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Interaction and online courses for satisfactory university learning during the COVID-19 pandemic

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ABSTRACT
The global COVID-19 pandemic that commenced in 2019 and the resulting prolonged social distancing have converted numerous universities’ offline courses to online ones. In South Korea, which is facing a low birth rate and a decrease in school-age population, university students of Generation Z have actioned lawsuits to pursue tuition refunds and have raised the issue of the low quality of university courses through social media. This research establishes research problems of the relationship between student satisfaction with online courses and influencing factors and the relationship between their satisfaction and continual use of the course system. This research obtained a sample of 123 undergraduate students majoring in management. This study implemented questionnaire with the sample and utilized the analysis of generalized structural equation modelling (GSEM). The study found that students’ feelings about instructors’ useful interaction (feedback) with them and their preference for online courses positively affected their satisfaction with those courses. Satisfaction also exerted a positive effect on their course recommendation to others. The implications of this finding are that instructors and universities need to enhance course quality and the students’ satisfaction level with online courses in a highly competitive where private educational services (e.g., massive open online courses [MOOC], Youtube) are offered and the number of new students is decreasing.

1. Introduction

Social distancing measures to prevent the pandemic spread of the coronavirus, which began at the end of 2019, and its variant (e.g., the rise of the Delta/Omicron) have been operating since 2020 (Lee, 2021b). As a result, online or distance education is becoming common as the new standard of educational services in universities. In addition to traditional recorded courses, online education has developed in various ways, such as real-time online courses using video/telepresence technology (e.g., Zoom, Webex, or Teams) and blended learning (Rasheed et al., 2020) combining recorded courses with real-time online courses.

However, after online courses became the norm, numerous unexpected problems relating to online learning arose, such as the low quality of courses compared to social expectations, public concerns about diminished learning performance among students, and the detection of large-scale cheating in online exams (Bahk, 2020; Ock, 2021). In particular, the Republic of Korea (hereafter, South Korea) is facing a precarious situation whereby its working-age population (i.e., people ages 15–64) has been decreasing since 2018 because of...
a low birth rate (Kim, 2019). Therefore, the potential number of new university enrollees would dramatically decrease because of the
unconducive combination of the low birth rate, societal disappointment regarding the poor quality of online courses, and the
diminished value of bachelor’s degrees provided by universities after the COVID-19 pandemic began. Furthermore, this forced
mainstreaming of online courses in response to the pandemic could increase the responsibility of universities to innovate their edu-
cation systems to improve course quality and student satisfaction, leading the student dropout rate to decrease.

The current changed environment, in which online courses have become almost compulsory since 2020, could have distinctively
different meanings for university students and their satisfaction with courses. Above all, these students are Generation Z (born after the
mid-1990s) (Sakdiyakorn et al., 2021) and are, therefore, naturally digitally savvy with smartphones and video media, unlike older
students. They consider themselves consumers of course services, actively complaining and opposing universities by expressing their
disappointment on social media for courses of low quality and suing the universities to obtain refunds of high tuition fees (Choi, 2020;
Choi & Lee, 2020; Kan, 2021).

Furthermore, universities are now operating in a different environment, competing with various alternative educational services,
such as the massive open online courses (MOOCs) of Coursera, YouTube, and other non-degree electronic learning (e-learning)
platforms. In this situation, many instructors can offer different education service formats by hosting offline or face-to-face courses
(hereafter offline courses), recorded courses, or real-time online courses, which would be a complicated mixture of circumstances, such
as different educational technologies, learning systems, students, instructors, and educational institutions (Rasheed et al., 2020).

Therefore, this study proposes two research questions on Generation Z students’ satisfaction with university courses during the new
coronavirus pandemic period. First (Research question 1 [RQ1]), which factors can affect student satisfaction with online courses?
Second (RQ2), how does this satisfaction affect their continual use (or the sustainability) of the system of online courses? This research
investigated 123 national and private university students in Korea. The research found that students’ perceived usefulness of in-
structors’ interactivity (feedback) and their preference for online courses positively affected their overall satisfaction. Contemporarily,
this satisfaction affirmatively impacted their continued use of the course system, such as when they highly recommended courses to
other students.

These findings highlight that students’ perceived usefulness of their instructors’ feedback would be critical for enhancing their
overall satisfaction and for sustaining the present online course system operating under COVID-19-related social distancing practices.
In other words, the instructor quality (Al-Fraihat et al., 2020; Sun et al., 2008), which was one of numerous quality-related factors in
e-learning before the COVID-19 outbreak, could be crucial among various quality-related factors in the currently mandated online
courses. Therefore, universities and instructors need to engender strong emotions among students regarding instructor–student in-
teractions so that these students can feel as though they are attending an offline course and find meaning in posing questions and in
undertaking assignments despite students’ frequent sense of isolation (Rueda et al., 2017).

2. Literature review, research framework and hypotheses development

This section outlines the key topics of online learning and the key factors of instructor feedback and student satisfaction in Sub-
section 2.1.1. It also reviews three important research models of student course satisfaction and quality factors such as the information
system success model, the perceived e-learning satisfaction model, and the evaluating e-learning system success model in Subsection
2.1.2. Finally, it establishes an original research model and seven research hypotheses based on the literature review and the research
model in Subsections 2.2 and 2.3.

2.1. Literature review: key components and theoretical models of online learning and student satisfaction

2.1.1. Online learning and instructor feedback for student satisfaction

Online courses could denote the system of Internet education in which an instructor helps learners to self-pace their course by
leading them to re-watch an instructor’s recorded videos or access files, which the former provided through telepresence technologies
(e.g., Webex, Zoom) and/or to interact with course members (e.g., an instructor, classmates) (Louten & Daws, 2022). These Internet
courses could promote instructor-led teaching and discussion among students in the mixed sphere (e.g., hybrid class) of virtual lectures
and physical classrooms in which instructors offer their contents through recorded or a real-time education (Louten & Daws, 2022).
The courses could also incorporate their topics, lecture content sequences, evaluation methods, and interfaces in their virtual and/or
offline classroom (Birgili & Demir, 2022).

Online courses currently allow members (i.e., instructors and students) to participate in real-time online learning and communica-
tion between them using various electronic devices and platforms (e.g., telepresence, YouTube, and other social media services)
(Rasheed et al., 2020). These courses can essentially utilize online classroom webpages and promote students’ participation and re-
ponsibility, unlike offline learning and e-learning, for which there is a time lag between lecturing, attending the course, and members’
feedback (Sanford, 2017). In particular, online courses are characterized by course presence, in which members ask questions and
submit answers through chats or verbally in real-time (Rasheed et al., 2020). This course format and system can better fit Generation Z
students (Sakdiyakorn et al., 2021) familiar with using the Internet, smartphones, and social media.

An instructor needs to assume a more active role as a learning facilitator in online courses than in offline or traditional courses
(Bolliger, 2004; McFarland & Hamilton, 2005; Swan, 2001). It could not be easy for instructors and students to build a close relation-
ship between them because they do not directly interact with each other (Bolliger, 2004; Rueda et al., 2017). For instance, students
may feel isolated and frustrated when there is a lack of communication or interaction with course participants during distance courses
(Bolliger, 2004; Rasheed et al., 2020). Such feedback between instructors and learners could be an important influencing factor for
students’ satisfaction with online and in traditional courses (Swan, 2001). Therefore, the instructor needs to provide adequate feedback or interaction with learners through questions and responses to check their understanding of learning, conversations with informal or daily topics, and their participation, such as in discussions (Bolliger, 2004; McFarland & Hamilton, 2005).

Student satisfaction with courses is becoming increasingly important to students and universities. High satisfaction with courses could enhance students’ motivation for their university life, achievement in learning (Bolliger, 2004), and continuous offer, expansion, or both of relevant courses and programs (Chiu et al., 2007). On the other side, dissatisfaction and disappointment about courses could lead to students leaving their universities (e.g., dropping out or transferring to other schools), making it difficult for educational institutions to operate and develop courses (Bolliger, 2004). Some criticism has been raised that universities have offered online courses to reduce their operating costs of education, and students’ dissatisfaction was evidenced in their dropout rate of up to 30–50% in distance learning (Bolliger, 2004).

2.1.2. Theoretical foundation: models of students’ course satisfaction and quality factors

Students’ satisfaction with online courses could mean their overall evaluation of the courses they take and their perceived level of positive responses to the courses (Chiu et al., 2007; DeLone & McLean, 2003; Sun et al., 2008). Various factors can affect this satisfaction, such as the course itself, an instructor, educational technology, and systems that operate and manage the course, and environmental and demographic aspects related to instructors, students, and the learning process (Sun et al., 2008). The literature has proposed and developed some representative theoretical models that explain learners’ satisfaction with e-learning or online education, such as the information system success (ISS) model (DeLone & McLean, 2003), the perceived e-learning satisfaction (PELS) model (Sun et al., 2008), and the evaluating e-learning system success (EESS) model (Al-Fraihat et al., 2020).

The ISS model defines the stages in which information systems, including e-commerce and e-learning, are accepted by users, utilized, and extended to the influence of individuals and organizations (DeLone & McLean, 2003). User satisfaction is an important influencing variable regarding their continuous and successful use of information systems (Chiu et al., 2007; DeLone & McLean, 2003). The quality of the system, the information or knowledge it provides, and the service it realizes can affect the user’s general satisfaction (DeLone & McLean, 2003).

Distinctive features of several variables could measure the quality of these important factors (e.g., the quality of the Internet system regarding its ease of use, availability, and reliability), or content characteristics of factors (e.g., consumers’ perceptions on the quality of information regarding sufficiency and reliability of the content on their e-commerce website (DeLone & McLean, 2003)). In addition to these variables, users’ utilization of systems and their impact (individual impacts or net benefits) obtained through the information systems can influence their satisfaction in stages (DeLone & McLean, 2003).

E-learning or web-based learning is a systemic service in which an instructor provides information necessary for education or training to learners using information and communication technology, such as recorded courses and online classrooms of webpages (Chiu et al., 2007; Sun et al., 2008). The PELS model focuses on the relationship between the e-learner’s perceived satisfaction and its influencing factors (Sun et al., 2008). This model reflects on the educational technology or system, the course’s information, or content, and the service dimensions suggested by the ISS model as factors affecting learner satisfaction (Sun et al., 2008). In addition, the model includes new dimensional variables of instructor, learner, environmental, and design, which are essential components of e-learning (Sun et al., 2008).

![Fig. 1. This study’s research model based on literature review and hypotheses (H1–H7)
*Source: Authors’ work revising the relevant research model. **Note. Tables 1 and A1 explain the definitions of variables and questionnaires based on Fig. 1.](image-url)
Finally, the EESS model synthesizes the previously mentioned research frames of ISS, the technology acceptance model, and e-learning quality models (Al-Fraihat et al., 2020). The model clarifies the relationship of learners’ acceptance (e.g., satisfaction, usefulness, usage), benefits in various qualities of e-learning, the existent five quality factors (i.e., course, service, information, instructor, and learner), and various aspects of system quality (i.e., education, support, and technical system) (Al-Fraihat et al., 2020).

In summary, learners’ satisfaction with courses could play a critical role in students’ continual use of their course system, their perceptions and universities’ management and innovation of education in different distance and e-learning formats, and the advancement of online learning. Traditional quality factors regarding the course, system (technology), instructor, and learner suggested by various models (ISS, PELS, EESS), and environmental factors surrounding the learner and the instructor could also influence students’ perceived satisfaction with courses and universities.

2.2. This study’s research framework and model

This study synthesizes the models of related studies (i.e., ISS, PELS, and EESS models) and establishes a comprehensive research model about overall satisfaction among university students taking online courses due to the coronavirus and its antecedents (Fig. 1). Above all, this model could explain how courses, course systems or technologies, instructors, learners, and related environmental factors could affect the satisfaction perceived by students in the current environment of advanced online learning. Next, the model could also represent how satisfaction could influence learners’ continuous use of related courses and course systems based on its expected effect of individual impact or benefit (Al-Fraihat et al., 2020; DeLone & McLean, 2003). This study measures quality factors, overall satisfaction, and continuous use with 15 detailed variables (Fig. 1 & Table 1).

2.3. Hypotheses development

This study proposes seven hypotheses on the relationship among quality-related factors, overall satisfaction, and the continual use of courses (Fig. 1). Information quality could denote the degree or level of students’ awareness of course materials and course content (Chiu et al., 2007; DeLone & McLean, 2003). The quality could be defined in various ways, such as accuracy and ease of understanding course materials or information (Chiu et al., 2007). This research measures quality as students perceived level of course materials, on

| Conceptual variables | Definitions of the variables | References | This research’s definitions of variables (notations) |
|----------------------|------------------------------|------------|-----------------------------------------------|
| Information quality  | Learners’ perceptions about content or materials in online courses (e.g., completeness, ease of understanding) | Chiu et al. (2007); Sun et al. (2008): Course quality, DeLone and McLean (2003) | Learners’ perceived satisfaction about course materials (Satmat) |
| Service quality      | Learner’s perceptions of support provided by web-based learning | Chiu et al. (2007); Sun et al. (2008): Course quality, DeLone and McLean (2003); Sutherland et al. (2019) | Learners’ perceived levels of difficulty about a course (Diff) |
| Course system (Technology) quality | Learners’ beliefs in the characteristics of the access environment in web-based learning (e.g., availability, ease of use) | Chiu et al. (2007); DeLone and McLean (2003); Sun et al. (2008) | - Learners’ perceived satisfaction with their course system (Satsys) - The number of learners’ devices ready to be used in their online courses (Devlin) - Learners’ perceived usefulness about an instructor’s feedback (Usefeed) - Learners’ perceived satisfaction with learning outcome influenced by an instructor (Satperf) |
| Instructor quality   | Learners’ perception of the various characteristics of the instructor | Al-Fraihat et al. (2020); Rueda et al. (2017); Sun et al. (2008): Teaching presence | - Learners’ preferences for online learning to offline learning (Onliprof) - The number of online courses learners have taken (Onlinum) - The weekly hours to study this course (Weekstudy) - The number of applications or programs learners use, on average, during their online course (Appn) |
| Learner quality      | Learners’ various features related to their online course | Al-Fraihat et al. (2020); Sun et al. (2008): Learner dimension | - Learners’ perceived levels of variety about the learning process (Variety) - Learners’ demographic characteristics (e.g., gender, age) |
| Environmental (Demographic) factors | - Learners’ perceived levels of variety about the learning process | Sanford (2017); Sun et al. (2008) | - The weekly hours of part-time work (Weeklabor) - Years in university (Year) - Gender (Genderm) |
| Overall satisfaction | Learners’ perceived levels of positive response to their overall web-based learning experience | Chiu et al. (2007); DeLone and McLean (2003); Sun et al. (2008) | Learners’ perceived overall satisfaction with this course (Satisfaction) |
| Intention to Continual use | Learners’ subjective probability of continuing to utilize their present web-based learning | Al-Fraihat et al. (2020); Chiu et al. (2007); DeLone and McLean (2003) | Learners’ perceived levels of recommendation about this course to other students (Recm) |

*Note. Notations of variables also correspond to those in Tables 3–5 and A1-2.*
the whole, to minimize students’ response errors and focus on the core meaning of information quality. Since the quality of course materials could be important for students to understand and learn course-related knowledge (Chiu et al., 2007), this study suggests the following hypothesis.

**Hypothesis 1 (H1)**. Students’ satisfaction with course materials (information quality) can positively impact their overall satisfaction with courses.

Service quality could mean students’ subjective perception regarding the level of support or help related to course service, and the quality could be refined in various ways, such as students’ perception of the level of reliability or fulfilled needs regarding the whole course system, website or Internet-related conditions (Chiu et al., 2007). This research defines service quality as students’ recognized level of difficulty regarding courses in general. For example, British university students majoring in business perceived themselves as

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### Table 2
Descriptive statistics of the final sample.

| Contents and relevant variables | Figures (unit: students) |
|---------------------------------|--------------------------|
| University                      | Private: 74 (60.2%), Public: 49 (39.8%) |
| Gender                          | Female: 72 (58.5%), Male: 51 (41.5%) |
| Students’ year                  | Sophomore: 57 (46.3%), Junior: 42 (34.1%), Senior: 24 (19.5%) |
| Department                      | Management: 112 (91.1%), Others: 11 (8.9%) |
| Number of online courses taken  | Average: 3.4, Standard deviation: 1.4, Min: 0, Max: 5 |
| Number of devices available for online courses | Average: 1.1, Standard deviation: 0.2, Min: 1, Max: 5 |

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### Table 3
Descriptive statistics of variables.

| Variables | Notations | Mean | SD  | Min | Max |
|-----------|-----------|------|-----|-----|-----|
| Students’ perceived level to which this course is “recommendable” to other students | Recm | 5.4 | 1.2 | 3  | 7  |
| Students’ perceived level of “overall satisfaction with this course” | Satall | 5.8 | 1.0 | 1  | 7  |
| Students’ perceived level of satisfaction with this course’s “materials (contents)” | Satmat | 4.7 | 1.9 | 1  | 7  |
| Students’ perceived level of “difficulties” about this course | Diff | 4.5 | 1.5 | 2  | 7  |
| Students’ perceived level of satisfaction with this course’s “system” | Satsys | 5.4 | 1.2 | 1  | 7  |
| Students’ perceived level of “usefulness about an instructor’s feedback” | Usefeed | 5.7 | 1.1 | 3  | 7  |
| Students’ preference about online courses to offline courses | Onlins | 3.4 | 1.4 | 0  | 5  |
| Number of students taking online courses in university | Onlinum | 2.1 | 1.2 | 1  | 4  |
| Weekly study hours for courses | Weekstudy | 1.1 | 0.9 | 0  | 3  |
| Number of apps used together when taking online courses | Appn | 2.0 | 0.8 | 1  | 5  |
| Students’ perceived level of satisfaction with their “learning outcomes” | Satsys | 5.6 | 1.3 | 1  | 7  |
| Weekly hours for part-time jobs | Weeklabor | 0.27 | 0.09 | 1  | 3  |
| Number of ready-to-use electric devices (e.g., laptop, tablet, PC) | Devin | 0.4 | 0.5 | 0  | 1  |
| Students’ years in university | Year | 2.7 | 0.8 | 2  | 4  |
| Dummy variable of gender | Genderm (1: male, 0: female) | 0.4 | 0.5 | 0  | 1  |

*Note. Standard Deviation (SD).

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### Table 4
Ordinal logistic regression analysis of the nested model.

| Notation: D | I | Coefficients | SE  | OR | SE  |
|-------------|---|--------------|-----|----|-----|
| Recm        | Satall | 0.911 ***   | 0.180 | 2.487 *** | 0.447 |
| Satall      | Satmat | 0.070       | 0.116 | 1.073       | 0.125 |
| Diff        | 0.047   | 0.131       | 1.048       | 0.138 |
| Satsys      | 0.321   | * 0.175     | 1.378 *     | 0.241 |
| Devin       | –0.252  | 0.260       | 0.777       | 0.202 |
| Usefeed     | 0.907 *** | 0.200     | 2.478 *** | 0.495 |
| Onlins      | 0.260 **  | 0.105     | 1.296 **     | 0.136 |
| Onlinum     | 0.013   | 0.125       | 1.013       | 0.127 |
| Weekstudy   | –0.339 ** | 0.157     | 0.713 **     | 0.112 |
| Appn        | –0.078  | 0.218       | 0.925       | 0.202 |
| Satsys      | 0.226   | 0.162       | 1.254       | 0.204 |
| Weeklabor   | 0.038 *  | 0.020      | 1.038 *      | 0.020 |
| Year        | 0.580   | ** 0.252    | 1.787 **     | 0.450 |
| Genderm     | –0.300  | 0.357       | 0.740       | 0.265 |

**Observation**: 123

Bonferroni-adjusted Wald test for null hypotheses about zero coefficients of respective variables: 68.58*** (DF: 14)

Likelihood-ratio test for model comparison (i.e., nested model vs. full model): 16.87 (DF: 13)

*Notes. Dependent variables (D). Independent variables (I). Standard Error (SE). Odds Ratio (OR). p-value<0.01: ***. p-value<0.05: **. p-value<0.1: *. Degree of Freedom (DF).
consumers of courses for their future employment rather than learners, and when evaluating course satisfaction, they tended to evaluate courses based on the level of difficulty in following their course rather than learning the course content (Sutherland et al., 2019). Therefore, this study proposes the following hypothesis.

H2. Service quality can positively affect the overall satisfaction with the course.

H2a. The degree of difficulty (easy) students feel can negatively (positively) affect the overall satisfaction.

System quality could denote the technical environment or characteristics related to online courses, and it could be measured as users’ recognized easiness (e.g., accessibility) about their course system, website, and internet usability (Chiu et al., 2007; Sun et al., 2008). This study defines quality as students’ satisfaction with the course system, and the number of different electronic devices that can directly access the course system (i.e., the degree of accessibility of their devices to the system). Therefore, this study suggests the following hypothesis.

H3. System quality can positively influence students’ overall satisfaction with their courses.

H3a. Students’ satisfaction with the course system can positively affect overall satisfaction.

H3b. The number of devices students can use to connect to their course system can positively affect overall satisfaction.

Instructor quality could be relevant to a learner’s perception of various characteristics regarding their instructor, and quality could be defined as interaction or feedback between the instructor and the learner, such as responsiveness, enthusiasm, and attitude (Al-Fraihat et al., 2020; Sun et al., 2008). This study focuses on the interaction between the instructor and the learner in the online course, and it defines instructor quality as learners’ perception of the degree of usefulness (or helpfulness) from the instructor’s feedback on their questions or responses. Therefore, this study proposes the following hypothesis.

H4. Instructor quality can positively affect students’ overall satisfaction with their courses.

H4a. The degree to which students perceive their instructor’s feedback as useful can positively influence overall satisfaction.

Learner quality could be relevant to several characteristics of students taking courses. Examples of quality are their experience in online courses, preference or attitude toward online courses, confidence in learning performance or outcomes through online courses (e.g., self-efficacy), and concerns about using online courses (e.g., learning anxiety) (Al-Fraihat et al., 2020; Sun et al., 2008). This research defines learner quality as the number of online courses students have taken, their preference for online courses to off-line courses. Learning confidence is defined as their satisfaction with course performance. Furthermore, this study newly considers the number of applications in their devices when taking courses concerning their attention level to define learning attitudes, and their

Table 5
Ordinal logistic regression analysis of the full model.

| Notation | D I Coefficients | SE | OR | SE |
|----------|------------------|----|----|----|
| Recm     | 0.768 ** 0.227   | 2.156 ** 0.490 |
| Satmat   | −0.270 0.113 | 0.764 ** 0.086 |
| Diff     | 0.043 0.126 | 1.044 0.132 |
| Satsys   | 0.112 0.167 | 1.119 0.187 |
| Devin    | −0.309 0.249 | 0.734 0.183 |
| Usefeed  | 0.349 0.201 | 1.417 0.285 |
| Onlipref | 0.026 0.104 | 1.026 0.107 |
| Onlinum  | −0.095 0.124 | 0.909 0.113 |
| Weekstudy| −0.050 0.149 | 0.951 0.142 |
| Appn     | −0.015 0.211 | 0.985 0.208 |
| Sahperf  | 0.180 0.160 | 1.197 0.191 |
| Weeklabor| 0.013 0.019 | 1.013 0.019 |
| Year     | −0.425 0.245 | 0.654 0.160 |
| Genderm  | −0.430 0.349 | 0.651 0.227 |

| Notation | D I Coefficients | SE | OR | SE |
|----------|------------------|----|----|----|
| Satall   | 0.070 0.116 | 1.073 0.125 |
| Diff     | 0.047 0.131 | 1.048 0.138 |
| Satsys   | 0.321 0.175 | 1.378 0.241 |
| Devin    | −0.252 0.260 | 0.777 0.202 |
| Usefeed  | 0.907 ** 0.200 | 2.478 ** 0.495 |
| Onlipref | 0.260 ** 0.105 | 1.296 ** 0.136 |
| Onlinum  | 0.013 0.125 | 1.013 0.127 |
| Weekstudy| −0.339 ** 0.157 | 0.713 ** 0.112 |
| Appn     | −0.078 0.218 | 0.925 0.202 |
| Sahperf  | 0.226 0.162 | 1.254 0.204 |
| Weeklabor| 0.038 0.020 | 1.038 0.020 |
| Year     | 0.580 ** 0.252 | 1.787 ** 0.450 |
| Genderm  | −0.300 0.357 | 0.740 0.265 |

*Notes. Standard Error (SE). Odds Ratio (OR). p-value<0.01: **. p-value<0.05: *. p-value<0.1: *. Degree of Freedom (DF).
weekly self-study hours (excluding simply taking online courses) as reflective of their learning effort. Therefore, this study proposes the following hypothesis.

**H5.** Learner quality can positively affect students' overall satisfaction with the course.

**H5a.** The higher the online course experience (number of times), the more positively it can influence overall satisfaction.

**H5b.** The higher the preference for online courses, the more positively it can affect overall satisfaction.

**H5c.** The higher the satisfaction with online courses' learning performance, the more positively it can affect the overall satisfaction.

**H5d.** When listening to an online course, the higher the number of applications (the more dispersed the concentration) students use on average, the more negatively it can affect overall satisfaction.

**H5e.** In addition to taking online courses, the higher students' weekly study time (willingness to study), the more positively it can affect overall satisfaction.

Environmental factors could be relevant to contextual variables learners can perceive in relation to online courses (Sun et al., 2008) or students' demographic characteristics (e.g., gender and age) (Sanford, 2017). This research defines these factors as control or controllable variables that could differ from the quality-related factors but plausibly influence students' learning processes and performance during online courses. This study includes the variables regarding students' weekly part-time working hours; gender, which is a dummy variable (male: 1, female: 2); and years in university (e.g., sophomore, junior, or senior students) as environmental variables. For example, male students in Korean universities could take a leave of absence for part-time jobs and compulsory military service because most of their courses have been offered in online learning formats due to the ongoing global coronavirus infection and social distancing policies (Lee, 2021a). Therefore, the gender effect of an increase in part-time work hours can negatively impact students' attention to their online courses and overall satisfaction with courses.

In addition, students' courses experience and information about comparable online courses can increase when they get older. As students advance to juniors in universities, their burden of preparing for graduation and employment can increase, and as a result, they can evaluate courses as consumers of courses rather than learners (Sutherland et al., 2019); students' attention to and concentration on their courses, and their satisfaction could eventually decrease. Therefore, this study proposes the following hypothesis.

**H6.** Environmental factors can affect their satisfaction with courses differently depending on the characteristics of their variables.

**H6a.** Higher weekly part-time hours may negatively influence overall satisfaction.

**H6b.** Male students may have lower overall satisfaction with courses than female students.

**H6c.** Longer lengths of time in university can negatively affect students' overall satisfaction.

The intention to continually use courses could refer to learners' subjective perception or probability of continuing to use their present online course (Chiu et al., 2007; DeLone & McLean, 2003). A high level of student satisfaction can positively affect their intention or willingness to use online courses in the future (Chiu et al., 2007; DeLone & McLean, 2003). In this regard, this study defines intention to continually use online learning as the extent to which learners recommend their present course to other students under the condition that the instructor, course system, and its service are perceived by students as stable. Therefore, this study suggests the following hypothesis.

**H7.** The higher students' overall satisfaction with the course, the more positively it can affect their intention to continually use online learning.

**H7a.** The higher the overall satisfaction, the higher their probability of recommending their present course to other students.

Lastly, the previously mentioned factors of quality and environment may influence the continual use of online learning. This study firstly analyzes the nested or restricted model that includes all variables except the relationship in which quality and environmental factors influence the continued use of online learning. This research also analyzes the full or saturated model in which, in contrast to the nested model, the relationship of all variables is accounted for. The research then performs a comparative test (e.g., likelihood ratio [LR] test) between two models in the result section. In general, compared to the full model, the nested model requires assumptions or constraints that independent variables excluded from the model do not influence the dependent variable. Comparing the explanatory power or significant variable relationship between the models could be reasonable to establish robust findings or messages based on the results of relevant analyses instead of offering one of the models.

3. Research design: methodology and sample data

3.1. Methodology

This study utilizes the estimation method regarding multivariate analysis of ordinal logistic regression for the relationship between university students' course satisfaction and factors influencing online courses. This research gathers the survey data of students taking these courses. The data consists of two dependent variables measured on a seven-point Likert scale (i.e., overall satisfaction with the course, willingness to take the relevant course, recommendation from other students). As these dependent factors are non-continuous
variables, multivariate logistic or probit regression could be more appropriate in estimating than multivariate linear regression (Cameron & Trivedi, 2010; Gujarati & Porter, 2009; Kennedy, 2008). The sample data in this research is a cross-sectional dataset in which the dependent variables are measured on a seven-point Likert scale, and the research performs the estimation method of ordinal logistic regression.

Furthermore, this logit analysis does not assume a multivariate normal distribution with equal variances for the independent variables (Bewick et al., 2005; Peng et al., 2002). Therefore, it may be a more robust analysis than ordinary multivariate linear regression analysis, which requires such assumptions and assessments of the fulfillment of the assumptions. This logit analysis also requires several conditions, such as a low correlation between independent variables and sufficiently large data size (or volume), like normal regression analysis, to obtain results with statistical significance from the analysis (Bewick et al., 2005).

As independent variables concurrently affect the two dependent variables of overall satisfaction and recommendation, the analytical method of simultaneous equations or structural equations that estimate several related equations (Kennedy, 2008) with ordinal logistic regression could be more appropriate than those with linear regression. In particular, when one or more equations in n equations are nonlinear relational expressions, such as ordinal logistic or probit regression caused by survey data (i.e., n-point Likert scale) in the multilevel estimation model, it could be reasonable for researchers to utilize the generalized structural equation model (GSEM) rather than the structural equation model (SEM) (Bartus, 2017; Dil & Karasoy, 2020; Palmer & Sterne, 2015; StataCorp, 2021).

This study establishes several equations reflecting the research framework and related variables (Fig. 1 & Table 1). In short, this research utilizes multivariate analysis of ordinal logistic regression to estimate two simultaneous equations: the relationship between the influence of quality and environmental variables on the overall satisfaction of the course and the influence of overall satisfaction on the course recommendation. The research utilizes Stata software to perform these analyses. Using Equations (1)–(4), the result estimated by Stata software does not include a constant term as an independent variable with the GSEM estimation method (Cameron & Trivedi, 2010).

\[
s_i = x_i'b + e_i \quad (1)
\]

\[
\text{If } a_{j-1} < s_i \leq a_j, \quad s_i = j, \quad j = 1, \ldots, 7. \quad (\text{i.e., } 7 - \text{point Likert scale})
\]

The upper equations are plausible if \(a_0 = -\infty, a_m = \infty\)

\[
P(s_i = j) = P(a_{j-1} < s_i \leq a_j) = P(a_{j-1} < x_i'b + e_i \leq a_j)
\]

\[
= P(a_{j-1} - x_i'b < e_i \leq a_j - x_i'b)
\]

\[
= C(e_j - x_i'b) - C(e_{j-1} - x_i'b)
\]

\[
C(k) = e^k / (1 + e^k) \quad (4)
\]

Notes. This research establishes Equations (1)–(4) by revising the corresponding ones in the literature (Cameron & Trivedi, 2010; Kennedy, 2008). \(s_i\): a matrix of dependent variables at a student \(i\). \(x_i\): a matrix of independent variables at a student \(i\). \(C(\cdot)\): a cumulative density function (i.e., cdf) of \(e_i\).

### 3.2. Data collection and the final sample

This research designs a questionnaire comprising 16 questions (Tables 1 and A1 in appendix). When conducting the survey, students were advised that the study would maintain confidentiality and anonymity regarding their responses and other information provided (Drennan et al., 2005). Respondents who did not agree to provide their demographic information (e.g., gender and student information) had the option to stop participating in the survey. This questionnaire used a seven-point Likert scale to measure many questions and answers, such as students’ perceived levels of satisfaction and the degree to which the courses would be recommended to other students. The study also evaluated numeric questions and answers and open-ended responses, such as students’ weekly study hours for courses and weekly hours for part-time work (Table A1).

This study surveyed for two weeks in July 2020, and respondents were students at two universities in Korea (a public university in Gangwon province and a private university in Gyeonggi province). The respondents were the students who took more than one of six core courses for all students to complete the curriculum for their business majors. This research excluded freshmen entering in 2020 because they did not seem to have sufficient experience in university life and taking online courses due to the global coronavirus outbreak. The final sample was 123 respondents (49 students in the public university and 74 students in the private university), and the total response rate was 75.5% (123/163 students. Table 2). The response rate was 70% in the public university and 79.6% in the private university. Among the sample, the percentage of females was 58.5%, and the ratio of sophomores was 46.3%.
4. Results

This study presents the results in the order of descriptive statistics of variables, main analysis of regression, and additional analysis. First, the descriptive statistics for 15 variables obtained from a sample of 123 respondents in Table 3. Many variables were measured on a seven-point Likert scale, and some variables have some tendencies of values weighted on specific scores. For example, the values of the variable regarding the researcher’s course recommendations to others, which could range from one to seven, are on the range from three to seven. Similarly, the value range regarding the level of difficulty in courses (2–7) and the level of usefulness about an instructor’s feedback (3–7), are also concentrated in specific numbers. However, some variables, such as the number of devices during the online course, have somewhat realistic numbers in meaning (e.g., positive numbers) compared to values of the factors measured in Likert-scale.

Before performing regression analysis, it is necessary to check the correlation between variables to confirm the independent variables’ differential explanatory power for dependent variables. Among correlation values, the value of the correlation between dependent variables (0.44) and the value between overall satisfaction and instructor’s feedback (0.42) seem to be quite substantial (Table A2 in appendix). However, the maximum value and the mean of all variance inflation factors (VIF) are less than two, which could prove that there is a weak or low level of multicollinearity or correlation between variables (e.g., VIF < 5 (Gujarati & Porter, 2009)).

As the main analysis results, this research shows estimation outcomes regarding the impact of overall satisfaction with courses on course recommendation, and the effects of quality factors on satisfaction by utilizing GSEM with ordinal logistic regressions in Tables 4 and 5. In addition, Table 4 displays the results regarding the nested model of Table 5 (full model). The nested or restricted model in this research assumes that other factors (i.e., quality and environmental factors) do not influence the relationship that overall satisfaction has on course recommendation.

Before finding meaningful variables, this research assesses the model by testing null hypotheses in which the coefficient of the respective variable is zero (the penultimate row in Table 4). This study implements the Wald Chi-squared test with the Bonferroni-adjusted option, which sets the p-value more strictly than the test because of the concurrent test of many null hypotheses (Cameron & Trivedi, 2010). The result shows that null hypotheses were rejected, and the model seems to be significant.

This research presents the results according to the two research questions (RQs 1 & 2) regarding the influential quality factors on overall satisfaction with courses and the effects of overall satisfaction on continuous use of online courses (recommendation). First, the positively influential variables impacting overall satisfaction with the course are course system satisfaction, the instructor’s feedback, the preference regarding online courses, the weekly hours of part-time work, and the years in the university (Table 4). Conversely, the negatively influential variable is the weekly hours to study for the course. Next, overall satisfaction positively affects course recommendation in the second equation. In addition, the odds ratio (OR) explains the positive or negative impact of independent variables on dependent variables. For example, when students’ perceived levels of overall satisfaction with their course increase by one point (on the seven-point Likert scale), their perceived level of recommendation about this course to other students is expected to increase by 2.487 times on average provided the coefficients of all other variables are constant (i.e., ceteris paribus).

Table 5 shows the results reflecting the likely and respective impacts of course-related quality factors and environmental variables on the recommendation. As a result of performing the Bonferroni-adjusted Chi-squared test, the null hypotheses are rejected, and the model seems to be meaningful. Compared to the results in Table 4, the commonly confirmed findings consist of positive influential and negative influential factors. First, the variables that positively affect the overall satisfaction of the course are the satisfaction about the course system, the instructor’s useful feedback, the preference about the online course, and the years in university. On the other hand, the variable that has a negative effect is the weekly hours of study. The differences in the findings (Table 4) are statistically significant and negatively meaningful variables of the weekly hours of study and the weekly hours of work. Next, the table shows the positively influential variables (total satisfaction and feedback) and negatively influential variables (satisfaction with course materials and grade) in the relationship between all independent variables and the dependent variable of course recommendation (i.e., the full model). The finding consistent with Table 4 is a positive effect of overall satisfaction on the recommendation.

However, this research performed the likelihood ratio (LR) test to examine the significant difference in explanatory power for the nested model based on the literature (Table 4) and the full model (Table 5). The result showed that the null hypothesis is not rejected (the last row in Table 4), which means there is no difference in explanatory power between the two models (Cameron & Trivedi, 2010). Since adding the quality and environmental variables in the full model does not seem to increase the model’s explanatory power significantly, the result of the nested model in Table 4 appears to be preferred to that of the full model.

5. Discussion and implications

5.1. Theoretical implications

This study offers common findings based on the previous analytical results. Above all, positively influential factors on overall satisfaction are students’ perceived usefulness regarding an instructor’s feedback, preference for online learning, and satisfaction with the course system (Table 4). These variables are critical elements of the Generation Z student’s satisfaction, which are similarly confirmed in the literature in models of students’ satisfaction and quality factors (Al-Fraihat et al., 2020; Sun et al., 2008) (Fig. 1). Furthermore, the affirmative impact of overall satisfaction on the continual use of courses (i.e., course recommendation in this research) under the online learning resulting from the coronavirus seems to be similarly confirmed in the relevant literature (Al-Fraihat et al., 2020; DeLone & McLean, 2003) (Table 1).
This research also suggests new implications about the importance of instructor quality and learner quality in various factors. Previous studies emphasize the need to sufficiently consider various quality factors for student satisfaction in e-learning and online learning (Al-Fraithet al., 2020; Chiu et al., 2007; DeLone & McLean, 2003; Sun et al., 2008). However, this study highlights that the role of the instructor seems much more important in the online courses caused by social distancing since 2020.

For example, Korean students have some tendency to prefer online courses to offline ones, but their perception of the quality of the courses was not high compared to their preferences and expectations of online learning (Choi, 2020; Choi & Lee, 2020; Kan, 2021). This situation could suggest that an instructor’s effort to respond favorably to students’ questions or requests and manage relevant elements of their course is particularly important in meeting their expectations. In some respects, online courses can burden instructors to handle various teaching technologies (e.g., learning management systems, telepresence, or educational technologies like Webex and Zoom) skillfully, to produce appropriate course videos and to enlighten students to learn and feel confident (Rasheed et al., 2020).

However, the instructor needs to be like an orchestral conductor in their online education and learning to organize and coordinate some environment of course contents, technology systems, and students. In the current online and blended learning environment following the coronavirus outbreak, it could be more important for the instructor to fulfill their role as a facilitator who communicates with students and promotes learning and self-efficacy (Bolliger, 2004; McFarland & Hamilton, 2005; Swan, 2001).

Lastly, this study offers reliable findings that establish significant results through the GSEM methodology, which is more generally applicable than previous studies, considering complicated characteristics of a sample (e.g., dependent variables with non-continuous values). Previous research has measured the variable of satisfaction by using a n-point Likert scale in a survey and has analyzed the model with some linear-kind method such covariance-based structural equation modelling (CB-SEM) or partial least square SEM (PLS-SEM) from linear and multivariate regression (Al-Fraithet al., 2020; Chiu et al., 2007; Sun et al., 2008). However, when more than one dependent variable is gauged at discrete values (e.g., positive integer and count data) as a latent variable, GSEM, which can estimate such variables in a nonlinear manner (e.g., logistic regression and negative binomial regression), obtaining robust results could be more reasonably expected (Bartus, 2017; Dil & Karasoy, 2020; Palmer & Sterne, 2015; StataCorp, 2021).

5.2. Practical insights

This study can provide some practical message to universities and instructors about improving their quality of education and communication in considering their consumers (students) in online learning. For example, students can experience various difficulties following different courses and self-learning due to unfamiliar educational technology (e.g., Zoom, Webex, and others) and some sense of being isolated from courses and classmates (Rasheed et al., 2020). Therefore, it could be important for instructors and universities to provide student-friendly course materials and kind feedback (e.g., some sample and rehearsal about teamwork, presentation, or exams) so that students can reduce the anxiety or resistance they may face in courses and evaluations due to social distancing.

According to personal interviews the authors received after completing surveys and courses in July 2021, many students expressed a preference for recorded courses due to flexible scheduling, compared to real-time online courses accessed on platforms such as Zoom or Webex. However, they feel some difficulties in self-regulating (Rasheed et al., 2020), such as cramming for attending some weeks’ recorded courses in a day and complaining about the fast progress of online courses. Other university students in South Korea also felt that they were somewhat unsatisfied with online learning after social distancing (Choi & Lee, 2020). In addition, the number of students in South Korea taking a leave of absence has been increasing as the online semester in universities continues for more than a year (Lee, 2021a). These signals of course dissatisfaction and increasing numbers of students on leaves of absence could warn instructors and universities that they need to develop useful course content and perform educational innovation to manage students’ likely to drop out and meet their consumers (students’) needs.

Furthermore, it could be important for governments to actively prepare policy support tailored to universities’ educational innovation based on students’ and society’s requests for quality learning. For example, 35,000 Korean students from 42 universities across the country participated in lawsuits for a tuition refund in June 2020 (Woo, 2020b). In response to this social movement, several universities have decided to either refund part of their tuition (e.g., 8–10%) or return it as a study scholarship to students (Woo, 2020a). This situation seems to show many universities’ double hardship in financial conditions that their income has been decreasing due to increasing numbers of students on leaves of absence; their expenses have been increasing owing to the establishment of an online course system for large-scale students and additional costs for quarantine activities on their campus (Woo, 2020a).

However, the Ministry of Education was passive in mediating agreements between students and universities regarding students’ requests for tuition refunds (Park, 2020). It would be expected that universities’ business conditions appear to become more difficult due to the low birth rate and the prolonged outbreak of the virus. Therefore, governments in South Korea and other similar nations need to develop diverse and flexible policy tools, such as communication with stakeholders to relieve educational conflicts and tax reduction or financial support for hard-working universities as shown in active policy intervention, called new deal policies in socio-economic fields.

Lastly, it would be a strategic opportunity for universities, instructors, and students to make efforts to upgrade the online learning environment in this critical situation of the coronavirus amidst controversy regarding the quality cliff in higher education. For example, as of the 2020 spring semester, most universities in Korea have initiated nationwide online semesters for the first time. In this regard, some students demonstrated ambivalence towards massive cheating in online exams while raising concerns publicly about the poor quality of online courses through social networking services and taking legal actions to obtain tuition refunds (Bahk, 2020; Ock, 2021).

Resolving this complicated situation in higher education could require shared responsibility among universities, instructors, and students to be alert and minimize undesirable behavior that could injure the good faith among them. Furthermore, as public educators...
with professional knowledge, learning, formal socialization, and soft power, universities and instructors need to be more responsible in communicating with and correcting students’ misconceptions and behaviors, thereby alleviating conflicts between Generation Z students and the older people of professors and others in universities.

6. Conclusion

This research suggests research problems that Generation Z Korean students, who are familiar with smartphones and the Internet, are dissatisfied with online university courses, which have become common because of the global spread of COVID-19 and the resulting need for social distancing. This study empirically analyzes the two relationships: that between students’ satisfaction and its influencing factors and that between their satisfaction and their recommendation of the current course system to others. The research establishes models of student satisfaction and quality factors from previous studies. A sample of 123 Korean university students was obtained. The study utilizes the GSEM estimation method with multivariate ordinal logistic regression.

This research demonstrates that the principal quality variables positively affecting course satisfaction are the students’ perception of the usefulness of instructors’ feedback and their preference for online courses. This satisfaction has an affirmative influence on students’ propensity to recommend the course system to others. In analyzing the full model to check whether quality and environmental variables can affect the recommendation, this study confirms that students’ feelings of usefulness about the feedback and their preference for online courses positively affect their recommendation.

These findings suggest that although students prefer online courses in the unfavorable educational environment caused by the coronavirus, they want to feel a sense of satisfaction and meaning from courses through their instructors’ feedback on their questions and the assignments they complete. For example, the students’ satisfaction with courses could be linked to how happy they are with their university experience, which could prevent them from dropping out. This outcome could apply to nations such as South Korea that have been experiencing a dual decline in the birth rate and prospective new university enrollees. Therefore, communicating among universities, instructors, and students by ensuring that pupils feel that courses are useful could be timely and critical in the online learning context presently affected by COVID-19.

However, this research needs improvements if its present findings are to be generalized and used to conduct for future studies. Above all, it would be desirable for other researchers to adopt relevant factors in their research regarding interactions in online learning because instructors’ feedback could vary depending on the course characteristics, such as courses based on capstone design, flipped learning, or team-projects. For example, the more instructors consider and strive to improve various system elements for courses (e.g., different quality factors of education systems), the more they could achieve learning outcomes by improving course quality (Al-Fraihat et al., 2020). Furthermore, the interconnected variables regarding students’ characteristics and courses (e.g., task–technology fit) (Artino Jr, 2010; Wu & Chen, 2017) would be factors that would plausibly affect their learning satisfaction because the students’ learning style, their course format preferences (e.g., discussions and team projects), and personalities can affect how they learn and perform.

Lastly, future studies need to design and conduct comprehensive analysis by implementing comparative surveys to students who live in various nations and who are studying for different majors, such as engineering, social sciences, humanities and the arts, and natural sciences. For example, numerous universities have been seeking to raise their international reputation assessed in several institutional evaluations (e.g., the Times Higher Education [THE] World Ranking, the Quacquarelli Symonds [QS] World University Ranking, and Shanghai’s Academic Ranking of World Universities [ARWU]) by promoting programs for international students and faculty exchanges (Kang & Park, 2017). These comparative studies of Korean and international students could be strategically critical for universities in Asia and other regions, which may undervalue international reputation in the post-coronavirus era.

Author statement

All authors subscribed below confirm our participation in equal proportion in the different phases of the ideation and development process of this manuscript:

Conception and design of the work. Data collection. Data analysis and interpretation. Drafting the article. Critical revision of the article. Final approval of the version to be submitted. In addition, we make public our responsibility for the content of the work submitted for review.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Table A1
Variables and contents of questionnaires: 16 Questions

| Categories of variables | Survey contents (Notations of variables) | Measurement scales | References |
|-------------------------|------------------------------------------|--------------------|------------|
| D                       | I want to recommend this course to other students. (Recm) | 7-point Likert scale (from 1 to 7) | Continual use (Al-Fraihat et al., 2020; Chiu et al., 2007; DeLone & McLean, 2003) |
| D                       | I am generally satisfied with my course (e.g., contents, system, a professor’s feedback). (Satall) | 7-point Likert scale (from 1 to 7) | Overall satisfaction (Chiu et al., 2007; DeLone & McLean, 2003; Sun et al., 2008) |
| I                       | I am not satisfied with my course material. (Satmat) | 7-point Likert scale (from 1 to 7) | Information quality (Chiu et al., 2007; DeLone & McLean, 2003; Sun et al., 2008) |
| I                       | I think this course is generally difficult. (Diff) | 7-point Likert scale (from 1 to 7) | Service quality (Chiu et al., 2007; DeLone & McLean, 2003; Sun et al., 2008; Sutherland et al., 2019) |
| I                       | I am satisfied with my course system (e.g., access, response speed). (Satsys) | 7-point Likert scale (from 1 to 7) | System Quality (Chiu et al., 2007; DeLone & McLean, 2003; Sun et al., 2008) |
| I                       | An instructor’s feedback (e.g., professor) is useful for my learning. (Usefeed) | 7-point Likert scale (from 1 to 7) | Instructor quality (Al-Fraihat et al., 2020; Sun et al., 2008) |
| I                       | I prefer an online course to an offline one. (Onlipref) | 7-point Likert scale (from 1 to 7) | Learner quality (Al-Fraihat et al., 2020; Sun et al., 2008) |
| I                       | How many times have you taken online courses? (Onlinum) | Ordinal number (from 0 to 5) | Learner quality (Al-Fraihat et al., 2020; Sun et al., 2008) |
| I                       | How many hours per week do you study on average? (Please do not count hours spent simply taking this course.) (Weekstudy) | Ordinal number (from 1 to 5) | Learner quality (Al-Fraihat et al., 2020; Sun et al., 2008) |
| I                       | How many apps or programs do you usually use while taking online courses? (Appn) | Ordinal number (from 0 to 5) | Learner quality (Al-Fraihat et al., 2020; Sun et al., 2008) |
| I                       | I am satisfied with my learning outcomes. (Satperf) | 7-point Likert scale (from 1 to 7) | Learner quality (Al-Fraihat et al., 2020; Sun et al., 2008) |
| I                       | How many hours per week, on average, do you work part-time? (Please round up to one hour unconditionally for part-time jobs that are less than 59 minutes) (Weeklabor) | Open answers in positive integers, e.g., 1: One hour | Environmental factors (Sanford, 2017; Sun et al., 2008) |

(continued on next page)
Table A1 (continued)

| Categories of variables | Survey contents (Notations of variables) | Measurement scales | References |
|-------------------------|------------------------------------------|--------------------|------------|
| I                       | What year are you currently in university? (Year) | Ordinal number (from 1 to 4) | Environmental factors (Sanford, 2017; Sun et al., 2008) |
|                         |                                          | 1: Freshman or a first-year student, 2: Sophomore, 3: Junior, 4: Senior or more | |
| I                       | What is your gender? (Genderm) | Group number | Environmental factors (Sanford, 2017; Sun et al., 2008) |
|                         |                                          | 1: Male, 0: Female, | |
| Check                   | This survey requires your phone number and personal information. This survey follows the relevant laws encompassing Korea’s “Personal Information Protection Act (Articles 15 and 17).” Do you agree to share your information with this survey? *Your information is only used for this research, and the information will be deleted after completing the survey. | | |

*Notes. Dependent: D, Independent: I. Notations of variables also correspond to those in Tables 1, 3–5 and A2.

Table A2
Pearson correlation of variables and values about VIF

|            | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
|            |     |     |     |     |     |     |     |     |     |      |      |      |      |      |      |
| (1)        | 1   |     |     |     |     |     |     |     |     |      |      |      |      |      |      |
| (2)        | 0.44| 1   |     |     |     |     |     |     |     |      |      |      |      |      |      |
| (3)        | -0.12| 0.03| 1   |     |     |     |     |     |     |      |      |      |      |      |      |
| (4)        | -0.07| -0.18| -0.24| 1   |     |     |     |     |     |      |      |      |      |      |      |
| (5)        | 0.14| 0.32| 0.26| -0.29| 1   |     |     |     |     |      |      |      |      |      |      |
| (6)        | -0.09| -0.15| -0.48| 0.29| -0.17| 1   |     |     |     |      |      |      |      |      |      |
| (7)        | 0.35| 0.43| -0.15| -0.04| 0.05| -0.05| 1   |     |     |      |      |      |      |      |      |
| (8)        | 0.18| 0.29| 0.06| -0.23| 0.28| -0.02| 0.09| 1   |     |      |      |      |      |      |      |
| (9)        | -0.02| 0.07| 0.08| -0.08| 0.17| -0.13| -0.06| 0.14| 1   |      |      |      |      |      |      |
| (10)       | 0.01| 0.01| 0.21| -0.06| 0.16| -0.19| 0.22| 0.08| 0.03| 1    |      |      |      |      |      |
| (11)       | -0.03| -0.02| -0.20| 0.15| -0.10| 0.23| 0.17| -0.06| 0.04| -0.06| 1    |      |      |      |      |
| (12)       | 0.23| 0.35| 0.28| -0.39| 0.38| -0.38| 0.23| 0.23| 0.16| 0.17| -0.13| 1    |      |      |      |
| (13)       | 0.08| 0.03| -0.10| -0.06| -0.11| 0.02| -0.12| 0.02| -0.00| -0.01| 0.01| 0.07| 1    |      |      |
| (14)       | -0.03| 0.14| -0.30| -0.07| -0.00| 0.07| 0.07| -0.11| -0.06| -0.04| -0.01| -0.09| -0.16| 1    |      |
| (15)       | -0.12| -0.10| -0.03| -0.04| -0.09| -0.06| -0.00| -0.13| -0.02| 0.07| 0.00| 0.06| 0.01| 0.06| 1    |
| Max. V     | 1.69| 1.68| 1.55| 1.47| 1.34| 1.20| 1.14| 1.09| 1.05| 1.06| 1.04| 1.03| 1.02| 1    | 1    |
| VIF        | 1.35| 1.28| 1.20| 1.17| 1.13| 1.10| 1.06| 1.04| 1.04| 1.03| 1.04| 1.03| 1.02| 1    | 1    |

*Notes. (1): Recm, (2): Satall, (3): Satmat, (4): Diff, (5): Satsys, (6): Devin, (7): Usefeed, (8): Onlipref, (9): Onlinum, (10): Weekstudy, (11): Appn, (12): Satperf, (13): Weeklabor, (14): Year, (15): Genderm. Max. V: Maximum value of VIF. VIF: Variance Inflation Factor.

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