A structural equation model of second language writing strategies and their influence on anxiety, proficiency, and perceived benefits with online writing

Daniel R. Bailey1 · Norah Almusharraf2

Received: 30 September 2021 / Accepted: 6 April 2022 / Published online: 18 April 2022 © The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2022

Abstract
Second language (L2) writing strategies are essential for successful learning outcomes in courses with a substantial writing component and this is especially true during emergency remote teaching (ERT) when online writing tasks help compensate for the missing offline communication. Online writing tasks are multimodal and interactive, and widely delivered through assignment modules, discussion forums, social media, and other online channels, yet little is known pertaining to L2 writing strategies and online writing beliefs. The current study investigates the types of L2 writing strategies students employed during ERT in the midst of Covid-19 and then used structural modeling to understand how strategies relate to online writing task perceptions, L2 writing anxiety, and L2 writing proficiency. The four L2 writing strategy categories are related to planning, monitoring, reviewing, and translating. Following a cross-sectional survey design, a total of 256 South Korean EFL students completed the study’s questionnaire administered during their second semester of ERT. Overall, students reported using planning and monitoring strategies the most while using moderate levels of translation and review strategies. Translation strategies produced a significant positive relationship with L2 writing anxiety, indicating effort-avoidance behavior among apprehensive writers. Contrarily, planning and review strategies were positively associated with increased levels of perceived benefits with online writing tasks. When added to the model, the statistically significant correlations among monitoring category and outcome variables vanished, indicating a mediation effect. Along with addressing future directions in L2 writing strategy research in the post-Covid era, some pedagogical implications for the evolving application of translation strategies are discussed.

Keywords Writing strategies · Translation strategies · LMS · Videoconference · Writing anxiety · Writing instruction · Emergency remote teaching · Second language writing
1 Introduction

To follow social distancing efforts during the Covid-19 pandemic, university students in South Korea took part in emergency remote teaching (ERT). Instruction during ERT is distinct from face-to-face and online instruction since students are burdened with new technologies and a potentially unprepared university system (Hodges et al., 2020). ERT may entail using a learning management system (LMS) for asynchronous communication and videoconferencing for synchronous communication (Bailey et al., 2021; Moorhouse & Wong, 2021; Pereira & Guerreiro, 2021). During ERT, language instructors in South Korea provided L2 writers unique opportunity for interactivity that combined text, videoconferencing, audio, and video (Bailey et al., 2021; Washburn, 2021). Yet despite best efforts, educational institutes fell short of providing the same communication opportunities students came to expect in offline brick-n-mortar classrooms, with some students reporting that their instructors during ERT were not sufficiently prepared to teach in online settings (Rosli, 2021). In response to students’ needs during ERT, the current study attempts to identify writing strategies used to complete online assignments then understand how those strategies influence student characteristics.

Going into the first semester of emergency remote online classes, EFL instructors in South Korea planned to use LMS discussion forums and LMS assignment modules to deliver writing assignments (Bailey & Lee, 2020). These LSM writing assignments included essay writing tasks, collaborative writing tasks, business writing tasks, forum discussions, presentation scripts, and picture prompts. The current study posits that students that use the appropriate writing strategies when planning, monitoring, and reviewing their writing are in a good position to successfully complete the wide range of writing activities asked of them during ERT, resulting in high-quality compositions and a successful course outcome (Bailey et al., 2021; Gibriel, 2019; Zhong, 2021). Contrarily, students who use few writing strategies, skip planning or review strategies altogether, or rely heavily on classroom-based strategies (e.g., asking others for help), may struggle with successfully completing writing tasks during ERT. To this end, recognizing which strategies successful students use during ERT can guide writing training to assist less proficient L2 writers.

L2 writing strategies are partly classified here in terms of when the student employs them: the planning (before-writing), monitoring (when-writing), and reviewing (after-writing) stages (Baker & Boonkit, 2004). When analyzing writing strategies frequently used among EFL university students, L2 writers are found to rely on machine translation (Bailey, 2019). Consequently, the use of internet tools (e.g., machine translation, concordance tools, and grammar checkers) is an emerging fourth category that transcends planning, monitoring, and reviewing stages since students can resort to internet tools throughout the writing process. By answering the following question, the current study attempts to conceptualize translation strategies as a separate L2 writing strategy category within the planning, monitoring, and review strategy category framework.
1. How do translation strategies compare to planning, monitoring, and review strategies in the second language writing context?

Upon identifying the magnitude and type of L2 writing strategy categories used during ERT, this study mapped the influence those strategy categories have on perceived benefits for LMS writing activities. Students’ perceived benefits for LMS writing activities and how those perceived benefits are influenced by their writing strategy choices became increasingly relevant during ERT since text-based communication (e.g., email, instant messaging, forum discussions, chat-box messages, etc.) work in tandem with videoconferencing software to replace in-class communication. To understand the influence writing strategies have on perceived benefits with online writing activities, the following question is asked.

2. How do L2 writing strategy preferences influence perceived benefits with online writing activities?

In general, students who prefer to use more strategies and use them more effectively will be less prone to negative learner characteristics like L2 writing anxiety and will consider themselves to have higher levels of L2 writing proficiency than students who resort to fewer writing strategies and are less effective at applying them when writing. Here lies the third area of interest and final research question in this study which addresses the influence of L2 writing strategies on perceived levels of L2 writing anxiety and L2 writing proficiency among students participating in ERT.

3. How do L2 writing strategy preferences influence L2 writing anxiety and L2 writing proficiency?

2 Literature review

With the crux of this paper centering on the strategies EFL students use to complete their English compositions, the theoretical framework for this study is based on a subset of language learning strategy theory that focuses on L2 writing. Language learning strategy theory posits that a broader range and more appropriate use of learning strategies contributes significantly to second language acquisition. Language learning strategies can be considered “specific actions taken by the learner to make learning easier, faster, more enjoyable, more self-directed, more effective, and more transferable to new situations” (Oxford, 1990, p. 8). Second language writing strategies, specifically, are the processes and actions taken by L2 writers to produce concise and coherent writing. The appropriate application of writing strategies partly mediates language acquisition since students are actively engaged in planning, creating, and reviewing target language output (Lei, 2008). With a specific focus on writing strategies, the following sections present L2 writing strategy research regarding how they are categorized and how they relate to learner characteristics.

2.1 Second language writing strategies

Maarof and Murat (2013), among others (Bailey, 2019; Baker & Boonkit, 2004), categorized writing strategies according to the chronological order they occur during
the writing process (i.e., before, when, and after writing stages). In the writing process, brainstorming and outlining occur during the planning stage; visual monitoring during the when writing stage; and reviewing and peer-editing during the after writing stage. Online translation and automatic writing evaluation software (e.g., Google Translate and Grammarly) support a quickly emerging category of writing strategies that complement writing at the pre-, when-, and after-writing states.

Increasingly sophisticated neural machine translation systems and AI algorithms (Wu et al., 2016) are contributing to the higher use of L2 writing strategies associated with eLearning tools. Accordingly, second language writers carry out machine translation with websites like Google Translate (Tsai, 2019) and automatic writing evaluation with websites like Grammarly. In fact, Google Translate was found to be superior to self-written text among a group of 124 university students with intermediate English levels (i.e., CEFR B1-B2 level) (Tsai, 2019). A growing body of literature supports the use of machine translation and other AI driven tools when appropriately applied in the classroom (Lee, 2020). In this vein, Lee’s (2020) study on the use of Google Translate in the EFL classroom identified a series of benefits machine translations offer writers which include double checking, paraphrasing, rewriting, and comparing different versions of writing.

The positive outlook towards machine translation put forward by Lee (2020) and others (Chen et al., 2015; Garcia & Pena, 2011) is in contrast to Baker and Boonkit’s perspective (2004) which strictly considered translating from the L1 to the L2 as a negative strategy mostly associated with lower proficient L2 students. High use of translation strategies may be problematic because students are not negotiating meaning in the target language when generating content or learning the skills necessary for being an independent writer (Beiler & Dewilde, 2020). While lower proficient students resort to machine translation more often than their higher proficient counterparts out of necessity (Bailey, 2019; Baker & Boonkit, 2004), students at all levels can improve the quality of their final drafts when using machine translation (Lee, 2020), automatic writing evaluation and tools appropriately.

2.2 Writing strategies and LMS-supported writing activities

Strategy choices are often influenced by the framing of the writing assignment (Plonsky, 2011). Regarding task type, a comprehensive range of writing strategies entailing planning, monitoring, and reviewing would be more beneficial for high-stakes writing assignments such as term papers (Rahmawati, 2019), while monitoring strategies, exclusively, may be sufficient for low-stakes computer-mediated writing assignments like emails, direct messages, social media posts, and LMS discussion threads are becoming more prevalent in foreign language classes as technology continues to play a larger role in the learning environment (Barrot, 2021).

Currently, the association between writing strategies and perceived benefits with LMS supported writing tasks remains relatively unexplored, especially in the context of ERT. Regarding the use of LMS during ERT, Washburn (2021) recognized that South Korean students preferred text-based interactions over more dynamic interactivity with
videoconference, video recordings, and audio recordings. Previous studies have emphasized EFL students’ perspectives toward utilizing digital platforms in online learning (Makumane, 2021; Washburn, 2021), such as LMS. Reported results varied from LMS integration and had positive impacts on EFL learners’ English writing achievements (Irzawati, 2021; Rahman et al., 2020). However, LMS should be carefully integrated to avoid challenges that students might encounter, for example, issues related to flexibility in communication between learners themselves and learners with the instructor (Makumane, 2021). The flexibility in communication LMS provide is partly reflected in the types of writing assignments LMS afford, namely student–teacher (e.g., assignment module) or student–student-teacher (e.g., forum discussion module). Writing activities during Covid-19 utilized wiki (Khan & Hameed, 2021), WhatsApp (Budianto & Arifani, 2021), and Facebook (Ghounane, 2021), indicating technology and creativity influence task type and consequently strategies used when writing in a second language.

2.3 Writing strategies and anxiety

Writing apprehension is an individual’s experience of anxiety, stress, and nervousness during the writing process, and these feelings lead to L2 writers being disconnected and producing low-quality compositions (McLeod, 1987). General language anxiety and the frequency of language learning strategy use show a significant negative correlation with one another (Noormohamadi, 2009). Rosli (2021) used Penuelas’s (2012) writing strategy inventory to conceptualize writing strategies according to Oxford’s six subcomponents to measure the influence of writing strategy preference on L2 writing anxiety beliefs. Stewart et al. (2015) explored the relationship between student writing anxiety on undergraduate students’ self-reported use of metacognitive writing strategies, resulting in finding that provided evidence that reductions in students’ writing anxiety are associated with increases in students’ perceptions of using metacognitive writing strategies” (p. 11). When investigating possible relationships between writing strategies and anxiety, Gibriel (2019) found a combination of positive and negative correlations between individual strategy items and overall writing anxiety. From the 38 strategy items, only four had a statistically significant relationship with anxiety, two in the positive and two in the negative direction. On the other hand, Erol’s (2021) study examined the relationship between EFLs’ writing anxiety and foreign language writing performance, and the results showed no significant relationship between the writing anxiety of the participants and their writing performance.

2.4 Writing strategies and L2 writing ability

Approaching writing strategies from both a chronological (before-writing, when-writing, and after-writing) and SILL perspective, Baker and Boonkit’s (2004) found differences between low and high L2 proficiency groups negligible but existent. The negative writing strategy items included writing without a plan, translating from the L1 to the L2, and not making an effort to remember feedback. The negative writing strategy specifically referencing resorting to translation revealed the most significant
difference between proficiency groups. Overall, Oxford’s six categories offered little insight into writing strategy use or differences between successful and less successful writers (Baker & Boonkit, 2004, p. 319). Baker and Boonkit (2004) found that the low L2 proficiency group used more negative strategies such as those pertaining to resorting to translating from the L1 to L2 (e.g., I like to write a draft in Thai first and then translate it into English). High-performing writers report using planning, editing, reviewing, and social strategies at higher rates, while lower-performing writers report higher uses of memory strategies but lower strategies use overall (Chien, 2010; De Silva & Graham, 2015). Low-performing students begin writing, generally, without having any plans and frequently use translation strategies throughout the writing process (Maarof & Murat, 2013). Contrarily, planning strategies are frequently used by successful L2 writers (Abdullah, 2009; Mu & Carrington, 2007). Among a group of 231 American undergraduate students, Penuelas (2012) revised Oxford’s (1989) strategy inventory for language learning (SILL) for the context of writing strategies. Slight differences were noticed between high and medium proficiency groups. In contrast, high and low proficiency groups showed significant differences in memory, cognitive, compensation, and affective strategy categories. With the increasing use of asynchronous communication through course LMS, more and more students rely on translation tools are becoming increasingly accurate. Such writing tools are a valuable time-saving resource if used appropriately; however, they may prevent low-performing students from developing a sophisticated writing strategy repertoire (Beiler & Dewilde, 2020).

3 Methods

This study used a cross-sectional questionnaire to identify the associations among L2 writing strategy categories used during ERT due to COVID-19 and learner characteristics. A cross-sectional study is a type of observational study that selects participants based on inclusion criteria. For inclusion into this study, students were attending EFL course taught remotely using videoconference software and LMS for their online course. EFL courses in South Korea teach speaking, writing, grammar, reading, listening, and other communication skills related to English. During Covid-19, universities in South Korea transferred these courses online in response to social distancing efforts.

3.1 Participants

At the time of the study, South Korean university students were attending their second semester of emergency online courses due to the Covid-19 pandemic. Convenience sampling was used to recruit instructors teaching EFL courses. The three participating instructors each had at least 10 years of experience teaching EFL in South Korea and held graduate degrees related to English and/or education. Two professors were employed at universities in the capital city of Seoul while the third participating professor was working at a provincial university located in the countryside. In

 Springer
all, 256 students (142 males, 114 females) ages 18 to 25 (M = 21.5, SD = 1.95) were asked to complete the study’s questionnaire on a voluntary basis. Student majors included Korean, English, Business Administration, Engineering, Architecture, Economics, Trade, Korean History, and Education. Students reported to have moderate levels of L2 speaking proficiency (M = 5.2, SD = 2.02) when asked to self-rate their speaking proficiency on a scale from 1 (low) to 10 (high). The pooled sample of participants appeared to adequately represent the EFL student cohort in South Korea.

3.2 Emergency remote teaching

Students met for between 120 (n = 125) to 180 (n = 131) minutes each week for the 16-week semester through the videoconference platform Zoom (zoom.us) to practice conversational English, presentation, listening, and other synchronous activities (e.g., group discussions, role-plays, and live lectures). The three instructors used activities from the textbooks Smart Choice 2 (Wilson, 2016) and Jazz English (Breaux, 2015). These activities explore topics related to entertainment, travel, hobbies, food, and technology and are designed to help students speak and write in English. The videoconference instruction followed a presentation-practice-production lesson plan: instructors modeled correct use of language with engagement activities, then students completed worksheets, and finally some form of target language output occurred (e.g., presentation, group discussion, or role-play activity). Students were instructed to apply what they learn during the videoconference portion of the course to their online writing tasks.

Online writing occurred through the instructors’ course LMS (i.e., Moodle). The participating instructors used the LMS to assign a wide array of writing tasks (e.g., essays, self-disclosure blogs, business emails, picture prompts, etc.). The two most frequently used LMS modules for collecting writing tasks were the assignment module and forum discussion module. However, instructors also used social media channels (e.g., Kakao talk) to deliver online writing assignments which they would collect through either the LMS assignment module or during the live videoconference session.

3.3 Questionnaire

Items for the writing strategy scales emanate from a background review of past writing strategy research (Bailey, 2019; Baker & Boonkit, 2004; Maarof & Murat, 2013). These studies separate writing strategies in line with when they are likely to occur during the composition stage (i.e., planning, monitoring, and review stages). In likeness to Bailey’s (2019) problem-solving strategy category and Baker and Boonkit’s (2004) negative writing strategy category, a translation strategy category was added. The appendix lists the items along with factor weights. All items loaded above 0.45 in their respective scales, well above the recommended 0.32 level (Tabachnick et al., 2007).

In addition to the writing strategies, three outcome measures were added to the study’s model to check the influence writing strategy categories have on positive
and negative learning attributes. The first was L2 writing anxiety, measured using five items from Cheng’s (2004) cognitive anxiety measure. The following variable of interest pertained to self-perception of writing performance and was measured using a single item. Students were asked to rate their writing ability on a scale from 1 (low) to 10 (high). Admittedly a simple measure that relies on memory, self-rating has been found to have strong internal consistency and face validity (Luoma & Tarananen, 2003). Lastly was the perceived LMS writing benefits scale. On a five-point Likert scale (0, not beneficial at all to 4, highly beneficial), students were asked to rate the benefits of completing asynchronous online writing activities delivered through the course LMS offers. A professional translation specialist with over ten years of experience translating academic documents translated all survey items from English to Korean.

### 3.4 Procedures

First, the researchers gained permission to administer the questionnaire described above. The online survey software Google Forms (forms.google.com) was used to survey students. The researchers provided instructions for the participating teachers on how to introduce the survey to their students. A written explanation of the nature and purpose of the study was provided to the students in the first language (i.e., Korean). Students were informed that their responses were anonymous and would be saved under password protection. They were given 25 min to complete the survey and had the opportunity to opt out of having their responses submitted for research purposes.

### 3.5 Data analysis

SPSS (Version 25.0) was used to conduct descriptive analysis, bivariate analysis, and reliability tests of the questionnaire. Further, SPSS was used to carry out exploratory factor analysis to extract the variables of interest, including EFL learners’ writing strategies, writing anxiety, and perceived benefits with online writing tasks delivered via LMS. Item analysis, exploratory factor analysis, and reliability analysis were carried out to check the construct validity of the variables of interest. Principal Component Analysis (PCA) was conducted to check the construct validity of the scales. PCA was chosen for its wide use in identifying dimensionality and extracting latent components (Stevens, 2009). To test the proposed model, confirmatory factor analysis (CFA) was carried through structural equation modeling using Analysis of Moment Structure (AMOS; Version 11).

#### 3.5.1 Data cleaning and exploratory factor analysis

Kurtosis and skewness measures were used to check distributions. All items were within acceptable ranges of normality, skewness values ranging between -0.431 and 0.137, and kurtosis values ranging between -0.497 and 1.091. It was determined that data was normally distributed. All but two items in Cronbach alphas ranged from 0.77 to 0.92, within adequate range of internal reliability (Table 1), above the
To check for multicollinearity, Pierson correlation was used. No cross-item correlations had Pierson r values above 0.90. Varimax rotation was used to carry out Exploratory Factor Analysis (EFA). Varimax rotation is a recommended technique when working with simple structures (Gorsuch, 1983, p. 205) and with self-report surveys in second language studies (Brown, 2009). To test the factorability of the variable data, the Kaiser–Meyer–Olkin (KMO) and Bartlett’s Test of Sphericity (BTS) were calculated. The KMO value was 0.843, above the recommended value of 0.60 (Tabachnick et al., 2007), and BTS was statistically significant ($X^2 (300) = 2564.601, p < 0.05$), supporting the appropriateness for factor analysis. A PCA with varimax rotation was performed with the initial analysis producing five factors that had eigenvalues greater than 1, ranging from 1.38 to 6.59.

### 4 Results

Once EFA was complete, the study computed mean scores and carried out a Pearson correlation analysis for the variables of interest. In response to research question 1, the most frequently reported strategies were monitoring (when-writing) strategies followed by planning (before-writing) strategies. Items pertaining to translation and review strategies were moderately used with mean scores at 3.10 and 3.08, respectively. There were a number of noteworthy findings pertaining to the mean scores of the variable values. In general, students perceived the online asynchronous component of their course beneficial to writing practice ($M = 2.92, SD = 1.94$). Students reported using before and monitoring strategies the most, in the 3.5 to 5.0 range, while using moderate levels of translation and review strategies. Regarding L2 writing anxiety, students reported high levels of apprehension when composing in...
English (M = 3.61, SD = 0.977), a common characteristic among South Korean language learners (Pae, 2012). Regarding gender, females reported higher levels of L2 writing anxiety and reported lower levels of self-perceived L2 writing ability. Furthermore, females are also reported using more translation strategies than their male counterparts. Concerning self-reported L2 writing ability, the stronger the writer, the less apprehension they perceived themselves as having.

As displayed in Table 1, correlation analysis revealed a wide range of statistically significant relationships. Regarding correlations, review strategies produced statistically significant relationships. Students who reported to practice review strategies also held higher perceptions about their writing ability, recognized more benefits with LMS writing activities, and reported higher use of the other strategy categories, including translation strategies (which have been considered negative choice for writing strategy use). Contrarily, the translation strategy category produced the fewest statistically significant relationships with the other variables, and these relationships were often in the negative direction indicating their use among lower-performing students with elevated levels of writing anxiety. In fact, the translation strategy category was the only strategy category that negatively related to self-reported L2 writing level. Further, the translation strategy category was the only strategy category to have a statistically significant relationship with L2 writing anxiety, and this relationship was positive, indicating that apprehensive students are more likely to resort to automatic translation tools instead of more cognitively challenging writing strategies related to planning, outlining, or guessing.

4.1 Structural model

Once the factors were established through EFA using SPSS (see Appendix), the next step in the study involved CFA with AMOS to test the study’s model. Upon checking the model’s indices, poor model fit was observed. After following recommendations from modification indices, adequate model fit was achieved. Several fit indices were examined to evaluate the model fit, including the chi-square magnitude, Chi-square/df ratio, which should be lower than 3, the good fit index (GFI), the normal fit index (NFI), and the comparative fit index (CFI) with the cut value greater than 0.90, and the Root Mean Square Error of Approximation (RMSEA) below 0.06 (Schreiber et al., 2006). Results were within the acceptable fit index ranges: Chi-square/df ratio (1.76), RMSEA (0.055), CFI (0.908), IFI (0.910), NFI (0.813), TLI (0.900), and PCLOSE (0.124).

Figure 1 illustrates the final model with the significant paths. When allowed to covary, the bivariate correlations seen in Table 1 disappeared for monitoring strategies, indicating that those relationships were partly explained through the other strategy categories. Regarding planning strategies, they only revealed a positive path coefficient with perceived benefits with online writing activities, while review strategies showed a statistically significant path coefficient with both perceived benefits with online writing activities and self-reported L2 writing ability. In line with the correlation analysis in earlier steps, the translation strategy category showed a positive path coefficient with L2 writing anxiety and a negative one with L2 writing
ability, both in the moderate to strong effect size range (Cohen, 1989). The proceeding chapter explains the findings concerning the study’s research questions and within the context of extant literature explains.

5 Discussion

The emergence of technology has arguably been a force for good in the classroom and nowhere is this more evident than with second language writing, where translation and other eLearning tools help students produce original content and navigate second language communication (Vitta & Al-Hoori, 2020). Several noteworthy findings pertaining to the frequency and type of writing strategies used during emergency remote online courses emanated from this study. Further, a connection was recognized between writing strategy categories and perceived benefits with LMS writing activities, L2 writing anxiety, and self-reported L2 writing ability.

Concerning research question 1, (i.e., How do translation strategies compare to planning, monitoring, and review strategies in the second language writing context?), it was found that translation strategies were reported less than planning and reviewing ones and were significantly associated with L2 writing anxiety and low writing proficiency.

Anecdotal evidence by the participating instructors indicated translation strategies were popular during emergency online remote classes, with reasoning attributed to the lack of direct observation of students and information communication technology to carry out classes (e.g., LMS and videoconference software). Translation
strategies that entail using tools like Google Translate are an easy alternative to higher-order thinking strategies that are associated with self-regulated approaches to language learning (e.g., planning and help-seeking behavior). Such translation tools allow second language (L2) students to avoid creating content in the target language (Bahri & Mahadi, 2016) and consequently create dependency on technology.

Machine translation with tools like Google Translate offers advantages and disadvantages to language learners and teachers alike. Benefits include improved quality of writing (Lee, 2020), increased motivation (Niño, 2009), more time for other forms of language practice, and accessibility (Alhaisoni & Alhaysony, 2017). However, negative effects of machine translation include avoidance behavior in using the target language (Musk, 2014), incorrect translations, poor grammatical solutions (Josefsson, 2011), and instances of gender or cultural bias (Fitria, 2021). Murtisari et al. (2019) consider one affordance of machine translation to include increased autonomy since students are less reliant on help-seeking strategies. Although, this trade-off between translating and help-seeking prevents students from developing social strategies associated with review and editing, frequently used by high-performing L2 writers (Bailey, 2019). Students that rely heavily on automatic translation tools or conventional word-for-word translation strategies suffer the most from high levels of L2 writing anxiety. Students who report high levels of translation strategies also identify as low-performing writers. Increasing levels of review strategies were associated with those who identified as stronger writers. Teachers can encourage machine translation; it is inevitable; however, they need to train students on how to combine editing and review strategies alongside translation strategies.

The results from research question 2 (i.e., How do L2 writing strategy preferences influence perceived benefits with online writing activities?) revealed that students who reported using planning and reviewing strategies also reported higher levels of perceived benefits with online writing activities. This is in line with extant literature, which shows that more proficient, higher-achieving students dedicate time to planning and revisions (Wingate & Harper, 2021). A similar pattern of results was obtained in Rahman et al. ’s (2020) study, which revealed that perceived LMS writing benefits were positively reported as they aided learners with written communication skills, confidence, and interest in learning English writing. Continuously evaluating and developing the LMS experience is critical to learners’ behavioral intention to utilize similar platforms for learning purposes in the future (Raza et al., 2021).

Regarding research question 3 (i.e., How do L2 writing strategy preferences influence L2 writing anxiety and L2 writing proficiency?), the translation strategy category strongly predicts L2 writing anxiety and self-reported L2 writing ability. As levels of L2 writing anxiety increase, so does the likelihood of those anxious students using translation tools. This may be problematic due to the heavy association reliance on translation strategies with low-performing writers (Baker & Boonkit, 2004). Translation websites like Google Translate are beneficial in the short run and in a non-testing context; however, high reliance on such software may prove detrimental to the goal of second language acquisition.

Regarding self-reported L2 writing ability, review strategies positively predicted self-perception of writing ability, and translation strategies negatively predicted them. Students who seek out feedback from others (e.g., teachers and classmates),
use that feedback, and self-edit are also more likely to think higher of their writing ability than their lower strategy using counterparts. Contrarily, translation strategies and self-reported L2 writing anxiety produced a strong negative path coefficient, supporting past anxiety literature showing apprehensive students perceive themselves as poor writers (Kelly et al., 2020).

On a final note regarding the study’s model, mediation was recognized after carrying out the structural equation modeling technique. When allowing writing strategy categories to covary (see Fig. 1), monitoring strategies showed no association with any of the model’s dependent variables, eliminating the bivariate correlation reported in Table 1 and indicating mediation by the other strategy categories. While monitoring strategies are considered to be essential to the writing process, planning and review strategies were more predictive of the positive learner characteristics observed here. Contrarily, translation strategies were associated with writing anxiety and low writing proficiency.

To summarize, students reported using a wide variety of strategies to accomplish their L2 writing goals. Overall, students engaged in planning and monitoring strategies, indicating that university students were well prepared to begin and carry out L2 writing. Contrarily, review strategies (e.g., seeking help, reflecting, and self-editing) were used more often by students that consider themselves proficient writers. In stark contrast, students that regularly practiced translation strategies reported low levels of writing proficiency as indicated by the study’s model (Fig. 1). Review strategies were also associated with perceived benefits with online writing activities (e.g., wikis contributions, forum discussions, and blogs), indicating that students who reported utilizing editing, redrafting, and help-seeking strategies were more likely to recognize benefits with online writing activities.

### 5.1 Pedagogical implications

A critical pedagogical implication proceeding from this study is the recognition for instructors to improve and build upon students’ translation activities in teaching English writing. Incorporating translation should be integrated as an elective activity to avoid students’ anxiety. Further, the facilitation of translation activities would help students scaffold, and perhaps streamline, meaning-making opportunities (e.g., machine translation in L2 social media interactions). The study results further implied that, within academic writing instruction, planning and process writing is fundamental to the English writing lesson. For instance, English instructors can incorporate LMS writing activities that improve students’ ability to explore and navigate information from multiple sources and even utilize automatic translation tools to facilitate such exploration.

Further, time-mediated revision strategies, such as coming back to a piece of writing with *fresh eyes* (e.g., reflection and self-editing strategies), scheduling more time to complete a writing assignment, and other author-mediated strategies were analogous with before-writing and after-writing strategies associated with high performing students, echoing findings from past studies (Lei, 2008). A last recommendation of note entails LMS participation. Students who find benefits with LMS
activities are equipped with planning and review strategies. In other words, students
who plan but do not review still have low self-reported levels of writing ability, so
planning and editing, and reviewing are considered crucial to achieving moderate to
expert levels of L2 writing ability.

By in large, the language learning strategies a student possesses and the more fre-
quently they use them, the better. At a certain point, the learner reaches a near expert
level, at which point they can rely on fewer strategies to help finalize their second
language acquisition. Second language writing strategies may follow similar trends;
however, even experienced writers understand the importance of planning, self-edit-
ing, peer-editing, and reviewing. Therefore, instructors are encouraged to implement
strategy training at each stage of the writing process.

6 Conclusion

With the onset of technology over the years, more and more reasons for communi-
cating through writing via information technology modes have become apparent. No
longer are L2 writers required to write high-stakes compositions, but instead can, and
sometimes required, to microblog, write memos, self-disclose through social media,
post regularly in discussion forums, and contribute to chatrooms (Rahmawati, 2019).
Students rely more on translation tools than time-consuming planning and reviewing
strategies for these types of writing tasks. In EFL classes that integrate multimedia
assignments rather than process writing essays, students may lose the opportunity to
develop sophisticated writing strategies associated with higher writing quality. Instead,
they resort to using eLearning tools like Google Translation and concordances.

The results from the current study may be considered a further validation of EFL
Students’ perceived benefits with online writing activities. Only translation strategy
exhibited a significant relationship with L2 writing anxiety among the four writing
approach categories. Contrarily, planning and review strategies influenced increased
perceived benefits with online writing activities, indicating that such students were
more prepared to accomplish asynchronous online assignments. Review strategies
were associated with both perceived benefits with online writing activities and self-
reported L2 writing ability while planning strategies were only associated with per-
ceived benefits with online writing activities. Only the review strategy category dis-
played a positive relationship with L2 writing ability, suggesting that this category,
along with planning, was associated with strategic L2 writers.

The paper’s limitations are crucial to discuss since they hold the ground for
future research. It could be argued that this study did not consider writing strate-
gies such as L2-mediated writing strategies (e.g., the explicit practice of L2 lan-
guage points). Future research should include the integration of more strategies with
a close examination of each. Although the sample size is widely accepted within the
study, future research could include a larger population from international contexts
to achieve more generalizable results. When added to the model, the monitoring
strategy category produced no significant association with the outcome variables.
To explore this mediation further, future studies may wish to model the mediation
effect higher-order thinking strategies (e.g., planning and reviewing strategies) have on real-time monitoring strategies in the L2 writing context. Further, future work could focus on a gender-specific study that investigates and compares behaviors of male and female participants with the EFL English writing classrooms. This study provides evidence indicating students’ writing apprehension levels decrease when they have time to plan, use eLearning tools to complete activities, and revise their writing. Future research should take a more qualitative approach to explore these propositions from the students’ voices through sources including interviews, focus groups, and journaling. This is a critical component in future attempts to understand the rationale behind learners’ behaviors. Future studies could also fruitfully explore this issue further by collecting qualitative (i.e., students’ artifacts, written responses, and interview sessions) and quantitative translation of learning analytics. Universities in Korea and elsewhere should develop student satisfaction levels by enhancing the LMS functionality and practicality interface.

**Appendix**

**Questionnaire Items and Factor Loading from Principal Component Analysis**

| Planning (before-writing) strategies | Factor | M   | SD  |
|-------------------------------------|--------|-----|-----|
| 1. Write an outline or take notes before writing in English | 0.734  | 3.76 | 0.94 |
| 2. Organize your thoughts before you start writing in English (e.g., Brainstorm) | 0.700  | 3.94 | 0.78 |
| 3. I plan my schedule so that I can have enough time to write in English | 0.654  | 3.69 | 0.87 |
| 4. When I write in English, I set aside time (e.g., planning and brainstorming) in advance | 0.642  | 3.54 | 0.93 |

| Monitoring (when-writing) strategies | Factor | M   | SD  |
|-------------------------------------|--------|-----|-----|
| 5. When I write unfamiliar English words, I try to guess | 0.691  | 3.98 | 0.78 |
| 6. Before writing the concluding paragraph (or last sentence), I review the article to make sure it matches the main idea of the text | 0.661  | 3.94 | 0.78 |
| 7. When writing, I first select vocabulary and phrases that I know | 0.640  | 3.74 | 0.72 |
| 8. When writing, I review my English writing for vocabulary, spelling, and capitalization mistakes | 0.635  | 3.78 | 0.88 |
| 9. When writing, if there is any word that is confusing, I stop writing and look up the word | 0.585  | 4.23 | 0.73 |
| Planning (before-writing) strategies | Factor | M    | SD  |
|-------------------------------------|--------|------|-----|
| Review (after-writing) strategies   | 10     | 0.762| 3.25| 1.00|
| 11 After writing in English, I ask others to help me with my English writing | 0.678  | 2.70 | 1.06|
| 12 I use peer comments to improve my English writing skills | 0.594  | 2.93 | 1.02|
| 13 When I write in English, I write a second draft | 0.485  | 2.84 | 0.95|
| 14 I use my teacher’s feedback to improve my English | 0.426  | 3.66 | 1.01|

| Translation Strategies | 15 When writing in English, sentences are written in the native language (Korean) and translated into English | 0.773  | 3.21 | 1.09|
| 16 When writing in English, I use an online translator (e.g., Google Translate or Papago, Naver) | 0.647  | 3.33 | 1.17|
| 17 I translate my writing literally, word by word | 0.540  | 2.76 | 1.04|

| Benefits with online writing assignments | 18 Participate in online discussions | 0.709  | 2.97 | 0.70|
| 19 Create an online learning portfolio | 0.697  | 2.74 | 0.71|
| 20 English reading practice | 0.645  | 3.09 | 0.67|
| 21 English writing practice | 0.636  | 3.09 | 0.65|
| 22 Production of English content (e.g., text, audio, video, etc.) | 0.617  | 2.74 | 0.75|
| 23 Submit assignment | 0.608  | 3.09 | 0.57|
| 24 Provide feedback to classmates | 0.537  | 2.85 | 0.73|
| 25 Build an online community (build an online community through a blog, exchange with classmates through social media platforms) | 0.501  | 2.81 | 0.77|

| Second language writing anxiety | 26 I’m worried I’ll make mistakes when writing in English | 0.879  | 3.59 | 1.09|
| 27 I am anxious about making grammatical errors when writing in English | 0.856  | 3.72 | 1.05|
| 28 If I rate and score my English writing, I will be worried that I will get a very low score | 0.838  | 3.48 | 1.13|
| 29 I am worried and anxious when I know that I get scored for what I write | 0.760  | 3.64 | 1.11|
Acknowledgements The researchers thank Prince Sultan University for funding this research project under grant Education Research Lab-(ERL-CH-2021/2). In addition, this article was supported by Konkuk University in 2021.

Author contribution Dr. Daniel Bailey (abstract, theoretical framework, introduction, literature review, data collection and analysis, and discussion).
Dr. Norah Almusharraf (theoretical framework, report, discussion, conclusion, and narratives).

Declarations

Competing interests None.

References

Oxford, R., & Nyikos, M. (1989). Variables affecting choice of language learning strategies by University students. The Modern Language Journal, 73(3), 291–300. https://doi.org/10.1111/j.1540-4781.1989.tb06367.x
Abdullah, M. R. T. L. (2009). The writing strategies used by engineering ESL Malay learners. In Conference of the International Journal of Arts & Sciences, 1(12), 168–185. Retrieved from http://eprints.utm.edu.my/2035/
Pereira, L., & Guerreiro, J. (2021). Evaluation on Moodle LMS Data Usage During the First Wave of Covid-19’s Pandemic. In International Conference on Human-Computer Interaction (pp. 154–166). Springer.
Oxford, R. L. (1990). Language learning strategies-What every teacher should know. Heinle & Heinle.
Pae, T. I. (2012). Skill-based L2 anxieties revisited: Their intra-relations and the inter-relations with general foreign language anxiety. Applied Linguistics, 34(2), 232–252. https://doi.org/10.1093/applin/ams041
Penuelas, A. (2012). The writing strategies of American university students: Focusing on memory, compensation, social and affective strategies. Elia, 12, 77–113. http://institucional.us.es/revistas/elia/12/art4.pdf
Alhaisoni, E., & Alhaysony, M. (2017). An investigation of Saudi EFL university students’ attitudes towards the use of Google Translate. International Journal of English Language Education, 5(1), 72–82. https://doi.org/10.5296/ijele.v5i1.1069
Plonsky, L. (2011). The effectiveness of second language strategy instruction: A meta-analysis. Language Learning, 61(4), 993–1038. https://doi.org/10.1111/j.1467-9922.2011.00663
Bahri, H., & Mahadi, T. S. T. (2016). Google Translate as a supplementary tool for learning Malay: A case study at Universiti Sains Malay. Advances in Language and Literary Studies, 7(3), 161–167. Retrieved from: https://www.journals.aiac.org.au/index.php/all/article/view/2305
Bailey, D. R. (2019). Conceptualization of second language writing strategies and their relation to student characteristics. Journal of ASIA TEFL, 16(1), 135–148. https://doi.org/10.18823/asiatefl.2019.11.1.9.135
Rahman, A. M. A., Azmi, M. N. L., & Hassan, I. (2020). Improvement of English writing skills through blended learning among University students in Malaysia. Universal Journal of Educational Research, 8(12A), 7694–7701. https://doi.org/10.13189/ujer.2020.082556
Bailey, D. R., & Rakushin-Lee, A. (2020). Learning from experience in the midst of COVID-19: Benefits, challenges, and strategies in online teaching. CALL-EJ, 21(2), 178–198.
Bailey, D. R., Almusharraf, N. M., & Hatcher, R. (2021). Finding satisfaction: Intrinsic motivation for synchronous and asynchronous communication in the online language learning context. Education and Information Technologies, 26(6), 2563–2583. https://doi.org/10.1007/s10639-020-10369-z
Baker, W., & Boonkit, K. (2004). Learning strategies in reading and writing: EAP contexts. RELC Journal, 35(3), 299–328. https://doi.org/10.1177/0033688205052143
Barrot, J. S. (2021). Social media as a language learning environment: A systematic review of the literature (2008–2019). *Computer Assisted Language Learning*, 1–29 Advance online publication. https://doi.org/10.1080/09588221.2021.1883673

Beiler, I. R., & Dewilde, J. (2020). Translation as translilingual writing practice in English as an additional language. *The Modern Language Journal*, 104(3), 533–549. https://doi.org/10.1111/modl.12660

Breaux, G. (2015). *Jazz English: Real conversations real improvement* 2 (3rd ed.). Compass Publishing.

Brown, J. D. (2009). Statistics Corner. Questions and answers about language testing statistics: Principal components analysis and exploratory factor analysis: Definitions, differences, and choices. Shiken: *JALT Testing & Evaluation SIG Newsletter*, 13(1) 26–30. Retrieved March 30, 2009 from http://jalt.org/test/bro_29.htm

Budianto, L., & Arifani, Y. (2021). Utilizing whatsapp-driven learning during covid-19 outbreak: Efl users’ perceptions and practices. *Call-Ej*, 22(1), 264–281.

Chen, M. H., Huang, S. T., Chang, J., & Liou, H. C. (2015). Developing a corpus-based paraphrase tool to improve EFL learners’ writing skills. *Computer Assisted Language Learning*, 28(1), 22–40. https://doi.org/10.1080/09588221.2013.783873

Cheng, Y. S. (2004). A measurement of second language writing anxiety: Scale development and preliminary validation. *Second Language Writing*, 13(4), 313–335. https://doi.org/10.1016/j.jslw.2004.07.001

Chien, S. (2010). Enhancing English composition teachers’ awareness of their students’ writing strategy use. *The Asia-Pacific Education Researcher*, 19(3), 417–438. https://doi.org/10.3860/taper.v19i3.1851

Cohen, I. J. (1989). *Structuration theory: Anthony Giddens and the constitution of social life*. Macmillan International Higher Education.

Rahmawati, N. (2019). Writing strategies used by Indonesian EFL graduate students. *IJER (Indonesian Journal of Educational Research)*, 4(1), 33–39. https://doi.org/10.30631/ijer.v4i1.80

De Silva, R., & Graham, S. (2015). The effects of strategy instruction on writing strategy use for students of different proficiency levels. *System*, 53, 47–59. https://doi.org/10.1016/j.system.2015.06.009

Raza, S. A., Qazi, W., Khan, K. A., & Salam, J. (2021). Social isolation and acceptance of the learning management system (LMS) in the time of COVID-19 pandemic: An expansion of the UTAUT model. *Journal of Educational Computing Research*, 59(2), 183–208. https://doi.org/10.1177/073533120960421

Erol, S. (2021). Investigation of the writing anxiety of Syrian refugees learning Turkish as a foreign language in Turkey. *International Education Studies*, 14(6), 23–33. https://doi.org/10.5539/ies.v14n6p23

Rosli, R. M. (2021). Exploring faculty’s experiences in teaching english online: A study at the university level in Indonesia. *Computer Assisted Language Learning*, 22(3), 126–145. http://callej.org/journal/22-3/Gufron-Rosli2021.pdf

Fitria, T. N. (2021). Gender bias in translation using Google Translate: Problems and solutions. *Language Circle: Journal of Language and Literature*, 15(2), 285–292. https://doi.org/10.15294/lc.v15i2.28641

Garcia, I., & Pena, M. (2011). Machine translation-assisted language learning: Writing for beginners. *Computer Assisted Language Learning*, 24(5), 471–487. https://doi.org/10.1080/09588221.2011.582687

Ghounane, N. (2021). Facebook as a learning platform in Algeria during the COVID-19 pandemic. *Global Journal of Foreign Language Teaching*, 11(2), 80–93. https://doi.org/10.18844/gjflt.v11i2.5555

Gibriel, M. (2019). Investigating writing strategies, writing anxiety and their writing achievement: A mixed method design. *The Journal of Asia TEFL*, 16(1), 429–436. https://doi.org/10.18823/asiatefl.2019.16.1.33.429

Gorsuch, R. L. (1983). *Factor analysis* (2nd ed.). Lawrence Erlbaum Associates.

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research*, 99(6), 323–337. https://doi.org/10.3200/JOER.99.6.323-338

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educause Review*, 27, 1–12. http://hdl.handle.net/10919/104648

Stevens, J. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). Routledge Academic.
Stewart, G., Seifert, T. A., & Rolheiser, C. (2015). Anxiety and self-efficacy’s relationship with undergraduate students’ perceptions of the use of metacognitive writing strategies. *Canadian Journal for the Scholarship of Teaching and Learning, 6*(1), 4. https://doi.org/10.5206/cjsott-rccea.2015.1.4

Irzawati, I. (2021). The utilization of digital platforms in online learning: EFL students’ perspectives. *Indonesian EFL Journal, 7*(2), 131–138. https://doi.org/10.25134/ieflj.v7i2.4566

Joseffson, E. (2011). Contemporary approaches to translation in the classroom: A study of students’ attitudes and strategies. Retrieved from https://www.diva-portal.org/smash/get/diva2:519125/FULLTEXT01.pdf

Kelly, S., Smith, T., & Brown, W. (2020). Emotional intelligence as a predictor of writing and public speaking anxieties. *Business Communication Research and Practice, 3*(2), 76–85. https://doi.org/10.22682/bcrp.2020.3.2.76

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). Using multivariate statistics (Vol. 5, pp. 481–498). Pearson. Retrieved August 2, 2021, from https://www.pearsonhighered.com/assets/preface/0134790545.pdf

Khan, M. I., & Hameed, P. F. M. (2021). An analysis of wiki writing on writing performance in Saudi EFL learners: exploring new pedagogies in COVID times. TESOL International Journal, 16(1), 57–72. Retrieved online at: https://www.tesol-international-journal.com/volume-16-16-issue-1-2021/

Lee, G., & Wallace, A. (2017). Flipped learning in the English as a foreign language classroom: Outcome and perceptions. *Teso Quarterly, 52*(1), 62–84. https://doi.org/10.1002/tesq.372

Lee, S. M. (2020). The impact of using machine translation on EFL students’ writing. *Computer Assisted Language Learning, 33*(3), 157–175. https://doi.org/10.1080/09588221.2018.1553186

Lei, X. (2008). Exploring a sociocultural approach to writing strategy research: Mediated actions in writing activities. *Journal of Second Language Writing, 17*(4), 217–236. https://doi.org/10.1016/j.jslw.2008.04.001

Tsai, S. C. (2019). Using google translate in EFL drafts: A preliminary investigation. *Computer Assisted Language Learning, 32*(5–6), 510–526. https://doi.org/10.1080/09588221.2018.1527361

Vitta, J. P., & Al-Hoori, A. H. (2020). The flipped classroom in second language learning: A meta-analysis. *Language Teaching Research, 1–25. https://doi.org/10.1177/1362168820981403

Luoma, S., & Tarnanen, M. (2003). Creating a self-rating instrument for second language writing: From idea to implementation. *Language Testing, 20*(4), 440–465. https://doi.org/10.1119/0265532203lt2670a

Makumane, M. A. (2021). Students’ perceptions on the use of LMS at a Lesotho university amidst the COVID-19 pandemic. *African Identities, 1–18. https://doi.org/10.1080/14725843.2021.1898930

Maarof, N., & Murat, M. (2013). Writing strategies used by ESL upper secondary school students. *International Education Studies, 6*(4), 47–55. https://doi.org/10.5539/ies.v6n4p47

McLeod, S. (1987). Some thoughts about feelings: The affective domain and the writing process. *College Composition and Communication, 38*(4), 426–435. https://doi.org/10.2307/357635

Washburn, D. F. (2021). Korean EFL learner preference for text-based digital composing during emergency remote learning. *English Teaching, 76*(2), 131–152. https://doi.org/10.1585/engteal.76.2.202106.131

Moorhouse, B. L., & Wong, K. M. (2021). Blending asynchronous and synchronous digital technologies and instructional approaches to facilitate remote learning. *Journal of Computers in Education, 1–20. doi.org/10.1002/s40692-021-00195-8

Mu, C., & Carrington, S. (2007). An investigation of three Chinese students’ English writing strategies. *TESL-EJ, 11*(1), 1–23. Retrieved August 2, 2021, from https://eprints.qut.edu.au/13130/1/a1pdf

Murtisari, E. T., Widiningrum, R., Branata, J., & Riana, D. S. (2019). Google Translate in language learning: Indonesian EFL students’ attitudes. *Journal of Asia TEFL, 16*(3), 978–986. https://doi.org/10.18823/asiatelf.2019.16.3.14.978

Wilson, K. (2016). *Smart choice* (2nd ed.). Oxford University Press.

Musk, N. (2014). Avoiding the target language with the help of Google: Managing language choices in gathering information for EFL project work. *TESOL Quarterly, 48*(1), 110–135. https://doi.org/10.1002/tesq.102

Wingate, U., & Harper, R. (2021). Completing the first assignment: A case study of the writing processes of a successful and an unsuccessful student. *Journal of English for Academic Purposes, 49*, 100948. https://doi.org/10.1016/j.jeap.2020.100948

Niño, A. (2009). Machine translation in foreign language learning: Language learners’ and tutors’ perceptions of its advantages and disadvantages. *ReCALL, 21*(2), 241–258. https://doi.org/10.1017/S095834400900172
Noormohamadi, R. (2009). On the relationship between language learning strategies and foreign language anxiety. *Journal of Pan-Pacific Association of Applied Linguistics, 13*(1), 39–52. Retrieved August 2, 2021, from https://files.eric.ed.gov/fulltext/EJ921023.pdf

Nunnally, J. C. (1994). *Psychometric theory 3E*. Tata McGraw-hill education.

Wu, Y., Schuster, M., Chen, Z., Le, Q. V., Norouzi, M., Macherey, W., … & Dean, J. (2016). Google’s neural machine translation system: Bridging the gap between human and machine translation. http://arxiv.org/abs/1609.08144

Zhong, Q. M. (2021). Fostering group autonomy through collaborative learning in an online environment. *Studies in Self-Access Learning Journal, 12* (1), 79–91. Retrieved August 2, 2021, from https://doi.org/10.37237/120106

**Publisher’s note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

**Authors and Affiliations**

**Daniel R. Bailey¹ · Norah Almusharraf²**

Norah Almusharraf
nmusharraf@psu.edu.sa

Daniel R. Bailey
dbailey0566@kku.ac.kr

¹ English Language and Culture Department, Konkuk University’s Glocal Campus, Chungju, South Korea

² Applied Linguistics, Prince Sultan University, Riyadh, Kingdom of Saudi Arabia