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Strategies for Reducing Cognitive Overload in the Online Language Learning Classroom

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Abstract

As a result of the COVID-19 pandemic, foreign language courses were among the many types of classes that teachers adapted to online learning environments. Online instruction can impede learning and lower student outcomes for a variety of reasons, one of which is cognitive overload. Cognitive overload occurs when learners are given more information or tasks to process than they are capable of managing. It can occur during face-to-face instruction but runs a high risk of occurring in online language learning situations because of the additional complexities associated with processing a foreign language and participating in an online class. This paper briefly outlines why online language classes can be prone to causing cognitive overload among learners. Next, strategies that were used to reduce the risk of cognitive overload among English learners in first-year language courses at a university in Japan are discussed; namely, pre-task activities, allowing the use of students' first language, and collaborative learning. To attempt to gain an idea of the effectiveness of these approaches, a t-test is done using the average grades from online courses of the fall 2020 semester and the mostly face-to-face courses of the fall 2021 semester.

Keywords: cognitive load, online learning, pre-task activities, collaborative learning, first-language usage

1. Introduction

In order to reduce the spread of COVID-19, many educational institutions were faced with either halting instruction altogether or moving classes online in the spring of 2020. The shift to online instruction forced both teachers and students to adapt to this different learning format, and as new waves of COVID-19 infections spread, online learning approaches continued throughout 2021 as schools and universities renewed their policies to reduce the risk of infection and protect the health of students and staff. Online courses and web-based learning are not novel, but had previously been done by instructors who had opted to teach in this way, and by students who had chosen these modes of learning. However, the COVID-19 pandemic required teachers and learners to adjust to this manner of education en masse, compelling those who may have been less predisposed to technology and remote web-based learning to use an approach they might not have elected to otherwise.

Transitioning from face-to-face instruction to teaching online can present problems for both teachers and students. Teachers might need to learn new technology, manage internet connectivity issues for themselves and their students, and change their teaching methods to suit web-based instruction. At the same time, students may also struggle in many ways as a result

of online learning. The nature of video conferencing software and online on-demand lesson modules make it easy for students to disengage from lessons. Student attentiveness can suffer when they leave their webcams off, which creates a sense of not being supervised, and the reduced ability to pick up on a teacher's non-verbal cues in an online class can make following a lesson more difficult (Maimaiti *et al.,* 2021). In their study, Kofoed *et al.* (2021) found that online courses resulted in worse academic performance for students as a whole, and that this decrease was even greater among students who already struggled academically. Bird *et al.* (2020) had similar findings, reporting that the transition to online learning due to COVID-19 resulted in an average 6.7 percentage point decrease in scores for students in their study, and that there was a higher rate of dropping out when classes moved online. There are a number of potential reasons for why students perform worse in online classes than in face-to-face courses, such as a lack of familiarity with online course tools and problems with technology (Wang, 2013; de la Varre *et al.,* 2014), as well as less interaction and problems communicating with teachers and peers during online lessons (Jung *et al.,* 2002; Patricia Aguilera-Hermida, 2020). Adding to this, web-based learning environments and the use of online learning tools can cause cognitive overload among learners, which in turn can lead to worse course outcomes.

1.1. Overview of Cognitive Overload

Cognitive overload occurs when learners are given more information or tasks to process than they are capable of managing due to the limits of their working memory, and this causes a reduction in student learning (deJong, 2010). There are three types of cognitive load. Intrinsic cognitive load is associated with the complexity of the content being learned, extraneous cognitive load refers to the mental activities students engage in that are not related with learning the target content, and germane cognitive load results from the efforts made to store the content into long-term memory (Chen *et al.,* 2011). With regards to instruction, teachers might not always be able to make the content of their courses drastically easier and still keep to stated course goals, so there is sometimes little to be done about intrinsic cognitive load, though teachers can still adjust course content to some extent to suit their students. However, to create the best learning environment possible, extraneous cognitive load resulting from the way content is presented and other mental distractions unassociated with the content being learned need to be minimised, while germane cognitive load, or the mental processes focused on internalising the lesson material, needs to be maximised according to student ability (van Merriënboer *et al.,* 2006).

It follows then that the added cognitive overload of online lessons due to extraneous sources inherent in the very use of technology and video conferencing software is something that educators must try to manage carefully in order to deliver quality lessons to their students. The COVID-19 pandemic era gave rise to the expression "Zoom fatigue", a term which refers to how focusing on a speaker in a video conference for an extended period of time can be mentally exhausting, and a well recognized example of extrinsic cognitive overload resulting from online classrooms. Add to this the difficulty in learning and using other digital learning tools, the potential distractions of the home environment students may experience while doing lessons remotely, as well as lesson plans that were poorly adapted from face-to-face settings to online settings, and there are many sources of extraneous cognitive overload that can potentially hamper student learning. And even when students are trained in the use of a digital-based learning system, they can still perform worse in a learning activity due to the greater

cognitive load that comes from using devices than their peers who do a similar learning activity without technology (Chu, 2014). Certain learner characteristics, such as being less computer savvy and having lower language proficiency also put students at greater risk of experiencing information overload during online lessons using computer mediated communication (Chen *et al.,* 2011).

1.2. Cognitive Overload and Language Learning

Naturally, cognitive overload is also a concern in second language education. Second language learners must make a conscious effort in order to listen and speak a foreign language, and therefore must devote greater cognitive resources to comprehending a sentence that would otherwise be easily understood if it were in their native language (Sweller, 2017). The process of mentally switching between a first language (L1) and a second language (L2) requires cognitive resources, and if a class is taught in the L2, then students must process both the content of the lesson and the foreign language itself, adding an extra layer of cognitive load to the learning process. Students who report greater anxiety during language learning have been shown to experience heavier cognitive loads as well, and subsequently perform worse on tests (Chen & Chang, 2017). However, cognitive overload can occur more easily with web-based language learning than in physical classrooms because of the unique characteristics of online lessons (Zhang, 2013). Long hours of watching a courseware screen which is filled with text, sound, graphics, pictures, photographs, animation and moving video may constitute cognitive load and make the students become tired (Liu, 2011). Language teachers must then consider ways of effectively utilising online tools and multimedia in their classrooms to enhance learning while keeping the unnecessary extraneous cognitive load from the use of technology to a minimum (Chen *et al.*, 2009).

1.3. Purpose

This paper discusses some approaches that were employed to reduce cognitive overload in online lessons for English Presentation and English Debate at Rikkyo University in Tokyo during the Fall 2020 semester. Following this, inferential statistics are used to determine if these measures were effective by looking at the average class scores of the online classes from the fall 2020 semester and those of the mostly face-to-face fall 2021 semester. Did the online classes perform worse, as would be expected (Kofoed *et al.,* 2021; Bird *et al.,* 2020)? A t-test is used to assess the null hypothesis: there is no difference in average class scores between the online and mostly face-to-face classes. If the null hypothesis holds, then it is possible to conclude that the measures to reduce cognitive overload may have had some effect.

1.4. Class Details

English Presentation and English Debate are two new mandatory courses for first-year students that Rikkyo University introduced in the fall 2020 semester. The aim of English Presentation is to teach students presentation skills, such as making eye-contact, emphasising words, and gesturing. The primary course goals of English Debate are to teach students to argue a side in a debate, conduct research to support their opinions, and refute the arguments of the other side. In English Presentation and English Debate, the final grade is calculated as a combination of participation in class activities and homework assignments, mini-presentations or mini-

debates, and a final presentation or debate. Both classes have 14 lectures during the semester, and each lecture is 100 minutes long.

When both courses were initially designed, it was intended for students to do their classes on campus. However, with the COVID-19 pandemic forcing classes online in the 2020 spring semester, both English Presentation and English Debate had to be adapted for the online environment in the fall of 2020. As a result, all 14 classes for both courses were conducted using Zoom and Blackboard in the Fall of 2020, and students were evaluated according to the presentations and debates they did over Zoom. One year later, at the beginning of the fall 2021 semester, infection rates in Tokyo were still high enough to warrant conducting classes online to protect the health of students and teachers. However, the daily COVID-19 infection rate for Tokyo began to fall a few weeks after the start of the fall 2021 semester, and so classes returned to campus in the fifth week. In this semester, students did 10 of their 14 classes face-to-face, and all of their mini-presentations or mini-debates, as well as their final presentation or final debate, were evaluated in face-to-face lessons inside physical classrooms.

2. Measures to Reduce Cognitive Overload

Below, some of the different approaches employed to lower cognitive overload in English Presentation and English Debate classes during the fall 2020 semester are discussed. In particular: pre-task activities, collaborative learning, and permitting L1 usage.

2.1. Pre-Task Activities

Pre-task activities help students learn useful vocabulary, generate ideas, and familiarise themselves with new skills or concepts prior to the main learning task. Often employed in some fashion in flipped classroom teaching, where students learn on their own and then come to class to apply what they have learned, pre-task activities and flipped classroom methods can result in higher student outcomes and reduced cognitive load (Karaca & Ocak, 2017; Turan & Goktas, 2016). Pre-task activities reduce cognitive overload by allowing students to learn at their own pace and therefore manage intrinsic cognitive load and germane cognitive load by giving the learner the time needed to process content. Afterwards, when the main learning task begins, they are able to draw upon the content of the pre-task activity from their long-term memory, freeing up short-term memory processing for the task at hand. For language learners, pre-task activities can help improve confidence and make content easier to learn because of the reduction in cognitive load (Tonkin *et al.,* 2019).

Pre-task activities were introduced to reduce the cognitive load of students in online English Presentation and English Debate lessons. For English Presentation classes, the goal was to have students use class time to practise presentation skills, as well as rehearse and then give their presentations. With this in mind, students were asked to prepare presentation scripts as homework, as well as watch videos related to the presentation skills they were learning from the textbook's website. In this way, students could devote cognitive resources during class to memorising their scripts and practising their presentations while using the presentation skills they had learned from watching the videos. If students had needed to write their complete scripts in class and learn new presentation skills, all while practising their presentations, then their attention and cognitive capacity would be split between too many tasks within a single lesson, and this would harm the internalisation of the presentation skills or the contents of their

own presentations. For online English Debate classes, students were asked to do reading in English related to the theme for the debate of the following week as homework in an effort to reduce cognitive overload. In this way, they could familiarise themselves with vocabulary and ideas that they could later use in constructing their debate arguments. Since students had time prior to class to devote to learning relevant new words and different perspectives on a debate topic, they could use class time and apply their cognitive effort to creating reasons to support their team's position in the debate. Pre-task activities like these can produce greater cognitive thinking and superior reasoning during main task activities, as more mental resources are available to engage in the main task (Kim *et al*., 2017).

2.2. Collaborative Learning

Collaborative learning activities involve students working together on a learning task, and by sharing perspectives and ideas with each other, they can gain a more thorough understanding than if they had worked independently. Collaborative learning permits groups of students to use their collective working memory, which allows each member of a group to share in the effort of processing information (Janssenn & Kirschner, 2020). Working in a group can therefore reduce the intrinsic cognitive load of a task, but the nature of group work itself creates extraneous cognitive load because members must share information and coordinate with each other. For a given learner, if the extra use of cognitive resources to work with others is less than the additional intrinsic cognitive load that would have been used if the task had been done individually, then the collaborative learning activity results in a net reduction of cognitive load (Kirschner et al., 2011; Kirschner et al., 2018). In online English Presentation classes, regular questions were created to supplement the material of the textbook to help deepen student understanding of the use of presentation skills and effective ways to make slideshows. Students then discussed these questions in groups before we took up the answers as a class. The aim of making these activities collaborative was to reduce the intrinsic cognitive load required to answer all of the questions and increase germane cognitive load, allowing students to better internalise the use of presentation skills and the rules for making slideshows.

In English Debate classes, debates were done in teams of typically five students, so they were naturally collaborative. Students typically began preparing for their debates by brainstorming ideas for their team's position. To reduce cognitive load during brainstorming, students were encouraged to organise ideas according to categories such as "cost" and "health", verbally share ideas throughout the brainstorming process, and if a group was struggling, ideas would be "seeded" by asking them to consider certain perspectives (Kolfschoten, 2011). After students brainstormed ideas, they conducted research to support their arguments before writing their team speeches. When they were ready, they presented their arguments as a group to the other team. After hearing the other team's arguments, students would consult with their team on what they had heard and understood, and then plan together to make cross-examination questions. Following this, students worked with their team to create refutations to the other team's points, and then finally create a summary of the debate from their team's perspective. By working together, students can benefit from mutual cognitive interdependence, which occurs when they learn about, and rely on, the expertise of other members of their group (Janssen & Kirschner, 2020). This can lessen the cognitive load of less knowledgeable members of a group as their more knowledgeable peers offer advice and share knowledge.

Furthermore, since the entire process of a debate is complex, students benefit from the effect of collective working memory that comes with collaboration (Kirschner et al., 2009).

2.3. Permitting L1 Usage

Non-native speakers must allocate more cognitive resources when processing a foreign language, and this can cause cognitive overload (Sweller, 2017; Volk et al., 2014). Since cognitive resources are used to understand the foreign language, there is less processing power available to the learner to comprehend and internalise the content of the lesson. In their research on the relationship between processing information in a foreign language and cognitive load, Roussel et al. (2017) found that conveying academic content in a foreign language was worse for learning both the language and the content than conveying it in a native language, or in a foreign language with an accompanying translation. A language teacher must then consider carefully when to require the use of the L2 and when to permit the use of L1, keeping in mind that L2 usage might increase extraneous cognitive load depending on the nature of the content being learned. Additionally, students who are allowed to use their L1 in the classroom during group activities can more easily divide labour and share information, which can reduce the cognitive load associated with doing the task (Bruen & Kelly, 2014). As was discussed in the previous section, coordinating with team members and sharing knowledge can increase extraneous cognitive load, and doing so in a foreign language would demand further cognitive resources. However, these activities are typically not essential to the content being learned or the task goals, so allowing students to use their L1 while performing these activities can allow them to focus on learning the material and committing it to long term memory.

Teams of students in online English Debate classes were permitted to use their L1 while doing collaborative tasks in their Zoom breakout rooms to facilitate the division of labour, explain vocabulary, share the information they had researched for their debate, and choose what arguments to use. Allowing the use of L1 in these collaborative tasks could reduce the extraneous cognitive load that comes from working with others, allowing students to devote more of their concentration to the tasks at hand. Additionally, using an L1 can facilitate recall for students (Ochi, 2009), making it easier for them to remember information they had researched during preparation that they could use to more quickly refute the opposing team's points in a debate. In online English Presentation classes, students could use their L1 when working together in their Zoom breakout rooms to answer the questions that had been made to improve their understanding of presentation skills and slideshow creation, but English was used when taking up the answers. Since the aim behind creating these questions was to have students better understand things such as when to gesture during a presentation, or what words to emphasise, or how not to crowd a slide with too much information, using the L2 was not essential to this understanding and would only add unwanted extraneous cognitive load to these tasks. Finally, students were permitted to use their L1 in online English Presentation classes when they were giving each other feedback after their practice presentations. Peer feedback can lead to improved student outcomes (Saito, 2013), and so it was critical that students could easily articulate and understand feedback without the added cognitive demands that come from processing a foreign language. Ultimately, peer feedback that is not understood would be of no use in aiding students improve their presentation technique, so ensuring that students could make sense of comments from their peers was more important to achieving the goals of peer feedback activities than making them use English.

3. Method

Since online learners perform worse than their face-to-face counterparts (Kofoed *et al.,* 2021; Bird *et al.,* 2020) and cognitive overload is partially responsible for why students using technology for learning activities perform worse (Chu, 2014; Chen *et al.,* 2011), it stands to reason that if the measures employed to reduce cognitive overload in the online classes of the fall 2020 semester were effective, then the average scores of these classes should be similar to those of the mostly face-to-face 2021 fall semester classes. A one-tailed t-test is used to determine if the null hypothesis is valid: there is no significant difference between the average class scores of the online semester and mostly face-to-face semester.

3.1. Sample Details

Aggregated grades of ten online fall 2020 classes were compared to aggregated grades of eleven mostly face-to-face fall 2021 classes. All classes consisted of approximately 20 first-year university students, and each individual class was composed of students from the same major with approximately the same TOEIC scores. At Rikkyo University, students are placed into four different English levels based on their TOEIC scores: Level 4 Students have scores below 279, Level 3 students have scores between 280 and 479, Level 2 students have scores between 480 and 699, and Level 1 students have scores of 700 and above (there were no Level 1 classes in this sample). The fall 2020 classes consisted of seven English Presentation classes and three English Debate classes. Five of the English Presentation classes were Level 2, one was Level 3, and one was Level 4. One of the English Debate classes was Level 2, and the other two were Level 3. The fall 2021 classes consisted of six English Presentation classes and five English Debate classes. Four of the English Presentation classes were Level 2, one was Level 3, and one was Level 4. Two of the English Debate classes were Level 2, and the other three were Level 3. All classes from both semesters were taught by the same instructor and evaluated under the same rubric, so any differences in class scores should not be the result of teaching style or assessment.

3.2. Procedure

To calculate the average grade of each class, the final grades out of 100 points were added up for all students in a class and then the sum was divided by the number of students in the class. After this, classes were grouped according to English level and type (English Debate and English Presentation) and then the average for each group was calculated for both semesters so that they could be discussed separately. Finally, a two-sample t-test was performed by grouping all the fall 2020 classes together and all the the fall 2021 classes together to determine if there was any meaningful difference in the average scores of the two groups. For the t-test, a significance level of $p < .05$ was used to decide whether or not the null hypothesis was valid or not.

4. Results

The tables below illustrate the grade averages of each class. Table 1 shows the average grades of the fall 2020 classes, and Table 2 shows the average grades of the fall 2021 classes. The standard deviation from the average grade for each class has also been included. Classes of the same type (English Presentation or English Debate) and Level (1 - 4) are organised into rows

and given a letter designation (a, b, c, etc.). The final column of each row shows the grade average for all classes of that type and Level. In instances where the standard deviation is high, such as *Class a, Class c, Class d,* and *Class e* from the online Level 2 English Presentation group, it is typically the result of students dropping out of the course or ceasing to attend the class at some point in the semester. In such cases, the grades of these students were still used in the calculation of the average grade for the class they belonged to, resulting in a lower class average. As can be seen in the tables below, there are more instances of high standard deviation in the online classes, reflecting the fact that more students dropped or ceased attending online classes than their face-to-face peers a year later. This is in keeping with findings by Bird *et al.* (2020).

Table 1.
Average Grades of Online Fall 2020 Classes

Class Type and Level	Individual Average Class Grades (and Standard Deviation)	Average
Lvl 2 Eng. Presentation	a = 74.3 (27); b = 83.8 (7.5); c = 73.8 (21); d = 82.9 (20.8); e = 76.0 (23)	78.16 %
Lvl 3 Eng. Presentation	a = 73.5 (17.3)	73.5%
Lvl 4 Eng. Presentation	a = 75.2 (9.6)	75.2%
Lvl 2 Eng. Debate	a = 85.7 (9.6)	85.7%
Lvl 3 Eng. Debate	a = 83.0 (10.9); b = 84.0 (11.2)	83.5%

Table 2.
Average Grades of Mostly Face-to-Face Fall 2021 Classes

Class Type and Level	Individual Average Class Grades and Standard Deviation	Average
Lvl 2 Eng. Presentation	a = 82.7 (6.4); b = 83.1 (10.9); c = 80.2 (8); d = 87.1 (5.9)	83.27 %
Lvl 3 Eng. Presentation	a = 75.1 (20.5)	75.1 %
Lvl 4 Eng. Presentation	a = 74.1 (9.7)	74.1 %
Lvl 2 Eng. Debate	a = 84.6 (10.9); b = 83.0 (18.4)	83.8 %
Lvl 3 Eng. Debate	a = 83.1 (7.9); b = 75.0 (9.2); c = 87.1 (7.5)	81.73%

In comparing the results from Table 1 and Table 2, there are only small differences in the average grades when looking at the groups across the two semesters. The Level 2 English Presentation classes from the mostly face-to-face semester performed better on average than their online peers from a year earlier, with the gap between the average grades of the two groups being 5.115 percentage points in favour of the mostly face-to-face group. The difference between all other class groups is much smaller, and with the exception of Level 3 English Presentation, which had a difference of 1.6 percentage points between its online version and its mostly face-to-face version, the online classes all performed slightly better than their mostly face-to-face peers by an average of 1.59 percentage points.

However, when performing the t-test, it was found that the null hypothesis cannot be rejected, since there was no significant difference in the average grades $t(19) = -1.01567$, $p = .161274$ between the online fall 2020 semester classes ($M = 79.22$, $SD = 5.02$) and the mostly face-to-face fall 2021 classes ($M = 81.37$, $SD = 4.70$).

5. Discussion

While there were slight differences in the average grades between the online fall 2020 and mostly face-to-face fall 2021 classes when grouped according to class type and English level, the t-test reveals that these differences are not significant when all classes are considered. It is therefore reasonable to suggest that the fall 2020 online semester students may not have suffered from cognitive overload during their lessons to the extent that would have been typically expected (Zhang, 2013; Liu, 2011). From this, it is possible to conclude that the measures to reduce cognitive overload for online students during the fall 2020 semester may have been effective. However, more research needs to be done on this. While the results of the t-test indicate that it is not possible to reject the null hypothesis, they do not by themselves validate the null hypothesis or invalidate the alternative hypothesis: that there is a difference in average grades between the online and mostly face-to-face classes.

In looking at the average grades of all online class groupings and comparing them to all face-to-face groupings, only the online Level 2 English Presentation group performed worse to an extent in keeping with what other researchers have found (Kofoed *et al.,* 2021; Bird *et al.,* 2020). The online Level 3 English Presentation class grouping also performed slightly worse than their face-to-face peers, so it could be that the measures meant to reduce cognitive overload for English Presentation classes were less effective than those used for English Debate classes. The Level 4 English Presentation online group did have a slightly better average grade than the same group from the mostly face-to-face semester, so it may not be the case that measures for reducing cognitive overload were less effective for English Presentation students, but the sample size for each of these groups is small, so it is not possible to make any definite conclusions since there was only one class in each these groups.

In contrast to the English Presentation classes, the online English Debate classes performed slightly better on average than their mostly face-to-face peers, so it could be that the measures to reduce cognitive overload for debate students were particularly effective. However, it is possible that other forces influenced student outcomes. Since both groups of students had the same instructor and were graded in the same way, teacher differences or evaluation differences likely did not influence student outcomes from either semester, but there are other possible influences that are not accounted for in this research. For example, student attributes may have resulted in the online fall 2020 semester classes performing better than would have been expected. One such factor includes a greater familiarity with online learning (Wang, 2013; de la Varre *et al.,* 2014). The fall semester is the second semester in Japan, so the students of the fall 2020 semester would have already had one semester online and could have become accustomed to this mode of learning. This would mean that extraneous cognitive overload resulting from the use of technology would have occurred to a lesser extent, so it is possible that students in the fall of 2020 performed well because they had become accustomed to computer-based learning. Students with better motivation and self-regulation strategies are also less impacted by online learning (Kofoed *et al.,*2021;Wang, 2013). It is therefore possible that the fall 2020 students had the necessary experience with technology or personal qualities to excel in an online learning environment despite the associated obstacles, and not because of the specific measures employed to reduce cognitive load. Finally, even though Rikkyo University returned to on-campus instruction in the fall 2021 semester, there were many infection prevention regulations that had to be followed in the classroom. These measures included requiring students to sit further apart than in the pre-COVID era, and limiting the

number of students speaking in a group at once. It is possible that these rules hindered group activity and learning, thereby negatively impacting the grades of the face-to-face students such that they were more similar to their online predecessors.

To better understand whether the employed strategies for reducing cognitive overload were effective, further study is required. It would have been useful to have students complete a survey at the end of 2020, asking them to self-assess their familiarity with computer-based learning and motivation. Employing a student self-reporting measurement instrument of the mental effort used in a task, similar to what Paas (1992) developed, would also be useful in determining whether students experienced low levels of cognitive load as a result of these strategies. Finally, an experiment in which one online learning group is taught using these strategies for reducing cognitive overload and another online group is not would make comparing average class grades more meaningful, as the learning environments of the two classes would be more similar. Unfortunately, due to the limitations of this study, such methods were beyond its scope, but they certainly create interesting avenues for future research.

6. Conclusion

It should be noted that none of the strategies for reducing cognitive load that were adopted for the online Fall 2020 classes are restricted to web-based learning environments or classes which employ technology. Similar strategies were employed in face-to-face classes in the fall of 2021 to some extent. For example, collaborative activities were used in face-to-face English Debate classes simply because of the team oriented nature of debating, and students were permitted the use of their L1 in both English Presentation and English Debate classes for certain activities, but to a lesser extent than when classes were entirely online a year earlier. Of course, it is also possible to employ these strategies for other language courses, and even more content oriented classes can benefit from collaborative activities and pre-task activities to reduce cognitive load. Moreover, there are other strategies for reducing cognitive overload, some specific to the use of technology and online learning environments, and teachers wanting to maximise student outcomes should consider how best to minimise extraneous cognitive load so that students can focus on learning. Ultimately, it is important to be mindful of what the course objectives are, and take steps to improve germane cognitive load, while allowing students to manage intrinsic cognitive load as much as possible, as doing so will lead to the best possible learning outcomes.

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