attractors*, and responsive to changes in a teaching and learning environment (e.g., EOL). Therefore, this study uses the DST, instead of a linear system theory, to investigate the transition process, including changes by the *attractors* in higher education during the onset of the pandemic, to conceptualise the current learning constructs which support students to achieve learning goals and graduate successfully.

According to Schöner (2009), behavioural patterns in dynamic systems generally resist change and are stable. The face-to-face model of teaching and learning has been the predominant mode historically, with online learning

only appearing as an alternative in the 1980s and 1990s and becoming more popular at the turn of the century (Castellanos-Reyes, 2020; Harasim, 2000; Mason, 2000). Kaplan and Garner (2017) explained that within dynamic systems, the 'state of the system emerges on the basis of its previous state and will provide a basis for its next state' (p. 2038). So, whilst online learning emerged as a possible teaching and learning platform, its form and function reflect the same objectives as face-to-face delivery. To expand on this point, according to Howe and Lewis (2005), the 'behaviour of the system depends on its initial starting conditions and can change rapidly at first such that it may "overshoot" its eventual stable pattern or attractor, oscillate for a whilst, and finally arrive at a stable point' (p. 249). These oscillations may manifest as *repellors*, which the system will self-organise away from (Kaplan & Garner, 2017) and, therefore, not be part of the system moving forward. Be it face-to-face, online or hybrid learning, the optimal relationship between these forms of learning creates *attractors* (Cupit, 2007) for the system to develop common states of behaviour and provide a level of stability. Hence, universities globally have been creating preferred systems upon which teaching and learning are facilitated through the process of understanding *attractors* and *repellors* within university-student level system constructs. However, the advent of the pandemic acted as a *driving force* (Howe & Lewis, 2005) for universities and students globally, initiating a period of instability for the system.

Within this study, DST had a great influence on our thinking among different hierarchical constructs of the conceptualised learning environment and the period of reformation during the pandemic (Newman & Newman, 2020; Schermerhorn & Cummings, 2008). Smith (2005) investigated how to examine complex questions whilst discussing the parts and the whole in the principles of dynamic systems. Granic (2000) also used this theory to develop a framework for research about the family's influence on children's development. Whilst this theory is ideal for investigating children's learning and development (Spencer, 2009) as dynamic systems (i.e., family and education contexts); the same logic translates that DST can be applied and used as a theoretical underpinning to understand university students' transitional teaching and learning process during the COVID pandemic. The reason behind this lies in that the theory aims to address the process of learning rather than the outcomes of change and development (Newman & Newman, 2020; Thelen et al., 1991). Newman and Newman (2020) commented that the dynamic systems theory's main contributions are related to facilitating the examinations of the overall patterns of change, being stabilisation, destabilisation and self-regulation. In summary, it is important to reiterate that universities are generally stable systems, albeit complex and dynamic.

## 2.2 | Current research on learning constructs in higher education

Previous research has studied parameters that influence university students learning constructs at two levels: university-level and student-level. In university-level constructs, much research has been focused on university infrastructure in the areas of ICT infrastructure and the provision of various learning resources in teachers' and students' navigations, evaluation and applications. For example, Perrotta (2021) recently studied a learning analytics Application Programming Interface as a learning management system. Other researchers, such as Decuypere and Landri (2021) and Hartong (2021), examined the spreading of digital platforms and the development of big data infrastructures in educational research. Other than the infrastructure, academic knowledge and teaching approaches (including curriculum knowledge, planning, and appropriate assessment strategies) and communicative strategies have also been studied. Farr-Wharton et al. (2018) studied the attrition of 363 university students to investigate the impact of the lecturer-student relationship on students' engagement, course satisfaction and achievement. Recent research also includes a report on an empirical study of academics' perspectives on the concept of 'teaching excellence in higher education' (Wood & Su, 2017); and Xiao and Wilkins (2015) studied 24 lecturers and 456 students in one university to examine the effects of lecturer commitment on student perceptions on teaching quality and student satisfaction. In addition, Sambell et al. (2013) wrote a book about how to develop assessments in higher education. Such studies provided

insight into the current focus in higher education on the need to consider teaching and its impact on student experience within university-level constructs.

Research has also examined the student-level constructs. Nicholson et al. (2013) identified student motivation and realistic expectations as keys for undergraduate students' successful achievement in their studies. Hong et al. (2021) also found students' critical attitude can positively impact their learning engagement within their critical thinking processes. In 2013, Macaskill and Denovan developed an intervention to help autonomous learning in first-year university students via positive psychological perspectives, leading high level of learning enjoyment. Much of this research is very specific in nature and detailed learning approaches and learning styles within specific areas of study. Liu and Hou (2021) designed a multidisciplinary teaching method within a clinical situation for nursing students. They studied the effect of multidisciplinary teaching on learning satisfaction and self-confidence in their learning performance and found that multidisciplinary teaching should be promoted in nursing teaching. Wang et al. (2018) studied that science students' learning efficacy should be comprised of different aspects from cognitive skills, practical work and everyday application.

# 3 | RECONCEPTUALISE THE LEARNING CONSTRUCTS IN HIGHER EDUCATION AND THE DEVELOPMENT OF RESEARCH QUESTIONS

## 3.1 | Emergency online learning (EOL)

Prior to the pandemic, many universities were still relying on traditional teaching and learning methods, with limited engagement in the online or blended learning space. However, during the pandemic, universities had to respond quickly to the closure of onsite facilities and needed to analyse traditional forms of teaching and learn to adapt to this emerging crisis. This resulted in lectures and tutorials needing to be swiftly moved to e-forms with various information technology methods: Emergency Online Learning (EOL). For example, lecturers delivered classes via online delivery forms rather than the traditional classroom format (Rapanta et al., 2020). Although the online learning platform has gained acceptance in higher education in previous years (Bouilheres et al., 2020), it was considered an "emergency" movement necessitated by the pandemic.

Nevertheless, the transition from more traditional approaches to an emergency online approach within higher education has been challenging for students and teachers (David et al., 2018; Jin et al., 2021). Lee et al. (2022), for example, conducted a systematic analysis of university teaching activities during the pandemic and highlighted the complex factors underpinning individual academics' experiences from the academic perspective. Flores et al. (2021) also studied higher education students in Portuguese adaption to online teaching and learning after the closure of the institution.

These studies emphasised that this quick movement has caused some concerns among academics and students. The concerns include (a) the lack of professional training to make the best use of the technologies in EOL for lecturers' teaching and students' learning, (b) the quality of teaching and learning in EOL (He & Yang, 2021), and (c) the impact on social practice in teaching (Kovacs et al., 2022). Thus, questions emerge, such as how to keep students engaged in the online teaching and learning context during and post the pandemic and whether the combination of traditional and online methods (Ifijeh & Yusuf, 2020), i.e., hybrid learning, is indeed appropriate for quality higher education outcomes.

## 3.2 | Reconceptualise the learning constructs with EOL as the driving force

There exists a solid body of literature researching online learning and teaching approaches, with several theories and models having been established to support the planning and instructional design (Oliveira et al., 2021).

However, established models or methods do not conceptualise the emergency or ad-hoc change to online learning necessitated by the pandemic. Whilst the pandemic did not change the physical infrastructure of universities, it has played a significant role in disrupting the traditional teaching and learning method as an external factor (Adedoyin & Soykan, 2020; Almusharraf & Bailey, 2021). Marinoni et al. (2020) reported that 91% of higher education institutions worldwide had replaced their in-person teaching (or were in the process of being replaced) with remote activities. Adedoyin and Soykan (2020) further commented there are concerns about the absence of adequate planning, designing, development, and delivery of the courses. Hodges et al. (2020) pointed out that the background reasons for these concerns come from the differences between "the normal and everyday type of effective online learning" and "the rushed and emergency unprepared online learning". Moreover, Mohmmed et al. (2020) described the rushed use of any available remote teaching tools or educational materials that were used in normal online and hybrid learning environments without consideration of learners' needs when articulating from traditional to online learning.

Currently, the available research on student experience within an online learning environment has focussed on student experience during the pandemic (e.g., Adedoyin & Soykan, 2020; Jojoa et al., 2021; Oliveira et al., 2021; Yan et al., 2021). In addition, there remains very limited research that investigates student experience before, during and after the EOL. This *driving force* forms the external constructs of the learning context in higher education; it will be interesting to examine how universities reflect a balance of *attractors* and *repellors* between student-level and university-level constructs. Thus, this study evaluated the internal constructs in higher education with the *driving force* from the external constructs, i.e., EOL, to develop a framework of how dynamic systems of learning constructs *attract* each other before, during and after the EOL. Figure 1 shows the conceptualised framework of learning constructs in higher education with the external impact of the EOL. Moreover, the importance of the paper lies in analysing this reconceptualised framework with the *driving force* before, during and after the EOL. Particularly, the attractors from the driving force need to be studied to investigate the impact of the driving force in the reconceptualised framework.

## 3.3 | Development of research questions

Based on the theoretical learning of the DST and the current studies of learning constructs in higher education, this study reconceptualised learning constructs using EOL as the *driving force*. However, there is a need to investigate the *attractors* and *repellors* within the framework. Particularly, the impact of the *driving force* on the student-level and university-level constructs is to be explored. Therefore, two research questions have been developed in this study:

1. Within the underpinning of DST, did the EOL (*driving force*) cause observable patterns of the impact on teaching and learning over the transition period (i.e., before, during and after EOL)?
2. What were the *attractors* and *repellors* among the two levels of learning constructs (student and university), and how are the interacted relationships within each learning construct impacted by the *attractor*s and/or *repellors*?

## 4 | METHODS

Surveys can be used to acquire information from the participant(s) about their opinion, characteristics, attitudes or prior experience (Authors, 2014; Leedy et al., 2016). In this study, a questionnaire survey was administered among 193 university students in one university in Southeast China. Quantitative data were collected through closed questions, and qualitative data were collected by open-ended questions in the questionnaire. This research
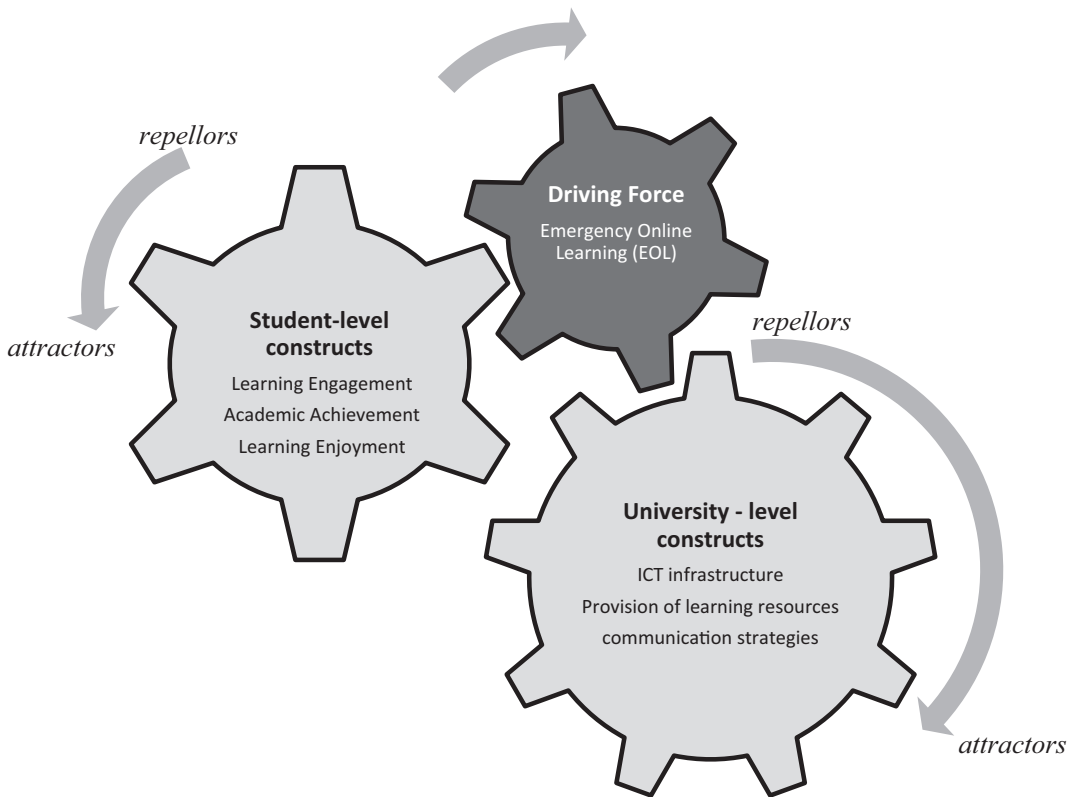
**FIGURE 1** Reconceptualised university learning constructs.

obtained ethical approval from the participating university in September 2020, and consent was obtained from the participating students.

## 4.1 | Research context

Due to the nature of the pandemic, it was an unforeseen event and there was no potential to foresee the arrangement of the research design before, during and after EOL, rather enacted post the event. This section introduces the research context of using a Chinese university as a case study, as this university went through the transition from the traditional face-to-face teaching mode to EOL (owing to the COVID lockdown restrictions) from February to July 2020 and then to a mixed-mode delivery from October 2020. In detail, the researchers invited the participating students to reflect on their experience before, during and after the EOL to demonstrate the "lived experience" throughout the pandemic. Although universities across the world are going through the stages of before, during and after EOL, this paper provides a purposeful case study of one university during this dynamic transition period.

## 4.2 | Participants

Participants from a university in the Southern East area of China were invited to participate in this study, and one hundred and ninety-three students completed the survey. Of the 193 participants, 35 (18.13%) were male

students, and 158 (81.87%) were female students. The participating students used face-to-face learning modes before EOL, although most of them had access to online learning prior to university studies. They then were studying through EOL during the pandemic, and now studying through the hybrid learning (face-to-face and online) mode.

The participating students were from the School of Education, majoring in STEM (including mathematics, science and technology studies), Humanities and social science (including ideological studies, Chinese, and English language education), and the Arts and PE (including Music Education and Health and PE). Table 1 shows the participating students' disciplines.

The participants' age range was from 18 to 30 years old, with 54.90% being 21–25, 43.50% being 18–20, and 1.60% being 26–30 years. Of the 193 participants, there were 163 (84.46%) studying undergraduate degrees, and 30 (15.54%) studying postgraduate degrees.

## 4.3 | Instruments

In this study, the survey was developed based on the tool developed by Nininger and Abbott (2019). There were five sections in the survey, being (1) Participants' opinions towards their learning enjoyment level before, during and after EOL; (2) Participants' self-perceived academic achievement or outcome before, during and after EOL; (3) Participants' learning engagement level before, during and after EOL; (4) Participant's learning experience with the infrastructure provided by the university, the resources using experience and communicative strategies they used before, during and after EOL, and (5) open-ended questions about the participants' opinions of their learning context. In Section 1, students were asked to rate their enjoyment from 1, the lowest, to 5, the highest. The university's ethics committee suggested the researchers invite the participants to self-rate their academic achievement in Section 2, instead of using their actual learning grades. In Section 3, the participants were invited to rank their engagement levels into three categories (low, medium and high) across six engagement areas: Concentration, energy, creativity, persistence, precision and satisfaction. Section 4 asked the participants to provide their opinions on the learning constructs across the university level, including their use of digital infrastructure, locating, interpreting, evaluating and applying learning resources provided by the university, and communicative strategies. The participants were asked to answer all four sections of questions before, during and after EOL periods. In Section 5, the participants were provided opportunities to discuss their specific learning experiences and identify the strategies they found useful, particularly after the EOL period.

Before the instrument was administered to the 193 participants, it was tested for the use of wording and appropriateness. Five PhD students who studied full-time at the university were used to test the research instrument of the survey. The students were chosen because they had an online learning experience and research experience as well. The five students were asked to go through the instrument individually and carefully to ensure there were no misspellings or misunderstandings. All five students indicated they believed this instrument was satisfactory in September 2020. The test took approximately 20 min each in duration.

**TABLE 1** Participating students in different disciplines in the School of Education.

| Major | n | Percentage |
| --- | --- | --- |
| STEM | 82 | 42.49 |
| Humanities and social science | 78 | 40.41 |
| Arts and PE | 33 | 17.10 |

*Note*: N = 193.

## 4.4 | Procedure

With the ethics approval, consent was obtained first from the teaching staff. With the assistance of the teaching staff, the information sheet and consent forms were provided to the participants before the survey. Consent was then obtained successfully from the participants. The questionnaire survey was then administered in hard copy and handed out to the participants with the assistance of the teaching staff from October to December 2020.

## 4.5 | Data analysis

Both quantitative and qualitative analyses were used in this study. All the written answers to quantitative data were transcribed and entered into the Statistical Package for Social Science (SPSS) Version 27.0. In detail, frequencies and descriptions were used to present the means and standard deviations of the participants' learning engagement, enjoyment and perceived learning outcomes before, during and after EOL first. Boxplots were also used to demonstrate the means and standard deviations of their learning engagement, enjoyment and learning outcomes across their year level of studying and their disciplines. Then the Friedman Test was used to analyse the interacted relationships within the student-level and university-level constructs before, during and after EOL. Pearson Correlation was next used to investigate the relationships of the attractors between the two levels of learning constructs before, during and after EOL periods. Wilcoxon Signed-Rank test was also used to determine whether the differences were significant among the *parameters* within the learning constructs. Scatter plots were used to present the difference in the interacted relationships to find the patterns of the impact on teaching and learning before, during and after EOL. The alpha level as a significance criterion was set as .05.

In terms of the qualitative data, themes were categorised and defined from the participant's responses to the open-ended questions. During the coding process, researchers met on a regular basis to compare coding and discuss key themes drawn from the transcripts. The researchers used the analysis proceeding by visiting and revisiting the data and connecting them with in-depth and emerging insights and consequently leading to a focused understanding of categories and themes. Moreover, they actively self-reported their potential biases (Johnson & Christensen, 2014). Three cycles of data process (Alase, 2017) were in data coding by inductively quantifying and collecting common themes and grouping more basic themes into keywords or phrases. In detail, the researchers first coded the qualitative texts related to the internal and external parameters, by carefully quantifying the themes. Then in the second coding cycle, more detailed attention was paid to the keywords or phrases to identify the themes into four categories of personal interactions with others, use of self-efficacy, time management and technology impact on learning outcomes, related to the literature. Interweaving relationships were identified in the third cycle to develop the framework and investigate new knowledge. In addition, certain codes were compared, refined and validated by comparing analytical insights from different researcher perspectives. The frequency tables were used to present the categorised themes. Moreover, the themes from the open-ended questions were then also used to testify to the validity of the impact of the driving force (EOL) on the attractors and/or repellors of the framework.

## 5 | FINDINGS

### 5.1 | Student–level constructs

#### 5.1.1 | Enjoyment of learning

Table 2 presents the participants' enjoyment of learning before, during and after EOL. A Friedman test was run, and it was found there was a significant difference in the enjoyment of learning before, during and after EOL, $X^2(2) = 6.51$,

**TABLE 2**  Enjoyment of learning (before, during and after EOL).

|  | Skewness | Kurtosis | Maximum | Minimum | Mean | SD | N |
|---|---|---|---|---|---|---|---|
| Before EOL | −0.84 | 0.52 | 5 | 2 | 3.67 | 0.71 | 193 |
| During EOL | −0.56 | −0.52 | 5 | 1 | 3.45 | 1.04 | 193 |
| After EOL | −1.02 | 0.51 | 5 | 1 | 3.66 | 1.05 | 192 |

*Note: 1 = do not like it at all, 2 = dislike it, 3 = neutral, 4 = like it, and 5 = like it very much.*

**TABLE 3**  Self-perceived academic achievement (before, during and after EOL).

|  | Skewness | Kurtosis | Maximum | Minimum | Mean | SD | N |
|---|---|---|---|---|---|---|---|
| Before EOL | −0.07 | −0.32 | 5 | 1 | 3.24 | 0.94 | 190 |
| During EOL | <−0.01 | −0.22 | 5 | 1 | 3.17 | 0.96 | 184 |
| After EOL | −0.04 | 0.10 | 5 | 1 | 3.16 | 0.89 | 182 |

*Note: 1 = Well below average, 2 = below average, 3 = average, 4 = above average, and 5 = well above average.*

**TABLE 4**  Means and SD of the six engagement areas before, during and after EOL.

|  | Concentration | | Energy | | Creativity | | Persistence | | Precision | | Satisfaction | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Before EOL | 2.17 | 0.55 | 2.28 | 0.62 | 1.99 | 0.62 | 2.26 | 0.64 | 2.13 | 0.59 | 2.10 | 0.57 |
| During EOL | 1.64 | 0.66 | 1.80 | 0.70 | 1.79 | 0.65 | 1.80 | 0.67 | 1.78 | 0.65 | 1.70 | 0.64 |
| After EOL | 2.17 | 0.60 | 2.31 | 0.59 | 2.03 | 0.59 | 2.24 | 0.59 | 2.11 | 0.57 | 2.05 | 0.58 |

*Note: 1 = low, 2 = medium, 3 = high.*

$p = .04$. The following Wilcoxon Signed-ranked test showed the enjoyment of learning was significantly lower during EOL than either before EOL, $Z = −2.57$, $p = .01$, or after EOL, $Z = −2.07$, $p = .04$. Wilcoson Signed-ranked test showed no significant difference of enjoyment of learning before and after EOL, $Z = −0.34$, $p = .74$.

### 5.1.2 | Self-perceived academic achievement

Table 3 shows the participants' self-perceived academic achievement before, during and after EOL.

Although the participants' self-perceived academic achievement has been rated lower during and after EOL, than before EOL, their lower rates were not significantly different from each other, $X^2(2) = 1.30$, $p = .52$.

### 5.1.3 | Engagement of learning

Table 4 presents the means and standard deviations of the six areas of engagement of learning before, during and after EOL, which are concentration, energy, creativity, persistence, precision and satisfaction.

Friedman test was run, and it was found the participating students showed significantly lower engagement during EOL, including concentration, energy, creativity, persistence, precision and satisfaction than before EOL (see Table 5). When it was after EOL, their engagement levels returned similar to the levels before EOL across all six areas.

**TABLE 5**  Learning engagement levels across six areas before, during and after EOL.

| | Before EOL/during EOL/after EOL | |
| --- | --- | --- |
| | $X^2(2)$ | $p$ |
| Concentration | 117.88 | <.001 |
| Energy | 92.03 | <.001 |
| Creativity | 31.61 | <.001 |
| Persistence | 72.45 | <.001 |
| Precision | 56.60 | <.001 |
| Satisfaction | 62.58 | <.001 |

A new variable, "Engagement" was created by adding the values of the six areas and then dividing them by three. When it was after EOL, their engagement levels returned similar to the levels before EOL, $X^2(2) = 98.02$, $p < .001$.

## 5.2 | University-level constructs

### 5.2.1 | ICT infrastructure

The participants showed their satisfaction and confidence in using the ICT infrastructures provided by the university, mean = 3.72, $SD = 0.83$ (before EOL), mean = 3.95, $SD = 0.73$ (during EOL), and mean = 4.06, $SD = 0.64$ (after EOL). A Friedman test was run, and it was found their satisfaction and confidence in using ICT infrastructure had been significantly improved from before EOL, during EOL and after EOL, $X^2(2) = 48.37$, $p < .001$.

### 5.2.2 | Learning resources

The participants were asked to rate their user experience in locating learning resources, thoroughly interpreting learning resources, evaluating, organising and synthesising learning resources and applying learning resources to form their own opinions. The means and $SD$s are provided in Table 6.

Friedman test was undertaken, and it was found the participating students showed significantly higher confidence in using learning resources across the areas (locating, interpreting, evaluating and applying) during EOL and highest after EOL than before EOL (see Table 7).

A new variable, "Learning resources", was created by adding the values of the four areas and then dividing them by four. It was found using the Friedman test that there was a significant difference before EOL, during EOL and after EOL, $X^2(2) = 73.03$, $p < .001$.

### 5.2.3 | Communication strategies

The participants were asked to rate their experience in using communicative strategies provided by the university they used to communicate with their lecturers/teachers and peers. The means and $SD$s are provided in Table 8. Friedman test was also used, and it was found students' confidence in using communicative strategies provided by the university is significantly higher during and after EOL than before EOL, $X^2(2)$ (with their lecturers/teachers) = 45.79, $p < .001$; and $X^2(2)$ (with their peers) = 50.18, $p < .001$.

**TABLE 6** Means and *SD*s of learning resources provided by the university.

| | Locating | | Interpreting | | Evaluating | | Applying | |
|---|---|---|---|---|---|---|---|---|
| | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** |
| Before EOL | 3.76 | 0.83 | 3.04 | 0.88 | 3.28 | 0.88 | 3.15 | 0.90 |
| During EOL | 3.98 | 0.72 | 3.37 | 0.86 | 3.60 | 0.65 | 3.42 | 0.84 |
| After EOL | 4.03 | 0.68 | 3.50 | 0.88 | 3.65 | 0.84 | 3.46 | 0.84 |

*Note*: 1 = lowest, 5 = highest.

**TABLE 7** Confidence in using learning resources before, during and after EOL.

| | Before EOL/during EOL/after EOL | |
|---|---|---|
| | **$X^2(2)$** | **p** |
| Locating | 26.14 | <.001 |
| Interpreting | 67.92 | <.001 |
| Evaluating | 43.79 | <.001 |
| Applying | 26.38 | <.001 |

**TABLE 8** Means and *SD*s of communicative strategies provided by the university.

| | With their lecturers/teachers | | With peers | |
|---|---|---|---|---|
| | **Mean** | **SD** | **Mean** | **SD** |
| Before EOL | 3.51 | 0.94 | 3.72 | 0.84 |
| During EOL | 3.84 | 0.86 | 4.01 | 0.76 |
| After EOL | 3.85 | 0.90 | 4.03 | 0.76 |

*Note*: 1 = lowest, 5 = highest.

## 5.3 | Interrelated relationship between the student-level constructs and university-level constructs

The section presents the dynamic changes made from the interrelated relationships between student-level constructs and university-level constructs before, during and after EOL.

Figure 2 shows the comparison among the correlations between students' learning engagement and university-level constructs before, during and after EOL. It shows although the correlations were not significant across before, during and after EOL, indicating participating students' learning engagement has limited relationships with university-level constructs. However, it was also found that the participants' engagement level had a higher correlation during EOL than before EOL, and the higher correlation extended to after EOL, *p* = .05.

Figure 3 also shows the comparison among the correlations between students' academic achievement and university-level constructs before, during and after EOL. It was also found the participants' academic achievement had a significantly higher correlation during EOL and after EOL than before EOL, *p* = .01.

It was found in Figure 4 that the participants' learning enjoyment levels had higher correlations during EOL and after EOL than before EOL, *p* = .04.

In order to develop a dynamic systems model among learning constructs in higher education, correlations have been used to evaluate the relationships among the three constructs at the student levels and three constructs
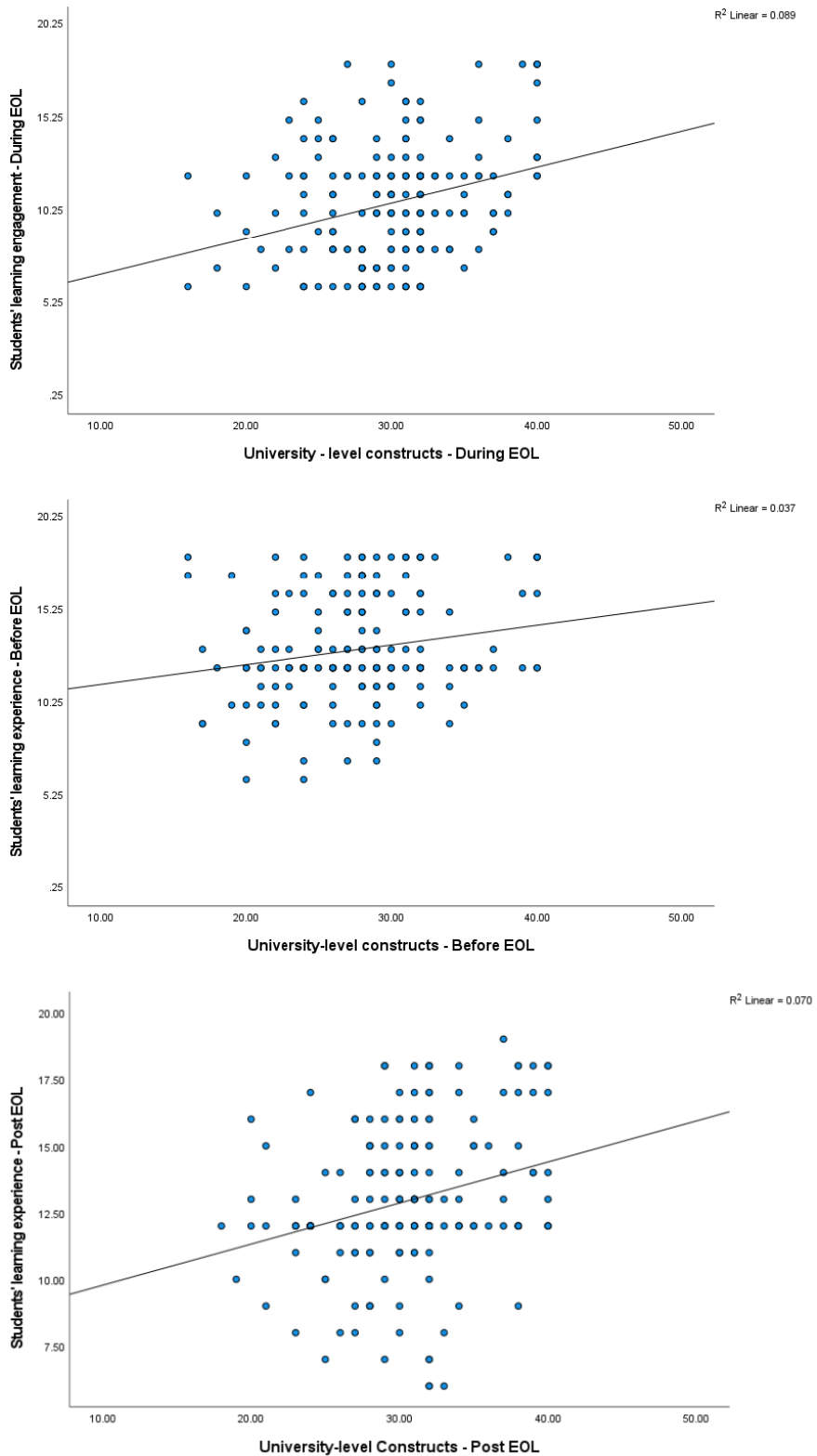
**FIGURE 2**  Correlations between students' learning engagement and university-level constructs.
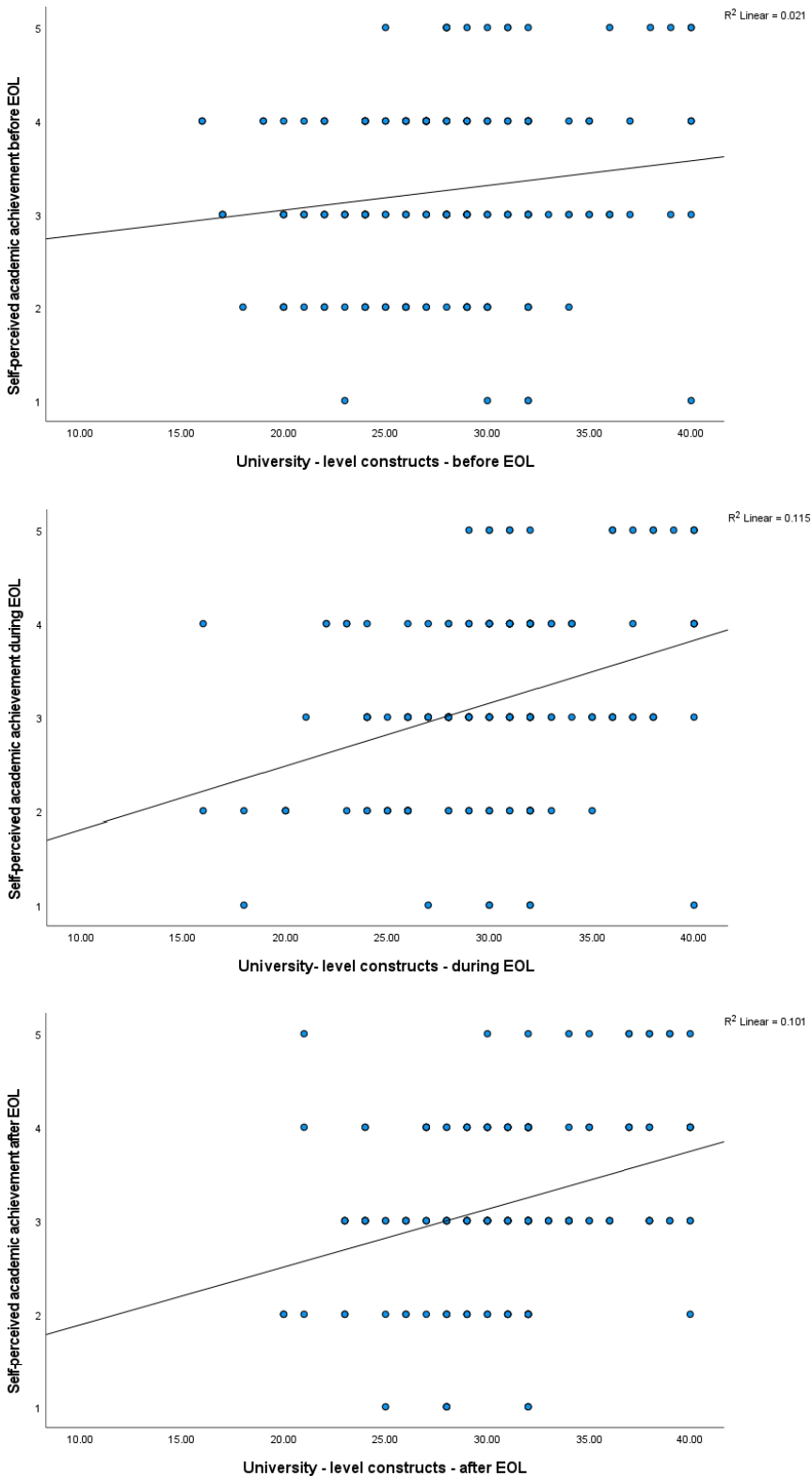
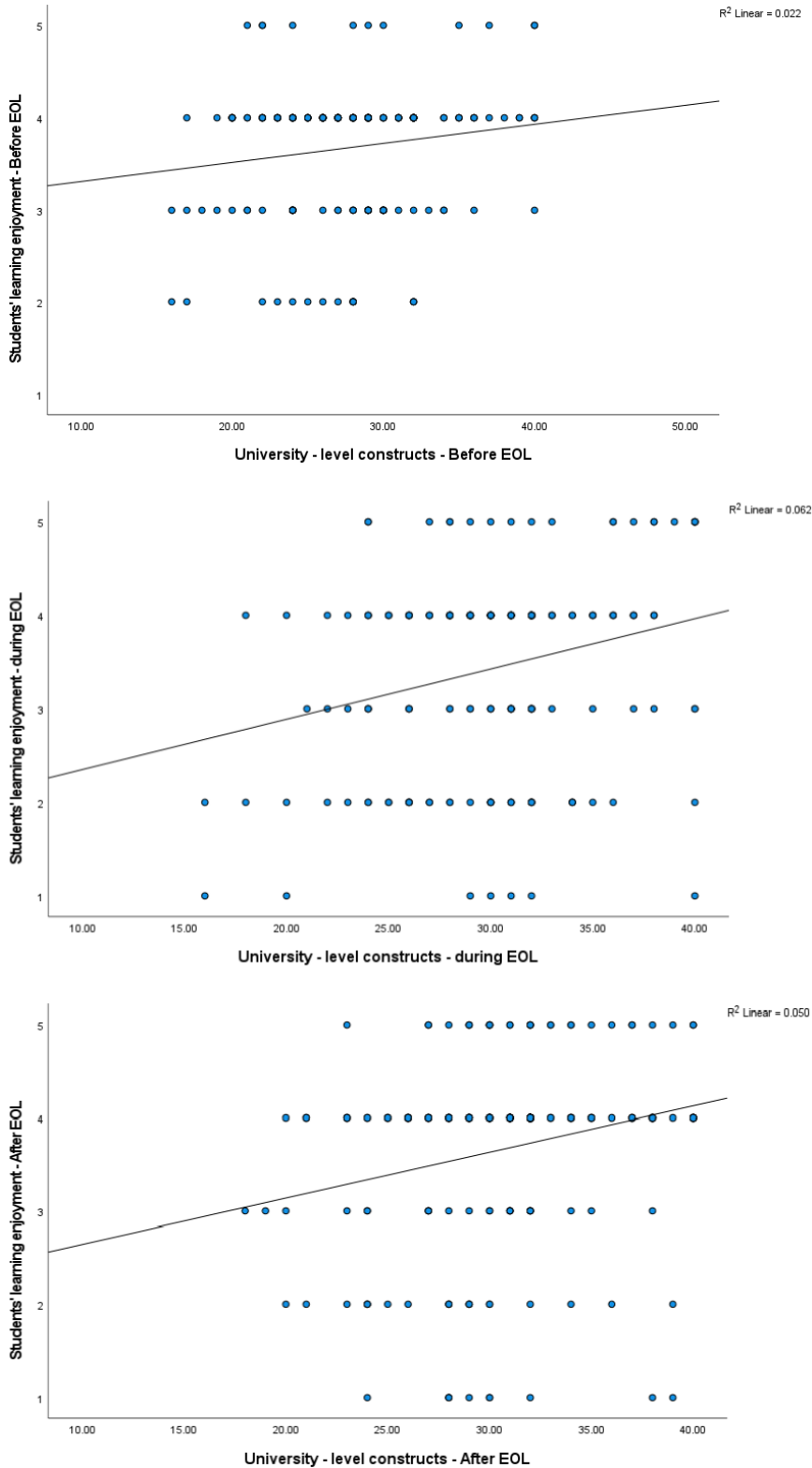**FIGURE 3** Correlations between students' academic achievement and university-level constructs.

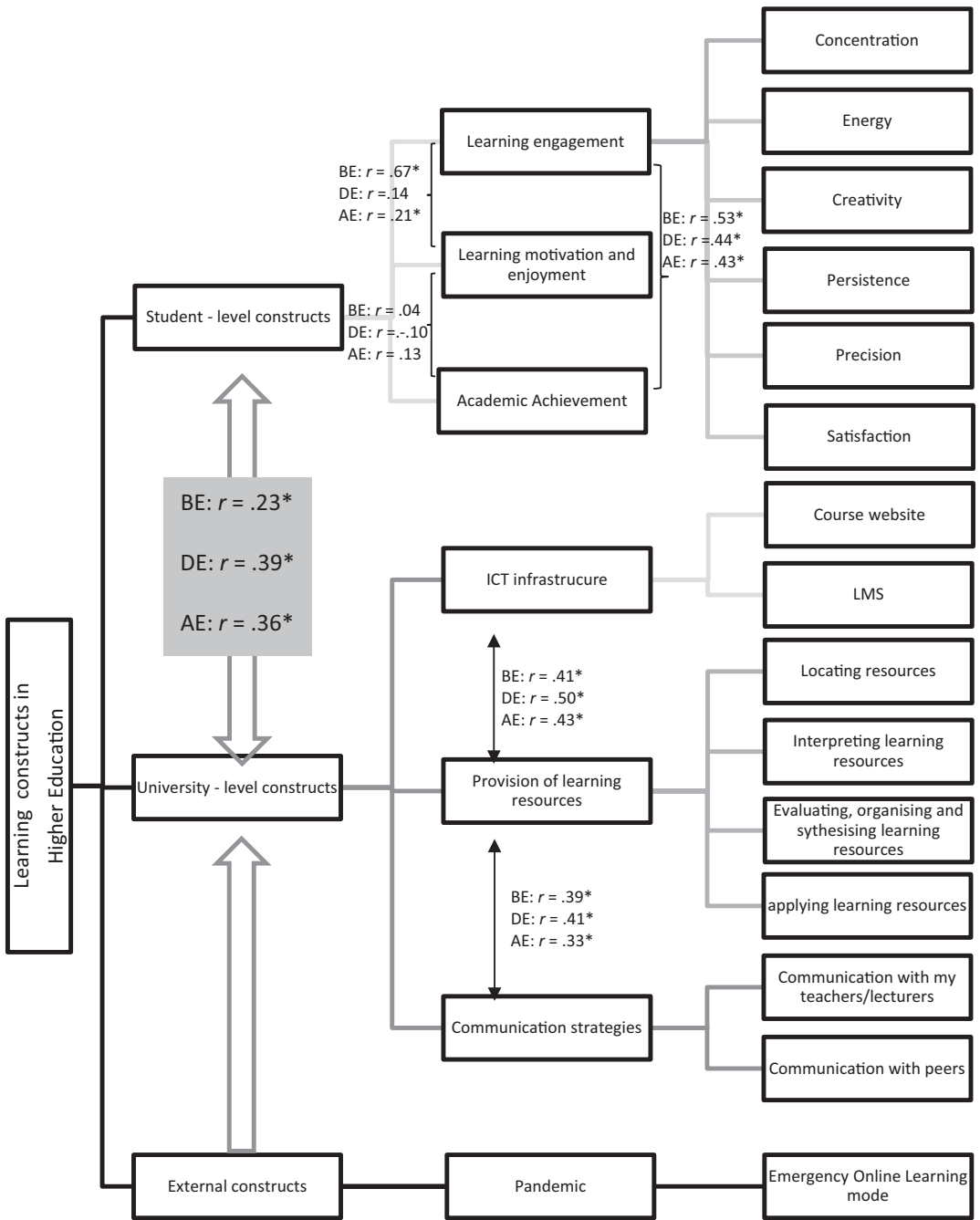**FIGURE 4** Correlations between students' learning enjoyment and university-level constructs.

**FIGURE 5** Overview of learning constructs in higher education. (a) BE = Before EOL, DE = During EOL, and AE = After EOL; (b) *p<.01.

at the university levels. Figure 5 presents the overview of the correlations between the two learning constructs with the driving force of EOL, and r values are shown before, during and after EOL. It was found the relationship between the student-level constructs and university-level constructs has higher positive correlations during and after EOL than before EOL, *p<.01*.

**TABLE 9** Feedback on learning experience during EOL.

| Feedbacks | Number/percentage | Examples |
|---|---|---|
| Lack of personal interactions with others | 175 (90.67%) | We should have more interactive classes, not just watching recorded videos. I also think teachers also had limited evaluation of their student's learning process |
| | | Online learning should be done through more interactions; although we know how to use different ICT tools, there are really limited opportunities for us to talk or communicate with each other |
| | | Studying should not be a task for one alone |
| | | There should be more synchronous teaching and no more recordings |
| High dependence on self-efficacy | 124 (64.24%) | There is limited monitoring of our learning process, and we will mainly rely on ourselves to learn. For any students who do not have good self-efficacy, their learning will not be successful |
| | | Sometimes it was challenging to focus on learning, and online learning required a lot of time to focus on myself |
| | | I can concentrate on my studying without being disturbed |
| Time management | 54 (27.98%) | I found it difficult sometimes to get used to completing an online task within the timeline |
| | | Assessments feedbacks need to be returned within a reasonable timeline to ensure continuous studying |
| Technology improvement | 31 (16.06%) | I hope the video analysis technologies can solve the problem of not being able to meet my teachers during my learning |
| | | The length of the recorded classes can be improved, and the content can be more engaging |

The students were also asked to provide feedback on their experience during and after EOL, and the open-ended answers were categorised into the following table (Table 9). The four categories of feedback include personal interactions, self-efficacy and time management strategies, which are the student-level learning constructs, and technology improvement, which belong to the university-level learning constructs. The feedback was used to reinforce and capture other *repellors* and *attractors* that have impacted the students' learning experiences. Table 9 shows the majority (more than 90%) of the participants viewed personal interactions with others played a significant component towards a positive learning experience. More than half (64.24%) of the participants reinforced the importance of self-efficacy. Further, time management and technology facilities also impact the university students' learning experience.

## 6 | DISCUSSION

This paper investigated the student-level and university-level learning constructs with the *driving force* from the EOL. A Chinese university was case studied due to the availability of observation of university and student-level constructs that had been through the collective process of EOL and returned to an adapted hybrid learning environment after EOL. The present paper framed these constructs as a *dynamic system* whereby the system had been thrown into instability by the *driving force* of EOL. This section discusses the findings in relation to the two research questions related to (a) the observable patterns of the impact of the EOL as *a driving force* on the interacted relationships among the learning constructs on teaching and learning before, during and after EOL, and (b) the *attractors* and *repellors* on the learning constructs to enhance students' learning experience.

## 6.1 | Observable patterns of the impact of the EOL among the learning constructs

Many students showed a lower degree of enjoyment during EOL than before EOL, but it improved after hybrid learning was introduced. Additionally, although the participating students showed a high level of confidence in communicative strategies with lecturers and peers during and after EOL, they demonstrated significantly lower learning engagement levels during EOL than before and after EOL. Their further comments include a lack of interactions with their lecturers. This is a significant concern for online learning as the sole form of teaching and learning in higher education during EOL. Learning engagement is a vital component in learning, as Farr-Wharton et al.'s (2018) found that the lecturer-student relationship has a significant impact on students' engagement and course satisfaction. University students' engagement levels are closely related to university lecturers' teaching quality and teaching competencies (Wood & Su, 2017), no matter in face-to-face learning before EOL, emergency online learning during EOL or hybrid learning after EOL. Correspondingly, if students are dissatisfied with the level of engagement in online learning, eventually, the system of higher education will self-organise based on feedback received. Consequently, the university-level constructs, that are aimed at providing platforms for online learning will need to investigate ways to enhance engagement and communication in the online context or consider using hybrid modes of delivery.

This study also found that the participating students had similar self-perceived academic achievements before, during and after EOL, indicating the change in learning contexts, such as EOL, did not have a significant impact on their academic learning outcomes. It can be related to the parameters at the student level, such as the students' self-confidence and critical attitude, because they positively influence the cognitive dimension of their learning experience (Hong et al., 2021). This means if students can study with similar self-confidence and learning attitudes in different contexts at university, they could still find ways to achieve their learning goals successfully. Thus, despite the instability in part of the system impacted by EOL, the factors of self-confidence and attitudes at the student level remain the same and resist individual change.

## 6.2 | Attractors and repellors on the changes within the learning constructs

The relationships of the learning constructs are investigated to explore the *attractors* and *repellors* that supported or disrupted the stability of the system during the pandemic and out of it. In terms of the learning constructs at the university level, there were strong positive corrections between the ICT infrastructure and other parameters, i.e., communication strategies and provision of learning resources before, during and after the EOL. This finding indicates many universities have already started developing their ICT infrastructures before the pandemic outbreak (Decuypere & Landri, 2021; Hartong, 2021; Perrotta, 2021). Therefore, participating students had prior experience in online learning environments, reflecting their high level of personal digital capabilities and experience in using ICT infrastructure and learning resources provided by the university. However, it was also found from the students' text comments that technologies are still needing to be improved to help the students engage with the content and allow for more interactive and communicative opportunities instead of the use of pre-recorded lectures.

When considering the student-level construct, it was found that students' engagement has a positive correlation with their learning experience. However, the low levels of engagement and enjoyment during EOL, especially the lack of communication between lecturer and students, would suggest they are major *repellors* for the system. Nevertheless, it was also found the participants' learning experience did not have a correlation with their academic performance before, during and after the EOL, which acts as an *attractor* of stability for participants' academic achievements.

With consideration of all the parameters among the learning constructs on the student's learning experience, *attractors* and *repellors* have been identified for the success of the dynamic system. The *attractors* include students' and universities' readiness to adapt to transitions quickly to achieve successful learning experiences

and academic performance. The identified *repellors* include the lack of communicative opportunities and limited technology provision. They need to be investigated and developed into appropriate *attractors* that support system stability for lecturers and students when engaging in an online or hybrid learning environment and reach higher confidence in their academic achievement after EOL.

## 7 | CONCLUSION AND FUTURE STUDY

This paper investigated the learning constructs in higher education as a dynamic system and reconceptualised the learning constructs with the *driving force* of EOL. This study makes a major contribution to understanding the *attractors* and *repellors* of the dynamic systems with the driving force on the student-level and university-level learning constructs in the current university environment. The researchers found a dynamic relationship between the university-level and student-level constructs. It was also found EOL has had a significant impact on the learning constructs, although students' self-efficacy and self-confidence in their academic achievement stayed similar no matter if they were going through EOL or not. The *attractors* include both students and the university's readiness to adapting the transition quickly. The participating students' needs to have interactions with their lecturers and peers were found to be the *repellors* among the learning constructs.

The limitations of this study lie in that the study was only conducted in one Chinese university, and only education students participated in this study. With most universities coming out of the EOL, further studies should be conducted among other universities in more countries. Moreover, this study only included students' self-perceived academic achievements. Although the study shows the students' self-confidence and self-efficacy levels, it does not represent the students' actual learning outcomes or academic performance. Therefore, an evaluation of students' actual academic results would support deeper insights into the relationship between students' learning experiences and academic outcomes. Whilst driving forces for change, such as the COVID-19 pandemic, aren't expected, they have provided opportunities for both universities and students to re-evaluate learning in future. This study can be useful in helping both universities, and students themselves, to prepare for a satisfactory learning experience and better academic performance and achievement.

### AUTHOR CONTRIBUTIONS
**Gretchen Geng**: Conceptualization; Investigation; Methodology; Validation; Software; Formal analysis; Project administration; Writing—review & editing; Writing—original draft; Data curation; Supervision; Resources; Visualization; Funding acquisition. **Yue Zhu**: Conceptualization; Investigation; Writing—review & editing; Methodology; Data curation; Formal analysis; Project administration; Software; Validation. **Leigh Patrick Disney**: Writing—review & editing; Data curation; Formal analysis; Project administration; Software; Validation; Methodology.

### CONFLICT OF INTEREST STATEMENT
The authors have no relevant financial or non-financial interests to disclose. The authors have no conflicts of interest to declare that are relevant to the content of this article. All authors certify that they have no affiliations

with or involvement in any organisation or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. The authors have no financial or proprietary interests in any material discussed in this article.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

## ETHICS APPROVAL

Approval was obtained from the Ethics Board of Zhejiang Normal University.

## ORCID

*Gretchen Geng* https://orcid.org/0000-0003-3087-6567
*Yue Zhu* https://orcid.org/0000-0002-6028-2973
*Leigh Patrick Disney* https://orcid.org/0000-0002-5633-5673

## REFERENCES

Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments*, 1–13. https://doi.org/10.1080/10494820.2020.1813180

Alase, A. (2017). The interpretative phenomenological analysis (IPA): A guide to a good qualitative research approach. *International Journal of Education and Literacy Studies*, *5*(2), 9–19. https://doi.org/10.7575/aiac.ijels.v.5n.2p.9

Ali, M. M. A., Yunus, M. M., Hashim, H., Rahim, A. A. A., & Khamis, N. Y. (2019). Strategic development of flipped framework on educators and learning constructs for ESL context: The experts' agreement. *International Journal of Academic Research in Business and Social Sciences*, *9*(3), 1414–1422. https://doi.org/10.6007/IJARBSS/v9-i3/5805

Almusharraf, N. M., & Bailey, D. (2021). Online engagement during COVID-19: Role of agency on collaborative learning orientation and learning expectations. *Journal of Computer Assisted Learning*, *37*(5), 1285–1295. https://doi.org/10.1111/jcal.12569

Authors. (2014). Exploring pre-service teachers' knowledge of and ability to use text messaging. *The Australian Journal of Teacher Education*, *39*(7), 173–182. https://doi.org/10.14221/ajte.2014v39n7.4

Bouilheres, F., Le, L. T. V. H., McDonald, S., Nkhoma, C., & Jandug-Montera, L. (2020). Defining student learning experience through blended learning. *Education and Information Technologies*, *25*(4), 3049–3069. https://doi.org/10.1007/s10639-020-10100-y

Castellanos-Reyes, D. (2020). 20 years of the community of inquiry framework. *TechTrends*, *64*(4), 557–560. https://doi.org/10.1007/s11528-020-00491-7

Cupit, G. (2007). The marriage of science and spirit: Dynamic systems theory and the development of spirituality. *International Journal of Children's Spirituality*, *12*(2), 105–116. https://doi.org/10.1080/13644360701467402

David, S. S., Hilda, R. G., Michael, G., & Xing, L. (2018). Learning to become an online learner in a Chinese university: A tale of transformative pedagogy. In L. M. Karen (Ed.), *Cultivating diverse online classrooms through effective instructional design* (pp. 45–66). IGI Global.

Decuypere, M., & Landri, P. (2021). Governing by visual shapes: University rankings, digital education platforms and cosmologies of higher education. *Critical Studies in Education*, *62*(1), 17–33. https://doi.org/10.1080/17508487.2020.1720760

Farr-Wharton, B., Charles, M. B., Keast, R., Woolcott, G., & Chamberlain, D. (2018). Why lecturers still matter: The impact of lecturer-student exchange on student engagement and intention to leave university prematurely. *Higher Education*, *75*(1), 167–185. https://doi.org/10.1007/s10734-017-0190-5

Flores, M., Barros, A., Simão, A. M. V., Pereira, D., Flores, P., Fernandes, E., Costa, L., & Ferreira, P. C. (2021). Portuguese higher education students' adaptation to online teaching and learning in times of the COVID-19 pandemic: Personal and contextual factors. *Higher Education*, *83*(6), 1389–1408. https://doi.org/10.1007/s10734-021-00748-x

Granic, I. (2000). The self-organisation of parent-child relations: Beyond bidirectional models. In M. D. Lewis & I. Granic (Eds.), *Emotion, development, and self-organisation: Dynamic systems, approaches to emotional development* (pp. 267–297). Cambridge University Press.

Harasim, L. (2000). Shift happens: Online education as a new paradigm in learning. *The Internet and Higher Education*, *3*(1), 41–61. https://doi.org/10.1016/S1096-7516(00)00032-4

Hartong, S. (2021). The power of relation-making: Insights into the production and operation of digital school performance platforms in the US. *Critical Studies in Education*, *62*(1), 34–49. https://doi.org/10.1080/17508 487.2020.1749861

He, X., & Yang, H. H. (2021). Technological barriers and learning outcomes in online courses during the Covid-19 pandemic. In R. Li, S. K. S. Cheung, C. Iwasaki, L.-F. Kwok, & M. Kageto (Eds.), *Blended learning: Re-thinking and re-defining the learning process* (pp. 92–102). Springer International Publishing.

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020, March 27). The difference between emergency remote teaching and online learning. *Educause Review*. https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Hong, J.-C., Hsiao, H.-S., Chen, P.-H., Lu, C.-C., Tai, K.-H., & Tsai, C.-R. (2021). Critical attitude and ability associated with students' self-confidence and attitude toward "predict-observe-explain" online science inquiry learning. *Computers and Education*, *166*, 104172. https://doi.org/10.1016/j.compedu.2021.104172

Howe, M. L., & Lewis, M. D. (2005). The importance of dynamic systems approaches for understanding development. *Developmental Review*, *25*, 247–251.

Huber, S. G., & Helm, C. (2020). COVID-19 and schooling: Evaluation, assessment and accountability in times of crises-reacting quickly to explore key issues for policy, practice and research with the school barometer. *Educational Assessment, Evaluation and Accountability*, *32*(2), 237–270. https://doi.org/10.1007/s11092-020-09322-y

Ifijeh, G., & Yusuf, F. (2020). Covid-19 pandemic and the future of Nigeria's university system: The quest for libraries' relevance. *The Journal of Academic Librarianship*, *46*(6), 102226. https://doi.org/10.1016/j.acalib.2020.102226

Jin, Y. Q., Lin, C.-L., Zhao, Q., Yu, S.-W., & Su, Y.-S. (2021). A study on traditional teaching method transferring to E-learning under the COVID-19 pandemic: From Chinese students' perspectives. *Frontiers in Psychology*, *12*, 632787. https://doi.org/10.3389/fpsyg.2021.632787

Johnson, B., & Christensen, L. B. (2014). *Educational research: Quantitative, qualitative, and mixed approaches* (5th ed.). Sage Publications.

Jojoa, M., Lazaro, E., Garcia-Zapirain, B., Gonzalez, M. J., & Urizar, E. (2021). The impact of COVID 19 on university staff and students from Iberoamerica: Online learning and teaching experience. *International Journal of Environmental Research and Public Health*, *18*(11), 5820. https://doi.org/10.3390/ijerph18115820

Kaplan, A., & Garner, J. K. (2017). A complex dynamic systems perspective on identity and its development: The dynamic systems model of role identity. *Developmental Psychology*, *53*(11), 2036–2051. https://doi.org/10.1037/dev0000339

Kovacs, H., Zufferey, J. D., Tormey, R., & Jermann, P. (2022). Teaching under lockdown: The change in the social practice of teaching. *Higher Education*, *5*, 1–19. https://doi.org/10.1007/s10734-022-00863-3

Lee, K., Fanguy, M., Bligh, B., & Lu, X. S. (2022). Adoption of online teaching during the COVID-19 Pandemic: A systematic analysis of changes in university teaching activity. *Educational Review (Birmingham)*, *74*(3), 460–483. https://doi.org/10.1080/00131911.2021.1978401

Leedy, P. D., Ormrod, J. E., & Ormrod, J. E. (2016). *Practical research planning and design* (11th ed.). Pearson.

Liu, Y.-M., & Hou, Y.-C. (2021). Effect of multidisciplinary teaching on learning satisfaction, self-confidence level and learning performance in the nursing students. *Nurse Education in Practice*, *55*, 103128. https://doi.org/10.1016/j.nepr.2021.103128

Macaskill, A., & Denovan, A. (2013). Developing autonomous learning in first year university students using perspectives from positive psychology. *Studies in Higher Education (Dorchester-on-Thames)*, *38*(1), 124–142. https://doi.org/10.1080/03075079.2011.566325

Marinoni, G., Van't Land, H., & Jensen, T. (2020). *The impact of COVID-19 on higher education around the world*. IAU Global Survey Report UNESCO. https://www.iau-aiu.net/IMG/pdf/iau_19_and_he_survey_report_final_may_2020.pdf

Mason, R. (2000). From distance education to online education. *The Internet and Higher Education*, *3*(1), 63–74. https://doi.org/10.1016/S1096-7516(00)00033-6

Mgutshini, T., Oparinde, K., & Govender, V. (2021). Introduction: Managing higher education in and after the era of a worldwide pandemic. In T. Mgutshini, K. Oparinde, & V. Govender (Eds.), *Covid-19: Interdisciplinary explorations of impacts on higher education* (pp. xiii–xvi). African Sun Media.

Mohmmed, A. O., Khidhir, B. A., Nazeer, A., & Vijayan, V. J. (2020). Emergency remote teaching during coronavirus pandemic: The current trend and future directive at Middle East college Oman. *Innovative Infrastructure Solutions*, *5*(3). https://doi.org/10.1007/s41062-020-00326-7

Newman, B. M., & Newman, P. R. (2020). Dynamic systems theory. In B. M. Newman & P. R. Newman (Eds.), *Theories of adolescent development* (pp. 77–112). Academic Press. https://doi.org/10.1016/B978-0-12-815450-2.00004-8

Nicholson, L., Putwain, D., Connors, L., & Hornby-Atkinson, P. (2013). The key to successful achievement as an undergraduate student: Confidence and realistic expectations? *Studies in Higher Education (Dorchester-on-Thames)*, *38*(2), 285–298. https://doi.org/10.1080/03075079.2011.585710

Nininger, J., & Abbott, M. R. (2019). Engagement tools in the online classroom: Formative assessment. *Nurse Educator*, *44*(6), 299. https://doi.org/10.1097/NNE.0000000000000670

Oliveira, G., Grenha Teixeira, J., Torres, A., & Morais, C. (2021). An exploratory study on the emergency remote education experience of higher education students and teachers during the COVID-19 pandemic. *British Journal of Educational Technology*, *52*(4), 1357–1376. https://doi.org/10.1111/bjet.13112

Perrotta, C. (2021). Programming the platform university: Learning analytics and predictive infrastructures in higher education. *Research in Education (Manchester)*, *109*(1), 53–71. https://doi.org/10.1177/0034523720965623

Posthuma, R., González-Brambila, C., Fowler, D. J., & Al-Riyami, S. (2017). A comprehensive model of management education for Latin America: Learning constructs, instructional techniques, and outcomes. *Management Research (Armonk, N.Y.)*, *15*(4), 405–424. https://doi.org/10.1108/MRJIAM-09-2016-0691

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity. *Postdigital Science and Education*, *2*, 923–945. https://doi.org/10.1007/s42438-020-00155-y

Sambell, K., McDowell, L., & Montgomery, C. (2013). *Assessment for learning in higher education*. Routledge. https://doi.org/10.4324/9780203818268

Schermerhorn, A. C. & Cummings, C. K. (2008). Transactional family dynamics: A new framework for conceptualising family influence processes. In R. Kail (Ed.), *Advances in child development and behavior* (pp. 187–250). Elsevier. https://doi.org/10.1016/S0065-2407(08)00005-0

Schöner, G. (2009). Development as change of system dynamics: Stability, instability, and emergence. In T. J. Spencer (Ed.), *Toward a unified theory of development connectionism and dynamic system theory reconsidered*. Oxford University Press.

Smith, L. B. (2005). Cognition as a dynamic system: Principles from embodiment. *Developmental Review*, *25*(3), 278–298. https://doi.org/10.1016/j.dr.2005.11.001

Spencer, J. (Ed.). (2009). *Toward a unified theory of development connectionism and dynamic system theory reconsidered*. Oxford University Press.

Thelen, E., Ulrich, B. D., & Wolff, P. H. (1991). Hidden skills: A dynamic systems analysis of treadmill stepping during the first year. *Monographs of the Society for Research in Child Development*, *56*(1), i–103. https://doi.org/10.2307/1166099

Wang, Y.-L., Liang, J.-C., & Tsai, C.-C. (2018). Cross-cultural comparisons of university students' science learning self-efficacy: Structural relationships among factors within science learning self-efficacy. *International Journal of Science Education*, *40*(6), 579–594. https://doi.org/10.1080/09500693.2017.1315780

Wood, M., & Su, F. (2017). What makes an excellent lecturer? Academics' perspectives on the discourse of "teaching excellence" in higher education. *Teaching in Higher Education*, *22*(4), 451–466. https://doi.org/10.1080/13562517.2017.1301911

Xiao, J., & Wilkins, S. (2015). The effects of lecturer commitment on student perceptions of teaching quality and student satisfaction in Chinese higher education. *Journal of Higher Education Policy and Management*, *37*(1), 98–110. https://doi.org/10.1080/1360080X.2014.992092

Yan, L., Whitelock-Wainwright, A., Guan, Q., Wen, G., Gašević, D., & Chen, G. (2021). Students' experience of online learning during the COVID-19 pandemic: A province-wide survey study. *British Journal of Educational Technology*, *52*(5), 2038–2057. https://doi.org/10.1111/bjet.13102